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Emergency health care in a Nepali hospital: patient characteristics and mortality after emergency care

Findings from a local emergency registry and implications for strengthening emergency health care systems in low-resource settings

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Norwegian University of Science and Technology
Thesis for the Degree of
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Trondheim, March 2020

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SAMMENDRAG

Øyeblikkelig hjelp- pasienter ved et akutt-mottak i Nepal: Helseproblemer ved ankomst og dødelighet etter akuttbehandling.

Akutte sykdommer bidrar til en betydelig sykdomsbyrde og dødsfall. I 2015 skyldtes 28,3 millioner dødsfall akuttmedisinske tilstander, og belastningen av slike tilstander i lavinntektsland (LICs) er 4,4 ganger større enn i høyinntektsland (HICs). Imidlertid er helsevesenet i mange LICs lik som Nepal, underutviklet i forhold til akuttmedisinsk beredskap og behandling. Kunnskap om utbredelse av akuttmedisinske tilstander er avgjørende for å konsolidere og styrke akuttilbudet i helsetjenesten. Dette til tross, vet vi for lite om omfang og alvorlighet av akuttmedisinske behov i de fleste lavinntektsland, inkludert Nepal.

Prosjektet hadde som mål å beskrive utbredelse av ulike tilstander hos akuttpasienter som kom til akuttmottaket ved Dhulikhel sykehus i Nepal. I tillegg hadde vi som mål å evaluere dødeligheten og risikofaktorer for død 90 dager etter at pasienten oppsøkte akuttmottaket.

Vi etablerte et elektronisk akuttpasientregistreringssystem og introduserte et triagesystem til akuttmottaket ved sykehuset i Nepal. Pasienter som søkte akuttmottaket fra september 2013 til desember 2016 og registrert i akuttpasientregisteret ble beskrevet i studien. Vi ringte opp pasient eller familiemedlem etter 90 dager og gjennomførte et strukturert telefonintervju.

I den første artikkelen beskrev vi belastningen av akuttpasienter ved Dhulikel sykehuset under jordskjelvene i april 2015 i Nepal. Vi observerte en høy pasienttilstrømming de første dagene, og spesielt var tilstrømningen høy før de internasjonale feltsykehusene ble opprettet. Andelene pasienter som var alvorlig skadde og som døde var relativt lave, noe som indikerer at de alvorlig skadde pasientene sannsynligvis ikke nådde sykehuset. Det ble brukt et forenklet triagesystem som hadde blitt innført som en del av prosjektet, og det ble utført rask vurdering av alvorlighet og behandlingsbehov.

I den andre studien beskrev vi kjennetegn og tilstander hos voksne pasienter som søkte akuttmottaket ved Dhulikhel sykehus, og vi vurderte dødeligheten 90 dager etter akuttbehandlingen. Vi observerte at nesten en tredjedel av pasientene kom grunnet skader, og at flertallet av disse var unge menn. Dødeligheten innen 90 dager etter utskrivelse fra akuttmottaket var mer enn 20 ganger dødeligheten under akuttbehandling. Nesten en av fire pasienter med luftveis- og hjerte-plager døde i løpet av 90 dager etter behandling i akuttmottaket. Den høyeste dødeligheten var hos personer med kronisk lungesykdom.

Analfabetisme og eksponering for både tobakksrøyk og røyk fra åpen ildsted til matlaging var relatert til økt dødelighet, spesielt hos kvinner.

Den tredje studien beskriver tilstander, fordeling av triagekategorier og dødelighet 90 dager etter akuttbehandling hos barn (≤16 år) ved akuttmottaket ved Dhulikhel sykehus. De fleste akutte barnepasienter hadde skader eller infeksjoner. Det var færre jenter enn gutter av de behandlingsøkende barna, men dødeligheten etter behandling var spesielt høy blant jenter og spedbarn. Røde og oransje triagekategorier var sterkt assosiert med intensivbehandling og dødelighet etter akuttbehandling.

Denne studien ble utført på et nepalesisk sykehus, og etter vår kunnskap er det den første studien som i detalj beskriver akuttpasienter, tilstander og alvorlighetsgraden innen et stort antall pasienter som søker akuttbehandling i Nepal. Funnene fra denne studien belyser behovet for å styrke det lokale helsevesen for å sikre at de er i stand til å håndtere naturkatastrofer som jordskjelv, samtidig som helsesystemene kan opprettholde tilstrekkelig medisinsk akuttbehandling og oppfølging etter slik behandling. Den høye andelen skadde pasienter i en relativt ung befolkning understreker behovet for å prioritere skadeforebyggende programmer på nasjonalt nivå og å styrke organiserte traumetjenester i helsetjenestene. Våre funn som tyder på høy dødelighet etter akuttbehandling er nye og indikerer et presserende behov for flere oppfølgingsstudier i lignende omgivelser. Den lokale erfaringen fra dette akuttmottaket på et nepalesisk sykehus kan støtte at det er nyttig og gjennomførbart å bruke triagesystemer. Vi konkluderer også med at det er behov for å etablere et helsesystem som kan følge opp pasientene etter utskrivning fra sykehus og at det er behov for tiltak som kan redusere dødeligheten etter akuttbehandling. Funnene fra dette prosjektet kan komme til nytte for å planlegge utprøving av kostnadseffektive tiltak under og etter akuttmedisinsk behandling og understreker et behov for investeringer for å styrke akuttmedisin i lavinntektsland som Nepal.

Navn kandidat:	Samita Giri
Institutt:	Institutt for sirkulasjon og bildediagnostikk
Hovedveileder:	Associate Professor Kari Risnes
Biveiledere:	Professor Erik Solligård
	Professor Rajendra Koju

SUMMARY

Health care needs and mortality after emergency care among patients seeking emergency care in a Nepalese hospital

Emergency diseases or conditions contribute to substantial disease burden, disabilities and deaths. Globally in 2015, 28.3 million deaths were due to emergency medical diseases, and the burden in low-income countries (LICs) is 4.4 times that of high-income countries (HICs). However, emergency health care systems in many LICs, and in Nepal, are underdeveloped. Knowledge of emergency patient characteristics is essential to consolidating and strengthening emergency health care systems. Despite this necessity, few reports have provided high-quality data regarding the emergency population in Nepal.

This project aimed to describe the characteristics of emergency patients presented to Dhulikhel Hospital (DH) in Nepal. In addition, we aimed to evaluate mortality at 90 days after emergency care and associated mortality risk factors.

We established an electronic emergency patient registry system and introduced a triage system to the emergency department (ED) of DH. Patients seeking emergency care from September 2013 to December 2016 and registered into the emergency patient registry were included in the study. Patient households were followed up at 90 days after emergency care to assess mortality after emergency care by structured telephone interviews.

In the first study, we assessed the burden of emergency patients to DH during the 2015 earthquakes in Nepal. We observed a high caseload in the first few days, and the patient burden was particularly high before the international field hospitals were established. The proportions of severely injured patients and hospital mortality were relatively low, indicating that the most severely injured patients probably did not reach the hospital. The implementation of the simplified triage system was used for patient management and timely treatment according to severity.

In the second study, we described characteristics of adult patients seeking emergency care at DH and assessed mortality at 90 days after emergency care. We observed that nearly one-third of the patients presented with injuries and that the majority of these were young men. Mortality after emergency care was more than 20-fold the ED mortality. Nearly one in four patients with respiratory and cardiovascular complaints died within 90 days after emergency care. The highest mortality was in individuals with chronic lung disease. Illiteracy and exposure to both

tobacco smoke and traditional cooking stoves were strong determinants for mortality after emergency care in women but not in men.

The third study describes patient characteristics, distribution of triage categories and mortality at 90 days after emergency care in children (≤16 years) at DH. The majority of paediatric emergencies were injuries and infections. Emergency health care-seeking among girls was less frequent compared to boys, but mortality after emergency care was higher among girls and among infants. Red and orange triage categories were strongly associated with intensive care treatment and mortality after emergency care.

This study was performed in a Nepalese hospital, and, to our knowledge, it is the first study to describe in detail the characteristics and severity of a large number of patients seeking emergency care in Nepal. The findings from this study highlight the need to strengthen local health care systems to ensure that they are capable of managing natural disasters such as earthquakes while also maintaining adequate regular medical care. The high proportions of injured patients in a relatively young population underline a need to prioritize injury prevention programmes at national levels and to strengthen organized trauma services in health care facilities. Our findings on mortality after emergency care are new and indicate an urgent need for more follow-up studies in similar settings. The local experience may support the use of triage systems, the need to establish follow-up systems after hospital discharge and the need for interventions that can reduce mortality after emergency care. The information provided by the current project may be used to develop cost-effective interventions, better resource allocation, infrastructure development, training needs, and inferences for policymakers to standardize ED and underlines a need for investments in strengthening the health care system.

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This PhD project started since 2013 with an initiation of a quality improvement project at emergency department (ED) of DH in Nepal. Since the initiation, I started working as a project manager in this project. Later in 2015, this project resulted to a PhD project. Thankyou Dr. Sangina Ranjitkar for connecting me to this project. I would like to thank my local supervisor Prof. Dr. Rajendra Koju for believing on me and being supportive in carrying this project in DH. Thankyou Prof. Dr. Ram Kantha Makaju Shrestha for providing a platform to work.

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Table of Contents

ABSTRACT

Background: Functional emergency health care systems are essential for good health care around the world. Emergency departments (EDs) provide an entry point to health care for many patients with diverse diseases and emergency conditions, such as injuries, maternal health, and communicable and non-communicable diseases. In many low- and middle-income countries (LMICs) such as Nepal, emergency care takes low priority, and emergency systems are underdeveloped. Mounting evidence suggests that quality emergency care has the potential to address a significant proportion of the global burden of disease and, in turn, reduce mortality. Despite the compelling need to strengthen emergency care, data from this part of the health care system in LMICs are insufficient, specifically data from South Asia.

Aims: The primary aim of this PhD thesis was to study emergency patient characteristics by presenting complaints (PCs) at the ED of Dhulikhel Hospital (DH) in Nepal. The secondary aim was to assess mortality at 90 days after emergency care and explore associated factors.

Method: An emergency patient registry was established, and a triage system introduced in the ED of DH. The studies included in this thesis are based on these registries and describe approximately 30,000 emergency patients presenting to the ED during the study period (September 2013 to December 2016). Mortality information was based on structured telephone interviews with the patients' households and was assessed 90 days after initial presentation for emergency care at the ED.

Results: In *Paper I*, we describe the burden of emergency patients to a local hospital during the 2015 earthquakes in Nepal. We observed a high caseload of patients in the first few days, and the patient burden was particularly high before the international field hospitals could be established. The majority of injuries were fractures in lower extremities. The proportions of severely injured and hospital mortality were relatively low, indicating that the severely injured patients probably did not reach the hospital. We concluded that there is a need to develop consistent and robust local health care services capable of managing natural disasters such as earthquakes while also maintaining adequate medical care for other patients.

The aim of *Paper II* was to describe adult emergency patients' characteristics by PCs and to assess mortality at 90 days after emergency care. We observed that nearly one-third of the adult population presented with injuries and that the majority were young men. Mortality after emergency care was more than 20-fold (8%) higher than the mortality in the ED (0.3%). Patients presenting with respiratory and cardiovascular complaints at the ED had high mortality

after emergency care, at 25% and 23%, respectively. The highest mortality was in individuals with known chronic lung disease: in this group, 32% had died by 90 days after emergency care, regardless of PCs. The study findings suggest a need to establish a follow-up system after hospital discharge, especially among patients with chronic diseases and to conduct further post-discharge studies in similar settings.

Paper III aimed to describe characteristics of the paediatric (≤16 years) emergency population. We assessed PC distribution and indicators of severity, including triage categories, and explored associations with mortality after emergency care. We observed a high number of children with infections and injuries at ED presentation. The majority of the children seeking emergency care were boys (63%), but mortality after emergency care was higher among girls than boys. The more severe triage categories (red and orange) were strong indicators for the need for intensive care and for mortality follow-up after emergency care. The study supports the use of triage systems and the need for interventions that can reduce mortality after emergency care in the paediatric population.

Conclusion and future perspectives: This thesis provides comprehensive information on emergency patient distribution, severity and mortality after emergency care in a local hospital in Nepal, including a description of the patient load during earthquakes. The findings related to high mortality after emergency care are novel and alarming. The information provided by the studies is transferable to places facing similar challenges and can guide the development and reorganization of emergency health care services in such settings. Our findings should stimulate the development of cost-effective interventions to assure appropriate health care after emergency care. We emphasize strengthening emergency health care system in low-income countries such as Nepal that could substantially reduce many preventable premature mortality and disability.

Our study results suggest the need to strengthen the consistency of local health care systems in delivering health care during disasters such as earthquakes, and disaster preparedness and response at the local level are urgent. Our experience from this work suggests that developing cost-effective interventions, electronic patient registry and triage system is both possible and vital in patient management and quality care. Systems for patient follow-up after hospital discharge and interventions that can reduce mortality after emergency care are highly recommended. Similar studies that test factors associated with mortality after emergency care are warranted.

LIST OF PAPERS

Paper I

Samita Giri, Kari Risnes, Oddvar Uleberg, Tormod Rogne, Sanu Krishna Shrestha, Øystein Petter Nygaard, Rajendra Koju, Erik Solligård

Impact of 2015 Earthquakes on a local hospital in Nepal: A Prospective Hospital-based Study

PLoS One. 2018; 13(2): e0192076. doi: 10.1371/journal.pone.0192076

Paper II

Samita Giri, Tormod Rogne, Oddvar Uleberg, Eva Skovlund, Sanu Krishna Shrestha, Rajendra Koju, Jan Kristian Damås, Erik Solligård, Kari R Risnes

Presenting complaints and mortality in a cohort of 22,000 adult emergency patients at a local hospital in Nepal

Journal of Global Health. 2019; 9(2): 020403. doi: 10.7189/jogh.09.020403

Paper III

Samita Giri, Tine Halvas-Svendsen, Tormod Rogne, Sanu Krishna Shrestha, Henrik Døllner, Erik Solligård, Kari Risnes

Paediatric patients in a local Nepali emergency department: Presenting complaints, triage and post-discharge mortality

Frontiers in Pediatrics. (Is under revision)

ABBREVIATIONS

AIS	Abbreviated injury scale
CDs	Communicable diseases
CIs	Confidence intervals
COPD	Chronic obstructive pulmonary disease
CRF	Case Registration Form
CVD	Cardiovascular disease
DALYs	Disability-adjusted life years
DH	Dhulikhel Hospital
ED	Emergency department
ESS	Emergency symptoms and signs
HICs	High-income countries
HIV/AIDS	Human immunodeficiency virus and acquired immune deficiency syndrome
ICPC	International Classification of Primary Care
ICU	Intensive care unit
IQR	Inter-quartile range
LICs	Low-income countries
LMICs	Low- and middle-income countries
NCDs	Non-communicable diseases
NGOs	Non-government organizations
OBGYN	Obstetrics and gynaecology
OPDs	Outpatient departments
ORs	Odds ratios
OT	Operation theatre

PC	Presenting complaints
RETTS	Rapid Emergency Triage and Treatment System
SDG	Sustainable Development Goal
WHO	World Health Organization
WONCA	World Organization of Family Doctors
YLL	Years of life lost

1. INTRODUCTION

1.1 Emergency health care system

Emergency health care systems serve as an important functional element within all health systems, providing an entry point to health care [1]. Diverse conditions such as communicable diseases (CDs), non-communicable diseases (NCDs), injuries, and obstetric cases are served through emergency care [2-4]. Emergency health care provides first diagnostic and treatment for all emergency conditions, treatment of exacerbations and preventative care with regard to injuries and disease progression. However, myths about the emergency care system exist, equating emergency care to ambulances or transport while neglecting the role of the care provided in the community and in the health care facility [5].

Previously, emergency health care has been perceived as an expensive health service compared to primary care service [2,5]. Nonetheless, recent research has now argued that emergency care is cost-efficient and is sustainable in building resilient and functional health systems [1,2,6]. A systematic emergency care system, attained through the implementation of an acuity-based triage system, early recognition and resuscitation, simple patient management and timely referral, has been shown to decrease morbidity and mortality [7].

Emergency health care systems as well as the burden of health problems in low-income countries (LICs) are not comparable to those in high-income countries (HICs). A recent study reporting estimates from 40 different countries reported that death rates and disability-adjusted life-years (DALYs) attributable to emergency conditions are three times higher in LICs compared to HICs [8]. However, the Disease Control Priorities project has estimated that almost half of the deaths and over one-third of the disabilities in low- and middle-income countries (LMICs) could be addressed through effective emergency care [3,7]. Unfortunately, emergency health care is less prioritized in many LICs [4], and most emergency health care providers do not have specialized training in emergency care [9].

Many national health systems, especially in LICs, are oriented towards specific diseases rather than strengthening the health systems overall, although strengthening the health care system as a whole has a long-term impact on population health [10-13]. In 2006, Briggs and Garner reported evidence of an increase in service utilization and better health outcomes associated with improvements in the health care system [12]. The disease-specific programmes demonstrated substantial development in health service delivery, particularly in the prevention and treatment of individual diseases such as HIV/AIDS, malaria, under-5 mortality and

vaccine-preventable illness [14]. However, acute care and emergency health services are system-based and broad-based and are, by nature, designed to serve a larger population [6,10]. Investments in strengthening the emergency health care system would likely meet the health needs of broader populations in LICs such as Nepal.

The purpose of this thesis was to describe the characteristics of emergency patients, presenting complaints (PCs), patient severity and mortality after emergency care. This study is the first in Nepal to include a large emergency population and report characteristics and mortality after emergency care. The results of this thesis should have implications for strengthening emergency health care systems.

1.2 Definitions

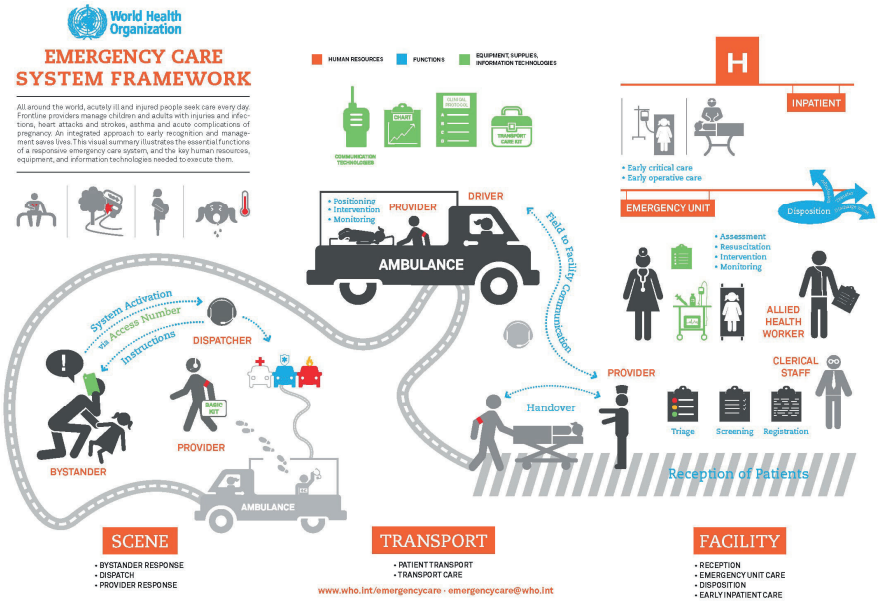
Emergency health care

"*Timely Emergency Care Saves Lives"[15].* An emergency is a time-sensitive situation in which every second and action counts. Emergency health care has been defined by different attributes. Common definitions include "care delivered within minutes or hours and care for conditions that require rapid intervention to avoid death or disability". Rapid intervention emphasizes the patients presenting with conditions such as shock or respiratory failure, for which delays can worsen prognosis [7]. In trauma care, the term "golden hour" is often used to reflect the crucial time immediately after an injury [16]. The health facility providing emergency care should provide rapid treatment for time-critical health problems, irrespective of patient's age, gender, location or condition, thereby providing the greatest chance of survival and reducing further complications [5,17]. However, much emergency care falls outside time-bound definitions, especially in regions where long transport times are the norm [7].

Emergency health care system

The World Health Organization (WHO) has defined a health system as a system that includes "all organizations, institutions and resources with established policies whose primary purpose is to promote, restore and/or maintain health" [18]. An emergency health care system is an integrated mechanism to address time-sensitive conditions [7]. Such a system includes the cooperative and delivery structures required to provide effective and efficient health care services for patients with emergency conditions [10]. WHO has defined a list of essential functions that ranges from pre-hospital care, transportation, and facility-based emergency care units to early operative and critical care, as shown in Figure 1 [7].

Figure 1. Emergency Health Care System Framework (figure used with permission).



Source: WHO, https://www.who.int/emergencycare/en/.

1.3 Emergency health care–historical background

Emergency medical services can be referred to as a starting point of medicine. The history of emergency health care goes back to the story of the Good Samaritan, in which a man who had been beaten was cared for by a passing Samaritan, who helped the wounded man with a bandage, poured oil and wine in his wound, and later transported him with his own donkey [19]. Many of the advances made in emergency health care are likely related to the progress made in military medicine [20]. In the Middle Ages, the Knights Hospitaller were known for assisting wounded soldiers in war zones [19]. The modern emergency health care system started during the Napoleonic Wars when a French surgeon, Dominique Jean Larrey, organized a system to treat and transport injured French soldiers [21]. He introduced the first ambulance, which would pick up the injured from the battlefield and bring them to the army surgeons. The aim was to transport the victims quickly from the battlefield to the nearest hospital and prevent further life-threatening problems. In 1832, a major advance was made by introducing a transport system for cholera patients in London.

In 1861, during the battle of Bull Run, there were an overwhelming number of wounded soldiers in the field hospital, where the US surgeons did not even have time to wipe the blood off the saws they used to amputate limbs [20]. The surgeons realized a need for organized systems to manage a large number of wounded and introduced equipped ambulances to serve the army. A triage system was introduced. The first hospital-based ambulance service was in operation in Cincinnati, Ohio, by 1865, followed by other notable services [22]. During World War I, other advances were made, including health care before and during transport, the introduction of traction splints for fractures, and the use of two-way radios for communication [23].

In the early 20th century, ambulances powered by steam, gasoline and electricity were introduced [20]. At the beginning of World War II, a modern ambulance with advanced medical equipment and staffed by physicians was introduced. American historians claim that the world's first civilian pre-hospital care began in 1928 when Julian Stanley Wise started the Roanoke Life Saving and First Aid Crew in Roanoke, Virginia. Canadian historians dispute this claim, asserting instead that such care began in the city of Toronto, with the first formal training for ambulance attendants in 1892.

Since the 1970s, the delivery of emergency care at pre-hospital settings has developed into two models, the Anglo-American model and the Franco-German model, each with distinct features [24]. These two models were evident until the end of the 20th century [24]. The Anglo-American model is based on the "load and go" philosophy, whereas the Franco-German model is based on the "delay and treat" philosophy [25]. The aim of the Anglo-American model is to bring patients to the hospital as quickly as possible, with fewer pre-hospital interventions. In contrast, the purpose of the Franco-German model is to bring a hospital to the patients. No model has yet been proven substantially better than the other, but this lack of distinction is partly due to the heterogeneity of conditions treated and the structural components affecting the use of services.

The paradigm in emergency health care has shifted from ambulance transport to more advanced pre-hospital care in the field and medical care at a health facility. By the middle of 1960, hospitals had grown more modernized and technologically advanced [26]. However, the medical expertise and a system for providing quality emergency care were lacking. Emergency medicine as a specialty is only 50 years old [26]. Until the beginning of specialty training in

the 1970s, the emergency departments (EDs) at the hospitals were generally staffed by general physicians [27]. Staffing an ED 24/7 first occurred in the U.S. in 1961 [27].

The white paper "Modern Society", written by experts for President Kennedy, laid the groundwork for the inclusion of the emergency medical system in legislation [20]. The National Highway Safety Act of 1966 encouraged the development of organized emergency medical service programmes [20]. Later, in 1973, the U.S. Congress passed the Emergency Medical Services Systems Act, which describes 15 essential components of the emergency medical services system [28]. In 1973, the "Star of Life" was adopted as the national emergency medical services symbol, consisting of six points; detection, reporting, response, on-scene care, care in transit, and transfer to definite care; the central staff with a serpent wrapped around it represented medicine and healing [28]. In 1988, the technical assistance programme published a list of elements of good emergency medical services systems: training, communication, trauma systems, and transportation. National standards based on these elements were established that remain important in forming the current concept of an emergency health care system.

1.4 Emergency health care components

Emergencies occur everywhere, every day and at any time, and each emergency requires resources and systems capable of achieving good outcomes. People in need of emergency care may access health care in various settings, regardless of the level of health care services available. Emergency health care has three main components: care in the community, care during transportation, and care on arrival at the health facility [5].

The event of illness or injury begins at home or in the community; thus, early recognition of emergency conditions should also begin both at home and in the community. Pre-hospital care is considered the first stage of the long journey from illness or injury to recovery and health. Early recognition of emergency conditions and early access to health care are crucial to improving outcomes of time-sensitive critical illness. For example, in the case of cardiac arrest, early CPR improves the chance of survival [29]. People requiring emergency care in the community are often helped by non-health professionals (family members, friends, community members) or by primary health care professionals at the site of the event (Figure 1). Thus, it is important to provide simple training and education to community volunteers who help to identify emergency conditions and prevent further complications, which is vital to saving lives. For example, maintaining airways, controlling excessive external bleeding, and immobilizing

fractures are a few such useful skills [5]. In the case of saving the lives of women in labour, reducing delays in accessing health care is essential [30].

Health care during transportation is the second component in emergency care and is equally important. Patients travel by ambulance, by foot or by any kind of transport system available. In general, medical interventions during transport may be difficult to perform. Several factors, such as the unavailability of ambulances or vehicles, ambulances without trained health professional staff, lack of essential medical equipment, difficult and poor roads and unaffordability are common barriers, particularly in resource-poor countries. In Nepal, the majority of the population lives in rural regions where most roads are gravelled or muddy. The mountainous landscape is an additional challenge for emergency transportation of the people living in these regions. However, interventions have shown improvements in patient outcomes. A study from Sierra Leone showed that investment in vehicles and an improved communication system has decreased obstetric mortality by 50% and has doubled the health service utilization rate [31]. In Mexico, the intervention of basic skills training in trauma care for ambulance staff has shown a reduction in deaths by half among patients during transport to the hospital [32].

Emergency care at the first-contact health facility is the third important component in an emergency health care system. The first-contact health facility could be either a primary health care centre or a tertiary-level hospital. The capacity of these health facilities differs widely with respect to available medical equipment, trained medical staff, available medicine and other resources [5]. However, it has been highlighted that every health care system should have some level of capacity to provide emergency health care [5]. Upon arrival at a health care facility, a patient may or may not be received by trained health care providers or a designated emergency area. Moreover, not all patients presenting to a health care facility will have life-threatening or urgent medical conditions that require immediate management [33]. Thus, it has been argued that an urgent preliminary assessment by health care professionals upon the patient's arrival to the health care facility should be established [7]. Evidence has demonstrated that simple, low-cost interventions at health care facilities have shown increased health outcomes, which has been described below in *1.13 Evidence that simple interventions in emergency rooms improve health outcomes*.

1.5 Global health priorities related to emergency care

Emergency health care systems address almost all health-related UN Sustainable Development Goals (SDG) targets, as well as those on disasters and violence. Despite evidence of progress, emergency health care has not been directly mentioned in SDG goals and universal health coverage [34], although it has been recognized that strengthening emergency care and essential surgical care is an important component of SDG universal health coverage targets [7,35]. This recognition was also reflected in the 68th World Health Assembly in 2015 [36]. The SDG have set an ambitious target of reducing mortality from road traffic injuries by 50% by 2020 and premature deaths from NCDs by a third by 2030 [37]. These targets cannot plausibly be reached without strengthening emergency health care systems.

WHO has dedicated itself to achieving universal access to emergency health care for all and has developed different guidelines, protocols, toolkits and surveillance systems to support the development of quality emergency health care [38]. The WHO 5-year work plan (2019-2023) included three main goals related to emergency care: one billion more people will be benefiting from universal health coverage, one billion more people will be protected from health emergencies, and one billion more people will be enjoying better health and well-being [34]. These goals were also endorsed by the 2018 World Health Assembly [34]. Furthermore, WHO has developed an emergency care system framework (Figure 1) with inputs from more than 30 LMICs, with an aim to support the strengthening of emergency health care [7]. The framework provides a visual understanding of essential emergency care system functions along with emergency care guidance tools that provide a shared language that health professionals and policymakers can employ to discuss what emergency health care systems should look like and thus evaluate system improvements [7]. The framework defines a set of key functions of an emergency health care system that facilitates system planning and development activities. It has been argued that the framework and an essential package of emergency care services represent a mechanism to strengthen emergency care globally towards universal health coverage and a range of SDG targets [7,39].

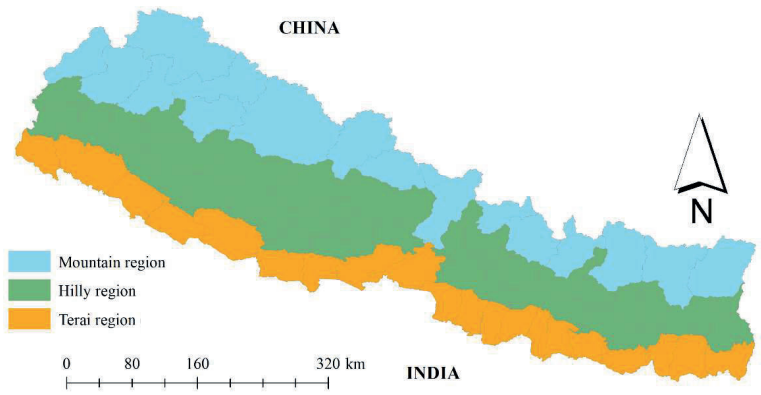
1.6 Nepal, the health care system and challenges

1.6.1 Introduction to Nepal

Nepal is a small, landlocked country in South Asia, bordered by India and China, and has a population of over 29 million [40]. Nepal is one of the least developed countries, with approximately one-quarter of the population living below the poverty line [41]. The country is

multiethnic, multilingual, multireligious and multicultural, with 125 caste and ethnic groups and 123 languages spoken [42]. Approximately 80% of the total population lives in rural regions, and agriculture is the mainstay of the economy for almost 70% of the population [42,43]. Administratively, Nepal is divided into seven provinces, 75 districts, and 744 local levels (metropolitan cities=13, municipalities=246 and village councils=481). Ecologically, the country is divided into three regions: the Terai (plains and tropical region) (1,000 m) to the south, the central hills (subtropical and temperate region) (1,000-3,000 m), and the Himalaya (subalpine and alpine region) (>3,000 m) to the north (Figure 2) [43,44]. Most of the population lives in the Terai region (50%), followed by the hills (43%) and the mountains (7%) [42].

Figure 2. Map of Nepal by geographical region (map used with permission) [45].



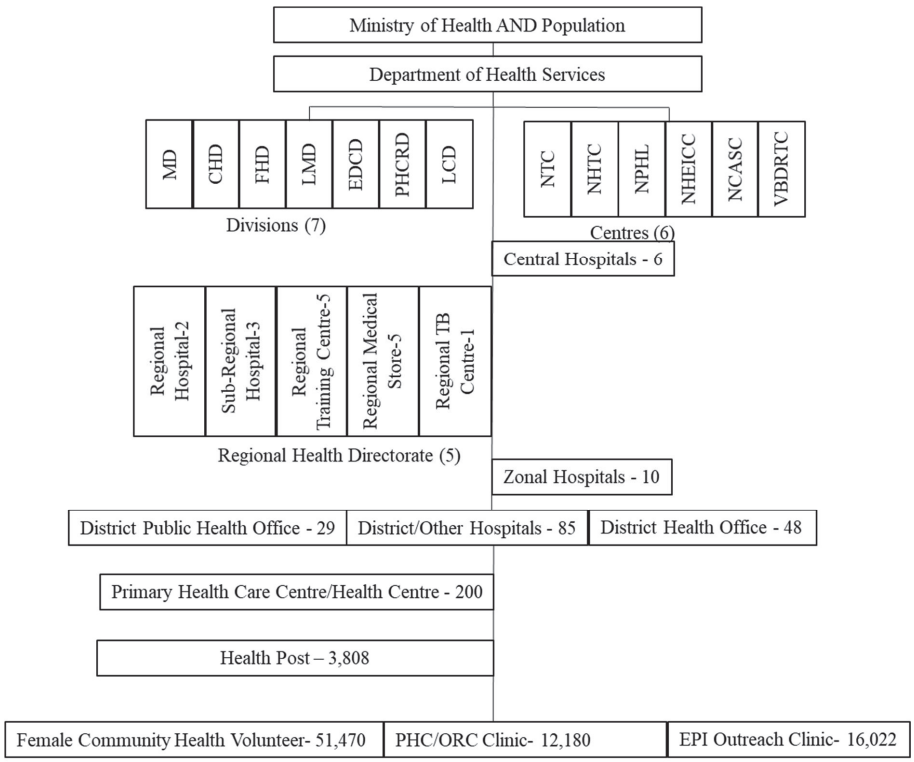
1.6.2 Health care practice and delivery in Nepal

Both traditional and modern health services are practiced in Nepal. Nepalese people still generally prefer to pursue traditional treatments (19% to 51%) before choosing modern health services [46,47]. In Nepal, traditional medicine is practiced based on the local culture and traditions from traditional healers [48]. Modern health services in Nepal are delivered through three providers: public institutions, private institutions and non-governmental organizations (NGOs) [49].

The public health system is governed by the Ministry of Health, as shown in Figure 3 [50]. The Department of Health Services is responsible for delivering preventive, promotive and curative health services. Nepal has a total of 764 hospitals, including both public (123) and private hospitals (641), these numbers are not updated in the organogram as presented in Figure 3 [50,51]. The main governmental health institutions that delivered health services in 2017 were 123 hospitals, 200 primary health centres, 3,808 health posts, and 12,180 primary health care outreach clinics [50]. Private health care services are provided by private hospitals, nursing homes, private medical colleges, polyclinics and private pharmacies [41]. A recent study reported that among users of modern health facilities, almost two-third use private pharmacies, which are generally operated by pharmacists [47]. Patients using private pharmacies often request medicines by themselves based on their symptoms, or the pharmacists prescribe medicines instead of seeking health institutions for proper diagnosis. NGOs provide health services through community hospitals, mission hospitals, and NGO clinics.

The Government of Nepal implemented a Free Health Care Policy in 2006 that provided access to essential health care through public health facilities up to the district-level hospitals [52]. However, a study in 2017 reported a lack of availability of essential medicines in public health facilities ranging from 16%-57%, depending on the geographical region [53]. Additionally, the government expanded the basic health package and provided incentives for the utilization of health services such as antenatal care and institutional delivery, treatment for tuberculosis, etc. [52]. The government established *Bipanna Nagarik Kosh* (medical treatment of deprived citizens) in 2012, which provides financial subsidies for underprivileged citizens that cover treatments for 12 diseases in empanelled hospitals [52]. These funds include subsidized treatments for kidney dialysis and transplants, cancers, head and spinal injuries, and others [54]. Likewise, the government began a long-term health insurance programme in 2013 that covers health care services beyond the basic package, which as of 2018 has scaled up in 25 of the 75 districts in the country [52,55].

Figure 3. Organogram of Department of Health Services.



MD=Management Division. CHD=Child Health Division. FHD=Family Health Division. LMD=Logistic Management Division. EDCD=Epidemiology and Disease Control Division. PHCRD=Primary Health Care Revitalization Division. LCD=Leprosy Control Division. NTC=National Tuberculosis Centre. NHTC=National Health Training Centre. NPHL=National Public health Laboratory. NHEICC=National Health Education Information and Communication Centre. NCASC=National Centre for AIDS and STD Control. VBDRTC=Vector Borne Disease & Training Centre. PHC/ORC=Primary Health Care Outreach Clinic. EPI=Expanded Programme of Immunization

1.6.3 Health financing in Nepal

Health care financing plays an important role in transforming the existing health care system into one that provides efficient and effective health care to the poor and vulnerable people living in Nepal. The Government of Nepal has consistently increased the budget for the health sector, from 5.9% in 2004/05 to 7.2% in 2007/08 [56]. However, in 2017/18, less than 5% of the total national budget was allocated to the health sector [50]. Out-of-pocket/household expenditure is the largest source of health funding in Nepal, accounting for approximately 62% of total health expenditure [43].

1.6.4 Health indicators in Nepal

Nepal has made impressive progress in achieving improved health outcomes in the last few years. Life expectancy has increased from 55 years in 1991 to an estimated 71 years in 2018 [40,42]. Progress in reducing maternal and childhood deaths has been praised internationally. Maternal mortality decreased from 539 to 239 maternal deaths per 100,000 live births between 1996 and 2016 but still remains the highest rate in South Asia [43,57]. Likewise, from 1996 to 2016, neonatal mortality fell from 50 to 21 deaths per 1,000 live births, infant mortality from 78 to 32 deaths per 1,000 live births and under-5 mortality from 118 to 39 deaths per 1,000 live births [43,57]. However, there remain urban-rural and rich-poor inequalities. Children born in rural regions are more likely to die before their fifth birthday compared to those born in urban regions, and children in poor families are twice as likely to die before reaching one and five years than those born in rich families [52]. Individuals in the greatest need of health care, especially in rural regions, are unable to receive health care due to inaccessibility to health care, inadequate drug supplies, expensive health care, unavailability of health professionals or ineffectively deployed services.

1.6.5 Challenges and disparities in health care in Nepal

In the past two decades, there has been incremental progress in the establishment of health care facilities in Nepal [43]. However, the distribution of health institutions, institutional capacity, human resources, and health outcomes are not comparable between rural and urban regions [58]. The country's difficult geographical terrain makes rural life even more challenging, often resulting in scant access to quality health care for people living in these regions. Distance alone is one of the major hindrances in accessing health care. Only 49% of the households in Nepal are within 30 minutes of a government health facility [57]. For most households in rural areas, at least 1-4 hours of travel is required to reach the nearest health institution, and it has been reported that less than one-third of households had easy access to a public health facility [59,60]. Accessibility is affected by rurality, mountainous regions and household economy [57]. The nearest health institutions to rural households are mostly primary health care centres or health posts, as shown in Figure 3, and the health services in these institutions are provided mostly by paramedics. One report showed that more than one-third of Nepalese women bypassed their nearest health facility in favour of well-equipped hospitals [61]. The unavailability of human resources in health facilities and unequal distribution of medical commodities are major challenges in Nepal. There are seven doctors, nurses and midwives per 10,000 population in Nepal, compared with the WHO threshold of 23 per 10,000 population

[62]. This shortage in the skilled health workforce is particularly prevalent in rural Nepal. Although most doctors are employed by the public sector, 90% of doctors are involved in private practice [43]. Moreover, the high turnover of health workers and system reorientation pose challenges to health care system development in LICs such as Nepal. These difficulties reflect an obvious and neglected gap in Nepal's health care system, which lacks systems that consider the population's needs when providing quality health care.

The number of private hospitals has exponentially increased in Nepal, from 16 in 1990 to 641 in 2016 [51,63], which has increased the use of private health facilities and transferred an enormous financial burden for health care onto individuals [49]. However, most specialized private health facilities are based in urban areas, and almost 47% are located in Kathmandu alone (the capital city) [43]. The poor and disadvantaged groups are less able to access health services from private health facilities and are dependent on the public institutions, which are inadequately resourced to fulfil their demand [43].

In 2015, Nepal underwent a political transition from the unitary system to a federal system with new roles and responsibilities. The transition from five development regions to seven provinces is in progress, and the previous health system model has not yet been fully replaced. The new federal structure offers the opportunity as well as challenges to improve the health care of the Nepalese people [52]. The decision level has been dispersed to provincial and local governments so that local health needs can be addressed. However, the increased complexity, particularly in the face of Nepal's political scenario and its players, could be a challenge [56]. The main challenges during the transition phase are likely to be the interruption of medical supplies and services because of the lower priority of health care [64]. Furthermore, the number of sanctioned posts has been reduced at the provincial level, and there is a critical need for appropriate health service structures and reallocation of skilled staff [64].

1.7 Emergency health care system and challenges

1.7.1 Emergency health care delivery in HICs

Emergency health care systems in HICs have continuously improved with decades of advances in clinical science and care delivery [65-68]. However, the organization of emergency health care varies considerably between countries and is incomparable between low-income and high-income countries. Differences within HICs can be illustrated by the United States and Norway: In the US, emergency health care is provided to an unselected population, and studies have recently reported that EDs deliver nearly half of US medical care [69,70]. A study reported that

patients with low socioeconomic status are twice as likely compared to those with high socioeconomic status to use emergency health care in the US because they perceive emergency care as less expensive, more accessible and of higher quality [71,72]. In Norway, EDs are not considered to provide primary health care services or outpatient treatments [73]. Norway has a well-organized primary health care system in which every resident is registered to a general practitioner, who is considered a gatekeeper by the Norwegian Health Care System [73]. The majority of patients admitted to Norwegian EDs have been seen by a primary care physician in advance or are admitted by emergency medical services.

1.7.2 Emergency health care delivery in LICs and in Nepal

Emergency health care in South Asian LICs is poorly developed [74]. Emergency health facilities in these settings provide health care to an unselected population of all ages, particularly a large number of young patients, for whom an immediate high level of care could be the difference between life and death [9].

The emergency health care system in Nepal is under-resourced and underdeveloped [51,75]. Emergency health care and emergency medicine in Nepal has undergone remarkable growth in the last few decades; nonetheless, it has been suggested that the system still requires further development in terms of training, education and specialization [51]. In Nepal, the unselected population are provided with emergency health care by EDs at the hospitals and by primary health care facilities at the local level [50]. As in other LICs, the population can directly access emergency care at the hospital, and primary care physicians at EDs are often the first contact point and the main health care providers. There is only one children's hospital run by the government in Nepal, located in the capital city. In the hospital ED, often the ED physician (or a paediatrician) attends the child on request [51].

All hospitals in Nepal are administered under the Ministry of Health, but no national emergency and/or trauma management guidelines exist [51,53]. The existing emergency practice models vary among institutions. Most emergency care in hospital EDs is performed by house medical officers, who are new graduates with five years of medical training, and most primary health care centres in the country are run by paramedics, who have three years of general medical training with no specialized emergency medicine training [51]. Although primary health care facilities are responsible mainly for delivering primary health care [76], urgent and emergency care are often provided in these settings [1]. A recent review study emphasized the need to integrate emergency health care with primary health care, especially in LICs, and to provide

emergency care training to primary health care providers [77]. Moreover, health facilities in Nepal do not have a coordinated system for referring patients from primary health care (often the first contact point in rural regions) to tertiary health care facilities and sharing medical information among facilities.

Undeveloped pre-hospital care, a lack of trauma centres and poorly organized emergency health care delivery are some of the major obstacles to timely response and good patient outcomes in low-resource settings [74]. Many emergencies, especially in countries such as Nepal, occur where travel times are longer, and referrals take several days [78]. Moreover, Nepalese people often do not seek care until a disease is in its later stages because of inaccessible and unaffordable health services [79]. Pre-hospital health care is significantly lacking in Nepal. Previous evidence from LICs has shown that investments in pre-hospital care resulted in increased health outcomes [31,32]. Patients at EDs in these countries are generally transported in private cars or by any other readily available transport system. A study in Bangladesh reported that less than 1% of the population used ambulances [80]. Other studies from Pakistan and Bangladesh reported that the average ambulance response time is more than 60 minutes [80,81]. A Nepalese hospital in 2007 reported that only 10% of its patients used ambulances [82]. These ambulances are often simple cars, possibly with a stretcher and oxygen, that do not have trained emergency medical professionals, essential medical supplies or emergency equipment and no systematic communication with the hospital to which the patient will be transported [83,84]. Patients transported by these ambulances to hospitals are accompanied by the patient's family members or friends, who choose a health facility based on feasibility rather than the patient's need for required facilities or specialized hospitals. In 2011, a National Ambulance Service with 5 well-equipped ambulances and trained emergency medical technicians was started in the capital city of Kathmandu [51]. In recent years, the number of proper ambulances with trained staff has increased, but these are mostly concentrated in the capital city. Recently, a few private hospitals in the capital city have started an air ambulance service, but it is very expensive. Nepal has also seen the streamlining of trauma management in Kathmandu, which began in 1997 with a plan to establish a National Trauma Centre in the capital city that was supposed to be first of its kind in South Asia. The trauma centre has been providing health services for trauma patients since 2015 [51].

As in other LICs [9,85], EDs in Nepal are generally overcrowded, with a very high number of severely ill patients seeking emergency care [51]. Upon the patient's arrival at the hospital, most EDs often do not have a systematic triage system, a lack that could lead to overlooking

those patients in need of immediate treatment. An observational study conducted in a Nepalese hospital located in Kathmandu reported a lack of lifesaving medications and basic supplies such as intravenous pumps [53]. In addition, the family members play a vital role in the care of patients at the hospital and are often responsible for purchasing medicines and devices from the pharmacy, as well as for delivering and collecting reports for blood tests and other diagnostic tests (X-rays, CT scans). This delegation of responsibility often leads to delayed treatment and a significant chance of infection and error. Furthermore, the majority of the documentation is paper-based, which leads to poor patient care, often creating gaps in patient treatment with minimal and inaccurate past history.

1.8 Burden attributed to emergency diseases and conditions

1.8.1 Emergency diseases and conditions: focus on LICs

Patients seeking emergency care include patients with acute trauma, surgical diseases, acute infectious illness, and exacerbations of chronic diseases, as well as routine medical needs that do not require immediate attention [6]. Globally, there were 28.3 million deaths in 2015 due to emergency diseases or conditions [86]. The mortality rate has increased by 6% from 1990 to 2015 and is more significant in LICs (12%) compared to HICs (1%) [86]. Recent reports have stated that 51%-90% of global causes of death and 42%-84% of global causes of DALYs are responsive to emergency care [8,86]. The emergency disease burden in LICs is 4.4 (in DALYs) and 5.1 (in YLLs) times higher than that of HICs (282.41 DALYs vs 64.69 DALYs per 1000 and 267.68 vs YLLs vs 52.46 YLLs per 1000) [86]. Table 1 further presents the emergency disease mortality rate and emergency disease burden in terms of DALYs and YLLs by World Bank income groups and WHO regions [86]. As expected, the ten leading causes of deaths in LMICs are mostly attributable to emergency conditions [87].

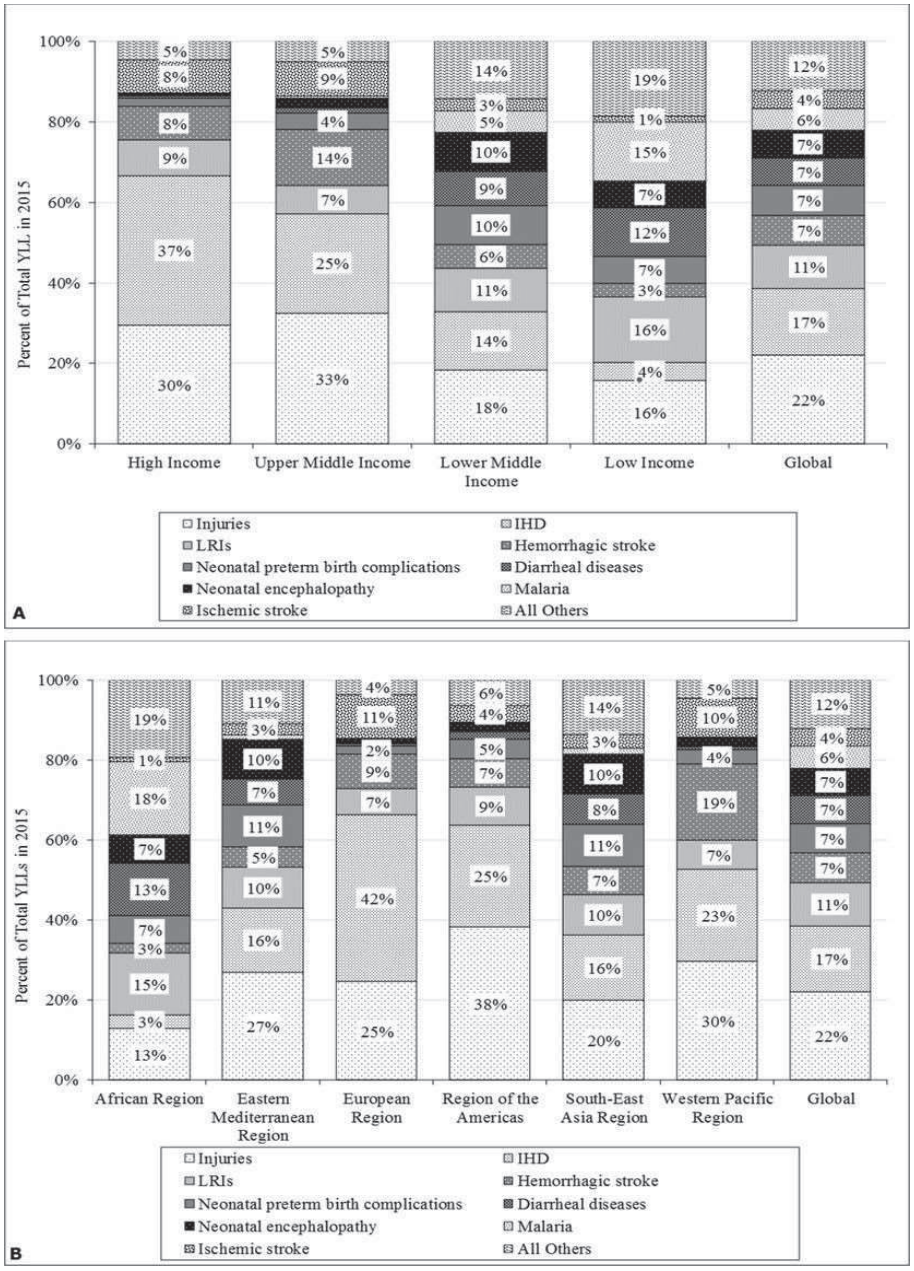
Table 1. Emergency medical diseases versus non-emergency medical diseases by mortality rate, DALYs and YLLs per 1000 by World Bank income groups and WHO regions (analysis of 2015 Global Burden of Disease) (table used with permission).

Geographical region	**Mortality rate**		**DALYs**		**YLLs**	
	EMDs	Non-EMDs	EMDs	Non-EMDs	EMDs	Non-EMDs
Global	3.86	3.71	140.35	194.05	128.58	98.37
WB income groups						
High-income	3.52	5.26	64.69	190.20	52.46	81.31
Upper middle income	3.52	3.56	96.10	177.94	86.46	84.26
Lower middle income	4.09	3.21	179.95	196.63	167.17	102.37
Low income	4.78	3.64	282.41	254.21	267.68	169.48
WHO regions						
Eastern Mediterranean region	4.52	3.63	180.90	172.56	166.42	83.52
African region	5.09	5.04	275.59	260.29	261.82	173.27
European region	2.88	3.97	101.46	199.18	87.69	91.35
Regions of the Americas	3.99	3.45	79.40	181.60	69.65	79.77
Southeast Asian region	3.31	3.67	163.35	196.10	150.84	98.49
Western Pacific region	3.31	3.64	83.35	168.26	74.27	77.10

DALYs=disability-adjusted life years. EMDs=emergency medical diseases. WB=World Bank. YLLs=years of life lost. Non-EMDs=non-emergency medical diseases.

A systematic review of emergency care in 59 LMICs reported an increased patient load and increased hospital mortality and that a large number of patients seeking emergency health care are young and free of chronic conditions [9], compared to HICs, which have an increasing burden of chronic diseases in elderly populations [72]. The Global Burden of Disease Study showed that mortality from NCDs increased by 30% and injuries by 24% from 1990 to 2010 [88]. Approximately 60% of all emergency medical diseases globally included injury (22%), heart disease (17%), lower respiratory infection (11%) or haemorrhagic strokes (7%) (Figure 4) [86]. These four diseases contributed to 84% of emergency medical diseases in HICs compared to 39% in LICs [86]. However, other diseases, such as neonatal disease and diarrhoeal disease, together made up a significant proportion of YLLs in African (36%) and Southeast Asian (27%) regions [86]. Globally, injury alone contributes to more than 100 million people seeking medical attention every year, of whom more than five million people die; however, 90% of the injury mortality occurs in LMICs [36,89]. Figure 4 below further shows the distribution of emergency medical diseases across World Bank income groups and WHO geographical regions [86].

Figure 4. Distribution of top ten emergency medical diseases across World Bank income groups (A) and WHO geographical regions (B) (figure used with permission).



WB=World Bank. EMDs=emergency medical diseases. YLLs=years of life lost. IHD=ischemic heart disease. LRI=lower respiratory infection.

Large differences exist within LMICs as well as among Asian and African countries; background characteristics, disease burden, available resources, and health systems are all main contributors to such differences. A recent report reported that deaths from emergency conditions related to NCDs (47%) and CDs (42%) were nearly equal in LICs [8]. However, Southeast Asia had higher proportions of deaths due to NCDs (61%), followed by CDs (27%) and trauma (12%), compared to rates in Africa (40%, 52% and 9%, respectively) [8].

1.8.2 Burden of emergency diseases and conditions: Nepalese context

Information on the burden and characteristics of emergency diseases and conditions in Nepal is lacking. According to the annual report for Nepal 2016/2017, 72% of the total population received outpatient services, and of the total number (n=11,030,646) of patients, 12% were admitted for treatment in hospitals, and 16% received emergency care services from hospitals [50]. According to the respective hospital websites, the EDs at the two largest hospitals in Nepal, BP Koirala Institute of Health Sciences and Tribhuwan University Teaching Hospital, each provide emergency care to over 40,000 patients every year [90,91]. The reports available, however, provide only fragments of the emergency patient picture, particularly when considering diseases.

Communicable and non-communicable diseases

CDs were most prevalent in Nepal until the year 2000 [92]. However, studies have shown that deaths from CDs are decreasing, having fallen to 50% in 2007 from 70% in 2000 [93,94]. CDs such as cholera and acute gastroenteritis have posed constant threats to the health system in all regions of the country [44]. The largest cholera outbreak was in 2009 in Jajarkot, in far-west Nepal, causing more than 500 deaths [95]. Patients with a water-borne disease such as typhoid fever and diarrhoeal disease are high in pre-monsoon and monsoon season and common in communities with poor sanitation [44]. According to the annual report of Nepal 2016/2017, pneumonia was the number one reason for hospital admission (15,033) followed by diarrhoea and gastroenteritis (11,620) and chronic obstructive pulmonary disease (COPD) (9,588) [50].

NCDs in Nepal have increased, especially in urban areas, and Nepal is trapped by the triple burden of disease [44]. NCDs contributed to 66% of all deaths, followed by communicable, maternal, neonatal, and nutritional diseases (25%) and injuries (9%) [96]. The death rate due to communicable, maternal, neonatal, and nutritional diseases dropped rapidly by 78% between 1990 and 2017, while the decline was slow for NCDs and injuries, at 18% and 20%, respectively [97]. A hospital-based prevalence study (including 31 health institutions from

different regions of Nepal) that included admitted patients aged 35 years or older reported that NCDs accounted for 31% of diseases, among which COPD was the most common (43%), followed by cardiovascular disease (40%), diabetes mellitus (12%) and cancer (5%) [98].

Road traffic injuries

Road traffic injury ranks 8th among the leading causes of premature deaths in Nepal [99]. Over 3 million vehicles were registered in Nepal by July 2018, and improvements in road conditions have been made. The number of motor vehicles has increased by five times the rate of the previous decade [100]. Similarly, there has been an increase in road construction of both blacktopped roads and local roads [100]. Local roads are constructed to access rural villages in the mountainous regions and are generally earthen or gravelled. Mortality related to traffic accidents is nearly 34 per 100,000 population [101]. The fatality rate of 17 per 10,000 registered vehicles in Nepal in 2009/10 is one of the highest in the world [102]. One Nepalese hospital reported 1,848 trauma patients in one year, 38% of whom presented with road traffic injuries [103]. Previous studies in Nepal have reported that young men and motorcyclists contribute to the majority of traffic injuries, with men accounting for 71% of traffic injuries, and 50% of them between 21 and 41 years of age [104,105]. A recent student thesis conducted in a Nepalese hospital reported that 33% of the injured patients presenting to the ED had head injuries; one-third of these patients were between 20 and 29 years of age [106]. Substantial resources are consumed by caring for injured patients at hospitals in LMICs, but much less attention is given to education and prevention initiatives [107]. The Nepal Road Safety Action Plan (2013-2020) has called for a multisectoral response to address road safety under the following five pillars: road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash response [108]. The last pillar requires a major response from the health sector.

Self-harm

Self-harm is a complex issue and often creates life-threatening situations when individuals present to the ED. Of the total number of worldwide deaths by suicide, 79% occurred in LMICs [109]. Southeast Asia accounted for 39% of this number with only 26% of the global population [110]. Nepal lacks national data on suicide. In 2012, WHO estimated that Nepal ranked 7th in the world in the deaths by suicide rate, at 25 per 100,000 population [110]. According to the police data in 2015/16, a total of 4,667 suicide deaths were reported, with a crude suicide rate of 16.4/100,000 [111]. A Nepalese study from 2008/09 reported that suicide (16%) rather than maternal-related issues (12%) was the single leading cause of death among women of

reproductive age [112]. The majority of the reported deaths by suicide were due to hanging (72%), followed by poisoning (25%) [111]. A recent study reported that 90% of the poisoning cases at one hospital were attempts to suicide and had used pesticides, of which the most commonly used chemicals were organophosphates (37%) and pyrethroids (36.7%) [113]. The incidence of death by suicide was higher in young adults (111.66/100,000 population), women (77.53/100,000) and those from Dalit ethnic groups (98.22/100,000) [113]. Although the data on mental health is very limited, it can be assumed that the burden of mental health is much higher due to the 10 years of armed conflict in the region, political instability, poverty, unplanned urbanization and the natural disasters such as the 2015 earthquakes [102].

1.9 Presenting complaints

Presenting complaints (PCs) are the patient's self-reported primary reasons for seeking emergency care that are interpreted and recorded by a triage nurse [114]. ED patients are often treated based on their PCs before any diagnosis is given, and the clinical utility of this approach has been widely accepted [115-118]. PCs in conjunction with vital signs are prominently used in the triage decision-making process [116], and patients with high-risk complaints in need of urgent assessment and treatment, such as chest pain and severe shortness of breath, are prioritized for immediate treatment. The use of PCs influences triage, clinical work, treatment and disposition [119,120]. Moreover, PCs are useful in syndromic surveillance, which is important in outbreak detection that focuses on early symptoms before laboratory or clinical confirmation of a particular disease [121]. Furthermore, PCs provide valuable information on the needs of the emergency population and on workloads and help health administrators determine resource allocation and training needs [116]. For example, a neonate presenting with fever requires testing and empiric antibiotics for several potentially lethal specific diseases, regardless of final diagnosis [10].

PC as a proxy measure is crucial in emergency care but will not obviate the need for provisional or final diagnosis [116]. The accuracy of PCs varies because they are recorded prior to physician involvement in care and therefore lack a physician's diagnostic precision [121]. Some complaints are accurate by definition (e.g., shortness of breath), whereas others are not (e.g., haematemesis that turned out to be haemoptysis) [116]. Efforts have been made in HICs to standardize PC nomenclature, but there is a dearth of such interventions in LICs [116]. Moreover, studies on PCs, especially those conducted in low-resource countries, are less common [116]. PCs and patients' condition severity in low-resource countries differ from those

in Western countries, and these differences require investigation and the development of appropriate models that could be applicable in these settings.

1.10 Mortality after emergency care

Mortality is a relevant outcome measure for emergency care [85,122]. Although the discharge of patients to their homes is not regarded as the completion of patient management [123], patients after discharge are often not followed-up, and health outcomes and/or mortality after ED care are usually not documented [124]. Studies from HICs have reported high mortality after emergency care [122,125-128], but there are very few reports from LMICs [85,129]. Studies from LMICs reporting mortality during emergency care were 3-4 times higher compared to reports that required follow up or outcomes after emergency care [124].

A Nepalese study reported that deaths in various hospitals in 2005 totalled 4,418, i.e., 6% of the total deaths in the community (n=73,592) [43], indicating that hospital mortality is not merely a single indicator for evaluating the quality of care. Moreover, death reporting in Nepal is influenced by various traditional value systems and is underreported [43]. The dearth of data and a poor reporting system pose challenges to evaluating the effectiveness of any health care system.

1.11 Importance of research in health system development

The emergency health care system plays an important role in all health care systems and helps to reduce a large number of deaths and disabilities. Health care facilities and their staff play a crucial role in patient management, emergency preparedness and response efforts in all kinds of emergencies, including patient management in regular EDs and response to natural/man-made disasters or during pandemic outbreaks. The burden of emergency disease and conditions for LICs at the country and regional levels is not well documented. Two studies used data from the 2010 [8] and 2015 Global Burden of Disease Study [86] to report the burden of emergency conditions at the global and regional levels. The sub-analysis of this study was focused on 40 countries, most of which were HICs. In many resource-poor countries, health information systems are weak, fragmented and unable to meet the needs of decision-makers [43,124]. Previous studies have emphasized the need to investigate the role of emergency care services within specific health systems, which could reduce the global burden of disease [1,10]. Studies have also highlighted the importance of hospital chart reviews to address the lack of quality epidemiologic data on emergency care [1,43]. Regardless of the positive impact that emergency care could have on health outcomes, there is a paucity of empirical evidence in low-resource

settings regarding the burden of emergency conditions and patient severity that makes setting clinical and policy priorities difficult [1,9,13,86,130].

Some studies from Nepal have focused on certain groups of emergency patients, such as those with injuries and infections and have reported that patient volume has increased in recent years [90,131,132]. A systematic review of road traffic injuries in Nepal reported that the mortality rate had almost doubled from 2001 to 2013 [104], and the incidence of NCDs has dramatically increased [98]. However, these reports do not provide an overall picture of emergency patients.

It has been noted that health system research not only translates public opinion into policy but is also a powerful tool for effective stewardship in health care system management [43]. The functional emergency care systems vary between countries and within regions; thus, studies describing patient characteristics seeking emergency care is essential for developing locally appropriate systems. The 2013 academic emergency medical conference in Atlanta highlighted the lack of studies reporting PCs as a critical gap in global emergency care research [116]. A lack of data from low-income settings has made it difficult to convince policymakers to invest in strengthening emergency care and health systems [9]. Further, a recent analysis has highlighted the need for studies on economic evaluations of the health system to inform policymakers when choosing investments in strengthening health systems that may be of good value in terms of greater health per budget expenditure [13]. Research findings linked with national and local policy contribute to realistic planning and need-based resource allocation [43].

To our knowledge, no data from Nepal that describes the ED population, PCs, severity at ED and the mortality after emergency care has previously been reported. The information provided through this study could fill the knowledge gap and support better resource allocation for emergency care.

1.12 Disaster plan and emergency preparedness for health care

Disaster preparedness is a key element in creating a resilient health system [133] and has been emphasized as a global priority in the United Nations International Strategy for Disaster Reduction and the "Hyogo Framework for Action 2005-2015" [134,135]. Of the total published studies related to disasters, 66% of articles in LMICs are related to natural disasters that were proportionately greater compared to those in HICs (21%) [136]. This finding likely reflects higher vulnerability to natural disasters in the low-resource settings. This possibility is supported by the study by Roy and colleagues that stated that 85% of disasters and 95% of

disaster-related deaths occur in low-resource countries. However, fewer than 1% of all disaster-related publications are from these countries, and there is little evidence-based disaster planning [137].

Nepal has been ranked the 4th most climate-vulnerable country in the world and hold the 11th most vulnerable position for earthquakes [138,139]. The country is highly susceptible to damage from a wide range of natural disasters, such as flooding, landslides and earthquakes [139]. Earthquakes kill more people than other natural disasters [140] and have been responsible for more than 300,000 human deaths in the past 10 years [141]. The most recent catastrophic earthquakes to strike Nepal occurred on the 25th of April 2015, with a magnitude of 7.8, and on the 12th of May 2015, with a magnitude of 7.3. Due to these earthquakes, close to 9,000 people were killed, approximately 22,000 people were injured, and 2,000,000 households were displaced from their homes [142,143]. Poorer rural areas were more adversely affected compared to urban cities because of the inferior quality of houses in rural regions [144]. These earthquakes also imposed significant damage on health infrastructures. Almost 90% of the health facilities were destroyed (n=500) or severely damaged (n=760) in the earthquake-affected regions [144,145]. The rural areas lacked pre-hospital and quality emergency care, which led to excess injury burden and mortality [51]. The available health facilities experienced an overwhelming number of patients and shortages of medical supplies [144,146] that resulted in compromised health care services in the disaster-affected regions. Some of the contributing high-risk factors included vulnerable population, mountainous landscape, fragile health system infrastructure, weak government institutions, and political instability [138].

The Central Natural Disaster Relief Committee is the primary committee under the Ministry of Home Affairs responsible for implementing policies and programmes for disaster response in Nepal [139]. The National Strategy for Disaster Risk Management was formulated in 2009 but had not yet been approved prior to the 2015 earthquakes [147]. National disaster policy and response guidelines were available but were found not fully functioning; there were coordination gaps among different ministries and health facilities, inadequate resource disbursement at the national, regional and district level, and poor knowledge among the local implementers [43,147]. A number of disaster-related guidelines were published to guide disaster resilience, prevention, preparedness and response in the health sector before the 2015 earthquakes, but these guidelines and the response observed in 2015 earthquakes suffered from disconnection [50,146,147].

Dealing with casualties during disasters such as earthquakes is challenging to most emergency health care systems. Although institutions have made significant contributions to support earthquake casualties in Nepal, various shortcomings were identified in hospital settings, such as a lack of coordination among health institutions/hospitals, inadequate waste management, inadequate medical supplies, lack of a detailed disaster management plan, irregular drills, unclear policy, lack of budget to implement the existing policies and lack of leadership [147]. The insufficient development of evidence-based disaster management influenced the consequences of the 2015 earthquake in Nepal and has placed the country in a vulnerable situation [148].

1.13 Evidence that simple interventions in emergency rooms improve health outcomes

Disease-specific treatments are essential. However, the emergency health care interface plays a vital role in linking undifferentiated patient presentations to appropriate definitive care [7]. In general, patients seeking acute care present with complaints such as fever, pain or difficulty breathing rather than pneumonia or appendicitis. These patients are often not aware of their illness severity and the level of treatment they require. It is emergency health care that both provides early assessment of severity and identifies immediate treatment needs as well as offering initial management until a diagnosis-based treatment is available [7].

There are some encouraging examples of interventions that have shown to be highly effective at a low cost. Some, such as implementation of triage, early recognition and resuscitation, reorganization, initial patient management and staff training and education, have been shown to decrease mortality within a range of medical conditions. In HICs, improvements in trauma system planning and organization with small investments resulted in reductions of 8-10% in trauma mortality [66,149,150]. Estimates suggested that in LMICs, the implementation of basic trauma care at a health care facility was likely to reduce 21% of the total injury burden [6]. Basic interventions in EDs, such as trauma resuscitation, wound management, laceration repair and tube thoracotomy for a limited set of surgical diagnoses, can reduce 18% of the total global burden of disease in LMICs [151]. Likewise, short training courses in trauma management were associated with reducing mortality in injured patients from 8.8% to 6.3% in Rwanda with no significant increase in resource usage [152]. In Malawi and Sierra Leone, organized emergency care unit and triage implementation were associated with reducing half of inpatient mortality [153,154] and reducing deaths within 24 hours from 36 to 12.6 percent [153]. Simple interventions among adults in Uganda, such as providing fluids, antibiotics and clinical

monitoring within the first six hours of hospitalization with serious infection, reduced mortality from 46 to 33 percent [155]. In rural Mali, increased access to emergency obstetric care halved the risk of maternal mortality [156]. This evidence shows that emergency health care is an effective means of saving lives and indicates that a range of simple and inexpensive interventions in low-resource settings could improve health outcomes. However, most interventional studies focus on African countries. It should be noted that there exists discrepancy in outcomes even within countries. One Indian study reported that being poor was associated with less access to timely emergency treatments in acute myocardial infarctions and with an increased mortality of 50% [157].

1.13.1 Triage and its importance in emergency care

Triage is a systematic process of classifying individual patients by their levels of acuity to best match the patient's need with the available resources [2]. Triage is a system of clinical risk management used to manage patient flow safely when clinical needs exceed capacity.

Triage originates from the French word "trier" and was applied by Baron Dominque Jean Larrey, Surgeon in Chief to Napoleon's Imperial Guard in 1792 [158]. The concept of triage was primarily focused on mass casualties and warfare situations and was used to sort patients in the battlefield [158]. Later, in the 1900s, with the development of organized medical systems in the Western world, the triage system emerged in EDs in the US and Europe [158]. EDs at hospitals are an appropriate site for implementing triage systems. Nurses in the ED usually perform the triage. The decisions made during triage determine the correct allocation of patients to emergency care at the most suitable time according to the severity of condition [159]. Various triage systems have been developed to help emergency health care providers make accurate triage decisions and minimize adverse outcomes. Although the techniques show considerable variation from one system to another, they all share the same goal: to prioritize clinical urgency based on the greatest need. Triage assessment is based on vital parameters, PCs and medical history.

Some of the most valid and commonly used triage systems are the Manchester Triage [160], the Canadian Triage Assessment Scale [161], and the Australian Triage Score [162]. The South African Triage Scale has been used throughout South Africa and in many developing countries [163-166]. The Rapid Emergency Triage and Treatment System (RETTS) was developed in Sweden and has been increasingly used in Sweden and other Scandinavian countries [16,167,168]. The RETTS triage grades patients in different categories using vital parameters

and algorithms for emergency symptoms and signs (ESS). This triage system includes two steps assessed simultaneously and includes one algorithm for vital signs and one algorithm for one of the 43 ESS. The ESS are specific to the RETTS protocol (appendix). The highest level of these algorithms is given the highest priority level. The scale sorts patients into five categories, from blue (no need of further triage or any hospital care) through green, yellow, orange and the highest category, red. Red is categorized as life-threatening and in need of immediate medical care. Orange is potentially life-threatening and should be seen by a doctor within 20 minutes. The recommended time or medical attention is within 120 minutes for yellow and 240 minutes for patients in the green category [169,170]. Studies of RETTS in Sweden and Denmark have shown that this triage system is simple and safe [170], has good predictive validity [171], has good inter-rater agreement among nurses and increases survival [167].

Several studies have shown that the introduction of a triage system may increase the efficiency of patients' treatment in the ED [162,172-174]. A systematic review in 59 LMICs emphasized the crucial need to strengthen triage for efficient resource allocation and effective emergency intervention [9]. Few studies have reported the feasibility of using triage systems in low-resource settings [175,176]. However, EDs in many hospitals in LMICs lack a formal triage system, and patients are often seen on "a first-come-first-service" basis [177]. A recent systematic review of 139 LMICs reported that only a quarter of these reported that triage systems had been implemented in those countries [124]. The lack of systematic triage in these settings could likely delay the treatment of seriously ill patients who require immediate treatment, and the lack of such systems will also contribute to the ineffective use of limited resources.

1.13.2 Usefulness of implementing an emergency registry

Patient registries in a health care facility are an important source of data and are useful for health care providers and managers in monitoring interventions, allocating resources, and evaluating patient outcomes in providing quality care. Public health decision making is dependent on the timely availability of sound data [178]. Electronic patient records provide quick information on patient characteristics, diagnoses, medications, treatment plans, and diagnostic results, and, over time, form a rich patient history leading to more efficient and better-quality care for patients. However, health facilities in most LMICs have limited information on emergency PCs, and the available information is mostly in paper form [179]

and are often not used. Reports from HICs and LMICs have shown that the implementation of patient registries has a positive impact on patients' health care processes and clinical outcomes [180,181]. Several other reports have highlighted the importance of hospital chart reviews in addressing the lack of quality data on emergency care [1,43].

In Nepal, the health management information system is the main source of health information [43]. The major sources for these data are outpatient and inpatient morbidity records, mainly from public health facilities. These data are limited in scope, coverage and quality [97]. Hospital information management systems, which are crucial in strengthening the health care system, are less prioritized [43]. In recent years, a very few hospitals in Nepal have begun keeping electronic health records in collaboration with international partner organizations [178]. Establishing emergency care surveillance can address critical data needs that can improve the quality of health care services [179]. However, the use of emergency patient registries are also important to address the current need in low-resource settings. This information is useful to identify the burden and characteristics of emergency patients, the severely ill and injured to plan the capacity needed for patient care, the number of staff members and their level of training, and other resources required [179].

2. AIMS

2.1 General aim of the project

The general aim of this project was to improve the quality of emergency health care services at Dhulikhel Hospital (DH), a Kathmandu University Hospital in Nepal, by administering changes in the ED through the development of an electronic emergency patient registry, implementation of triage, reorganization of the ED and providing simulation training to emergency staff. The papers in this thesis describe the findings from the emergency patient registries (details about data collection period below in 3.4.1) and address the knowledge gap in understanding emergency patient caseload, characteristics, PCs and mortality after emergency care among patients seeking care at the ED of DH.

2.2 Specific aims of the studies included in the thesis

Paper I:

- To describe the distribution of emergency patient load and the distribution of earthquake-related injuries and non-earthquake-related health problems treated by a local hospital from the first day of the earthquake in Nepal in 2015 and the following three weeks.
- To describe sociodemographic information and the effects that the earthquakes had on these patients 90 days after hospital admission.

Paper II:

- To describe the characteristics and presenting complaints (PCs) of adult patients presenting to the ED in a local hospital in Nepal.
- To assess mortality at 90 days after emergency care and assess factors associated with mortality in this population.

Paper III

- To describe characteristics and PC distribution in paediatric patients presenting to the ED in a local hospital in Nepal.
- To assess mortality at 90 days after emergency care and assess factors associated with mortality in this population.
- To assess associations between triage categories and indicators of severity in a subset of the paediatric emergency population where measures of triage were available.

3. MATERIALS AND METHODS

3.1 Study design

The three studies included in this thesis are all prospective observational studies that include all emergency patients presenting to the ED of DH from September 2013 until December 2016.

3.2 Study Setting

3.2.1 Dhulikhel Hospital

The study described in this thesis was conducted at Dhulikhel Hospital (DH) in Nepal. DH is an independent, non-government university hospital founded in 1996 [182]. The hospital is located in the semi-urban region of Dhulikhel Municipality in Kavrepalanchok District [182]. Topographically speaking, the hospital is situated in the hilly region of Nepal and is 30 km northeast of Nepal's capital city, Kathmandu. This 375-bed hospital provides low-cost health services to approximately 1.9 million people from both rural and urban regions and is one of the few specialized hospitals in the region [182]. DH has already provided health services to patients from more than 50 out of 75 districts of the country. In addition, the hospital provides health services in different rural regions through its 18 outreach centres.

The health services in the hospital are provided through two main entry points: outpatient departments (OPDs) and the ED. Patients may choose one of them. Health services at the ED are comparatively expensive, but service delivery is faster. Patients arriving at the hospital could arrive by walking, ambulance or any other kind of transport system available (motorcycle, jeep, car, truck, etc.). Since 2013, DH has operated an ambulance service staffed with trained paramedics and equipped with emergency drugs and equipment, but the number of ambulances is small. Patients arriving at DH could come directly from home or be referred/transferred from other health care facilities (rural or urban health facilities). Patients directed to the OPDs are attended by respective specialized doctors. The ED is the other entry point for patients at DH *(details described below in 3.2.3)*.

3.2.2 Background information and health services in the region

Kavrepalanchok District, where DH is located, has a population of 381,937, of which 51% are female [42]. The median age in this district is 23 years; 43% of the population are under the age of 20 (46% in Nepal), 40% are 20-49 years old (39% in Nepal), and 17% are 50 years of age or older (15% in Nepal) [42]. The three main ethnic groups in the district are Janajati (51%), Brahmin/Chhetri (36%) and Dalit (7%) [42]. The proportions of the different ethnic groups are

calculated in three broad categories from the data provided in the 2011 census report. The government in this region provides health services through one 15-bed hospital, 4 primary health care centres, 25 health posts and 65 sub-health posts [183]. In addition, 10 non-government or private hospitals, of which DH is one that provides health care services in different parts of the district. The government has sanctioned only 7 doctors for a district with a population of almost 400,000, compared to 0.17 per 1,000 population in the country, which is still substantially below the WHO recommendation of 2.3 doctors per 1,000 population [183,184]. According to the 2017 district profile, the main health problems reported are injuries and infectious diseases (mostly respiratory tract infections) [183].

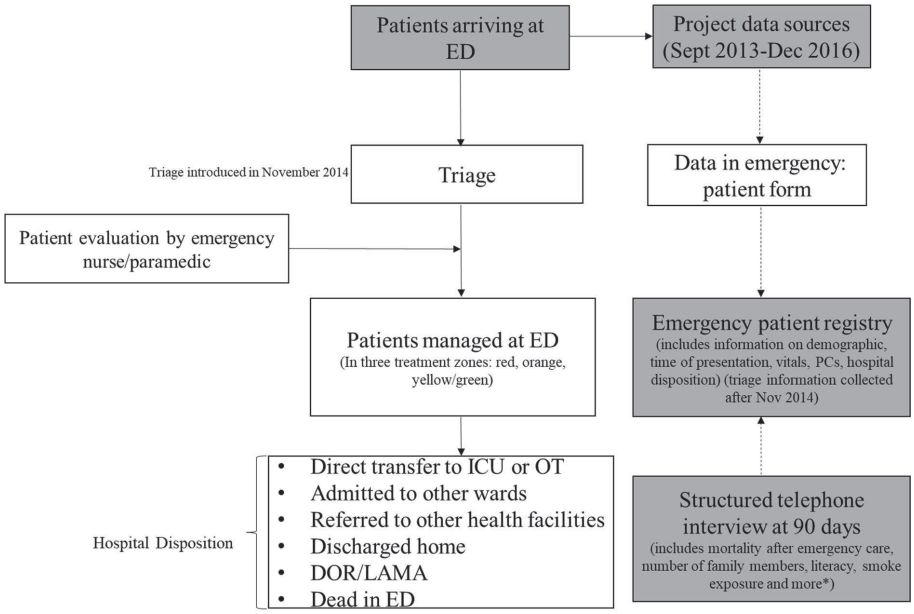
3.2.3 Emergency department at Dhulikhel Hospital

The ED at DH provides 24-hour emergency health services in three shifts (morning, evening and night) by 34 medical personnel (five general practice MDs, ten medical officers, seven nurses, six paramedics and six community medical assistants). The ED has a capacity of 23 beds: 2 beds in the shock room (red zone), 10 in the orange/yellow zone, 8 in the green zone, 2 in gynaecology and obstetrics examination room and 1 in triage room. The department is equipped with a portable radiology service including x-ray and ultrasound and has easy access to procedure rooms for minor surgery, operation theatre (OT), intensive care unit (ICU) and the trauma department. The ED is the main gateway to all hospital departments. Every year, over 10,000 patients are benefited from the ED [182]. The department provides acute health care to patients of all ages presenting at the department, including trauma patients. As part of government policy, the department also provides health services and counselling services for victims of gender violence through a "one-stop crisis management" project.

Most patients arriving at the ED have had no pre-hospital care and may arrive in any kind of transportation. Figure 5 below shows the patient flow at the ED of DH. Patients presenting at the ED are first evaluated by the triage nurse in the triage room. We introduced the RETTS triage system in November 2014 in the emergency room (*detailed explanation below in 3.3*). Patients at triage room are prioritized according to severity into four triage codes; red, orange, yellow and green (red being very severe and green, less severe). Patients requiring immediate ICU or OT admission are directly transferred after immediate consultation with the ED physician and the respective departments. The hospital has a total of five ICU beds. Patients are treated after triage in the respective treatment zones by respective ED doctors and nurses and are sent for diagnostic services if required. If required, specialist doctors from the

respective departments are called for further patient management at the ED. Patient disposition after initial treatment and management at the ED can be one of the following: admitted to respective inpatient wards, transferred to the ICU/OT, referred to other health facilities for further treatment, discharged home, discharged upon request or leave against medical advice. Patients discharged upon request or who leave against medical advice are discharged by their own or their family's wishes even though hospitalization is required based on medical evaluation. The inpatient wards at DH are as follows: orthopaedic/trauma; medicine; gynaecology and obstetrics; ear, nose and throat (ENT); surgery; and paediatric. The hospital's paediatric department provides health services to children from birth up to 16 years of age with 45 beds (30 general beds, 10 neonatal intensive care units, and 5 paediatric intensive care units).

Figure 5. Emergency health services delivery at Dhulikhel Hospital and the project data source.



ED=emergency department. ICU=intensive care unit. OT=operation theatre. DOR=discharge on request. LAMA=leave against medical advice. *Main occupation, hospital revisit (additional information for the patients during earthquakes were collected: type of house, location during earthquake, injured/loss of family members, living condition during interview, damages to house)

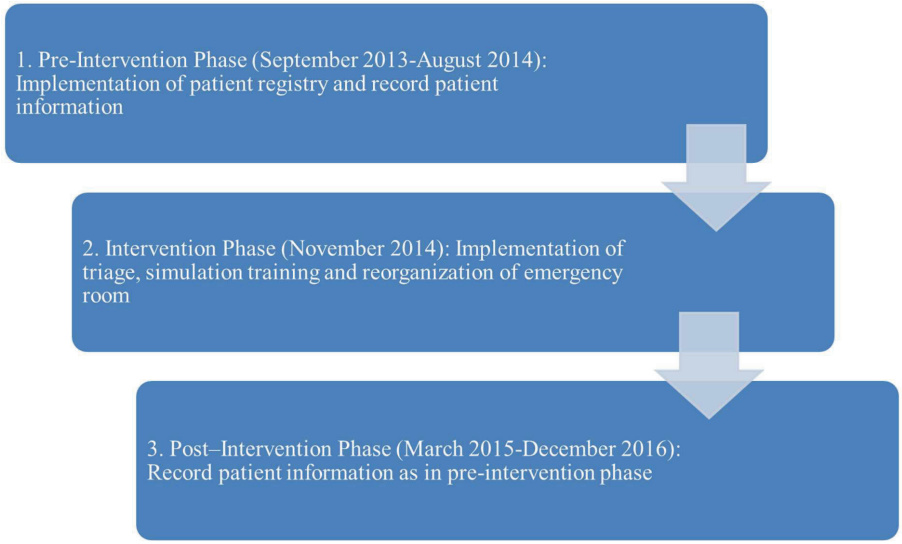
3.3 Dhulikhel hospital patient care (DHPCARE) project

The DHPCARE project was a collaborative project initiated in 2013 between DH, the Norwegian University of Science and Technology (NTNU) and St. Olav's Hospital, Trondheim University Hospital, Norway [185]. The DHPCARE study project was a quality improvement project with the following aims:

- To develop an emergency patient registry with demographic and clinical information on all patients presenting at the ED during the study period.
- To implement a validated triage system for the initial evaluation of patients, a systematic training programme for staff and reorganization of the emergency room at DH.
- To assess whether changes in the organization of emergency care, including the implementation of a triage system, a systematic training programme for staff and reorganization of the emergency room, can reduce mortality and improve quality of care.
- To enable a platform for project development and academic training of local personnel. The analyses of data from the emergency registry and follow-up interviews form the basis for the present PhD work, and the candidate contributed to all phases of the project.

The project had three phases, as shown in Figure 6;

Figure 6. Phases of the DHPCARE project.



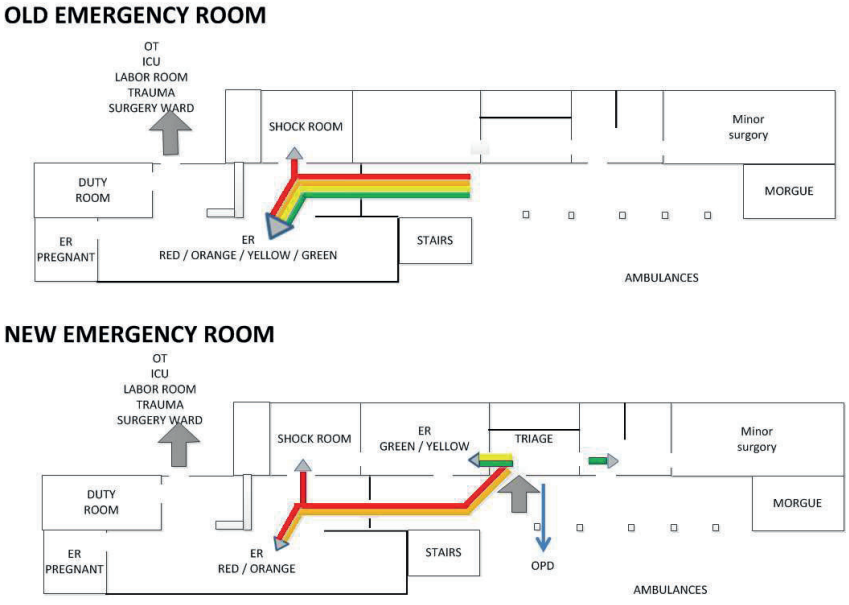
Phase 1: Pre-intervention Phase: Implementation of patient registry and record patient information

Patient medical records in the hospital are paper-based, and information on patients seeking emergency care were collected with two different forms (general emergency form and trauma form) (appendix). The information included demographic information (age, sex, ethnicity, home address), vital parameters (pulse, respiration rate, blood pressure, temperature, oxygen saturation and Glasgow Coma Scale), patient's complaint at ED presentation, treatment at ED and immediate outcome at ED (immediate mortality, referral to other hospitals, discharge or admission to hospital wards). We developed an electronic emergency patient registry system using a web-based CRF (case registration form) or Epi Info system *(described below in section 3.6)*. The local project's research nurses collected the emergency patient forms from the ED (Figure 5) and entered individual patients' information in the registration database. Patients or their close family members were interviewed through telephone interviews at 90 days after emergency care to determine the patient's health status, including information on mortality after emergency care and additional demographic information (Figure 5).

Phase 2: Intervention Phase: Planning and implementation of interventions

Interventions were planned together with the personnel from ED at DH and personnel from St. Olav's Hospital. A pre-intervention study performed at DH showed that of the hospitalized patients, 50% were admitted from outpatient departments and 50% from the ED, thus suggesting that sorting patients was necessary. In October 2014, a team from St. Olav's Hospital and NTNU in Trondheim travelled to Dhulikhel to teach and train the ED staff at DH. The main interventions were the implementation of the triage system, simulation training as a method for the introduction of a triage system and reorganization of the emergency room. The emergency room before (old) and after (new) the intervention is shown below in Figure 7.

Figure 7. Emergency room before and after the intervention.



OT=operating theatre; ICU=intensive care unit; ER=emergency room; OPD=outpatient department.

Figure 8. Patients' arriving at the ED during a bus accident in the region.

At the entrance of the emergency room

Inside emergency room

No triage system existed at DH before this project; instead, patients were generally prioritized for treatment on a "first come, first served" basis. We implemented the RETTS triage system at the ED of DH in November 2014. As a validated and reliable triage tool for both adults and children [171,186] and an established system at St. Olav's Hospital, RETTS was chosen to be introduced at DH with four triage categories (red, orange, yellow and green). The ED was reorganized to separate patients into three treatment zones (red, orange, and yellow/green) according to four triage categories (red, orange, yellow and green), with separate staff attending each zone (Figure 7). The ED before this intervention was providing health services through two rooms, a shock room with two beds for treating seriously ill patients and the other large room for all other patients regardless of urgency. A student thesis in 2016 that studied the implementation of the RETTS triage system reported that 70% of the ED patients were triaged [185].

Moreover, the layout of emergency patient records was changed during the project. From February to July 2015, a five-page patient record was introduced (appendix) that consisted of two pages of triage forms, one for adults and one for paediatric patients, and two other pages that varied depending on whether the patient was a trauma or medical patient. A new form was introduced in August 2015 (appendix) that now consists of two pages: one for triage evaluation and one for symptoms, provisional diagnosis and treatment. All patient records contain information about age, sex, address, vital parameters, PCs, provisional diagnosis and treatment given at ED, including information on triage at ED presentation.

Figure 9. Staff training during the intervention phase.

Training in a simulator setting

Phase 3: Post-intervention Phase

Data during the post-intervention phase (March 2015-December 2016) was collected in the same manner as during phase 1. However, the April 2015 earthquakes in Nepal appeared just at the beginning of the post-intervention phase, changing the original project plan of measuring the results of the intervention. It was obvious that the earthquakes had potentially more impact on the emergency population than the project interventions. Project outcome was therefore changed to description of patient characteristics, PCs and mortality after emergency care, with supplementary analyses related to possible changes after the EQ period. The results in *Paper II* and *Paper III* (in supplementary tables) showed no meaningful difference in patient characteristics before and after the earthquakes and no significant difference in hospital mortality after emergency care (data not reported in publication).

3.4 Data sources and study population

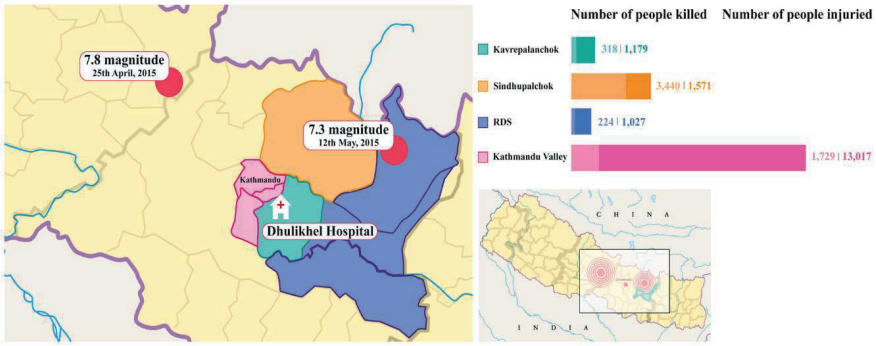
Emergency patients presenting to the ED, as shown in Figure 5, during the study period (September 2013 to December 2016) who are registered in the emergency patient registry *(described below in 3.4.1)* are included in the studies included in this thesis.

3.4.1 Emergency patient registry (Papers I-III)

Paper I included information from all patients presenting at DH during the devastating earthquake in Nepal between April 25 and May 16, 2015. This span also includes the second earthquake on May 12, 2015. The clinical and demographic information was prospectively entered in the systematic emergency registry from the hospital patient records for all patients.

Kavrepalanchok District, where DH is located, was one of the districts most severely affected by the two earthquakes. The hospital is located 108 km from the April 25th earthquake epicentre and 84 km from the May 12th earthquake epicentre (Figure 10) [187]. The hospital received a large number of earthquake casualties from the most badly hit districts: the Sindhupalchok, Kavrepalanchok, Kathmandu Valley, Ramechhap, Dolakha and Sindhuli districts of Nepal.

Figure 10. Map of Nepal, Dhulikhel Hospital and its beneficiary districts, including sites of two earthquake epicentres.



Left: enlarged map illustrating the two earthquake epicentres (red circles), Dhulikhel Hospital (DH) and its beneficiary districts (coloured sections). Top right bars: the bars show the number of people killed (lighter bar) and injured (darker bar) in the respective DH beneficiary districts [188]. RDS includes the Ramechhap, Dolakha and Sindhuli districts. Kathmandu Valley includes the Kathmandu, Lalitpur and Bhaktapur districts. Bottom right: Map of Nepal showing the two earthquake epicentres.

Paper II included all adult population (>16 years) presenting to the ED during the study period (September 2013 to December 2016). *Paper III* included all paediatric population (≤16 years) presenting to the ED during the study period. However, data collection or emergency registration was interrupted twice during the study period: the first time due to failure to continue data collection because of the project intervention planning and implementation phase (September 2014 to February 2015) and the second due to missing ED files (September and November 2016). Patients during the earthquakes period (April 25 to May 16, 2015) are described in *Paper I* and are not included in *Paper II* and *Paper III*. Demographic and clinical information was prospectively registered using systematic emergency forms by ED nurses, paramedics and doctors and was extracted into an electronic database by the research nurses. The variables included in the study are included in the appendix.

3.4.2 Follow-up interviews (Papers I-III)

No cause-of-death registry exists in Nepal, and many patients leave the hospital against medical advice (eventually to die at home); thus, the information about causes of death is sparse. Therefore, all patients who provided phone numbers during their ED visit were followed-up through systematic telephone interviews 90 days after emergency care. Mortality after emergency care was assessed in the telephone interview and is self-reported information from the patient's closest family members within 90 days after initial presentation to the ED. The

term “mortality after emergency care” was named differently in the papers based on the suggestions from reviewers of different journals. Nonetheless, the terms have the same definition and source of information. Thus, in *Paper I* and *Paper II*, we have used the term 90-day mortality, and in *Paper III*, we have used the term paediatric post-discharge mortality.

Structured telephone interviews were conducted by two trained research nurses with the patients or the closest family members 90 days following the ED visit. The research nurse attempted to contact a second time when patients were not reachable the first time, and a PhD student was responsible for continuous supervision and quality control throughout the process. The telephone interview included information on mortality within 90 days after emergency care, as well as demographic information (literacy, occupation, number of family members living together, exposure level to smoke and whether a second hospital visit had occurred). *Paper I* included additional information on the impact of earthquakes on patients’ lives, such as loss of family members, injured family members, living conditions, type of house and damage to house. The variables included in the structured telephone interview are included in the appendix.

3.5 Description of study variables (Papers I-III)

3.5.1 Demographic variables

Demographic variables included age in years, sex, ethnicity and home address. Ethnicity was categorized into four groups: Brahmin and Chhetri, Janajati, Dalit, and others based on the caste (i.e., last name) of the patient. These ethnic groups are closely related to socio-economic conditions owing to variations in education status, quality of houses or living conditions, land ownership, occupation, language, etc [189]. Brahmin and Chhetri are generally considered to have higher socioeconomic status, while Dalit have a lower socioeconomic status [190]. Based on patients’ home addresses, their residences were categorized as rural (living outside a municipality) or urban (living inside a municipality) by local research nurses with detailed knowledge of the area. However, for *Paper I*, patients’ home addresses were used to categorize their residences into four district categories: Sindhupalchok, Kavrepalanchok, Kathmandu Valley (includes Kathmandu, Bhaktapur and Lalitpur districts) and RDS (includes Ramechhap, Dolakha and Sindhuli districts) (Figure 10).

The telephone interviews included additional demographic information such as education, number of family members living together, exposure level to smoke, occupation and whether a second hospital visit had occurred. Patients’ education status was categorized into two groups,

illiterate and literate. The illiterate group included those who do not have formal education, and literate included those who have had a formal education. The number of family members living together was categorized as ≤5 members and >5 members. Smoke exposure was categorized as follows: no exposure, both tobacco smoke and traditional cooking stove (no outlet for smoke coming out from the stove), only tobacco, or only traditional cooking stove. For *Paper III*, exposure to smoke applied to the parents and was categorized as either exposed to traditional cooking stove or not exposed to traditional cooking stove. Occupation was defined as the patient's main occupation and was categorized as follows: paid job or business, agriculture or housewife (women taking care of own house and family), student and elderly or sick (cannot work because of old age or sickness).

For *Paper I*, additional information on earthquake damage to individual family members was added, and questions were asked during interviews to request information such as loss of family members, injured family members, damage to the house, and current living condition. This information was further classified as impacts of the earthquake on participants' lives, then further categorized as follows: very severe (loss of any family members or living in a temporary shelter or house completely damaged), moderate (any family members severely injured or migrated to new place or house partly damaged) and minor (any family members with minor injury or return to previous house or minor cracks in house).

3.5.2 Health-related variables in Paper I

Patients included in the study were classified into two broad categories: earthquake-related injuries and non-earthquake-related health problems. Earthquake-related injuries are those of patients whose registry information stated that injury was caused by earthquake, and non-earthquake-related health problems are those of patients whose registry information did not include information that the injury or health problem was directly caused by earthquake. Earthquake-related injuries with documented details on injury diagnoses were further categorized into body regions according to the abbreviated injury scale (AIS): head, face, neck/spine, thorax, abdomen, upper extremity, lower extremity and unknown region [191]. There was insufficient clinical information to perform injury grading using the AIS code set [191]. Severe injuries included patients with compartment syndrome, crush injuries and internal injuries. When the information in patient records included only earthquake injury but provided no details on injury diagnosis, these patients were classified as having earthquake injuries with unknown injury diagnosis.

3.5.3 Presenting complaints classification (Papers II and III)

PCs are recorded by an emergency nurse on the emergency patient record form during triage. The PCs are recorded in free-text format (for example, a woman with chest pain and fever). The complaints were later retrospectively classified into nine main categories. The categorization process was performed in three phases using Stata software (appendix). In the first phase, a total of 761 "PC texts" (e.g., fever, chest pain, abdominal pain, limb fracture, etc.) were generated and scored as 0 (no) or 1 (yes). Obviously related complaints were combined into a single group (e.g., fever and chills). In the second phase, one or more "International Classification of Primary Care-2 (ICPC-2)" codes [114,192] were allocated to each patient based on the complaint categories generated previously. In the third phase, one main PC was identified for each patient. The research group decided on a hierarchy of nine main complaint categories. The nine main PC categories, in hierarchical order, are self-harm, injuries, infection-related complaints, unconsciousness, CVD (cardiovascular-related complaints and diseases), respiratory complaints, OBGYN (obstetrics and gynaecology), abdominal complaints and other complaints. Within this hierarchy, "self-harm" is first and "other complaints" is last, i.e., if a patient made a suicide attempt, irrespective of other complaints, then he/she would be placed in the self-harm category. Self-harm implies attempted suicide, generally either by poisoning or by hanging in the adult population. However, in the paediatric population, children may experience accidental poisoning. Injuries were further categorized based on mechanism of injury *(Paper II and Paper III)*. The infection complaint category included infections and when PC was fever with no specification of organ system involved. The unconsciousness complaint category included patients who presented at the ED as unconscious or with seizures. The "other complaints" category included musculoskeletal, neurological, urinary, psychological and other complaints (general pain, feeling ill, male genital health, eye/ear complaints, etc.). The details of the PC categories and their respective ICPC-2 codes are presented in the appendix.

3.5.4 International Classification of Primary Care (ICPC-2)

The ICPC-2 is widely used for the systematic classification of clinical information in primary care and is recognized by the WHO [192]. ICPC is the copyrighted property of the World Organization of Family Doctors (WONCA). For the purposes of the current study, we have received consent from WONCA to use the ICPC-2 classification system, which allows for the classification of the patient's reason for encounter, problems/diagnoses managed and primary/general health care interventions. The classification system consists of 17 chapters,

depending on the system of the body, with an additional chapter on psychological and social problems. Each chapter is divided into 7 components that deal with process codes, symptoms and complaints, infections, neoplasms, injuries, congenital anomalies and other diagnoses. The ICPC-2 is primarily intended for use in general practice and in primary health care. Nevertheless, given the lack of other appropriate classification systems, several studies conducted in emergency settings have used the ICPC-2 classification system to describe emergency patients [114,193]. ICPC-2 codes are provided in the appendix.

For the current study, we used the ICPC-2 classification system retrospectively. We encountered several challenges in using this classification system due to incomplete information that was identified during classification. For example, patients with the complaint "chest pain" could either have experienced pain attributed to the heart (ICPC code K01), pain attributed to the respiratory system (ICPC code R01) or chest pain not otherwise specified (ICPC code A11). In our data set, we often did not have complete information; most records simply indicated "chest pain". These patients, however, were categorized as chest pain related to heart in the hierarchical order as described above. We propose using this classification system prospectively in similar settings where no other classification system is in use.

3.5.5 Time of presentation at emergency department

In *Paper I*, the patient's arrival time at the hospital was identified by days from the first earthquake on April 25, 2015 and was categorized into four groups: first week, second week, third week and unknown. Unknown includes patients whose date of admission was not recorded in the emergency registry. In *Paper II* and *Paper III*, patients presenting to the ED were categorized as follows: 08:00-16:00 weekdays (normal office hours of the weekdays) and 16:00-08:00 or holidays (holidays includes weekends and public holidays).

3.5.6 Emergency department disposition

The ED disposition is defined as the decision made by the ED physicians after the clinical evaluation or management of the individual patients. The ED disposition provided by emergency physicians is categorized as follows: died in the ED, admitted to the ICU, admitted to the OT, admitted to general wards, referred to other health facilities, discharged, discharged upon request or left against medical advice.

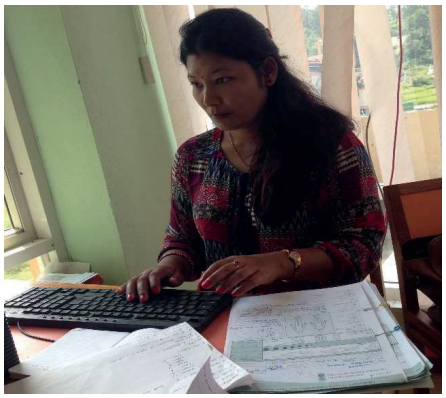
In *Paper I*, ED disposition is categorized as admitted, referred, discharged, discharged upon request or leave against medical advice, and died in hospital. In *Paper II*, ED disposition is

categorized as hospitalized and non-hospitalized. Hospitalized was further categorized as admitted to the ICU or OT, referred to other hospitals, and admitted to other wards in the hospital. Non-hospitalized was categorized as family-initiated discharge and doctor-initiated discharge. Family-initiated discharge includes discharged upon request or leave against medical advice. Patient discharge upon request could have several reasons: unfeasible for patient to stay longer at the hospital, desire to follow medications at home, unsatisfied with services or desire to go another hospital. Patients leaving against medical advice are considered to be very serious and they often have a poor prognosis. In *Paper III*, ED disposition is categorized as admitted to a paediatric ward or other general wards, admitted to ICU/OT/referred, discharged (includes family-initiated discharge and doctor-initiated discharge), and died in the ED.

3.6 Organization of data and data handling

The hospital did not have electronic medical record systems that could be used for systematic data collection or extraction for the study. Thus, patient record files at the ED were entered into the emergency patient registry by the research nurses during the study period using web-based CRF or Epi Info. Web-CRF is a password-protected web-based electronic registration system developed by NTNU for the research purpose. The research nurses were trained to use the Web-CRF system and uniform reporting from the emergency patient forms. However, we were not able to use Web-CRF for long period because of technical problems in Nepal. Thus, the data were later collected in Epi Info, a statistical software application developed by the Centers for Disease Control and Prevention in the United States. Nevertheless, we maintained the protection of the data with password-protected computers. Individual patient information such as hospital ID and telephone number was recorded for the purpose of following up with the patient in 90 days. However, this personal information was removed by the researcher after the completion of telephone interviews, and an anonymous patient ID was provided.

Figure 11. A research nurse (left) recording patient information from the ED file in an electronic database; individual patient record forms (right) set out to dry.



Data entry by a research nurse

Patient files at ED

3.7 Statistical Analysis

All statistical analyses were performed using Stata IC version 13.1 *(Paper I* and *Paper II)* and version 15 *(Paper III)*, StataCorp LP, College Station Texas, USA.

3.7.1 Descriptive statistics (Papers I-III)

Descriptive statistics are presented as absolute numbers, proportions (%) and medians with inter-quartile ranges (IQR). Pearson's chi-squared test was used for comparison of categorical variables. Statistical significance level was set at $p<0.05$. In *Paper I*, we used 95% confidence intervals (CIs) for percentages in each category to describe the distributions of patients and their characteristics.

3.7.2 Logistic regression analyses (Papers II and III)

The main outcome reported in *Paper II* and *Paper III* is mortality at 90 days after emergency care. Mortality after emergency care uses self-reported information from the patient's closest family members. The exposure variables include patient characteristics (age, sex, ethnicity), location (rural vs urban), education, number of family members living together, occupation, exposure to smoke, PCs at ED, time/day of presentation to ED, hospital revisit and ED disposition. Triage code was used in *Paper III*.

The associations between patient characteristics and mortality after emergency care were analysed using logistic regression. Univariable analysis of exposure and outcome were

performed as well as multivariable analysis with confounders included. The potential confounders (age and sex) were included in the model. Odds ratios (ORs) and adjusted odds ratios with 95% CI are reported. In *Paper II*, the modifying effect of sex on the associations between demographic factors and mortality after emergency care was assessed by logistic regression analysis with mortality after emergency care as the dependent variable, including an interaction term between demographic factors and sex. We identified evidence of interactions by sex in the analysis for associations between demographic factors and mortality after emergency care; thus, the results for associations between demographic factors and mortality after emergency care are presented separately for men and women. In *Paper III*, associations of triage codes with ED disposition (patients admitted to general wards and admitted to the ICU/OT/referred) and mortality after emergency care are reported.

3.8 Ethics

The study was approved by the institutional ethical review committee of Kathmandu University School of Medical Sciences in Nepal (58/13). The Regional Committee for Medical and Health Research Ethics in South East Norway evaluated the project in 2014 and later in 2018, with amendments regarding planned publications (2014/1246) and (2018/163). Individual consent for information to be entered in the emergency registry was waived by the ethics committee in Nepal. Approval was obtained from the local ethical committee to include patient data during the earthquake period and additional variables added in the follow-up telephone interviews. Consent was obtained during the ED disposition from the patient or the closest family members for the telephone interview at 90 days. Patients' identifying information (name and address) was recorded for the telephone interviews and was removed after the completion of the interviews.

Because of low literacy in the population, a procedure for oral information and oral consent was accepted for telephone interviews during follow up at 90 days after emergency care. Consent was obtained from legal guardians for patients under age 18. Patients were informed before the follow-up interview that the information would be used only for research purposes and that their personal identity would not be recorded. The interviewee was informed before the interview that he/she was able to decline to continue the interview at any time during the interview.

3.9 Financial support

This work was supported by a grant from St. Olav's Hospital, Trondheim University Hospital and the Liaison Committee between the Central Norway Regional Health Authority and the Norwegian University of Science and Technology (project number 46056902), as well as grants from the Children's Clinic at St. Olav's University Hospital. The funders had no involvement in study design, data collection, data analysis, data interpretation or writing the manuscripts. The study participants, researcher and colleagues received no financial benefits.

4. RESULTS

4.1 Paper I

Impact of 2015 Earthquakes on a local hospital in Nepal: A Prospective Hospital-based Study

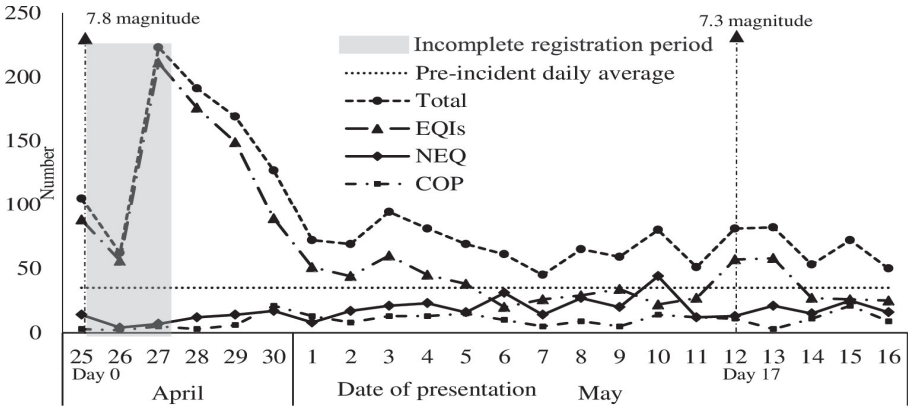
Aims: To describe the burden and distribution of earthquake-related injuries and non-earthquake-related health problems treated by Dhulikhel Hospital (DH) on the first day of the earthquake in Nepal in 2015 and the following three weeks.

Results: A total of 2,003 emergency patients were registered during the study period. Of the 2,003 patients, 1395 (70%) presented with earthquake-related injuries and 396 (20%) with non-earthquake-related health problems. The total patient load in the hospital in the first five days after the first earthquake was five times higher than the pre-incident daily average, as shown in Figure 12. Most patients with earthquake-related injuries were young and female, and the majority (55%) were from the severely affected Sindhupalchok District and from the hospital district (33%).

Lower extremity fractures comprised the highest proportion of earthquake-related injuries (56%). A total of 345 surgical procedures were performed in the operating room on 318 patients, 338 (98%) of which were orthopaedic procedures. The hospital treated 111 patients with severe injuries: compartment syndrome (n=18), crush injury (n=36) and internal injury (n=57). The most common non-earthquake-related health problems were infectious diseases (30%) and NCDs (27%).

Of the total number of included patients, a random sample of 346 patients were interviewed by telephone 90 days after hospital admission. Over 90% reported that they had been severely affected by the earthquakes, reporting complete house damage, living in a temporary shelter, or loss of close family members. The mortality after emergency care among earthquake-related injuries remained low (2%) but was higher in patients with non-earthquake-related complaints (11%).

Figure 12. Daily distribution of patients in the period from the first earthquake on 25 April and including the second earthquake on 12 May.

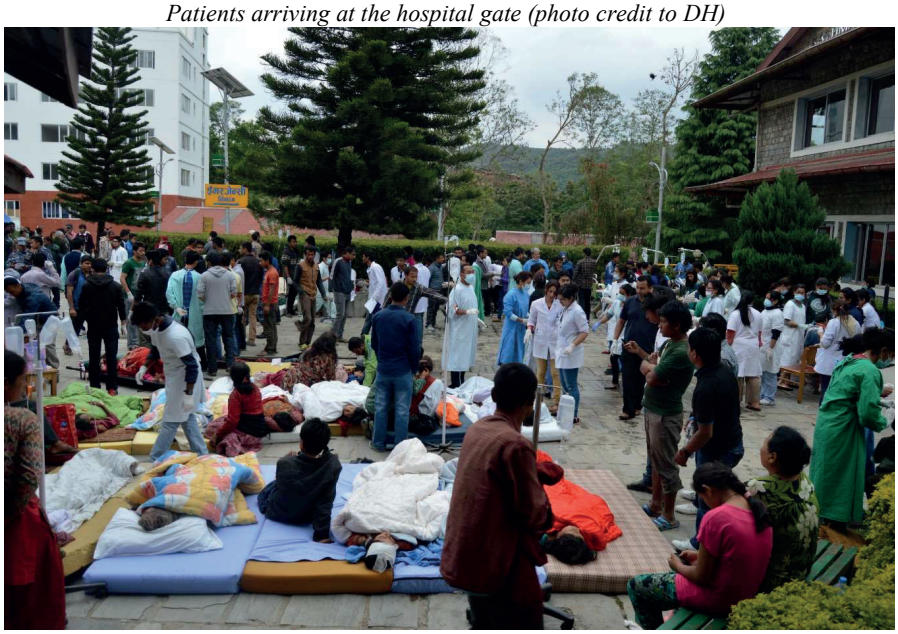


The horizontal axis refers to the patient presenting days to Dhulikhel Hospital (DH), starting from the first day of the earthquake on April 25 (day 0) through day 21, including the second earthquake on day 17. The figure shows a lower number of patients in the first two days, but, in reality, we saw an overwhelming number of patients but were unable to maintain the patient registration system during this time. The number of earthquake injuries was almost five times higher in the first five days compared to the pre-incident daily average. The number of patients increased for the first two days after the second earthquake on day 17, indicating that the mobile health facilities were in place. NEQ patients increased from day 11, and COP subsequently increased from day 5. EQIs=earthquake-related injuries. NEQ=non-earthquake-related health problems. COP=complication of pregnancy.

Conclusion: The hospital experienced a high workload during the first days after the first earthquake, with the majority of patients needing orthopaedic services. The burden of emergency patients was high before any international field hospitals could be established. It is difficult to predict a disaster with considerable certainty, but we can potentially minimize injury severity and mortality through better emergency preparedness and management strategies, especially in health facilities. The experience from this hospital underlines the importance of developing consistent and robust local health services capable of managing natural disasters such as earthquakes while also maintaining adequate medical care for other patients.

Figure 13A. Earthquake casualties at DH.

Patients arriving at the hospital gate (photo credit to DH)



Patients treated at the main entrance of DH (photo credit to DH)

Figure 13B. Triage and treatment at DH.

Triage at the main entrance of the hospital

Patient in the emergency room

4.2 Paper II

Presenting complaints and mortality in a cohort of 22,000 adult emergency patients at a local hospital in Nepal

Aims: To describe the characteristics of adult ED patients across PCs in a hospital in Nepal and to assess mortality after emergency care and assess factors associated with mortality in this population.

Results: A total of 21,892 patients were included in the study (Figure 14). The median age of the patients was 40 years (IQR 26-60). The most common PCs were injuries (29%), abdominal complaints (23%), and infections (16%). Among injured patients, almost two-thirds were young (17-45 years) and were men. Falls from heights were the most common cause of injury (36%), followed by traffic injuries (28%).

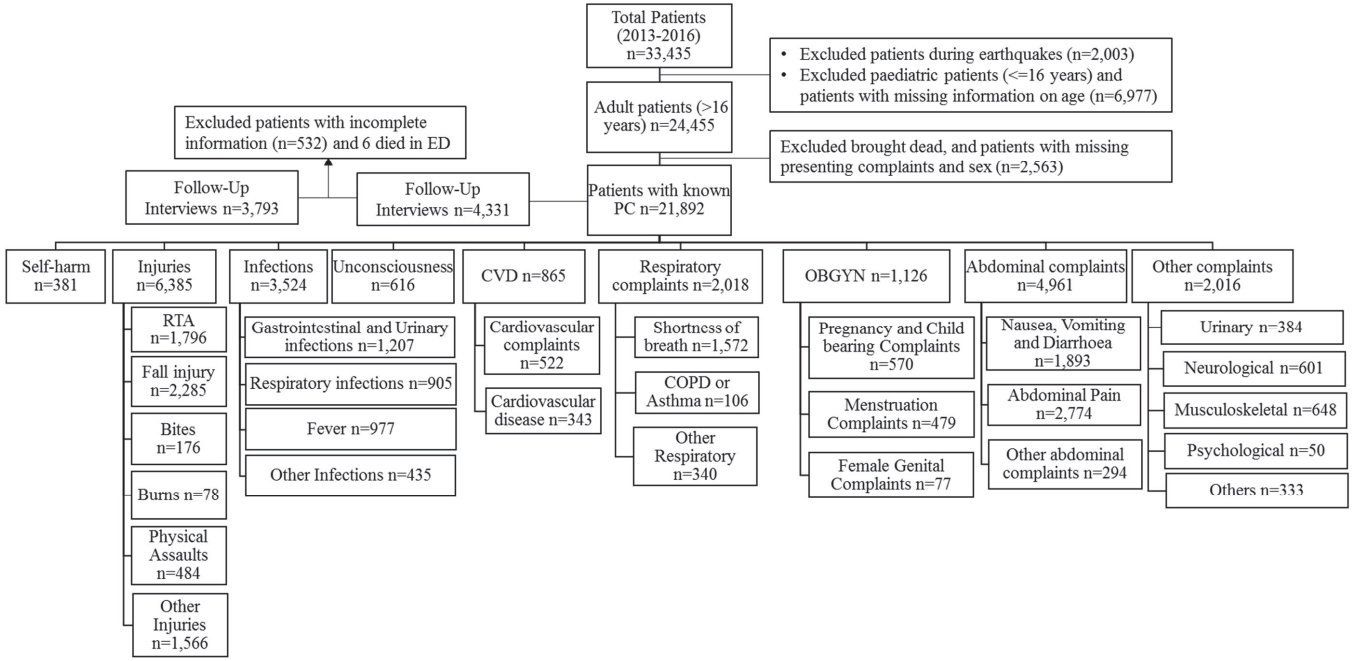
The majority (62%) of the patients presented to the ED between 16:00-08:00 hours or during the holidays. One-third of the patients presenting to the ED were hospitalized. Patients with respiratory and cardiovascular complaints had higher hospitalization rates (51% and 41%, respectively) than the average for the ED population (35%). Of the 12,101 (65%) non-hospitalized patients, 10% were family-initiated discharges. A total of 381 patients presented with self-harm complaint, the majority (73%) of whom were young (17-45 years) and mostly women (63%). The hospitalization rate was high (68%) in this group, and 27% required ICU treatment.

The mortality after emergency care was 8% (n=309). The mortality was higher in men (9%) compared to women (7%). The mortality was much higher in the older age group (23% in ≥60 years) compared to the younger groups (1% in 17-45 years). Compared to infections (7%), corresponding mortality for injuries was 3% (age- and sex-adjusted odds ratios (aORs) 0.6, 95% CI 0.4-1.0), for cardiovascular complaints 23% (aOR 2.5, 95% CI 1.5-4.1) and for respiratory complaints 25% (aOR 2.4, 95% CI 1.6-3.6). Family-initiated discharge was strongly associated with mortality after emergency care (aOR 5.4, 95% CI 3.3-8.9) compared to doctor-initiated discharge. In women, illiteracy was strongly associated with mortality after emergency care (age adjusted OR for illiteracy 7.0, 95% CI 2.1-23.6) compared to the literate group. In women, the association between exposure to smoke and mortality after emergency care was strong: age-adjusted ORs for mortality in women exposed to traditional cooking stoves, tobacco smoke, and tobacco plus traditional cooking stove compared to those with no

smoke exposure were 1.5 (95% CI 0.9-2.3), 1.8 (95% CI 1.0-3.2) and 2.8 (95% CI 1.6-4.9) respectively.

Conclusion: The study revealed that nearly one in ten patients died within 90 days of emergency care. This finding suggests a need to establish a follow-up system after hospital discharge, especially for patients with chronic diseases, and to replicate similar mortality studies in low-income countries. We consider that mortality after emergency care is a particularly important indicator of the quality of care in low-resource settings, where primary care health systems are limited, and transportation and economic issues may hinder adequate follow-up and treatment for complications or chronic diseases.

Figure 14. Flow diagram of cohort and distribution of presenting complaints.



ED=emergency department. PC=presenting complaint. RTA=road traffic accidents. CVD=cardiovascular diseases or complaints. COPD=chronic obstructive pulmonary disease. OBGYN=obstetrics or gynaecology-related complaints.

4.3 Paper III

Paediatric patients in a local Nepali emergency department: presenting complaints, triage and post-discharge mortality

Aims: To describe patient characteristics, PCs and indicators of severity, including triage categories, in a paediatric emergency population and to explore associations with mortality after emergency care.

Results: A total of 5,740 children were included in the main analysis, as shown in Figure 15. Of them, 961 children were included in the telephone interviews. Of the total 5,740 children, a subpopulation of 1,248 triaged children were included in the further analysis with triage and ED disposition, and 497 out of 1,248 were included in the analysis with mortality after emergency care.

The median age of the study population was 7 years (IQR 2-12 years). Boys were overrepresented (63%) in the total paediatric population. PCs were dominated by injuries and infections, each accounting for ~40%. Children with infection were typically younger (median 4 years) than injured children (median 9 years).

Two-thirds of the children presented to the ED between 16:00-08:00 hours or during the holidays. Over 60% of the children presenting to the ED were discharged home, while 8% were directly admitted to the ICU or OT or were referred to other health facilities. Among unconscious and poisoned children, a larger proportion were female children. The majority (30%) of poisoned children were admitted directly to the ICU or were referred to other health facilities, compared to the total (8%).

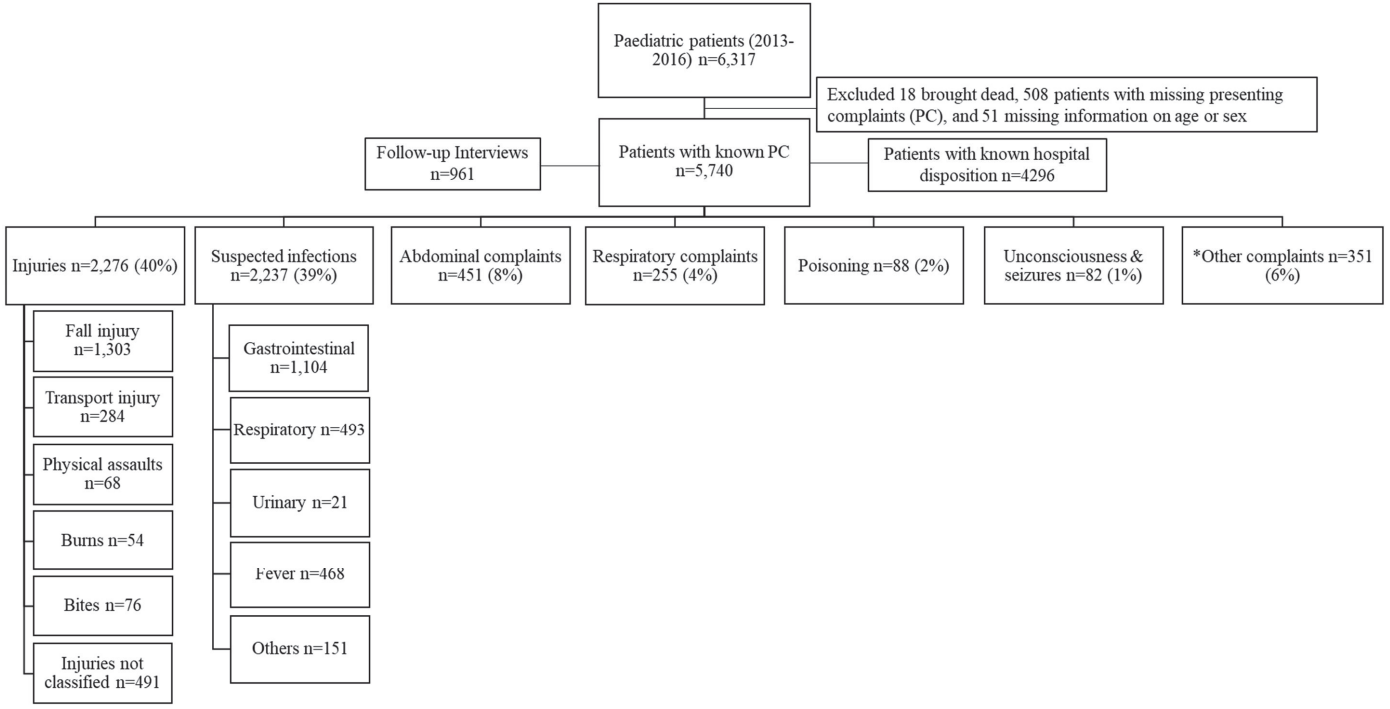
Paediatric mortality at 90 days after emergency care was low; only 12 (1.3%) of the 961 interviewed patients had died. Risk of mortality was higher in children under 1 year of age compared to children 5-16 years (sex-adjusted OR 4.3, 95% CI 1.2-15.5). Furthermore, the risk of mortality was higher in girls (2.1%) compared to boys (0.8%) (age-adjusted OR 2.6, 95% CI 0.8-8.4). Children from homes with a traditional cooking stove had an increased mortality risk (aOR 13.8, 95% CI 1.8-108.3) compared to homes without such stoves. Regarding mortality in different PC categories, two out of three children who died within 90 days of treatment had presented as suspected infections (aOR for mortality in infections compared to other complaints was 2.7, 95% CI 0.8-9.4).

Among the triaged subpopulation (n=1248), 4% of the children were in the red triage category, 15% in orange, 49% in yellow, and 32% in green. Red and orange cases indicated high severity

with the need of urgent care, and these two categories comprised 60% of the poisoned patients, 23% of infections, 13% of injuries and 14% of abdominal complaints. Associations between triage category and hospital disposition were assessed. For the red category, 28% of patients were admitted to the general wards (aOR was 4.1, 95% CI 1.9-8.9 compared to discharge from ED), and 42% were admitted to the ICU or OT or were referred to other hospitals (aOR was 32.1, 95% CI 13.5-76.6 compared to discharge from ED). Mortality after emergency care in the red category (16%) was high compared to the green category (0.7%), and aOR for death in the red category was 56.5 (95% CI 4.6-687.3).

Conclusions: The findings in this unselected paediatric emergency population highlighted a high number of children with infections and injuries. Sex-related differences were observed, with girls being attended at EDs less frequently but displaying a higher risk of death after emergency care. Triage categories were strong indicators for hospitalization, intensive care need and mortality after emergency care. The study supports the use of triage systems and the need for interventions that can reduce mortality after emergency care.

Figure 15. Flow diagram of cohort and distribution of presenting complaints.



PC=presenting complaint. *Other complaints included musculoskeletal, neurological, urinary, cardiovascular diseases or complaints, psychological and other general complaints.

5. DISCUSSION

5.1 Strengths, limitations and methodological considerations

Epidemiological study aims to study the distribution and determinants of health-related events in a specific population and obtain estimates of epidemiologic measures [194]. However, the estimates may be biased by random error or by systematic error that interfere with the precision and validity of the results [194].

5.1.1 Study design

Study designs are broadly classified into experimental and observational studies [194]. Experimental studies enable the researchers to identify the causal link between interventions and outcome of interest. Observational studies are either descriptive or analytical and do not explore causal effects [195].

This study is the first in Nepal to describe a large, unselected emergency population presenting to a local hospital in Nepal. Furthermore, this study is the first in Nepal to estimate emergency population mortality 90 days after emergency care. The main objective of this thesis and the included studies is to provide a descriptive overview of the emergency patients at a Nepalese hospital. Our study population was patients presenting to the ED of Dhulikhel Hospital (DH) during a three-year study period. For all three studies, we addressed the research questions through a prospective observational study. We followed up with the included patients through systematic telephone interviews 90 days after emergency care to estimate mortality after emergency care and to assess factors associated with mortality. Observational studies observe and assess the strength of the association between the exposure and outcome variable [195]. Descriptive studies are important for trend analysis, health-care planning and to generate hypotheses for testing in further analytical studies [195].

5.1.2 Precision (lack of random error)

Precision is a lack of random error; a precise estimate has few random errors [194,196]. Random error can be defined as variability in the observed data that cannot be readily explained [194]. An estimate depends upon the underlying variability of the data as well as the sample size. The more variation the population is, the higher the uncertainty of the estimate. Likewise, sample size affects precision: random error decreases as the sample size increases. The statistical significance test evaluates whether the association between exposure and outcome is likely caused by chance. The CI with effect size offers a way to explain the statistical results

with magnitude and is more reliable and informative than the p-value. A narrow CI indicates precise estimates [194]. Moreover, CI demonstrates not only the precision but also the size of the association [194,197].

One of the primary aims of *Paper II* and *Paper III* was to assess associations between patient characteristics and mortality after emergency care. The total cohort in *Paper II* and *Paper III* were fairly large, although the subset of the population followed up at 90 days after ED presentation was small. In *Paper II*, we found that patients with respiratory and CVD complaints showed statistically significant associations. Other associations between patient characteristics (hospital revisit, women's literacy and women's exposure to smoke) and mortality were statistically significant. Patients presenting with unconsciousness and those among Dalit ethnic (low-socioeconomic) groups, however, demonstrated a positive but statistically non-significant association, indicating that the study has insufficient power to reject chance as an alternative explanation. Thus, a larger sample size may be needed.

In *Paper III,* exposure variables such as patient characteristics (sex, age, rural region, exposure to smoke), suspected infections and ED disposition were shown to have positive associations. However, the associations are not statistically significant and they have wide CIs. The small-group analysis of the paediatric population examining the association between triage with ED disposition and mortality after emergency care shows a positive and statistically significant association, albeit with larger CIs. This finding indicates that the study must be replicated in future studies with less variability by including a larger sample size or decreasing loss to follow-up. We did not assess the statistical associations in *Paper I* because the study objectives were purely descriptive.

5.1.3 Validity (lack of systematic error)

Validity is defined as a lack of systematic error; a valid estimate has little systematic error [196]. Systematic error, however, is not affected by the size of the population [194]. Validity refers to how sound the research design and methods are to draw conclusions and make inferences about the population. There are two major types of validity: internal validity and external validity. Internal validity refers to whether the observed results represent the truth in the population we study and have no methodological errors. Internal validity can be affected by random error and systematic error. External validity refers to the ability to apply the study results to different settings outside the source population [198]. Systematic error is also known

as bias. The most common biases are selection bias, information bias and confounding [194]. Bias can lead to overestimation or underestimation of associations [199].

5.1.4 Selection bias

Selection bias is a systematic error that arises during the selection procedure of the study sample. Selection bias arises when the study participants selected for the study vary compared to those who do not participate [194]. Self-selection is a common source of selection bias that could affect the outcome of study [194].

Study cohort

The studies included in this thesis *(Papers I-III)* included all patients presenting to the ED of DH during the study period, 2013-2016. The inclusion criteria in *Paper II* and *Paper III* were patients with complete information on age, sex and PCs. The main strength of the studies included was the inclusion of an unselected population seeking emergency care in the ED of DH during the three-year study period, thereby limiting seasonal variations.

Paper I included all patients presenting to DH during the 2015 earthquakes *as described in section 3.4.1*. The main aim of this study was to describe the burden and distribution of emergency patients presenting to DH during the study period. Of the patients with earthquake-related injuries, 41% were not included in the injury analysis due to unknown injury information, which could lead to an underestimation of specific injury types. Another bias could be that we were not able to register numerous patients in the first two days because of an overwhelming number of patients and a failure to maintain the registration system. The patients in these first two days could have had more severe conditions, and patients with multiple injuries and head injuries could have been referred to other hospitals because of lower health service capacity. We observed a low number of severe injuries in the study hospital. We speculate that many severely injured people could have died before reaching health facilities or were not recorded in the first two days. This situation could be explained by the difficult geographical terrain in the earthquake-affected regions and continuous landslides affecting the transport system, which prevented many injured and ill people from accessing health facilities.

Loss to follow-up

The cohort included in *Papers I-III* was followed up through telephone interviews to determine health outcomes after ED disposition and/or mortality at 90 days after emergency care and to assess factors associated with mortality.

In all three studies, the follow-up rates were relatively low. There is a potential for selection bias in the interviewed patients since only patients who provided telephone numbers were called at 90 days after emergency care. We suspect that patients who provided telephone numbers might be wealthier and healthier compared to those who did not provide telephone numbers. Patients who did not provide telephone numbers were not interviewed; these patients might not have access to a phone due to economic conditions, and these patients could also be frailer, potentially leading to underestimation of mortality. We also consider the possibility that patients who were referred to other hospitals from the ED were transferred due to occupied ICU beds or cases of severe head injuries; these patients may not have provided their telephone numbers because they spent much less time at the ED at DH. Moreover, there is a possibility that those who were called and did not answer the phone were more likely to have died. Although patients not included in the interviews had similar characteristics to those included in interviews, we were not able to rule out the possibility of selection bias. We are therefore aware of the possibility of underestimation of mortality at 90 days after emergency care, which suggests the need to replicate similar studies with larger sample sizes and reduced loss to follow-up.

An unavoidable flaw in our study (for *Paper II* and *Paper III*) was the earthquake that occurred in the middle of the study period, which could completely distort the distribution of patient characteristics, presenting complaints and severity. However, the characteristics and distribution of patients before and after the earthquake did not differ, except that the hospitalization rate decreased in the ED population after the earthquake period.

5.1.5 Information bias

Information bias, also known as misclassification, is one of the most common sources of bias in health research [199]. Information bias is a systematic error that often occurs during data collection when the information collected is incorrect and/or the classification of categories in exposure, outcome and confounder variables is incorrect due to information bias [196]. Patients in the study might be placed into incorrect groups because of incomplete medical records, recording errors, misinterpretation of records and errors in records such as incorrect disease codes, participant recall bias or patients misunderstanding the question. Misclassifications can be differential or non-differential [196]. Differential misclassification occurs when error depends on other variables and non-differential when misclassification is independent of the values of other variables [196].

Patient information for *Papers I-III* was prospectively collected using emergency patient forms and was entered into the emergency registry, an electronic data system, by trained research nurses. The principal investigator and/or PhD student maintained close monitoring and supervision during data extraction and conducted the categorization themselves. Use of registry data minimizes the risk of information bias compared to self-reported information [199]. However, the PCs used in *Paper II* and *Paper III* were recorded on the individual emergency patient forms and were written in free text by the triage nurse at ED presentation. This information was later transferred to the electronic data system. The handwriting was sometimes quite difficult to understand, which could lead to inaccurate interpretation. This possibility was minimized by using local research nurses with experience working in EDs and frequent communication with ED staff. The PhD student and the research team retrospectively classified free-text PCs into 761 PC categories, which were later categorized into nine main PC categories. The process involved several meetings and discussions with the project research team. The PC classification process is explained above in section 3.5.3 in the materials and method section. The nine PC categories were classified based on the hierarchical approach to provide one main PC category for each patient. The nine main PC categories were self-harm (poisoning in *Paper III*), injuries, infections, unconsciousness, CVD (cardiovascular-related complaints or diseases), respiratory complaints, OBGYN complaints, abdominal complaints and other complaints. The classification of PC category in a hierarchical order may result in an underestimation of the frequency of complaints lower in the hierarchy. For example, if a patient had both pneumonia and COPD, then he/she would be allocated to the infection category. Thus, we recommend implementing a simple PC classification system prospectively during triage and recording the patient's main PC during triage rather than classifying PCs retrospectively.

Self-reporting is a common method of collecting information in medical research, although self-reported data are often considered unreliable and threatened by self-reporting bias [199]. Recall bias is a common type of bias in self-reported information [196]. Follow-up information in the current studies was collected through telephone interviews from the patients themselves or from the closest family members. We assume that information such as hospital revisit, exposure to smoke (tobacco smoke) and occupation could be affected by self-reporting bias and/or recall bias. Self-reporting bias arises in particular when anonymity and confidentiality cannot be guaranteed at the time of interview [199]. In the current study, confidentiality was maintained, which the respondent was informed of during the interview. However, if the responder was not the patient, then we could consider the potential for bias in reporting

information, where responders other than the patients themselves have the possibility of recall bias when providing patient-related information such as hospital revisit. The responder may or may not be an immediate caretaker of the patient. Moreover, we interviewed patients or close relatives without considering their age, which could possibly lead to recall bias. Information on tobacco smoke exposure could be under-reported, which would lead to underestimating the exact usage. Information on mortality after emergency care was also provided by the close relatives of the patients; we believe, however, that mortality information is free from recall bias.

5.1.6 Confounding

Confounding occurs when the association between exposure and outcome is affected by the presence of other variables, leading to bias [194]. A confounding variable is associated with exposure and outcome variable but is not an effect of exposure and outcome variable. A confounding variable must not be an intermediary pathway between exposure and outcome. Confounding occurs when the causal relationship between an exposure and an outcome is distorted by the effect of the third variable. Confounding is influenced by study design and is a major challenge in observational studies [200,201]. However, there are ways to address confounding factors using statistical measures, although such methods are limited to known and measured factors [200]. Confounding variables should be identified prior to experiments in which expert knowledge, whether clinical knowledge or epidemiological knowledge, is required on the research subject [202,203].

Paper I was a descriptive study in which we only describe the population using numbers and percentages. In *Paper II* and *Paper III*, age and sex were identified as potential confounding variables and were adjusted in multivariable logistic regression analysis. In *Paper II*, we found evidence of interactions by sex for associations between demographic factors and mortality. Thus, the results for associations between demographic factors and mortality after emergency care are stratified by sex. We suspect the possibility of residual confounding in *Paper II* and *Paper III*, which could lead to overestimation of associations. Other factors that were not considered in the current study might be affecting mortality after emergency care. In *Paper II*, we assessed associations between PCs and mortality after emergency care, taking NCDs into account. The results for these analyses show that mortality was particularly high for those who had an NCD diagnosis at ED presentation, regardless of PC. In *Paper III*, we assessed in a sub-population associations between triage codes and severity (mortality after emergency care and

ED disposition) to address the association with patient severity at ED presentation, which displayed a positive association; however, the estimates were not precise. This finding indicates a need for further studies that include information such as vitals at presentation, triage score, comorbidity, diagnosis at discharge, availability of follow-up systems, transportation and affordable medication.

5.1.7 External validity

External validity refers to generalizability, i.e., to what extent the study findings are applicable to other populations. The study included an unselected population seeking emergency care at a local hospital during the three-year study period. However, all three studies included in this thesis included patients treated at only one hospital in Nepal; the use of a single hospital as study site may limit the generalizability of our results. Thus, it may be possible that the results are not truly representative at the population level.

Nepal is a diverse country with unique population characteristics partially determined by geographical topography and the length of time it takes to reach health facilities. Age and sex distribution of the study region, however, was comparable to the country level. The literacy rate in the study region is slightly higher (70%) than in Nepal overall (66%) [204]. The population distribution by ethnic groups varies broadly by geographical region [204]. For example, most of the Janajati group lives in hilly/mountainous regions whereas the Madhesi group lives in the Terai region. In our study, the Madhesi group were underrepresented. Likewise, accessibility to health facilities varies between regions: 25% of the population living in the mountains must travel more than 60 minutes to reach the nearest public health facility, compared to 17% of the population in the hilly region and 3% of the Terai population [57]. Population health awareness, burden of disease and emergency conditions vary widely among the regions and between rural vs urban areas. This finding could be explained by the fact that children living in the Terai region are twice as likely to suffer from diarrhoea than those in the hills and mountain [57]. Likewise, the proportion of road traffic injuries is more common in the central and eastern regions (29% in each) compared to the western region (11%) [205]. However, we have shown that the study population was relatively representative for the region.

In *Paper I,* we describe the patient burden and distribution of earthquake-related injuries during the 2015 earthquakes in Nepal. Results reported from the field hospitals in Nepal [206-209] during the earthquake period were consistent with our findings. The health systems were overwhelmed, and the conditions made it difficult to collect national data on the distribution of

injuries. No other local hospitals have reported the injury burden during the 2015 earthquakes in Nepal. The characteristics of the population, geographical landscape, housing infrastructure, health system, and health response capacity differs between regions and between countries. Thus, some results from other LMICs were consistent, while others were conflicting [207,210-212]. Considering some of the potential challenges, the results from *Paper I* are likely generalizable to other similar settings facing similar challenges.

Paper II and *Paper III* included all adults and paediatric emergency patients, respectively, presented to a Nepalese hospital. The cohort consists of a large, unselected population and is representative of both rural and urban regions. The distribution of patient characteristics included in the study demonstrated high representativeness for the region with respect to age, gender, and ethnicity [204]. The literacy rate in our study population was 47%, which is lower than in the region overall, at 70% [204]. This differentiation largely depends on the classification system: we classified participants as literate if they had attended school, whereas in the baseline population, the definition of literate included those who can read and write, regardless of school attendance. The findings should be interpreted with caution to other similar settings in which emergency health care systems are underdeveloped. The country's geographical diversity and sharp divide between rural/urban regions affect the disease and injury burden, suggesting a need for further studies that include multiple study sites.

The findings for mortality at 90 days after emergency care in our study were novel. However, factors associated with mortality could differ among regions and among countries. The factors related to mortality and factors influencing the risk factors associated with mortality were similar to those in other countries, with some differences [129,213-217]. There are very few studies after hospital disposition in LICs with which to compare our findings. Our findings, however, are noteworthy and should be considered for further follow-up studies with a larger sample in Nepal and in other similar settings. As noted, generalization should be done with caution.

5.2 Discussion of main findings

The results presented in this thesis describe the characteristics, PCs and condition severity of emergency patients at a hospital in Nepal both during the 2015 earthquakes and a normal period. In *Paper I* we described patients during the earthquakes, and in *Paper II* and *Paper III*, we described the adult and paediatric emergency population, respectively, during a normal period.

5.2.1 Patient load at ED and a local hospital experience during the earthquakes

Over the course of the normal study period, over 30,000 adults and 6,317 children were treated in the ED. Most adults and children sought emergency care after office hours or during the holidays. This trend is not surprising given that outpatient departments (OPDs) are closed after 16:00 hours and on weekends and holidays, whereas the ED provides emergency care 24 hours a day, 7 days a week. Patients are allowed to choose either emergency care or OPD services, regardless of their care needs. Emergency care is comparatively more expensive than OPDs; however, we are uncertain whether patients seeking health care have enough knowledge on the differences in care provided through OPD and ED services. Regardless of urgency, patient load was much higher between 16:00 to 20:00 hours (data not reported in publication), indicating the need to consider a different approach in managing these patients.

During the earthquakes, approximately 2000 patients were treated by Dhulikhel Hospital (DH) in Nepal. The patient load was especially high in the first week following the first earthquake and was five times that of normal weeks. This surge stands in contrast to reports from the international field hospitals that began providing services three days after the first earthquake and reported a relatively low number of earthquake-related injuries [207-209]. International medical teams typically need several days after a disaster to initiate their services [207-209]. Until these teams arrived, patients were treated by the often poorly developed local health system, and many severely injured people likely died prior to receiving medical treatment. The study hospital set up immediate medical direction, 24-hour surgical services, infection control teams, and logistical management teams, who played a vital role in managing unpredicted workloads and providing efficient and quality health care.

The earthquake-related injury rate at the study hospital was elevated until 21 days after the first earthquake. Most injured patients came from the severely affected Sindhupalchok District, despite its being at least a two-hour drive from DH. According to official statistics, this region was highly affected with regard to number of deaths and damage to health facilities [188,218].

Many severely wounded individuals from this district likely never reached a health facility, and the travel distance likely explains the long-lasting peak of earthquake-related injuries presenting at the hospital, as well as the low mortality and relatively small number of severe injuries. In Nepal, many earthquake-affected areas are rural and mountainous, and there were continuous landslides in many of these areas [138,219,220], which affected transportation and prevented timely access to health facilities. The pre-existing but inadequate health system capacity and the destruction of the existing health infrastructure in these regions made access to health care even more difficult for those affected [146]. Thus, strengthening local health care systems, emergency preparedness and response is essential.

A relatively small number of patients with non-earthquake-related health problems sought health care in the first week after the first earthquake, but the numbers increased to normal levels in the second and third weeks. During disasters, regular health care for non-earthquake-related health problems is often less prioritized and even disrupted, although acute trauma care is likely jeopardized by inadequately controlled NCDs such as cardiovascular or diabetic disease [221]. Thus, treatment interruptions for non-earthquake-related health problems should be minimized during the acute phase of the emergency.

5.2.2 Characteristics of emergency patients

During the earthquakes, we found that females were particularly affected by earthquake-related injuries (59% versus 54% of women in the country) [222]. This finding may support the conclusion that women were particularly vulnerable to this earthquake, as it occurred on a Saturday morning, when many women would be inside their homes, busy with household chores. A field hospital [208] and a spinal cord rehabilitation centre in Nepal [206] observed similar findings. Studies have reported that women, very young or old people, those with disabilities, those with poor socio-economic status, or those inside the house at the time of the earthquake or having poorly constructed homes experienced higher health impacts during the earthquakes [211,223,224].

In the adult population, no differences were found between men and women seeking emergency care. In contrast, in the paediatric population, the majority of the children (63%) were boys, compared to approximately 51% boys aged 0-9 years in the 2017 Nepali population and there was no meaningful sex difference in children aged 10-19 years [225]. Interestingly, several paediatric studies from Asian LMICs have reported that boys were considerably overrepresented among those seeking emergency care [226-229]. Singhi et al. [226] suggested

that a possible explanation for this difference could be the increased vulnerability of boys to ill health. Another explanation may be that boys are more valued in these societies and, therefore, receive preferential attention from the family during illnesses, possibly particularly when resources are limited. It has been reported that in Nepal, boys are more valued in society and therefore receive advantageous attention and are prioritized for health care during illness [190,230,231]. The assumption of gender inequality in our study may also be strengthened by the observation of more girls than boys in the unconsciousness and poisoning categories, possibly indicating that girls were taken to the hospital only when they were critical or life-threateningly sick. There is a need for further large studies to be replicated in similar settings. Our findings for distribution of mortality after emergency care also show higher mortality in girls than boys.

Patients seeking emergency health care were generally young, both during the earthquakes and in the adult emergency population. Among patients with earthquake-related injuries, half were under the age of 35 years, and one in five patients with earthquake-related injuries were children under the age of 15 years. Similar age distribution was found in the field hospital [208]. This finding may be explained by the fact that children are often together with their mothers. In line with a systematic review in LMICs [9] and studies from Nepal [175] and Cambodia [232], the majority of the adult emergency population was young (median age was 40 years, IQR 26-60). In the paediatric population, the median age of the children was 7 years (IQR 2-12 years), and 39% of the children were 5 years or younger [42], compared to 15% in a hospital in eastern Nepal [233]. These figures could vary due to accessibility and health care capacity in different regions. The study hospital is one of the specialized hospitals for children in the region, whereas in the eastern regions, there are many options for health care.

No meaningful differences were found between the ethnic groups and rural vs urban distinction across the PC categories in all three studies. However, emergency care seeking among the Brahmin/Chhetri group (considered a group with higher socioeconomic status) was slightly higher (41% in adult and 45% in paediatric population) compared to that of the study region overall (36%) [204]. This difference suggests the need to study other factors that better describe the population's economic status.

5.2.3 Presenting complaints

In all three studies, injury was the main PC in patients seeking emergency care. During the earthquakes, it is obvious that the majority of the patients presented with injuries; nevertheless,

nearly one in four patients presented with non-earthquake-related health problems. In the adult emergency population, injury was the main PC, followed by abdominal complaints, infection-related complaints, and NCD-related complaints. In the paediatric emergency population, injuries and suspected infections dominated the PCs.

Injury

The majority of injuries during the earthquakes were fractures, often in lower extremities. Our findings were consistent with those of the field hospitals [207-209] and a local hospital in Nepal [234]. The proportions of severe injuries such as compartment syndrome, crush injuries and internal injuries were relatively low compared to the total number of injuries. Nevertheless, more than 100 severe injuries were treated in the hospital, and one in three injured patients had at least two different injuries. We believe that many severely injured individuals died before receiving health care because of the undeveloped health care infrastructure, inaccessibility to health facilities and non-functioning transportation systems. In our study, more than 300 patients underwent an orthopaedic procedure. Internal fixations (open and closed reductions) represented 61% of the performed procedures. In a review study on earthquake injuries in developing countries, debridement (33%), closed reduction (24%), open reduction and internal fixation (24%) and external fixation (12%) were described as the most common procedures performed [235]. Many survivors who reached the hospital in the present study needed treatment for orthopaedic injuries, and these findings are in line with others [235]. The hospital mortality was low; thus, appropriate medical and surgical care capacity is likely to have saved lives and spared disabilities. The high number of internal fixations may also have reduced infectious complications.

The ED In-Charge summarizes the situation as follows: *"Many patients had spinal fractures, flail chest and pneumothorax. I remember clearly the scared face of an old lady who was found gasping but improved drastically after chest tube insertion. Each and every dressing was opened. Most patients who arrived in the following days had wound infections with greenish, foul-smelling discharge. We took them to procedure rooms and performed wound cleaning and debridement. All such patients received 3rd-generation cephalosporin, gentamycin and metronidazole. The emergency procedure room was one of the busiest departments, and we had to set up the dressing and wound healing stations outside."*

In the adult and paediatric emergency population, injury was the main presenting complaint, similar to reports from other LMICs [227,236,237]. In the adult population, the proportion of

injury has increased by almost 10% compared to a report from the same hospital in 2013 [238]. Fall injuries were the most common injury type in both the adult and paediatric population, followed by road traffic injuries. Road traffic injuries are projected to be the sixth-leading cause of deaths and third-highest cause of DALYs by 2020 [1]. In Nepal, road traffic injury ranks 8th among the causes of premature deaths [99]. In the adult population, young men were the most commonly affected by injuries, consistent with comparable settings [104,175,238-242]. This difference could be explained by the fact that the hospital serves almost two-thirds of the patients from rural regions (hilly and rocky terrain), and young men are more active in outdoor work compared to women in this region. Furthermore, this hospital is centrally located from few major highways, and surrounding areas have narrow, rocky and earthen roads; high speed, overload, overtaking, and the popularity of motorcycles among young men are common causes of traffic accidents. In the paediatric population, the tendency of fall injuries decreased with increasing age, whereas traffic injuries increased with increasing age (data not reported in publication).

The mortality after emergency care in the adult injury population was 3% (n=34), a very high number given that the most severely injured patients may never have reached the hospital. These findings indicate the need to establish robust trauma services and underline the importance of strengthening the health response capacity and health infrastructure in the rural regions, given the hurdles posed by mountainous regions. Moreover, prevention of injuries should be a national priority and is achievable, as evidenced from other developed countries in past decades that have reported a significant decrease in traffic-related deaths [243].

Self-harm

Self-harm or suicidal attempt is a complex issue and is one of the most frequent complaints presenting to the ED. The maternal mortality and morbidity report from Nepal in 2008/09 reported that suicide was the single leading cause of death among women of reproductive age (16%), compared to maternity-related issues (12%) [112]. Suicide in Nepal is stigmatized, and many deaths by suicide are reported as accidents. In the adult population, more than two-thirds of self-harm cases were observed among young women. This differentiation could be explained by the fact that women face social hardships; studies have shown that partner violence, alcoholism, polygamy, the culture of silence, early age at marriage and financial dependency were the major predisposing factors for attempting suicide among women [244,245]. Furthermore, psychological coping mechanisms may not be sufficient to manage major stresses

in life in the younger population. In line with another study from Nepal [246], we found that these patients were seriously ill, and the majority were admitted to an ICU. Likewise, during the earthquakes, we observed twelve patients with severe self-harm poisoning; eight out of the twelve severe cases were women. A study from Nepal reported a 41% increase in suicides three months after the earthquakes, and a field hospital reported that 6% of all patients during the earthquake period suffered from psychiatric conditions [208,247]. It is possible that the population affected in this area felt vulnerable to despair and hopelessness, and the majority of the affected people were from rural and poor areas. These findings indicate that self-harm and/or mental health is a serious public health problem, especially among young women. Further studies and effective preventions are warranted.

Infection and NCD-related complaints

Over the last several decades, focus has shifted from communicable to non-communicable diseases worldwide. The increase in NCDs in LICs has overwhelmed the undeveloped health systems with the double burden of disease. In the adult population, infection-related complaints were the third-highest PC when seeking care at the ED, followed by NCD-related complaints. In the paediatric population, children with infection-related complaints were as frequent as those with injuries. Likewise, the majority of non-earthquake-related health problems treated during the earthquake period were infectious diseases and NCDs.

In the adult emergency population with infection-related complaints, the majority had gastrointestinal and urinary infections (30%), followed by fever (28%) and respiratory infections (26%) (data not reported in publication). Although injuries and infections formed the largest proportion of PCs, our result was consistent with previous findings from Nepal that NCDs were an increasing reason for seeking care among adults [98,248]. Nearly one in ten adults seeking emergency care presented with CVD-related complaints or respiratory-related complaints. In the earthquake-affected population, COPD, CVD and diabetes were common NCD-related complaints among older adults. Studies from other LICs were consistent with our results, reporting respiratory and abdominal complaints as the most common complaints at ED presentation [130,237,249]. No differences between men and women were observed in these groups. However, hospitalization and mortality were higher in these groups compared to those with other complaints. This difference indicates the need to implement preventive efforts, follow-up programmes and interventions when improving acute care in response to the growing burden of NCDs.

In the paediatric population, infection-related complaints were as frequent as injuries and were more common in children ≤5 years old, most often with gastrointestinal and respiratory infections. Likewise, in the earthquake population, the proportion of infection-related complaints was higher among children. The findings were consistent with studies among children from Nepal [250], a WHO report [251] and in other comparable settings [226,227,252-254]. The severity was high among children with respiratory infections, as shown by triage groups. The WHO reported that the leading causes of death for children under five in 2017 were preterm birth complications, acute respiratory infections, intrapartum-related complications, congenital anomalies and diarrhoea [251]. In 2016, the NDHS reported that child mortality in Nepal was highly related to area of residence (higher in rural children), mother's education and family income. The frequent presentation of infection, particularly among children, and of NCD-related complaints in older adults at the ED offer the opportunity for the development and implementation of uniform emergency medicine guidelines for commonly encountered infection-related complaints in children and NCD-related complaints in adults.

5.2.4 Hospital disposition

The hospitalization rate was high during the earthquakes and was higher for earthquake-related injuries (54%) compared to non-earthquake-related health problems (45%). However, referrals to other health facilities and mortality after emergency care were high among non-earthquake-related health problems. This distinction likely indicates a limited health care capacity in the hospital during earthquakes and prioritized health care assigned to earthquake-related injuries. In contrast, the proportion of hospitalization was lower in the adult population (29%), compared to other studies from Cambodia (60%) [232] and Pakistan (36%) [255]. Likewise, in the paediatric population, the proportion of hospitalized children was low (37%). The hospitalization rate in similar age groups in the paediatric population in similar settings was not consistent, ranging from 9%-51% [227-229]. This variation is likely due to heterogeneity in health care models in these countries. The study hospital receives unselected patients, and outpatient departments are equally an entry point for hospitalization; this study did not include those patients. The high proportion of patients discharged home from the ED in LMICs stands in contrast to that in countries where the primary health care system screens the majority of patients before they eventually present to the hospital ED [193].

Direct transfers from the ED to the ICU or OT in the adult population were less frequent (8%) than reported in Pakistan (13%) [255]. However, these proportions depend not only on the severity but also on the capacity of the ICU and OT in the hospital. Moreover, computed tomography (CT) scan and magnetic resonance imaging (MRI) were not available at DH during the study period. These observations indicate important variations in practice and capacity and may complement the findings from a systematic review and reports from Nepal and Pakistan that reported a need for specialty-trained ED providers [9], patient management protocols [51], availability of essential emergency equipment and knowledge among providers [256]. We found a high rate of family-initiated discharge (10%) compared to a study from India (4%) [257]. Over 50% of these patients were young adults (17-45 years), while only one-third were ≥ 60 years of age (often with COPD and CVD). Information on reasons for family-initiated discharge was not available for this study, but based on local knowledge, it is often related to financial reasons or a wish to continue medication at home. Especially in the elderly and severely ill population, terminal care at home is often preferred. In an Indian study, poor financial condition was reported as a main reason for discharge requests [257], whereas in the USA, delay in care and inadequate patient-provider communication were main reasons for family-initiated discharge [258]. Furthermore, we observed a very high mortality rate after emergency care among patients with family-initiated discharge, much higher than in a population-based study in Manitoba (Canada) [259]. The high mortality in this group can be explained by the Nepalese culture favouring dying at home. However, further investigations are required to understand the reasons for family-initiated discharge or leaving the hospital against medical advice.

5.2.5 Mortality and severity at 90 days after emergency care

In the earthquake population, mortality after emergency care in earthquake-related injuries and non-earthquake-related health problems was two and five times higher, respectively, than the overall hospital mortality rate. Patients who had died at home by 90 days after admission had severe injuries (spinal fracture, blunt trauma), burns or NCDs. Previous studies during earthquakes have not considered mortality after emergency care. However, the local tradition is strongly in favour of deaths occurring at home, and severely injured patients could therefore have been discharged to die at home. Nevertheless, we cannot ascertain the cause of death at home, which should be considered for further investigation. The information from the interviews after emergency care reveals that poor people are more vulnerable after an earthquake and that the effects of the disaster become more severe over time. Nearly nine in

ten of the interviewed patients had experienced severe damage to their house, had lost a family member, and/or were still living in a temporary shelter 90 days after the earthquake.

In the adult population, we found that mortality after emergency health care was more than 20-fold the ED mortality. Likewise, in the paediatric population, mortality after emergency care was high (1.3%) compared to the ED mortality (0.1%).

A local ED doctor at DH responded to the results as follows: "The high mortality is shocking. Now we know why our patients do not return: they are dead."

PCs are recognized as equally important as diagnosis in predicting long-term mortality [260]. Patients with respiratory and cardiovascular complaints experienced particularly high mortality. In the adult population, nearly one in four patients with these complaints died within 90 days. This rate is much higher than reports from HICs. The 60-day mortality among patients with respiratory complaints in a Spanish study was 6.3% [261]. In the paediatric population, we compared mortality after emergency care with suspected infection in ED with other PC categories and found that mortality in the first group was approximately three times that of the latter. In other paediatric studies, specific diagnosis has been the main target for analysis [129,213,214]. Thus, in those studies, typically malnutrition and respiratory tract infections had the highest mortality rates after discharge. It is important to note that the great majority of the studies included are from Africa [129].

Many factors may contribute to the high mortality after emergency care that we observed. We suspect that patients in this setting only seek emergency health care at hospitals in the late stages of chronic diseases and that adequate follow-up and long-term medication could be hindered by the lack of available follow-up care and unaffordable health services for many of these patients [79,215]. Typically, the availability of long-term treatments for COPD and CVD patients is very low, and follow-up systems for chronically ill patients are underdeveloped [215,216]. Moreover, local systems and transport systems that can handle rapid and adequate responses to acute illness are underdeveloped and contribute to mortality in these patients. These results suggest a need to develop post-discharge care systems, which would likely reduce long-term mortality in emergency patients.

The risk of dying is higher in older age groups. In the adult population, we found that mortality after emergency care was much higher in the age group ≥ 60 years (23%) compared to a study from Netherlands that reported a mortality rate of 10.5% among age groups ≥ 70 years [217]. In the paediatric population, infant age was associated with higher mortality after emergency

care, which is consistent with studies from Africa [213,262]. Although girls were underrepresented in our study, mortality after emergency care was higher in girls than boys. Similar sex-specific analyses were only performed in a few previous studies, and the patterns are not conclusive. Higher mortality for girls (about two times higher than for boys) were found in a study on diarrhoea from Bangladesh [263] and on respiratory tract infections from Kenya [264]. We are speculating that this difference could be explained by girls being taken to health care services at a later or more severe stage of the disease. Another possibility is that girls are not receiving the same level of post-discharge attention and treatment.

In the adult population, we found illiteracy independently associated with increased mortality at 90 days after emergency care in women but not in men. Secondary analysis of the 2011 Nepal Demographic and Health Survey reports that illiterate Nepalese women are less aware of health risks, which could result in less health-seeking behaviour [265]. Furthermore, higher mortality was observed with increased smoke exposure in women but not in men. A high burden of chronic lung disease in Nepalese women has been reported; one study reported that COPD comprised nearly half of the NCD burden in Nepal [98]. Another study reported that the prevalence and incidence of COPD in men were high, but corresponding mortality and DALYs were higher in women [266]. Furthermore, we also found that children living in a house with a traditional stove was a strong indicator of higher mortality risk in the paediatric population. In Nepal, approximately two-thirds (64%) of households use solid fuel for cooking, and such usage is even more common in the study region (78%) [42]. Nepalese women are often with their young children and typically spend substantial time cooking. Thus, many women are exposed to traditional cooking stoves, which affects respiratory health, and symptoms of respiratory problems are often long-standing without seeking health care [267,268]. Our finding is supported by a meta-analysis of 24 studies in children by Dherani et al. [269] that concluded the increased risk of pneumonia in young children by exposure to unprocessed solid fuel by a factor of 1.8. The results showed that mortality was higher among poor people living in rural regions.

5.2.6 Triage

EDs in LMICs are typically crowded and receive patients for assessment with a wide spectrum of conditions and severity. Thus, systems to prioritize patients are essential. The WHO conducted a study in 21 hospitals in low-income settings to assess the quality of care for seriously ill children [270] and found heterogeneity in paediatric critical care and competence

in assessing paediatric illnesses and treatment. A review of emergency medicine in Nepal concludes that the country has a critical shortage of health service providers and that emergency medicine has largely been neglected in terms of health system development and specialist training [51].

Various triage systems have been developed to help emergency health care providers make accurate priority decisions. We implemented the RETTS triage system at the ED of DH and reported the results for triage in the paediatric population. Paediatric emergency triage systems were recently systematically assessed, with the conclusion that there is some evidence for the reliability of the RETTS-P (RETTS-paediatric) [271]. However, the RETTS triage system has many algorithms, and we therefore assume that this system could be too complex and time-consuming for the Nepali setting. Only one of the 18 studies of triage system reliability identified in the systematic review [271] was from an LIC [272]. Thus, the present report, which assessed the associations between triage severity category and indicators of severity, such as hospital admittance, ICU treatment, and mortality, is unique. No previous study has assessed whether mortality after emergency care could be associated with severity at presentation as indicated by triage category. We explored the use of triage codes in indicating risk of mortality at 90 days after emergency care in the paediatric population and found a very strong association: mortality in the red category was 16%, and risk gradually reduced in lower triage categories. We are not aware of other studies that have assessed triage and mortality after emergency care. Further studies are needed to evaluate triage systems that can operate well in low-resource settings.

Likewise, the implementation of a triage system based on injury type (appendix) from the second day of the earthquake at the main entrance of the hospital was very helpful in patient management and ensuring timely treatment according to severity. The triage system consisted of three treatment zones (red, orange/yellow, and green) and four triage codes (red for highly severe, orange, yellow and green for less severe). The main recommendations by other reports for emergency health care system improvements in LMIC include systematic triage, regular monitoring and strengthening emergency care capacity [2,270,273,274].

6. CONCLUSIONS

Paper I

- The local hospital experienced a very high caseload during the first days after the first earthquake, and the majority of patients required orthopaedic services. The burden of emergency cases was high before the international field hospitals could be established.
- The proportion of severely injured and in-hospital mortality was relatively low, likely indicating that the most severely injured did not reach the hospital in time.
- Our study result underlines the importance of developing consistent and robust local health services capable of managing natural disasters such as an earthquake while also maintaining adequate medical care for other patients.
- The hospital staff rapidly initiated the systematic screening of patients arriving at the hospital using a simplified triage system and prioritized effective surgical services. The implementation of a triage system was beneficial in managing the large number of patients during the earthquakes.

Paper II

- Our findings on mortality after emergency care are novel: nearly one in ten adult patients seeking emergency health care died within 90 days of emergency care.
- Patients with respiratory and cardiovascular complaints had particularly high mortality: nearly one in four patients with these complaints died within 90 days.
- Studies after emergency care must be replicated with adequate systems that limit loss to follow-up, and appropriate follow-up programmes in low-resource settings where primary health care is underdeveloped are urgently needed.

Paper III

- Sex differences were observed in the paediatric emergency population, with girls being attended less frequently but displaying a higher risk of death after emergency care.
- Triage categories were strong indicators for intensive care need and for mortality after emergency care.
- The findings support the usefulness of systematic triage systems at EDs and the need for interventions that can reduce mortality after hospital discharge.

7. FURTHER PERSPECTIVES AND IMPLICATIONS

Emergency disease and conditions pose major challenges to the health system, particularly in LICs. The study findings provide an overview of emergency diseases and conditions and their severity in a hospital in Nepal. Research-based knowledge must be used by policy makers, health care providers and managers. This project highlights the need to strengthen emergency health care beyond ED care and for further studies that include multiple sites.

7.1 Strengthening emergency health care systems

Local health care response capacity during earthquakes and during normal periods

The 2015 earthquakes in Nepal primarily affected poor people living in rural regions. The insufficient development and implementation of strategies for disaster management likely affected the outcomes during the earthquakes in Nepal [148]. Local health facilities and local people are the first responders during the disasters, but health facilities in earthquake-affected regions were heavily damaged, thus reducing the response capacity. The transport systems were obstructed by continuous landslides. Thus, we recommend building earthquake-resistant health infrastructures, especially in rural regions, with regular medical supplies, disaster preparedness and response teams at different levels, regular drills and response training at local levels, and effective referral systems. This approach will likely reduce the impact of disasters such as earthquakes on population health in areas where the difficult landscape often poses a challenge. The study results further suggest a need for local health facilities and/or hospitals to be prepared in providing regular health services for patients with non-earthquake-related health problems (NCDs, CDs, obstetrics and gynaecology). Furthermore, coordination and leadership challenges were recognized during the earthquakes within and between the health care providers, as well as disconnection between national policy and implementation at the local level [146]. Thus, better communication and coordination strategies among national and international medical teams are required.

The high number of injuries during the earthquakes and the increasing number of road traffic injuries among young adults indicates the need to establish robust orthopaedic services and trauma competence to prevent premature deaths and disabilities at different levels. The increasing burden of road traffic injuries in these settings should reinforce the government to take immediate action in implementing preventive measures and strengthening legislation. The enforcement of laws and the adoption of safety standards, such as seat belt and motorcycle helmet use, forbidding drinking and driving, and imposing speed limits, as well as timely access

to emergency care, have shown improved outcomes and are achievable [275]. Likewise, EDs at hospitals should develop the capacity to deliver quality health care to patients presenting with poisoning or self-harm, often at very severe stages; NCDs, often at late stages; and infectious diseases in children. Cost-effective preventive interventions should aim at reducing the burden and complications of NCDs, particularly in urban regions, and infections among young children through improving health determinants. The WHO asserts that cost-effective interventions such as promoting exclusive breastfeeding, improving access to nutritious food, education and awareness of danger signs among family members, improving access to water and sanitation, and improving immunization coverage could reduce preventable child deaths [251].

Post-discharge care

The high mortality following emergency care may have several explanations. This higher rate may indicate that in this setting, only patients with very serious or long-standing illness presented to emergency care. Furthermore, the high mortality in this population may indicate a lack of local health systems to secure care among chronically ill patients and patients with complications after emergencies. Higher mortality after emergency care in patients with CVD and COPD indicates that these patients seek health care at a later stage. In addition, long-term medications for serious or chronic diseases may not be available or affordable. The findings underline an urgent need to replicate similar studies. Furthermore, the establishment of affordable and accessible health care services, especially for the chronically ill, with proper follow-up plans after hospital disposition at all possible levels should be emphasized. Moreover, interventions and follow-up plans for children, especially infants, aiming at treating infection are warranted.

Triage

We were not able to test the effect of triage implementation, reorganization of ED and staff training at ED. However, in *Paper III*, we found that triage categories were strong indicators of advance health care need and a higher risk of mortality after emergency care. Considering the findings from *Paper I* and *Paper III* and findings from other previous studies, we recommend implementing low-cost interventions such as a systematic triage system, reorganization of the emergency room, emergency patient management protocols, and regular staff training, followed by studies to evaluate these changes. Triage systems that are simple,

easy and feasible for their respective settings should be implemented, and a specific system for the paediatric population should be considered.

Pre-hospital care

Pre-hospital care is one of the essential components in an emergency health care system and should be a government priority in countries such as Nepal, where geographical landscape and transport system pose challenges. In most countries, the majority of trauma deaths occur in pre-hospital settings [149]. In Nepal, the lack of an organized system for pre-hospital care [276] has negative health outcomes; for example, the injured person may be carried on another person's back through miles of jungles and mountains before they reach a primary health care facility. Thus, improving pre-hospital care at the local level should be emphasized to decrease unnecessary deaths. Systems for immediate response to emergency health conditions, including trauma, at location or at home or in the community and during transportation should be developed. Trained citizens are the most likely individuals to provide initial care. This care could be provided through offering first aid training and education to community members (volunteers, schoolchildren and teachers). Furthermore, emergency health service delivery and response capacity at primary health care centres (often the first health care providers) can be increased through emergency response training for staff, regular supplies and developing effective referral and communication systems with referral hospitals. Improving the transport system and increasing the number of equipped ambulances are other interventions. In the absence of ambulances in rural regions, first aid training to public transport drivers could be an option.

7.2 Systematic emergency patient registry

Health care information is important to delivering quality health care and to developing and evaluating interventions. A major challenge for any health system is streamlining the health information system. A current report from Nepal stated that only 31% of Nepalese public hospitals report inpatient morbidity using ICD-10, and none of these hospitals report mortality using ICD-10 for the cause of death [43]. The quality, consistency, and completeness of data is vital to evidence-based decision-making processes and to planning an effective health care system and/or interventions. Moreover, the diverse and unpredictable nature of work at EDs contributes to inefficient data collection. Most hospitals in Nepal lack electronic patient registry system.

In our study, we observed the crucial need to establish electronic systematic routine emergency patient registries. No systematic emergency registry system existed before our project. We refer to one of the challenges that we faced in *Paper II* and *Paper III*. In these studies, we described the burden of emergency patients by reporting PCs. No classification system was in use to record patients' PCs at the ED, which were recorded in free text. We later classified PCs retrospectively based on the ICPC-2 classification system into broad categories as described in the papers. Thus, we assume the possibility of the underestimation of PCs that were lower in the hierarchy, which has been acknowledged as a limitation in the papers. We recommend using either ICPC-2 or another appropriate PC classification system prospectively at ED presentation that can be transferred easily to the emergency registry. WHO have also developed the "WHO International Registry for Trauma and Emergency Care" (WHO IRTEC), a web-based patient registry that is free for users. We strongly recommend that the establishment of systematic electronic patient registries in any health care system should be a priority. This method will be helpful not only for research purposes but also to monitor the quality of care provided and for implementing and evaluating effective interventions.

7.3 Further studies

Both disease severity and health care systems in developing countries differ from those in Western countries [85], and these differences require investigation and the development of appropriate health care system models that are applicable in these settings. The current studies included in this thesis were conducted at one Nepalese hospital; thus, more studies should be performed that include multiple health facilities and/or hospitals.

Early mortality after discharge indicates the quality of care. The impact of emergency health care on short- and long-term mortality is not well described, particularly in LICs. Studies from Nepal reported that hospital mortality and/or ED mortality was one percent or less. Our study was the first study to investigate mortality after emergency care. The high mortality after emergency care observed in our study indicates the need for post-discharge care, which could help reduce the number of deaths after emergency care. Furthermore, higher mortality after emergency care possibly indicated the interplay of many factors. It will be important to study factors that affect mortality after emergency care, such as affordability, availability of follow-up systems, accessibility, quality of care, etc. To confirm our observations and to further explore mortality after emergency care, there is a need to replicate similar studies with adequate systems that limit loss to follow-up in a larger population. More investigations on emergency

health care are needed to facilitate the delivery of standardized quality health care in these settings. Without knowledge of the magnitude of health problems and the risk of death, the ability to implement context-specific appropriate interventions is severely affected. A significant next step would be to establish emergency care surveillance that is of longer duration with more comprehensive data collection that enrols patients in many more EDs that represent the country overall.

8. REFERENCES

1. Hsia R, Razzak J, Tsai AC, Hirshon JM. Placing Emergency Care on the Global Agenda. *Annals of emergency medicine* 2010;56:142-9.
2. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C, Joshipura M. Emergency medical systems in low- and middle-income countries: recommendations for action. *Bulletin of the World Health Organization* 2005;83:626-31.
3. Kobusingye OC, Hyder AA, Bishai D, Joshipura M, Hicks ER, Mock C. Disease Control Priorities in Developing Countries 2nd edition. New York:Oxford University Press; 2006.
4. Razzak JA, Hyder AA, Akhtar T, Khan M, Khan UR. Assessing emergency medical care in low income countries: a pilot study from Pakistan. *BMC emergency medicine* 2008;8:8.
5. Razzak JA, Kellermann AL. Emergency medical care in developing countries: is it worthwhile? *Bulletin of the World Health Organization* 2002;80:900-5.
6. Marsh RH, Rouhani SA, Pierre P, Farmer PE. Strengthening emergency care: experience in central Haiti. *Lancet Glob Health* 2015;3 Suppl 2:S5-7.
7. Teri A. Reynolds HS, Andrés M. Rubiano, Sang Do Shin, Lee Wallis, and Charles N. Mock. Disease Control Priorities: Strengthening Health Systems to Provide Emergency Care. 3rd edition, WHO; 2017.
8. Chang CY, Abujaber S, Reynolds TA, Camargo CA, Jr., Obermeyer Z. Burden of emergency conditions and emergency care usage: new estimates from 40 countries. *Emergency medicine journal* 2016;33:794-800.
9. Obermeyer Z, Abujaber S, Makar M, Stoll S, Kayden SR, Wallis LA, et al. Emergency care in 59 low- and middle-income countries: a systematic review. *Bulletin of the World Health Organization* 2015;93:577-86g.
10. Calvello EJ, Broccoli M, Risko N, Theodosis C, Totten VY, Radeos MS, et al. Emergency care and health systems: consensus-based recommendations and future research priorities. *Acad Emerg Med* 2013;20:1278-88.
11. Olmen JV, Marchal B, Damme WV, Kegels G, Hill PS. Health systems frameworks in their political context: framing divergent agendas. *BMC public health* 2012;12:774.

12. Mounier-Jack S, Mayhew SH, Mays N. Integrated care: learning between high-income, and low- and middle-income country health systems. *Health policy and planning* 2017;32:iv6-iv12.
13. Verguet S, Feldhaus I, Jiang Kwete X, Aqil A, Atun R, Bishai D, et al. Health system modelling research: towards a whole-health-system perspective for identifying good value for money investments in health system strengthening. *BMJ global health* 2019;4:e001311.
14. Vasan A, Ellner A, Lawn SD, Gove S, Anatole M, Gupta N, et al. Integrated care as a means to improve primary care delivery for adults and adolescents in the developing world: a critical analysis of Integrated Management of Adolescent and Adult Illness. *BMC medicine* 2014;12:6.
15. WHO. Trauma Care Checklist improves care for injured patients 2016 [Available from: https://www.eurekalert.org/pub_releases/2016-11/s-wtc110216.php].
16. Farrokhnia N, Goransson KE. Swedish emergency department triage and interventions for improved patient flows: a national update. *Scandinavian journal of trauma, resuscitation and emergency medicine* 2011;19:72.
17. Debacker M, Hubloue I, Dhondt E, Rockenschaub G, Ruter A, Codreanu T, et al. Utstein-style template for uniform data reporting of acute medical response in disasters. *PLoS currents* 2012;4:e4f6cf3e8df15a.
18. WHO. Health systems strengthening glossary 2013 [Available from: http://www.who.int/healthsystems/hss_glossary/en/index5.html].
19. Hospitaller's K. First Aid: From Witchdoctors & Religious Knights to Modern Doctors [Available from: https://www.medicinenet.com/first_aid_witchdoctors_and_religious_knights/views.htm].
20. Richard W.O. Beebe DLF. Fundamentals of Emergency Care. USA;2001. [Available from: *Can be available from https://books.google.no/books?id=0AuoxgI7kKUC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false*].
21. Skandalakis PN, Lainas P, Zoras O, Skandalakis JE, Mirilas P. "To afford the wounded speedy assistance": Dominique Jean Larrey and Napoleon. *World J Surg* 2006;30:1392-9.
22. Barkley KT. The ambulance: the story of emergency transportation of sick and wounded through the centuries. New York;1978.

23. Bledsoe B, Barnes D. Traction splint. An EMS relic? *JEMS: a journal of emergency medical services* 2004;29:64-9.
24. Al-Shaqsi S. Models of International Emergency Medical Service Systems. *Oman medical journal* 2010;25:320-3.
25. Dick WF. Anglo-American vs. Franco-German emergency medical services system. *Prehospital and disaster medicine* 2003;18:29-35.
26. Suter RE. Emergency medicine in the United States: a systemic review. *World journal of emergency medicine* 2012;3:5-10.
27. GROUP N. History of Emergency Medicine 2017. [Available from: https://resident360.nejm.org/content_items/history-of-emergency-medicine].
28. Shah MN. The formation of the emergency medical services system. *American journal of public health* 2006;96:414-23.
29. Perkins GD, Lockey AS, de Belder MA, Moore F, Weissberg P, Gray H. National initiatives to improve outcomes from out-of-hospital cardiac arrest in England. *Emergency medicine journal* 2016;33:448-51.
30. Rosenfield A, Maine D. Maternal mortality--a neglected tragedy. Where is the M in MCH? *Lancet* 1985;2:83-5.
31. Samai O, Sengeh P. Facilitating emergency obstetric care through transportation and communication, Bo, Sierra Leone. The Bo PMM Team. *International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics* 1997;59 Suppl 2:S157-64.
32. Arreola-Risa C, Mock CN, Lojero-Wheatly L, de la Cruz O, Garcia C, Canavati-Ayub F, et al. Low-cost improvements in prehospital trauma care in a Latin American city. *J Trauma* 2000;48:119-24.
33. Schellein O, Ludwig-Pistor F, Bremerich DH. [Manchester triage system. Process optimization in the interdisciplinary emergency department]. *Der Anaesthesist* 2009;58:163-70.
34. Shanahan T, Risko N, Razzak J, Bhutta Z. Aligning emergency care with global health priorities. *International journal of emergency medicine* 2018;11:52.
35. Roa L, Jumbam DT, Makasa E, Meara JG. Global surgery and the sustainable development goals. *The British journal of surgery* 2019;106:e44-e52.
36. Price R, Makasa E, Hollands M. World Health Assembly Resolution WHA68.15: "Strengthening Emergency and Essential Surgical Care and Anesthesia as a Component of Universal Health Coverage"-Addressing the Public Health Gaps Arising from Lack

of Safe, Affordable and Accessible Surgical and Anesthetic Services. *World J Surg* 2015;39:2115-25.

37. UN. Sustainable Development Goal 3, Ensure healthy lives and promote well-being for all at all ages 2017 [Available from: https://sustainabledevelopment.un.org/sdg3].
38. WHO. Emergency care systems 2018. [Available from: http://www.who.int/emergencycare/en/].
39. Carlson LC, Reynolds TA, Wallis LA, Calvello Hynes EJ. Reconceptualizing the role of emergency care in the context of global healthcare delivery. *Oxford Academic, The journal of health policy and systems research* 2019;34:78-82.
40. Central Intelligence Agency. The World Factbook, South Asia: Nepal. Washington DC 2019. [Available from: https://www.cia.gov/library/publications/resources/the-world-factbook/geos/np.html].
41. Ranjit E. Pharmacy Practice in Nepal. *The Canadian journal of hospital pharmacy* 2016;69:493-500.
42. Central Bureau of Statistics. National Population and Housing Census 2011. Government of Nepal 2012. [Available from: https://unstats.un.org/unsd/demographic-social/census/documents/Nepal/Nepal-Census-2011-Vol1.pdf].
43. WHO. Health System in Nepal: Challenges and Strategic Options 2007. [Available from:https://apps.who.int/iris/bitstream/handle/10665/205257/B0677.pdf?sequence=1&isAllowed=y].
44. Rai SK. Changing Trend of Infectious Diseases in Nepal. *Advances in experimental medicine and biology* 2018;1052:19-38.
45. Joshi O, Parajuli R, Kharel G, Poudyal NC, Taylor E. Stakeholder opinions on scientific forest management policy implementation in Nepal. *PloS one* 2018;13:e0203106.
46. Sailesh Bhattarai SBP, Rajan Bikram Rayamajhi, Ishwari Sharma Paudel, Nilambar Jha. Health Seeking Behavior and Utilization of Health Care Services in the Village Development Committees of Ilam District of Nepal. *Journal of College of Medical Sciences-Nepal* 2015;11.
47. Shrestha MV, Paudel L, Pant S, Neupane S, Manandhar N. Health seeking behavior among women in Bhimtar, Sindhupalchowk district of Nepal. *International Journal of Community Medicine and Public Health* 2017;4:1854-7.
48. Baniya R. Traditional Healing Practices in Rural Nepal. *Journal of Patan Academy of Health Sciences* 2014;1:52-3.

49. Ministry of Health and Population. Nepal National Health Accounts 2012/13-2015/16. Kathmandu, Nepal: Government of Nepal 2018. [Available from: http://www.searo.who.int/nepal/documents/nepal_nha_2012_13_2015_16_mohp_june_2018.pdf].
50. Annual Report. Ministry of Health, Government of Nepal; 2016/2017. [Available from: http://dohs.gov.np/wp-content/uploads/2018/04/Annual_Report_2073-74.pdf].
51. Pandey NR. Emergency medicine in Nepal: present practice and direction for future. *International journal of emergency medicin*e 2016;9:20.
52. WHO. Nepal–WHO Country Cooperation Strategy, 2018–2022. New Delhi: World Health Organization, Regional Office for South-East Asia; 2018. [Available from: http://www.searo.who.int/nepal/documents/who_nepal_ccs_2018-2022.pdf].
53. Garha M. Health care in Nepal: An observational perspective. *Emergency Nursing* 2016;7.
54. Nepal Government. Bipanna Nagarik Kosh Kathmandu, Nepal: Ministry of Health; 2071 [Available from: http://202.45.147.103/bipanna/].
55. Ministry of Health. National Health Insurance Act Kathmandu, Nepal 2017. [Available from: https://shs.gov.np/site/content/detail/act-of-health-insurance-related].
56. Uprety S, Lamichhane B. Health Budgeting and Financing in Nepal: Policy Perspectives 2016. [Available from: https://www.herd.org.np/publications/45].
57. Nepal Demogrphic and Health Survey 2016. Ministry of Health, Government of Nepal 2017. [Available from: https://www.dhsprogram.com/pubs/pdf/fr336/fr336.pdf].
58. RTI International. Assessment of Health System Performance in Nepal 2010. [Available from: http://www.ministerial-leadership.org/sites/default/files/resources_and_tools/Assessment_of_Health_System_Performance_in_Nepal1.pdf].
59. Paudel R, Upadhyaya T, Pahari DP. People's perspective on access to health care services in a rural district of Nepal. *Journal of the Nepal Medical Association* 2012;52:20-4.
60. Adhikari SR. Choices of health care financing schemes for resource poor country: An analysis of Nepal's experiences. *Scientific Research* 2013;5:1295-302.
61. Karkee R, Lee AH, Binns CW. Bypassing birth centres for childbirth: an analysis of data from a community-based prospective cohort study in Nepal. *Health policy and planning* 2015;30:1-7.

62. WHO Global Atlas of the Health Workforce. Density of doctors, nurses and midwives in the 49 priority countries 2010. [Available from: https://www.who.int/hrh/fig_density.pdf].
63. Central Bureau of Statistics. A Report on Census of Private Hospitals in Nepal 2013. Kathmandu, Nepal 2014. [Available from: https://nepalindata.com/resource/a-report-on-census-of-private-hospitals-in-nepal-/]
64. Thapa R, Bam K, Tiwari P, Sinha TK, Dahal S. Implementing Federalism in the Health System of Nepal: Opportunities and Challenges. *International Journal of Health Policy and Management* 2019;8:195-98.
65. Boyle AA, Ahmed V, Palmer CR, Bennett TJ, Robinson SM. Reductions in hospital admissions and mortality rates observed after integrating emergency care: a natural experiment. *BMJ open* 2012; 2:e000930.
66. Nathens AB, Jurkovich GJ, Cummings P, Rivara FP, Maier RV. The effect of organized systems of trauma care on motor vehicle crash mortality. *JAMA* 2000;283:1990-4.
67. Kellermann AL, Hsia RY, Yeh C, Morganti KG. Emergency care: then, now, and next. *Health affairs (Project Hope)* 2013;32:2069-74.
68. Anselmi L, Meacock R, Kristensen SR, Doran T, Sutton M. Arrival by ambulance explains variation in mortality by time of admission: retrospective study of admissions to hospital following emergency department attendance in England. *BMJ quality & safety* 2017;26:613-21.
69. Marcozzi D, Carr B, Liferidge A, Baehr N, Browne B. Trends in the Contribution of Emergency Departments to the Provision of Hospital-Associated Health Care in the USA. *International journal of health services: planning administration, evaluation* 2018;48:267-88.
70. Wilper AP, Woolhandler S, Lasser KE, McCormick D, Cutrona SL, Bor DH, et al. Waits to see an emergency department physician: U.S. trends and predictors, 1997-2004. *Health affairs (Project Hope)* 2008;27:w84-95.
71. Kangovi S, Barg FK, Carter T, Long JA, Shannon R, Grande D. Understanding why patients of low socioeconomic status prefer hospitals over ambulatory care. *Health affairs (Project Hope)* 2013;32:1196-203.
72. Tang N, Stein J, Hsia RY, Maselli JH, Gonzales R. Trends and characteristics of US emergency department visits, 1997-2007. *JAMA* 2010;304:664-70.

73. Bjornsen LP, Uleberg O, Dale J. Patient visits to the emergency department at a Norwegian university hospital: variations in patient gender and age, timing of visits, and patient acuity. *Emergency medicine journal* 2013;30:462-6.
74. Choudry UK, Mahwish A, Areeba N. Emergency Patient Transportation in South Asia-Call for a Proper Pre-Hospital Care System. *Journal of Surgery and Emergency Medicine* 2017;1:1.
75. Moresky RT, Bisanzo M, Rubenstein BL, Hubbard SJ, Cohen H, Ouyang H, et al. A research agenda for acute care services delivery in low- and middle-income countries. *Acad Emerg Med* 2013;20:1264-71.
76. Chen LC, Cash RA. A decade after Alma Ata. Can primary care lead to health for all? *The New England journal of medicine* 1988;319:946-7.
77. Nakahara S, Ichikawa M, and Sakamoto T. Strengthening the Healthcare System in Low- and Middle-income Countries by Integrating Emergency Care Capacities. *JMA Journal* 2019;2:123-30.
78. Dean T. Jamison HG, Susan Horton, Prabhat Jha, Ramanan Laxminarayan, Charles N. Mock, Rachel Nugent. Disease Control Priorities: Improving Health and Reducing Poverty. 3rd edition. Washington DC, World Bank 2018.
79. Khanal S, Veerman L, Nissen L, Hollingworth S. Use of Healthcare Services by Patients with Non-Communicable Diseases in Nepal: A Qualitative Study with Healthcare Providers. *Journal of clinical and diagnostic research* 2017;11:Lc01-lc5.
80. Killewo J, Anwar I, Bashir I, Yunus M, Chakraborty J. Perceived delay in healthcare-seeking for episodes of serious illness and its implications for safe motherhood interventions in rural Bangladesh. *Journal of health, population, and nutrition* 2006;24:403-12.
81. Bhatti JA, Waseem H, Razzak JA, Shiekh NU, Khoso AK, Salmi LR. Availability and quality of prehospital care on pakistani interurban roads. *Annals of advances in automotive medicine* 2013;57:257-64.
82. Gongal R, Dhungana B, Regmi S, Nakarmi M, Yadav B. Need of improvement in emergency medical service in urban cities. *Journal of the Nepal Medical Association* 2009;48:139-43.
83. Waseem H, Naseer R, Razzak JA. Establishing a successful pre-hospital emergency service in a developing country: experience from Rescue 1122 service in Pakistan. *Emergency medicine journal* 2011;28:513-5.

84. Channa R, Jaffrani HA, Khan AJ, Hasan T, Razzak JA. Transport time to trauma facilities in Karachi: an exploratory study. *International journal of emergency medicine* 2008;1:201-4.
85. Ha DT, Dang TQ, Tran NV, Pham TN, Nguyen ND, Nguyen TV. Development and validation of a prognostic model for predicting 30-day mortality risk in medical patients in emergency department. *Scientific reports* 2017;7:46474.
86. Razzak J, Usmani MF, Bhutta ZA. Global, regional and national burden of emergency medical diseases using specific emergency disease indicators: analysis of the 2015 Global Burden of Disease Study. *BMJ global health* 2019;4:e000733.
87. WHO. The top 10 causes of death 2018. [Available from:https://www.who.int/en/news-room/fact-sheets/detail/the-top-10-causes-of-death].
88. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380:2095-128.
89. WHO. Global status report on road safety 2013. [Available from: https://www.who.int/violence_injury_prevention/road_safety_status/2013/en/].
90. B.P. Koirala Institute of Health Sciences. Emergency Hospital Services 2019. [Available from: http://www.bpkihs.edu/?hospital-services/emergency-hospital-services.html].
91. Institute of Medicine. Tribhuwan University Teaching Hospital 2019. [Available from: http://www.iom.edu.np/?page_id=182].
92. Rai SK, Rai G, Hirai K, Abe A, Ohno Y. The Health System in Nepal — An Introduction. *Environmental health and preventive medicine* 2001;6:1-8.
93. Suvedi BK. Of what diseases are Nepalese people dying?. *Kathmandu University Medical Journal* 2007;5:121-3.
94. Rai SK, Abe A, Ohno Y. Infectious diseases and malnutrition status in Nepal: an overview. *Mal J Nutr* 2002;8:191-200.
95. Pach A, Bhattachan A. Understanding Cholera in Nepal 2014. [Available from: https://www.stopcholera.org/blog/understanding-cholera-nepal].
96. The World Bank. Cause of death, by communicable diseases and maternal, prenatal and nutrition conditions 2016. [Available from: https://data.worldbank.org/indicator/SH.DTH.COMM.ZS].

97. NHRC. Nepal burden of disease 2017, A Country Report based on the Global Burden of Disease 2017 Study, Ministry of Health and Population and Monitoring Evaluation and Operational Research 2019. [Available from: http://nhrc.gov.np/wp-content/uploads/2019/04/NBoD-2017_NHRC-MoHP.pdf].
98. Bhandari GP, Angdembe MR, Dhimal M, Neupane S, Bhusal C. State of non-communicable diseases in Nepal. *BMC public health* 2014;14:23.
99. Institute for Health Metrics and Evaluation 2018. [Available from: http://www.healthdata.org/nepal].
100. Thapa AJ. Status paper on road safety in Nepal. Ministry of Physical Infrastructure and Transport, Government of Nepal 2013. [Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Status+paper+on+road+safety+in+Nepal&btnG=].
101. National Planning Commission. Nepal's Sustainable Development Goals, Baseline Report. Government of Nepal 2017. [Available from: https://www.npc.gov.np/images/category/SDGs_Baseline_Report_final_29_June-1(1).pdf].
102. Nepal Government. Nepal Health Sector Strategy 2015-2020, Ministry of Health and Population 2015. [Available from: http://www.nationalplanningcycles.org/sites/default/files/planning_cycle_repository/nepal/nhss-english-book-final-4-21-2016.pdf].
103. Bajracharya A, Agrawal A, Yam B, Agrawal C, Lewis O. Spectrum of surgical trauma and associated head injuries at a university hospital in eastern Nepal. *Journal of neurosciences in rural practice* 2010;1:2-8.
104. Karkee R, Lee AH. Epidemiology of road traffic injuries in Nepal, 2001-2013: systematic review and secondary data analysis. *BMJ open* 2016;6:e010757.
105. Shrestha VL, Bhatta DN, Shrestha KM, GC KB, Paudel S. Factors and Pattern of Injuries Associated with Road Traffic Accidents in Hilly District of Nepal. *Journal of Biosciences and Medicines* 2017;5:88-100.
106. Vannebo JW, Rosseland H, Shrestha D, Shrestha R, Shrestha S, Solberg T et al. Does Dhulikhel Hospital need a trauma center? (Thesis) Norwegian University of Science and Technology, Trondheim, Norway; 2016. [Available from: https://pdfs.semanticscholar.org/c54b/362f8083067cab521af74c5210c034a9619c.pdf]

107. Hofman K, Primack A, Keusch G, Hrynkow S. Addressing the growing burden of trauma and injury in low- and middle-income countries. *American journal of public health* 2005;95:13-7.
108. Government of Nepal. Nepal Road Safety Action Plan (2013-2020), Ministry of physical planning and transport management 2013.
109. WHO. Suicide data 2016. [Available from: http://www.who.int/mentalhealth/prevention/suicide/suicideprevent/en/].
110. WHO. Preventing suicide: a global imperative 2014. [Available from: http://apps.who.int/iris/bitstream/10665/131056/1/9789241564779_eng.pdf?ua].
111. Nepal police suicide data 2015. [Available from: https://www.nepalpolice.gov.np/images/statistic/webpage/data/aatma-hatya-sambandi/aatma-hatyapanchabarsiya-2073-06-18.pdf.
112. Suvedi BK, Pradhan A, Barnett S, Puri M, Chitrakar SR, Poudel P et al. Nepal Maternal Mortality and Morbidity Study 2008/2009, Summary of Preliminary Findings. Kathmandu, Nepal; 2009. [Available from: http://www.dpiap.org/resources/pdf/nepal_maternal_mortality_2011_04_22.pdf].
113. Gyenwali D, Vaidya A, Tiwari S, Khatiwada P, Lamsal DR, Giri S. Pesticide poisoning in Chitwan, Nepal: a descriptive epidemiological study. *BMC public health* 2017;17:619.
114. Malmstrom T, Huuskonen O, Torkki P, Malmstrom R. Structured classification for ED presenting complaints - from free text field-based approach to ICPC-2 ED application. *Scandinavian journal of trauma, resuscitation and emergency medicine* 2012;20:76.
115. Salvi F, Mattioli A, Giannini E, Vita D, Morichi V, Fallani M, et al. Pattern of use and presenting complaints of older patients visiting an Emergency Department in Italy. *Aging clinical and experimental research* 2013;25:583-90.
116. Mowafi H, Dworkis D, Bisanzo M, Hansoti B, Seidenberg P, Obermeyer Z, et al. Making recording and analysis of chief complaint a priority for global emergency care research in low-income countries. *Acad Emerg Med* 2013;20:1241-5.
117. Hong KJ, Shin SD, Ro YS, Song KJ, Singer AJ. Development and validation of the excess mortality ratio-based Emergency Severity Index. *Am J Emerg Med* 2012;30:1491-500.
118. Mehmood A, He S, Zafar W, Baig N, Sumalani F, Razzak J. How vital are the vital signs? A multi-center observational study from emergency departments of Pakistan. *BMC emergency medicine* 2015;15 Suppl 2:S10.

119. Bingisser R, Nickel CH. The last century of symptom-oriented research in emergency presentations--have we made any progress? *Swiss medical weekly* 2013;143:w13829.
120. Kuster T, Nickel CH, Jenny MA, Blaschke LL, Bingisser R. Combinations of Symptoms in Emergency Presentations: Prevalence and Outcome. *Journal of clinical medicine* 2019;8:345.
121. Conway M, Dowling JN, Chapman WW. Using chief complaints for syndromic surveillance: a review of chief complaint based classifiers in North America. *Journal of biomedical informatics* 2013;46:734-43.
122. Gabayan GZ, Derose SF, Asch SM, Yiu S, Lancaster EM, Poon KT, et al. Patterns and predictors of short-term death after emergency department discharge. *Annals of emergency medicine* 2011;58:551-8.e2.
123. Couturier B, Carrat F, Hejblum G. A systematic review on the effect of the organisation of hospital discharge on patient health outcomes. *BMJ open* 2016;6:e012287.
124. Abujaber S, Chang CY, Reynolds TA, Mowafi H, Obermeyer Z. Developing metrics for emergency care research in low- and middle-income countries. *African journal of emergency medicine* 2016;6:116-24.
125. Gunnarsdottir OS, Rafnsson V. Death within 8 days after discharge to home from the emergency department. *European journal of public health* 2008;18:522-6.
126. Guttmann A, Schull MJ, Vermeulen MJ, Stukel TA. Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada. *BMJ (Clinical research ed*) 2011;342:d2983.
127. Obermeyer Z, Cohn B, Wilson M, Jena AB, Cutler DM. Early death after discharge from emergency departments: analysis of national US insurance claims data. *BMJ (Clinical research ed)* 2017;356:j239.
128. Pouw ME, Peelen LM, Moons KG, Kalkman CJ, Lingsma HF. Including post-discharge mortality in calculation of hospital standardised mortality ratios: retrospective analysis of hospital episode statistics. *BMJ (Clinical research ed)* 2013;347:f5913.
129. Nemetchek B, English L, Kissoon N, Ansermino JM, Moschovis PP, Kabakyenga J, et al. Paediatric postdischarge mortality in developing countries: a systematic review. *BMJ open* 2018;8:e023445.
130. Khan A, Penoff BT, Pirrotta EA, Hosang R. Shifting the Paradigm of Emergency Care in Developing Countries. *Cureus* 2018;10:e2219.

131. Dulal P, Khadka SB. Victims of road traffic crashes attending the emergency department of Kathmandu Medical College Teaching Hospital. *Kathmandu University medical journal* 2004;2:301-6.
132. Murdoch DR, Woods CW, Zimmerman MD, Dull PM, Belbase RH, Keenan AJ, et al. The etiology of febrile illness in adults presenting to Patan hospital in Kathmandu, Nepal. *The American journal of tropical medicine and hygiene* 2004;70:670-5.
133. Dai ZY, Li Y, Lu MP, Chen L, Jiang DM. Clinical profile of musculoskeletal injuries associated with the 2008 Wenchuan earthquake in China. *Turkish journal of trauma & emergency surgery* 2010;16:503-7.
134. United Nations. Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters.International Strategy for Disaster Reduction Geneva, 2005. [Available from: http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf].
135. Matsuoka Y, Shaw R. Chapter 7 Linking Resilience Planning to Hyogo Framework for Action in Cities. Emerald Group Publishing Limited 2011;129-47. [Available from: https://doi.org/10.1108/S2040-7262(2011)0000006013].
136. Lee AC, Booth A, Challen K, Gardois P, Goodacre S. Disaster management in low- and middle-income countries: scoping review of the evidence base. *Emergency medicine journal* 2014;31:e78-83.
137. Roy N, Thakkar P, Shah H. Developing-world disaster research: present evidence and future priorities. *Disaster Med Public Health Prep* 2011;5:112-6.
138. UNDP. Nepal Country Report, Global Assessment of Risk 2009. [Available from: http://www.undp.org/content/dam/nepal/docs/reports/UNDP_NP_Nepal%20Country%20Report.pdf].
139. Center for Excellence in Disaster Management and Humanitarian Assistance. Nepal Disaster Management Reference Handbook 2017. [Available from: https://reliefweb.int/sites/reliefweb.int/files/resources/CFE-DM%20Reference%20Handbook-Nepal%202017.pdf].
140. Centre for Research on the Epidemiology of Disasters. The Human Cost of Natural Disasters 2015: a global perspective. [Available from: http://reliefweb.int/sites/reliefweb.int/files/resources/PAND_report.pdf].
141. EM-DAT. The International Disaster Database, Centre for Research on the Epidemiology of Disasters 2017. [Available from: http://www.emdat.be/].

142. Nepal Earthquake 2015: Disaster Relief and Recovery Information Platform: Country Profile. [Available from: https://www.icimod.org/?q=21324].
143. Adhikari B, Mishra SR, Raut S. Rebuilding Earthquake Struck Nepal through Community Engagement. *Frontiers in Public Health* 2016;4:121.
144. National Planning Commission, Government of Nepal. Nepal Earthquake 2015, Post Disaster Needs Assessment 2015. [Available from: https://reliefweb.int/sites/reliefweb.int/files/resources/PDNA-volume-B_0.pdf].
145. Nielsen MJ, Ferguson S, Joshi AK, Rimal S, Shrestha S, Magar SR. Post-earthquake recovery in Nepal. *Lancet Glob Health* 2015;4.
146. Hall ML, Lee AC, Cartwright C, Marahatta S, Karki J, Simkhada P. The 2015 Nepal earthquake disaster: lessons learned one year on. *Public health* 2017;145:39-44.
147. Shrestha B, Pathranarakul P. Nepal Government's Emergency Response to the 2015 Earthquake: A Case Study. *Social Sciences* 2018;7:127.
148. Lee ACK. Barriers to evidence-based disaster management in Nepal: a qualitative study. *Public health* 2016;133:99-106.
149. Mock C, Joshipura M, Arreola-Risa C, Quansah R. An estimate of the number of lives that could be saved through improvements in trauma care globally. *World J Surg* 2012;36:959-63.
150. Nathens AB, Jurkovich GJ, Rivara FP, Maier RV. Effectiveness of state trauma systems in reducing injury-related mortality: a national evaluation. *J Trauma* 2000;48:25-30.
151. Debas HT, Donkor P, Gawande A, Jamison DT, Kruk ME, Mock CN, editors. Essential Surgery: Disease Control Priorities, Third Edition (Volume 1). The International Bank for Reconstruction and Development /The World Bank 2015. [Available from: https://www.ncbi.nlm.nih.gov/pubmed/26740991].
152. Petroze RT, Byiringiro JC, Ntakiyiruta G, Briggs SM, Deckelbaum DL, Razek T, et al. Can focused trauma education initiatives reduce mortality or improve resource utilization in a low-resource setting? *World J Surg* 2015;39:926-33.
153. Molyneux E, Ahmad S, Robertson A. Improved triage and emergency care for children reduces inpatient mortality in a resource-constrained setting. *Bulletin of the World Health Organization* 2006;84:314-9.
154. Clark M, Spry E, Daoh K, Baion D, Skordis-Worrall J. Reductions in inpatient mortality following interventions to improve emergency hospital care in Freetown, Sierra Leone. *PloS one* 2012;7:e41458.

155. Jacob ST, Banura P, Baeten JM, Moore CC, Meya D, Nakiyingi L, et al. The impact of early monitored management on survival in hospitalized adult Ugandan patients with severe sepsis: a prospective intervention study. *Critical care medicine* 2012;40:2050-8.
156. Fournier P, Dumont A, Tourigny C, Dunkley G, Drame S. Improved access to comprehensive emergency obstetric care and its effect on institutional maternal mortality in rural Mali. *Bulletin of the World Health Organization* 2009;87:30-8.
157. Xavier D, Pais P, Devereaux PJ, Xie C, Prabhakaran D, Reddy KS, et al. Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. *Lancet* 2008;371:1435-42.
158. Robertson-Steel I. Evolution of triage systems. *Emergency medicine journal* 2006;23:154-5.
159. FitzGerald G, Jelinek GA, Scott D, Gerdtz MF. Emergency department triage revisited. *Emergency medicine journal* 2010;27:86-92.
160. Zachariasse JM, Seiger N, Rood PP, Alves CF, Freitas P, Smit FJ, et al. Validity of the Manchester Triage System in emergency care: A prospective observational study. *PloS one* 2017;12:e0170811.
161. Mirhaghi A, Heydari A, Mazlom R, Ebrahimi M. The Reliability of the Canadian Triage and Acuity Scale: Meta-analysis. *North American journal of medical sciences* 2015;7:299-305.
162. Ebrahimi M, Heydari A, Mazlom R, Mirhaghi A. The reliability of the Australasian Triage Scale: a meta-analysis. *World journal of emergency medicine* 2015;6:94-9.
163. Dalwai M, Valles P, Twomey M, Nzomukunda Y, Jonjo P, Sasikumar M, et al. Is the South African Triage Scale valid for use in Afghanistan, Haiti and Sierra Leone? *BMJ global health* 2017;2:e000160.
164. Soogun S, Naidoo M, Naidoo K. An evaluation of the use of the South African Triage Scale in an urban district hospital in Durban, South Africa. *South African Family Practice* 2017;59:133-7.
165. Massaut J, Valles P, Ghismonde A, Jacques CJ, Louis LP, Zakir A, et al. The modified south African triage scale system for mortality prediction in resource-constrained emergency surgical centers: a retrospective cohort study. *BMC health services research* 2017;17:594.
166. Dalwai MK, Twomey M, Maikere J, Said S, Wakeel M, Jemmy JP, et al. Reliability and accuracy of the South African Triage Scale when used by nurses in the emergency

department of Timergara Hospital, Pakistan. *South African medical journal* 2014;104:372-5.

167. Nissen L, Kirkegaard H, Perez N, Horlyk U, Larsen LP. Inter-rater agreement of the triage system RETTS-HEV. *European journal of emergency medicine : official journal of the European Society for Emergency Medicine* 2014;21:37-41.
168. Henning B, Lydersen S, Dollner H. A reliability study of the rapid emergency triage and treatment system for children. *Scandinavian journal of trauma, resuscitation and emergency medicine* 2016;24:19.
169. Engebretsen S, Roise O, Ribu L. Triage in Norwegian emergency departments. *Tidsskr Nor Laegeforen* 2013;133:285-9.
170. Widgren BR, Jourak M. Medical Emergency Triage and Treatment System (METTS): A new protocol in primary triage and secondary priority decision in emergency medicine. *The Journal of Emergency Medicine* 2011;40:623-8.
171. Perez N, Nissen L, Nielsen RF, Petersen P, Biering K. The predictive validity of RETTS-HEV as an acuity triage tool in the emergency department of a Danish Regional Hospital. *European journal of emergency medicine:official journal of the European Society for Emergency Medicine* 2016;23:33-7.
172. Parenti N, Reggiani ML, Iannone P, Percudani D, Dowding D. A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System. *International journal of nursing studies* 2014;51:1062-9.
173. Mirhaghi A, Heydari A, Mazlom R, Hasanzadeh F. Reliability of the Emergency Severity Index: Meta-analysis. Sultan Qaboos University medical journal 2015;15:e71-7.
174. Mirhaghi A, Mazlom R, Heydari A, Ebrahimi M. The reliability of the Manchester Triage System (MTS): a meta-analysis. *J Evid Based Med* 2017;10:129-35.
175. Basnet B, Bhandari R, Moore M. Initial resuscitation for Australasian Triage Scale 2 patients in a Nepalese emergency department. *Emergency medicine Australasia* 2012;24:430-4.
176. Bruijns SR, Wallis LA, Burch VC. Effect of introduction of nurse triage on waiting times in a South African emergency department. *Emergency medicine journal* 2008;25:395-7.
177. Baker T. Critical care in low-income countries. *Tropical medicine & international health* 2009;14:143-8.

178. GIZ. Digitalising Nepal's health sector, A country's journey towards an interoperable digital health ecosystem 2018. [Available from:http://health.bmz.de/ghpc/case-studies/digitalising_nepals_health_sector/GHPC_NEPAL_DIGI_FINAL_WEB__.pdf].
179. Mowafi H, Ngaruiya C, O'Reilly G, Kobusingye O, Kapil V, Rubiano A, et al. Emergency care surveillance and emergency care registries in low-income and middle-income countries: conceptual challenges and future directions for research. *BMJ global health* 2019;4:e001442.
180. Hoque DME, Kumari V, Hoque M, Ruseckaite R, Romero L, Evans SM. Impact of clinical registries on quality of patient care and clinical outcomes: A systematic review. *PloS one* 2017;12:e0183667.
181. Bommakanti K, Feldhaus I, Motwani G, Dicker RA, Juillard C. Trauma registry implementation in low- and middle-income countries: challenges and opportunities. *The Journal of surgical research* 2018;223:72-86.
182. Dhulikhel Hospital Kathmandu University Hospital Dhulikhel, Nepal 2018. [Available from: http://www.dhulikhelhospital.org].
183. Government of Nepal. District Profile, Kavrepalanchok 2017. [Available from: https://cbs.gov.np/wp-content/upLoads/2018/12/District_Profile_kavrepalanchok_2074.pdf].
184. Adhikari B, Mishra SR. Urgent need for reform in Nepal's medical education. *Lancet* 2016;388:2739-40.
185. Dønnem M, Eid K. Introduction of systematic triage in the emergency room at Dhulikhel Hospital, Nepal: Evaluation of a quality improvement project [dissertation]. Trondheim: NTNU; 2016. [Available from: https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/2417711/1364409_Eid%2c%20D%c3%b8nnem.PDF?sequence=1&isAllowed=y].
186. Westergren H, Ferm M, Haggstrom P. First evaluation of the paediatric version of the Swedish rapid emergency triage and treatment system shows good reliability. *Acta paediatrica* 2014;103:305-8.
187. Globefeed.com. Nepal Distance Calculator 2015. [Available from: http://distancecalculator.globefeed.com/Nepal_Distance_Calculator.asp.
188. UNHCR. Nepal: 2015 Earthquakes Nepal 2015. [Available from: http://data.unhcr.org/nepal/].
189. UNESCO. Forms and Patterns of Social Discrimination in Nepal. Kathmandu, Nepal; 2006. [Available from: https://unesdoc.unesco.org/ark:/48223/pf0000146086].

190. Bennett L, Dahal D, Govindasamy P. Caste, Ethnic and Regional Identity in Nepal Further Analysis of the 2006 Nepal Demographic and Health Survey. Nepal: USAID, Macro International Inc; 2008. [Available from: https://dhsprogram.com/pubs/pdf/FA58/FA58.pdf].
191. Gennarelli TA, Wodzin E. AIS 2005-Abbreviated Injury Scale. Barrington, IL Association for the Advancement of Automotive Medicine (AAAM); 2005.
192. World Organization of Family Doctors. International Classification of Primary Care (ICPC): Wonca International Classification Committee, 2017. [Available from: www.globalfamilydoctor.com].
193. Langlo NM, Orvik AB, Dale J, Uleberg O, Bjornsen LP. The acute sick and injured patients: an overview of the emergency department patient population at a Norwegian University Hospital Emergency Department. *European journal of emergency medicine : official journal of the European Society for Emergency Medicine* 2014;21:175-80.
194. Rothman KJ. Epidemiology: An Introduction. 2nd ed. New York, USA: Oxford University Press; 2012.
195. Song JW, Chung KC. Observational studies: cohort and case-control studies. *Plastic and reconstructive surgery* 2010;126:2234-42.
196. Rothman KJ, Greenland S, Lash TL. Modern Epidemiology, 3rd edition; 2008.
197. Lee DK. Alternatives to P value: confidence interval and effect size. *Korean journal of anesthesiology* 2016;69:555-62.
198. Carlson MD, Morrison RS. Study design, precision, and validity in observational studies. *Journal of palliative medicine* 2009;12:77-82.
199. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *Journal of multidisciplinary healthcare* 2016;9:211-7.
200. Meuli L, Dick F. Understanding Confounding in Observational Studies. *European Journal of Vascular & Endovascular Surgery* 2018;55:737.
201. Jepsen P, Johnsen SP, Gillman MW, Sorensen HT. Interpretation of observational studies. Heart. *BMJ Heart* 2004;90:956-60.
202. Janszky I, Ahlbom A, Svensson AC. The Janus face of statistical adjustment: confounders versus colliders. *European journal of epidemiology* 2010;25:361-3.
203. Groenwold RH, Klungel OH, Grobbee DE, Hoes AW. Selection of confounding variables should not be based on observed associations with exposure. *European journal of epidemiology* 2011;26:589-93.

204. NepalMap. NepalMap Kavrepalanchok 2018. [Available from: https://nepalmap.org/profiles/district-24-kavrepalanchok/].
205. NHRC. Epidemiological Study on Injury and Violence in Nepal 2009. [Available from: http://nhrc.gov.np/wp-content/uploads/2017/02/Injury-and-Violence.pdf].
206. Groves CC, Poudel MK, Thapa BP, Baniya MM. Spinal Cord Injuries Related to 2015 Nepal Earthquakes. *PM & R : the journal of injury, function, and rehabilitation* 2016;8:S154.
207. Bar-On E, Blumberg N, Joshi A, Gam A, Peyser A, Lee E, et al. Orthopedic Activity in Field Hospitals Following Earthquakes in Nepal and Haiti:Variability in Injuries Encountered and Collaboration with Local Available Resources Drive Optimal Response. *World J Surg* 2016;40:2117-22.
208. Ho ML, Lim JZ, Tan MZ, Kok WL, Zhang JR, Tan MY, et al. Humanitarian Assistance and Disaster Relief mission by a tripartite medical team led by the Singapore Armed Forces after the 2015 Nepal earthquake. *Singapore medical journal* 2016;57:426-31.
209. Ding S, Hu Y, Zhang Z, Wang T. A contrast study of the traumatic condition between the wounded in 5.12 Wenchuan earthquake and 4.25 Nepal earthquake. *China J Traumatology* 2015;18:157-60.
210. Kang P, Tang B, Liu Y, Liu X, Liu Z, Lv Y, et al. Medical Efforts and Injury Patterns of Military Hospital Patients Following the 2013 Lushan Earthquake in China: A Retrospective Study. *International journal of environmental research and public health* 2015;12:10723-38.
211. Kang P, Tang B, Liu Y, Liu X, Shen Y, Liu Z, et al. Profile and procedures for fractures among 1323 fracture patients from the 2010 Yushu earthquake, China. *Am J Emerg Med* 2016;34:2132-9.
212. Clover AJ, Jemec B, Redmond AD. The extent of soft tissue and musculoskeletal injuries after earthquakes; describing a role for reconstructive surgeons in an emergency response. *World J Surg* 2014;38:2543-50.
213. Moisi JC, Gatakaa H, Berkley JA, Maitland K, Mturi N, Newton CR, et al. Excess child mortality after discharge from hospital in Kilifi, Kenya: a retrospective cohort analysis. *Bulletin of the World Health Organization* 2011;89:725-32, 32a.
214. Nair H, Simoes EA, Rudan I, Gessner BD, Azziz-Baumgartner E, Zhang JSF, et al. Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. *Lancet* 2013;381:1380-90.

215. The Nepal NCDI Poverty Commission Report. The Nepal NCDI Poverty Commission; An Equity Initiative to Address Noncommunicable Diseases and Injuries 2018. [Available from: http://www.ncdipoverty.org/nepal-report].
216. Checkley W, Ghannem H, Irazola V, Kimaiyo S, Levitt NS, Miranda JJ, et al. Management of NCD in low- and middle-income countries. *Global heart* 2014;9:431-43.
217. Hofman SE, Lucke JA, Heim N, de Gelder J, Fogteloo AJ, Heringhaus C, et al. Prediction of 90-day mortality in older patients after discharge from an emergency department: a retrospective follow-up study. *BMC emergency medicine* 2016;16:26.
218. WHO. Rapid Hospital Needs Assessment Report –Mega-earthquake in Nepal 2015. [Available from: http://www.searo.who.int/entity/emergencies/rapid-assessment-report.pdf?ua=1].
219. BBC. Nepal earthquake: People flee as landslide blocks river 2015. [Available from: http://www.bbc.com/news/world-asia-32859353].
220. Landry MD, Sheppard PS, Leung K, Retis C, Salvador EC, Raman SR. The 2015 Nepal Earthquake(s): Lessons Learned From the Disability and Rehabilitation Sector's Preparation for, and Response to, Natural Disasters. *Physical therapy* 2016;96:1714-23.
221. WHO. Humanitarian crisis after the Nepal earthquakes 2015. [Available from: http://www.searo.who.int/entity/emergencies/phra_nepal_may2015.pdf?ua=1].
222. Nepal Demographic and Health Survey. Ministry of Health and Population, Government of Nepal 2011. [Available from: https://dhsprogram.com/pubs/pdf/fr257/fr257%5B13april2012%5D.pdf].
223. Cartwright C, Hall M, Lee ACK. The changing health priorities of earthquake response and implications for preparedness: a scoping review. *Public health* 2017;150:60-70.
224. Doocy S, Daniels A, Packer C, Dick A, Kirsch TD. The human impact of earthquakes: a historical review of events 1980-2009 and systematic literature review. *PLoS currents* 2013;5.
225. Population Pyramid. Population Pyramids of the world from 1950-2100: PopulationPyramid.net; 2017. [Available from: https://www.populationpyramid.net/nepal/].
226. Singhi S, Jain V, Gupta G. Pediatric emergencies at a tertiary care hospital in India. *Journal of tropical pediatrics* 2003;49:207-11.

227. Atiq H, Siddiqui E, Bano S, Feroze A, Kazi G, Fayyaz J, et al. The pediatric disease spectrum in emergency departments across Pakistan: data from a pilot surveillance system. *BMC emergency medicine* 2015;15 Suppl 2:S11.
228. Yore MA, Strehlow MC, Yan LD, Pirrotta EA, Woods JL, Somontha K, et al. Characteristics and outcomes of pediatric patients presenting at Cambodian referral hospitals without appointments: an observational study. *International journal of emergency medicine* 2018;11:17.
229. Goh AY, Chan TL, Abdel-Latiff ME. Paediatric utilization of a general emergency department in a developing country. *Acta paediatrica* 2003;92:965-9.
230. Pokhrel S, Snow R, Dong H, Hidayat B, Flessa S, Sauerborn R. Gender role and child health care utilization in Nepal. *Health policy* 2005;74:100-9.
231. United Nations. Sustainable Development Goals, Achieve gender equality and empower all women and girls. [Available from: https://www.un.org/sustainabledevelopment/gender-equality/].
232. Yan LD, Mahadevan SV, Yore M, Pirrotta EA, Woods J, Somontha K, et al. An observational study of adults seeking emergency care in Cambodia. *Bulletin of the World Health Organization* 2015;93:84-92.
233. Gupta PP, Malla GB, Bhandari R, Shah Kalawar RP, Mandal M. Patterns of Injury and Mortality in Pediatric Patients Attending Emergency Department in a Tertiary Care Center in Eastern Nepal. *JNMA; journal of the Nepal Medical Association* 2017;56:331-4.
234. Moitinho de Almeida M, van Loenhout JAF, Thapa SS, Kumar KC, Schluter BS, Singh R, et al. Clinical and demographic profile of admitted victims in a tertiary hospital after the 2015 earthquake in Nepal. *PloS one* 2019;14:e0220016.
235. MacKenzie JS, Banskota B, Sirisreetreerux N, Shafiq B, Hasenboehler EA. A review of the epidemiology and treatment of orthopedic injuries after earthquakes in developing countries. *World J Emerg Surg* 2017;12:9.
236. Myers JG, Hunold KM, Ekernas K, Wangara A, Maingi A, Mutiso V, et al. Patient characteristics of the Accident and Emergency Department of Kenyatta National Hospital, Nairobi, Kenya: a cross-sectional, prospective analysis. *BMJ open* 2017;7:e014974.
237. Hodkinson PW, Wallis LA. Cross-sectional survey of patients presenting to a South African urban emergency centre. *Emergency medicine journal* 2009;26:635-40.

238. Shrestha R, Shrestha SK, Kayastha SR, Parajuli N, Dhoju D, Shrestha D. A comparative study on epidemiology, spectrum and outcome analysis of physical trauma cases presenting to emergency department of Dhulikhel Hospital, Kathmandu University Hospital and its outreach centers in rural area. *Kathmandu University medical journal* 2013;11:241-6.
239. Gupta S, Gupta SK, Devkota S, Ranjit A, Swaroop M, Kushner AL, et al. Fall Injuries in Nepal: A Countrywide Population-based Survey. *Annals of global health* 2015;81:487-94.
240. Bhatta S, Pant PR, Mytton J. Usefulness of hospital emergency department records to explore access to injury care in Nepal. *International journal of emergency medicine* 2016;9:21.
241. Oteng RA, Whiteside LK, Rominski SD, Amuasi JH, Carter PM, Donkor P, et al. Individual and Medical Characteristics of Adults Presenting to an Urban Emergency Department in Ghana. *Ghana medical journal* 2015;49:136-41.
242. Sawe HR, Mfinanga JA, Mbaya KR, Koka PM, Kilindimo SS, Runyon MS, et al. Trauma burden in Tanzania: a one-day survey of all district and regional public hospitals. *BMC emergency medicine* 2017;17:30.
243. Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al. World report on road traffic injury prevention 2004. [Available from: https://apps.who.int/iris/bitstream/handle/10665/42871/9241562609.pdf?sequence=1].
244. Shahid M, Iqbal R, Khan MM, Khan MZ, Shamsi US, Nakeer R. Risk factors for deliberate self-harm in patients presenting to the emergency departments of Karachi. *Journal of the College of Physicians and Surgeons--Pakistan* 2015;25:50-5.
245. Simkhada P, Teijlingen EV, Winter RC, Fanning C, Dhungel A, Marahatta SB. Why Are So Many Nepali Women Killing Themselves? A Review Of Key Issues. *Journal of Manmohan Memorial Institute of Health Sciences* 2015;1:43-9.
246. Paudyal BP. Poisoning : pattern and profile of admitted cases in a hospital in central Nepal. *JNMA; journal of the Nepal Medical Association* 2005;44:92-6.
247. Cousins S. Nepal's silent epidemic of suicide. *Lancet* 2016;387:16-7.
248. Mishra SR, Neupane D, Bhandari PM, Khanal V, Kallestrup P. Burgeoning burden of non-communicable diseases in Nepal: a scoping review. *Globalization and health* 2015;11:32.

249. Wachira BW, Wallis LA, Geduld H. An analysis of the clinical practice of emergency medicine in public emergency departments in Kenya. *Emergency medicine journal* 2012;29:473-6.
250. Sharma KR, Dawadi S, Upadhayaya P, Khanal VK, Singh SB. Morbidity Profile of Under Five Children Residing in Barbote Village Development Committee of Ilam District of Eastern Nepal. *Birat Journal of Health Sciences* 2018;3:554-59.
251. WHO. Causes of child mortality 2017. [Available from: https://www.who.int/gho/child_health/mortality/causes/en/].
252. Kyu HH, Pinho C, Wagner JA, Brown JC, Bertozzi-Villa A, Charlson FJ, et al. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. *JAMA pediatrics* 2016;170:267-87.
253. Owais A, Tikmani SS, Sultana S, Zaman U, Ahmed I, Allana S, et al. Incidence of pneumonia, bacteremia, and invasive pneumococcal disease in Pakistani children. *Tropical medicine & international health* 2010;15:1029-36.
254. Ijaz N, Strehlow M, Ewen Wang N, Pirrotta E, Tariq A, Mahmood N, et al. Epidemiology of patients presenting to a pediatric emergency department in Karachi, Pakistan. *BMC emergency medicine* 2018;18:22.
255. Khan BA, Shakeel N, Siddiqui EU, Kazi G, Khan IQ, Khursheed M, et al. Impact of delay in admission on the outcome of critically ill patients presenting to the emergency department of a tertiary care hospital from low income country. *The Journal of the Pakistan Medical Associatio*n 2016;66:509-16.
256. Razzak JA, Baqir SM, Khan UR, Heller D, Bhatti J, Hyder AA. Emergency and trauma care in Pakistan: a cross-sectional study of healthcare levels. *Emergency medicine journal* 2015;32:207-13.
257. Naderi S, Acerra JR, Bailey K, Mukherji P, Taraphdar T, Mukherjee T, et al. Patients in a private hospital in India leave the emergency department against medical advice for financial reasons. *International journal of emergency medicine* 2014;7:13.
258. Southern WN, Nahvi S, Arnsten JH. Increased risk of mortality and readmission among patients discharged against medical advice. *The American journal of medicine* 2012;125:594-602.
259. Garland A, Ramsey CD, Fransoo R, Olafson K, Chateau D, Yogendran M, et al. Rates of readmission and death associated with leaving hospital against medical advice: a population-based study. *Canadian Medical Association journal* 2013;185:1207-14.

260. Safwenberg U, Terent A, Lind L. Differences in long-term mortality for different emergency department presenting complaints. *Acad Emerg Med* 2008;15:9-16.
261. Esteban C, Arostegui I, Garcia-Gutierrez S, Gonzalez N, Lafuente I, Bare M, et al. A decision tree to assess short-term mortality after an emergency department visit for an exacerbation of COPD: a cohort study. *Respiratory research* 2015;16:151.
262. Veirum JE, Sodeman M, Biai S, Hedegard K, Aaby P. Increased mortality in the year following discharge from a paediatric ward in Bissau, Guinea-Bissau. *Acta paediatrica* 2007;96:1832-8.
263. Islam MA, Rahman MM, Mahalanabis D, Rahman AK. Death in a diarrhoeal cohort of infants and young children soon after discharge from hospital: risk factors and causes by verbal autopsy. *Journal of tropical pediatrics* 1996;42:342-7.
264. Ngari MM, Fegan G, Mwangome MK, Ngama MJ, Mturi N, Scott JAG, et al. Mortality after Inpatient Treatment for Severe Pneumonia in Children: a Cohort Study. *Paediatric and perinatal epidemiology* 2017;31:233-42.
265. Lam Y, Broaddus ET, Surkan PJ. Literacy and healthcare-seeking among women with low educational attainment: analysis of cross-sectional data from the 2011 Nepal Demographic and Health Survey. *International journal for equity in health* 2013;12:95.
266. Adhikari TB, Neupane D, Kallestrup P. Burden of COPD in Nepal. *International journal of chronic obstructive pulmonary disease* 2018;13:583-9.
267. Po JY, FitzGerald JM, Carlsten C. Respiratory disease associated with solid biomass fuel exposure in rural women and children: systematic review and meta-analysis. *Thorax* 2011;66:232-9.
268. Smith-Sivertsen T, Diaz E, Pope D, Lie RT, Diaz A, McCracken J, et al. Effect of reducing indoor air pollution on women's respiratory symptoms and lung function: the RESPIRE Randomized Trial, Guatemala. *American journal of epidemiology* 2009;170:211-20.
269. Dherani M, Pope D, Mascarenhas M, Smith KR, Weber M, Bruce N. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. *Bulletin of the World Health Organization* 2008;86:390-8c.
270. Nolan T, Angos P, Cunha AJ, Muhe L, Qazi S, Simoes EA, et al. Quality of hospital care for seriously ill children in less-developed countries. *Lancet* 2001;357:106-10.

271. Magalhaes-Barbosa MC, Robaina JR, Prata-Barbosa A, Lopes CS. Reliability of triage systems for paediatric emergency care: a systematic review. *Emergency medicine journal* 2019;36:231-8.
272. Twomey M, Mullan PC, Torrey SB, wallis L, Kestler A. The Princess Marina Hospital accident and emergency triage scale provides highly reliable triage acuity ratings. *Emergency medicine journal* 2012;29:650-3.
273. Baker T. Pediatric emergency and critical care in low-income countries. *Paediatric anaesthesia* 2009;19:23-7.
274. Turner EL, Nielsen KR, Jamal SM, von Saint Andre-von Arnim A, Musa NL. A Review of Pediatric Critical Care in Resource-Limited Settings: A Look at Past, Present, and Future Directions. *Frontiers in pediatrics* 2016;4:5.
275. WHO. Global status report on road safety 2018. [Available from: https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/].
276. Karmacharya PC, Singh GK, Singh MP, Gautam VG, Par A, Banskota AK, et al. Managing the injury burden in Nepal. *Clinical orthopaedics and related research* 2008;466:2343-9.

9. PAPERS I-III

Paper I

Samita Giri, Kari Risnes, Oddvar Uleberg, Tormod Rogne, Sanu Krishna Shrestha, Øystein Petter Nygaard, Rajendra Koju, Erik Solligård

Impact of 2015 earthquakes on a local hospital in Nepal: A prospective hospital-based study

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Paper I

PLOS ONE

RESEARCH ARTICLE

Impact of 2015 earthquakes on a local hospital in Nepal: A prospective hospital-based study

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Abstract

Introduction

Natural disasters pose a great challenge to the health systems and individual health facilities. In low-resource settings, disaster preparedness systems are often limited and not been well described. Two devastating earthquakes hit Nepal within a 17-days period in 2015. This study aims to describe the burden and distribution of emergency cases to a local hospital.

Methods

This is a prospective observational study of patients presenting to a local hospital for a period of 21 days following the earthquake on April 25, 2015. Demographic and clinical information was prospectively registered for all patients in the systematic emergency registry. Systematic telephone interviews were conducted in a random sample of the patients 90 days after admission to the hospital.

Results

A total of 2,003 emergency patients were registered during the period. The average daily number of emergency patients during the first five days was almost five times higher (n = 150) than the pre-incident daily average (n = 35). The majority of injuries were fractures (58%), 348 (56%) in the lower extremities. A total of 345 surgical procedures were performed and the hospital treated 111 patients with severe injuries related to the earthquake (compartment syndrome, crush injury, and internal injury). Among those with follow-up

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interviews, over 90% reported that they had been severely affected by the earthquakes; complete house damage, living in temporary shelter, or loss of close family member.

Conclusion

The hospital experienced a very high caseload during the first days, and the majority of patients needed orthopaedic services. The proportion of severely injured and in-hospital deaths were relatively low, probably indicating that the most severely injured did not reach the hospital in time. The experiences underline the need for robust and easily available local health services that can respond to disasters.

Introduction

Earthquakes have a devastating impact on health and the medical infrastructure [1, 2]. Reports from 2006 to 2016 that describe 10 earthquakes worldwide found that between 600 and 220,000 people were killed per event [3]. The number of deaths and injuries vary greatly and depend on factors related to the nature of the disaster and the regional infrastructure. The impact of earthquakes has been reported to be highest in Asia, with China and Pakistan accounting for 40% of all earthquake-related mortality [1]. Following earthquakes in low-resource settings, health facilities are often damaged and thus the emergency response capacity is reduced [1, 4]. A systematic review of earthquakes in developing countries found that lower extremity fractures were the most common type of injury [4].

Nepal has low standard buildings and infrastructure, and is one of the countries in the world that is the most vulnerable to earthquakes [5]. In 2015, Nepal suffered from two earthquakes with magnitudes of 7.8 (April 25th) and 7.3 (May 12th) on the Richter scale [6, 7]. In total, close to 9,000 people were killed, 22,000 were injured [8], and 2,000,000 people were displaced from their homes [9]. Approximately 90% of the health facilities in the affected areas were destroyed or severely damaged [10]. The functioning health facilities were overwhelmed and there was shortage of medical supplies [11, 12]. As a result, the local health system ability to respond the health care needs in disaster-affected areas was compromised. The international field hospitals functioning three days after the first earthquake reported that only 25% of the patients treated were earthquake-related injuries [13–15].

Disaster preparedness is a key element to resilient health systems [16, 17] and has been emphasized as a global priority from the UN and others [17–19]. Although considerable effort has been devoted to better disaster planning [20], there is still little evidence to support disaster planning and disaster risk reduction activities in low and middle-income countries (LMIC) [17, 21].

Reports have stated that the national health information system of Nepal lack injury details from the earthquakes, and that the national disaster policy was independent to the evidence [12, 22]. Such information is important to develop effective policy, resource allocation and disaster preparedness.

This study aims to describe the emergency patient load and the distribution of earthquake-related injuries (EQIs) and non-earthquake (NEQ) related health problems treated by a local hospital from the first day of earthquake in Nepal in 2015 and the following three weeks. Systematic telephone-interviews were performed in a random sample of these patients 90 days after admission to describe sociodemographic information and the effects that the earthquakes

had on this group. We describe the local hospital's preparedness and share experiences about factors that may be useful for managing disasters in similar settings.

Materials and methods

Study design

A prospective observational study of all emergency patients presenting to Dhulikhel Hospital (DH) in Nepal for a period of 21 days after the first earthquake on April 25, 2015, the period include the second earthquake on May 12, 2015.

Study setting

DH is a non-government university hospital located in the Kavrepalanchok district, which was one of the districts most severely affected by the two earthquakes. DH has a capacity of 375 beds, provides low-cost health services to approximately 1.9 million people from both rural and urban areas and is one of the few specialized hospitals in Kavrepalanchok and the neighbouring districts [23]. DH is located 108 km from the April 25th earthquake epicentre and 84 km from the May 12th earthquake epicentre (Fig 1) [24].

Dhulikhel Hospital Patient Care project

DH [23] had never been the first-line health care provider after an earthquake. However, the hospital was in the process of improving emergency health care through the "Dhulikhel Hospital Patient Care (DHPCARE)" project, a collaborative project initiated in 2013 between DH, the Norwegian University of Science and Technology (NTNU) and St. Olav's Hospital, University Hospital Trondheim, Norway [26]. The main interventions in this project were the introduction of a systematic emergency registry, a systematic triage system, and simulator training among health personnel in the emergency department (ED). As part of the project, the ED was reorganized to separate patients into three treatment zones (red, orange/yellow, and green) according to four triage categories (red, orange, yellow and green), with separate staff attending each zone.

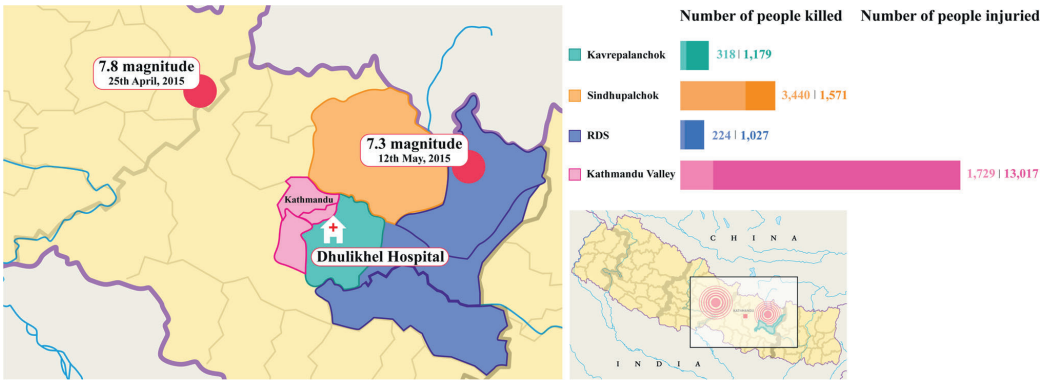

Fig 1. Map of Nepal, Dhulikhel Hospital and its beneficiary districts, including sites of two earthquakes epicenters. Left: enlarged map, illustrating the two earthquakes epicenters (red circles), Dhulikhel Hospital (DH) and its beneficiary districts (coloured sections). Top right bars: the bars show the number of people killed (lighter bar) and injured (darker bar) in the respective DH beneficiary districts [25]. RDS includes the Ramechhap, Dolakha and Sindhuli districts, and Kathmandu valley includes the Kathmandu, Lalitpur and Bhaktapur districts. Bottom right: Map of Nepal showing the two earthquake epicentres.

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Data collection

Clinical and demographic information was prospectively registered in the systematic emergency registry and hospital patient records for all patients and was extracted for the current study.

Health-related variables

Patients were classified into three broad categories: Earthquake related injuries (EQI); when the information in the registry included information that injury was caused by earthquake and non-earthquake (NEQ) related health problems; when the information in the registry did not include information that injury or health problem was caused by earthquake (Fig 2). Additionally, any complication of pregnancy (COP) was defined as a separate group. EQIs with documented details on injury diagnoses were further described. The EQIs with known injury diagnoses were categorized into body regions according to the abbreviated injury scale (AIS): head, face, neck/spine, thorax, abdomen, upper extremity, lower extremity and unknown region [27]. There was not sufficient clinical information in order to perform injury grading using the AIS code set [27]. Compartment syndrome, crush injuries and internal injuries were categorized as severe injuries. When the information in the records included only earthquake injury but no details on injury diagnosis, these were classified as earthquake injuries with unknown injury diagnosis.

The NEQ health problems were divided into six categories: infectious diseases, non-communicable disease (NCD), transport accidents, physical assault, poisoning and other NEQ. The categories of 'other NEQ' included health problems related to internal medicine, ear nose and throat, gynaecology or psychiatry not otherwise categorized. Mortality that occurred after arrival and during hospitalization was defined as hospital mortality.

Demographic and geographic variables

We identified four categories of ethnic groups; Brahmin and Chhetri, Janajati, Dalit and other/unknown [28]. Dalit ethnic groups generally have a lower socioeconomic status, whereas Brahmin and Chhetri have a higher socioeconomic status [29]. The patients' home address was

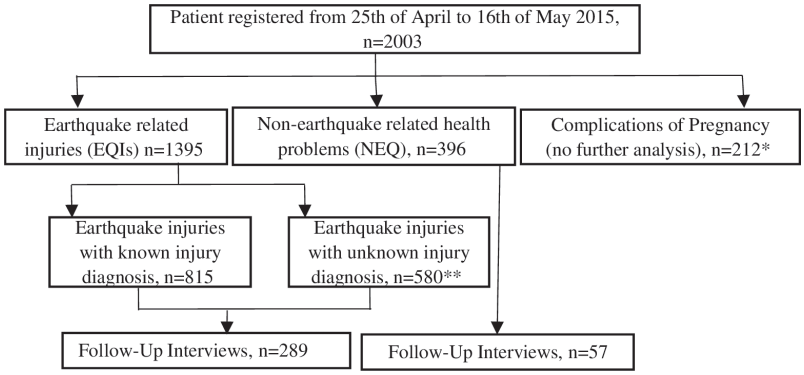

Fig 2. Flowchart of inclusion process. Flowchart of inclusion process of individuals in the study. *Excluded from further analyses because of incomplete information. **Excluded from detailed analyses because of missing information on injury diagnosis.

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used to categorize their residence into four districts categories: Sindhupalchok, Kavrepalanchok, Kathmandu valley (includes Kathmandu, Bhaktapur and Lalitpur districts) and RDS (includes Ramechhap, Dolakha and Sindhuli districts) (Fig 1). Patients' arrival time at the hospital was identified by days from the first earthquake on the 25th of April and was categorized into four groups: first week, second week, third week and unknown.

Follow-up interviews

Among the 1791 included patients for follow-up interviews, a total of 653 patients' phone numbers were recorded. Of these 653 patients', 346 patients were randomly selected and were followed up through structured telephone interviews 90 days after admission. Information was collected on health outcome and sociodemographic including the damages from the earthquakes. The impact of the earthquake on their lives were categorized as follows: very severe (loss of any family members or living in a temporary shelter or house completely damaged), moderate (any family members severely injured or migrated to new place or house partly damaged) and minor (any family members with minor injury or return to previous house or minor cracks in house).

Data analysis

Descriptive statistics using numbers and proportions (%) were calculated. We used 95% confidence intervals (CIs) for percentages in each category to describe the distributions of patients and their characteristics. We used STATA IC 13.1 (StataCorp LP, College Station Texas, USA) for all the analysis.

Ethics

The study was approved by the institutional review committee of Kathmandu University School of Medical Sciences in Nepal (58/13) and the Regional Committee for Medical and Health Research Ethics in South East Norway (2014/1246). Individual consent for information to be entered the emergency registry was waived by the ethical committee. Because of low literacy in the population, a procedure for oral information and consent was accepted for follow-up interviews and the consent was taken from the legal guardians for the patients under the age 18 years.

Results

During the study period, we registered 2,003 emergency patients and classified these as shown in Fig 2. Of the 2,003 patients, 1,395 (70%) presented with EQIs, and 396 (20%) with NEQ-related health problems. An additional 212 patients (10%) presented with pregnancy related complications. The distribution of patients during the study period is shown in Fig 3. The total patient load in the hospital in the first five days after the first earthquake was five times higher (n = 150 per day) than the pre-incident daily average (35 emergency patients per day) [26]. The second earthquake occurred on day 17, and the number of EQIs peaked to 80 for the first two days and later returned to the baseline level of approximately 25 patients. Excluding pregnancy complications, the hospital received 896 patients during the first week, 820 (59%) of who were EQIs (Table 1).

The demographic characteristics of the study population are presented in Table 1. The majority of the EQIs were female (n = 818, 59%). Children <15 years accounted for 18% of the EQIs, and the median age of EQIs was 33 years (IQR 19–52). The majority of EQIs were from Sindhupalchok (n = 763, 55%), 33% were from the hospital district (Kavrepalanchok)

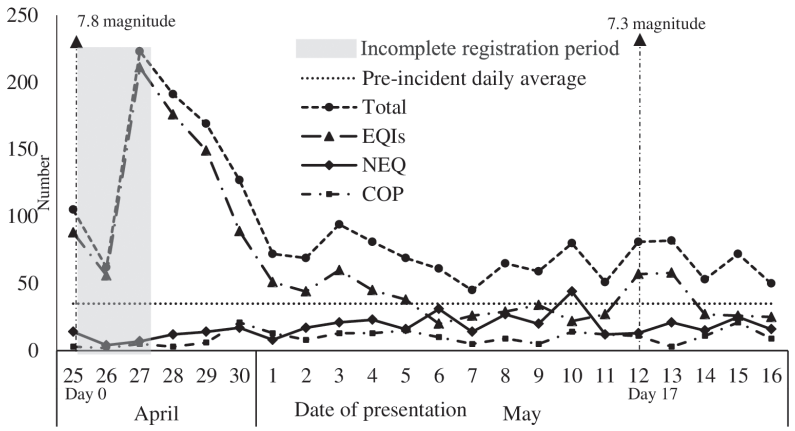

Fig 3. Daily distribution of patients from first earthquake 25th April including second earthquake 12th of May. The horizontal axis refers to the patient presenting days to Dhulikhel Hospital (DH) starting from the first day of earthquake on April 25 (day 0) until day 21 including second earthquake on day 17. The figure shows less number of patients in the first two days but in reality we had overwhelming number of patients but the patient registration system could not be maintained. Number of earthquake injuries was almost five times higher in the first five days compared to pre-incident daily average. The number of patients increased for the first two days after the second earthquake on day 17, indicating the mobile health facilities were in place. NEQ patients increased from day 11 and COP subsequently increased from day 5. EQIs, Earthquake related injuries; NEQ, Non-earthquake related health problems; COP, Complication of pregnancy.

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(n = 463). Most of the EQIs that presented in the emergency room were admitted to the hospital (n = 758, 54%) and they were hospitalized longer than NEQ patients (median 8 versus 5 days). The number of NEQ patients was relatively low during the first 10 days (average 14 per day) but increased after day 10 (average 21 per day), constituting nearly a fourth of the total patient load at day 10 (Fig 2). The most common NEQ health problems were infectious diseases (30%) and NCDs (27%) (S1 Table).

Information on EQIs with known injury diagnosis is presented in Table 2, and more detailed information on fractures is presented in S2 Table. Of the EQIs, 815 (58%) had information on injury diagnoses for a total of 1,083 injuries, 624 (58%) of those were fractures. More than half of the fractures were in the lower extremities (n = 348, 56%). A total of 345 surgical procedures were performed in the operating room on 318 patients, 338 (98%) of these were orthopaedic procedures. The most common procedures were: internal fixations including open and closed reductions (n = 211, 61%), debridement (n = 59, 17%) and external fixation (n = 37, 11%). The hospital treated 111 patients with severe injuries related to the earthquake: compartment syndrome (n = 18), crush injury (n = 36) and internal injury (n = 57). Eight patients with internal head injuries were referred to the hospital in Kathmandu for neurosurgery services. The hospital mortality was low, 1% in EQIs (n = 9) and 2% in NEQ patients (n = 6) (Table 1).

A random sample of 346 patients participated in a structured telephone interview 90 days after hospital admission. The majority of the interviewed had poor housing (Kachha) made of mud, bricks, bamboo and timber and majority reported agriculture as their main occupation (Table 3). The earthquake had a severe impact on 91% of the patients' lives (completely damaged houses or still living in a temporary shelter or loss of any family members). The majority (76%) had been inside their home at the time of the earthquake. The 90-days mortality among

Table 1. Characteristics of earthquake related injuries and non-earthquake related health problems in Dhulikhel Hospital from 25th April to 16th May 2015.

Demographic Characteristics	Total, n(%)	EQIs, n(%)	95% CI‡	NEQ, n(%)	95% CI‡
Total	1791	1395 (78)		396 (22)	
Sex					
Male	790 (44)	577 (41)	39–44	213 (54)	49–59
Female	1001 (56)	818 (59)	56–61	183 (46)	41–51
Age (years)					
<15	326 (18)	252 (18)	16–20	74 (19)	15–23
15–35	563 (31)	459 (33)	30–35	104 (26)	22–31
35–65	659 (37)	513 (37)	34–39	146 (37)	32–42
>65	243 (14)	171 (12)	11–14	72 (18)	15–22
Median age (IQR)	35 (19–52)	33 (19–52)		38 (19–55)	
Ethnicity					
Janajati‡	779 (44)	603 (43)	41–46	176 (44)	40–49
Brahmin & Chhetri‡‡	707 (39)	553 (40)	37–42	154 (39)	34–44
Dalit‡‡‡	229 (13)	185 (13)	12–15	44 (11)	8–15
Others & Unknown$	76 (4)	54 (4)	3–5	22 (6)	4–8
Arrival Week					
First Week	896 (50)	820 (59)	56–61	76 (19)	16–23
Second Week	411 (23)	262 (19)	17–21	149 (38)	33–43
Third Week	442 (25)	276 (20)	18–22	166 (42)	37–47
Unknown$	42 (2)	37(2)	2–4	5 (1)	1–3
Pre-incident Daily Average	35	-		35	
District					
Sindhupalchok†	841 (47)	763 (55)	52–57	78 (20)	16–24
Kavrepalanchok††	666 (37)	463 (33)	31–36	203 (51)	46–56
Kathmandu Valley†††	75 (4)	46 (3)	2–4	29 (7)	5–10
RDS	70 (4)	47 (3)	3–4	23 (6)	4–9
Others & Unknown$	139 (8)	76 (6)	4–7	63 (16)	13–20
Hospital Outcome					
Admitted	938 (52)	758 (54)	52–57	180 (45)	41–50
Discharged	374 (21)	233 (17)	15–19	141 (36)	31–40
DOR/LAMA*	24 (1)	13 (1)	1–2	11 (3)	2–5
Referred**	56 (3)	20 (1)	1–2	36 (9)	7–12
Dead in hospital***	15 (1)	9 (1)	0.2–1	6 (2)	1–3
Unknown$	384 (22)	362 (26)	24–28	22 (5)	4–8
Length of Hospital Stay, days median(IQR)	7 (3–16)	8 (3–19)		5 (3–7)	

EQIs, Earthquake related injuries; NEQ, Non-earthquake related health problems; DOR, Discharge on Request; LAMA, Leave against Medical Advice; RDS, Ramechap, Dolakha and Sindhuli districts.

‡95% confidence interval of the percentages.

‡Low ethnic groups.

‡‡High ethnic groups.

‡‡‡Lowest ethnic groups.

$missing information of patients.

†Sindhupalchok is the most affected district by the earthquakes and the nearest place of Sindhupalchok is at least a two-hour drive from the hospital.

††Hospital district.

†††"Kathmandu Valley" includes three districts (Kathmandu, Lalitpur and Bhaktapur).

*24 patients are either discharged on request or left hospital against the medical advice.

**Referred to higher center for higher treatment.

***15 patients died in the hospital during treatment.

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Table 2. Type of injuries by body region in 815 earthquake patients with known injury diagnosis presenting to Dhulikhel Hospital from 25th April to 16th May 2015.

Injury Classification	Total, n (%)	Head, n	Face, n	Neck/Spine, n	Thorax, n	Abdomen, n	UE, n	LE, n	Unknown, n
Fracture	624 (58)	6	9	86	20	0	152	348	3
Soft tissue Injury NOS	106 (10)	9	4	2	7	8	18	37	21
Laceration	83 (8)	18	16	0	0	2	16	22	9
Internal†	55 (5)	28	1	7	11	7	1	0	0
Crush	36 (3)	0	0	0	1	1	5	29	0
Compartment	18 (2)	0	0	0	0	0	0	17	1
Contusion	24 (2)	3	0	0	2	5	6	8	0
Dislocation	25 (2)	0	0	1	0	0	3	19	2
Burns	11 (1)	0	0	0	0	0	0	0	11
Sprain	7 (1)	0	0	0	0	0	0	7	0
Avulsion	1 (0.09)	0	0	0	0	0	0	1	0
Degloving	1 (0.09)	0	0	0	0	0	0	1	0
Amputation*	5 (0.4)	0	0	0	0	0	4	1	0
NOS	87 (8)	25	7	2	3	6	14	30	0
Total	1083	89	37	98	44	29	219	520	47

UE, Upper Extremity; LE, Lower Extremity; NOS, Not otherwise specified.

Number and percentage of injury types by body region among 815 earthquake patients with a total of 1083 injuries.

†Eight internal head injuries referred to higher-level hospital in Kathmandu.

*Amputation of two lower arm, two fingers and one foot.

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EQIs remained low (2%) but was higher in NEQ related patients (11%). The sensitivity analyses showed that the demographic characteristics of the interviewed group did not differ significantly from those of the total group of included patients (S3 Table).

Discussion

We found that the local hospital provided emergency health care to a large number of EQIs, and that the patient load was particularly high during the first five days. The majority of EQIs were female, young and from the severely affected Sindhupalchok district. Most EQIs were lower extremity fractures. The hospital performed orthopaedic procedures on more than 300 of the injured and more than 100 presented with severe injuries. Likely, many lives and much disability was spared because of existing local emergency and surgical services.

Patient load and the role of local capacity

There are no previous studies describing the patient load at a local hospital in Nepal after the 2015 earthquakes. We found that a very high number of EQIs treated during the first five days. This is in contrast to reports from the international field hospitals that started providing services three days after the first earthquake and reported a relatively low number of EQIs [13–15]. The international medical teams typically need some days after a disaster to initiate their services [13–15]. Until they arrive, patients are treated by the often poorly developed local health system, and many severely injured likely died prior to receiving medical treatment.

The EQI patient load at the hospital was high until 21 days after the first earthquake. This finding is in contrast with a previous study, which found that during the China-Lushan earthquake, the majority (n = 266; 80%) of patients were treated during the first two days [30]. According to the world disaster report in 2007, people in rural mountainous regions had

Table 3. Characteristics of interviewed patients with earthquake injuries and non-earthquake related health problems treated in Dhulikhel Hospital during a 21 days period from an earthquake.

Demographic Characteristics	Total, n(%)	EQIs, n(%)	95%CI‡	NEQ, n(%)	95%CI‡
Total	346	289 (84)		57 (16)	
Sex					
Male	135 (39)	103 (36)	30–41	32 (56)	43–68
Female	211 (61)	186 (64)	59–70	25 (44)	32–57
Age					
<15	48 (14)	44 (15)	12–20	4 (7)	3–17
15–35	121 (35)	103 (36)	30–41	18 (32)	21–45
35–65	136 (39)	111 (38)	33–44	25 (44)	32–57
>65	41 (12)	31 (11)	8–15	10 (17)	10–30
Ethnicity					
Janajati	138 (40)	108 (37)	32–43	30 (53)	40–65
Brahmin & Chhetri	163 (47)	144 (50)	44–56	19 (33)	22–47
Dalit	35 (10)	30 (10)	7–14	5 (9)	4–20
Others & Unknown$	10 (3)	7 (3)	1–5	3 (5)	3–15
Occupation					
Paid Work	74 (22)	57 (20)	16–25	17 (30)	19–43
Agriculture	181 (52)	154 (53)	47–59	27 (47)	35–60
Children & Elderly†	91 (26)	78 (27)	22–32	13 (23)	14–36
Type of House•					
Concrete *(pakka)*	40 (12)	32 (11)	8–15	8 (14)	7–26
Mud+Concrete *(Kachha+Pakka)*	46 (13)	31 (11)	8–15	15 (26)	16–39
Mud *(Kachha)*	259 (75)	225 (78)	73–82	34 (60)	46–72
Impact after Earthquake					
Very Severe*	315 (91)	266 (92)	88–95	49 (86)	74–93
Moderate**	15 (4)	10 (3)	2–6	5 (9)	4–20
Minor***	16 (5)	13 (5)	3–8	3 (5)	2–15
Location During Earthquake••					
Inside house/office	256 (76)	216 (76)	71–81	40 (73)	59–83
Outside house/office	68 (20)	54 (19)	15–24	14 (25)	16–39
Others	14 (4)	13 (5)	3–8	1 (2)	0.2–12
Outcome after Discharged•					
Better	308 (89)	263 (92)	87–94	45 (79)	66–20
Unchanged	23 (7)	18 (6)	4–10	5 (9)	4–20
Worse	2 (1)	1 (0.3)	0.04–2	1 (1)	0.02–12
Died‡	12 (3)	6 (2)	1–5	6 (11)	5–22

EQIs, Earthquake related injuries; NEQ, Non-earthquake related health problems.

‡95% confidence interval of the percentages.

$missing information in patients records.

†Childrens under age 15 years and elderly more than 65 years.

•One did not respond

••Eight did not respond.

*Very Severe: any family members died or still living in temporary shelter or house completely damaged.

**Moderate: any family members severely injured or migrate to new place or house partly damaged.

***Minor: any family members has minor injuries or back to previous house or house has minor cracks.

‡12 patients died after discharged from hospital within 90 days of hospital admission.

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challenges accessing health services [31]. In Nepal, many earthquake affected areas are rural and mountainous and there are continuous landslides [5, 22, 32], which affect transportation and prevent timely access to health facilities. The pre-existing inadequate health system capacity and destruction of the existing health infrastructure in these regions made access to health care even difficult for the affected people [12]. After the second earthquake on May 12, there were fewer EQIs and an increased patient load lasted for the first two days only. This finding could be explained by the fact that many people had moved to a safer place in a temporary shelter after the first earthquake or that many international field hospitals may have been in place by the time of the second earthquake. However, international relief assistance is often based in urban centres and is often not sustainable in a rural setting [31, 33], and we are unaware of whether they reached people in the affected area who were in need. During the response phase, coordination and leadership challenges exist, within and between the health-care service providers and often a disconnection between a national policy and implementation at a local level especially in LMICs like Nepal [12, 17]. This reflects the importance of strengthening local health systems and developing a better communication and coordination strategy with national and international medical teams. The insufficient development of disaster management likely affected the outcomes of the 2015 earthquakes in Nepal [34].

Characteristics of EQIs

We found that the majority of EQIs were women (59% versus the 54% proportion of women in the country);[28] this finding may support the conclusion that women were particularly vulnerable to this earthquake, as it occurred on a Saturday morning, when many females would be inside the house busy with household chores. The field hospitals observed similar findings [14], and spinal cord rehabilitation centre reported 56% (n = 65) of spinal injuries were among women [35]. A review study found that, women, young or old people, those with disabilities, having a poor socio-economic status, or being inside the house and having poorly constructed homes had higher health impact during the earthquakes [1, 17, 36]. In the current study, nearly half of the EQIs were under the age of 35 years, and one in five EQIs were children under the age of 15 years. A similar age distribution was found in the field hospital [14]. This finding may be explained by the fact that children are often with their mothers.

The majority of EQIs in DH were from the severely affected Sindhupalchok district [25]. This finding may be surprising, as the closest place to DH in Sindhupalchok is at least a two-hour drive. According to official statistics, this area had a higher number of deaths (n = 3,440) than Kavrepalanchok (n = 318) and more than half of the health facilities including the district hospital were completely damaged [25, 37]. Many severely wounded individuals from this district likely never reached a health facility, and the distance can likely explain the long-lasting peak of EQIs presenting at the hospital and the low mortality and few severe injuries.

Types, severity and mortality of injuries

Other studies have described that earthquakes typically cause injuries to the musculoskeletal system [38]. This trend was consistent with our findings, which showed that the majority of injuries were fractures, often in lower extremities. In line with our findings, two field hospitals reported that the majority of patients (81% and 44%) had musculoskeletal injuries [13, 14] and that more than half of the injuries were limb fractures [13, 15]. There are also other events comparable to the 2015 earthquakes in Nepal, such as the 2010-Yashu and 2013-Lushan earthquakes in China (magnitude 7.1), which reported fewer lower extremity fractures at 21% and 47%, respectively [30, 36]. In contrast, a study of the 2010-Haiti earthquake (magnitude 7.0)

reported a rate of lower extremity fractures of 63% and fewer minor injuries (13%) [13] than our study (20% minor injuries).

More people are killed in earthquakes than in other natural disasters [39]. In the current study, the hospital mortality was low and was comparable with hospital mortality observed during normal days [40]. The proportions of severe injuries such as compartment syndrome, crush injuries and internal injuries were relatively low compared to the total number of injuries. Nevertheless, more than 100 severe injuries were treated in the hospital, and one in three injured patients had at least two different injuries. We believe that many severely injured individuals died before receiving health care because of the undeveloped health care infrastructure, inaccessibility to health facilities and non-functioning transportation systems [41]. The number of patients reaching hospital is not a complete picture of injuries after an earthquake, since many patients were treated by voluntary health workers locally and were not registered. In a review study on earthquake injuries in developing countries, debridement (33%), closed reduction (24%), open reduction and internal fixation (24%) and external fixation (12%) were described as the most common procedures performed [4]. In our study, more than 300 patients had orthopaedic procedure. Internal fixations (open and closed reductions) represented 61% of the performed procedures. Many survivors who reached the hospital in the present study needed treatment for orthopaedic injuries, and these findings are in line with others [4]. Thus, appropriate medical and surgical care capacity is likely to have saved lives and spared disabilities. The high number of internal fixation may also have reduced infectious complications.

Characteristics of NEQ patients

During disasters, the regular health care for NEQ related health problems is often compromised and disrupted, although acute trauma care is likely jeopardized by inadequately controlled NCDs such as cardiovascular or diabetic disease [7]. A review study in LMICs has emphasized a preparedness need for changing health priorities of the patients during earthquakes, from an acute treatment of injuries to general health needs that is required within the first week [17]. In our study, a relatively low number of patients with NEQ related health problems sought health care in the first week, but the numbers increased to normal levels in the second and third week. From day five, the hospital established an outpatient desk with a medical team to manage NEQ outpatients, and these individuals were not included in the present study. The majority of NEQ health problems were infectious diseases and NCDs, including chronic obstructive pulmonary disease, cardiovascular disease and diabetes. Infectious diseases included gastroenteritis, pneumonia and urinary infections and was higher (30%), compared to pre-incident period previously reported (18%) [42]. A field hospital reported that during this period, 19% of patients had respiratory illness and 17% had a gastrointestinal illness [14]. Twelve patients with severe self-harm poisoning observed in our study, the majority were women. A study from Nepal reported 41% increase in suicides three months after the earthquakes and a field hospital reported 6% of all patients during the earthquake period suffered from psychiatric conditions [14, 43]. Based on our observation of a relatively high number of infections and self-harm, we speculate that infectious diseases and psychiatric issues could be a major problem after disasters such as earthquakes, but the current data cannot fully conclude to this. Thus, treatment interruptions for NEQ patients should be minimized during the acute phase of the emergency, as they will otherwise increase the risk of complications and death.

Follow-up 90 days after admission

The majority of the interviewed patients were of low socioeconomic status, with poor housing and small-scale agriculture as major source of income. Nearly nine in ten of the interviewed

patients had experienced severe damage to their house, had lost a family member, and were still living in a temporary shelter 90 days after the earthquake. These findings are supported by a systematic review, in which socioeconomic status, location of individuals, construction materials and design of the house, emergency response and local health systems were among the risk factors associated with mortality and injury severity during an earthquake [1]. Furthermore, the 90-day mortality of EQIs and NEQ health problems was two times and five times higher than the hospital mortality rate, respectively. Patients who had died at home by 90 days after admission had severe injuries (spinal fracture, blunt trauma), burns or NCDs. Previous studies have not considered mortality after discharge. However, the local tradition is strongly in favour of deaths occurring at home, and severely injured patients could therefore have been discharged to die at home. We are not aware of the follow-up study after earthquakes in similar setting. Post-disaster investigations in a larger sample are needed in the future to further describe health and living conditions in earthquake victims. Nevertheless, the information from the post-discharge interviews reveals that poor people are vulnerable after an earthquake and that the effects of the disaster become severe over time.

Dhulikhel Hospital experience

In the first day after the earthquake, the number of EQIs escalated in the hospital, where all the beds and almost all the space in the courtyard was occupied and the working conditions were continuously demanding. Power was out most of the time, and internet and telecommunication were down for the first two days. The triage system at the main entrance of the hospital and the three treatment zones (red, orange/yellow, and green) according to four triage codes (red for highly severe, orange, yellow and green for less severe) were very helpful tools in patient management and ensuring timely treatment according to severity. The hospital had a local emergency communication system that was not tele- or web-dependent was important for being able to respond in this situation. The hospital set up immediate medical direction, 24-hour surgical services, infection control teams, and logistical management teams, who had a vital role in managing unexpected workloads and providing efficient and quality health care.

Limitations

The diagnosis and demographic information was partly incomplete because of the high workload in the hospital during the first days after the first earthquake. We registered many EQIs who did not have detailed information on injury diagnoses and could not be included in the injury description, and their omission may have led to an underestimation to specific injury loads. The diagnoses of the patients was done by different doctors and was often incomplete. To balance this we used the discharge diagnoses and when available we used procedures (CT, X-Ray, cast) and operation information of individual patients. Another limitation is that in the first few days, patients with multiple injuries and head injuries could have been referred to a higher health facility before the registration, which means severe injuries could be underestimated. A high number of women with pregnancy complications presented to the hospital (n = 212) but could not be described in detail because of incomplete information. Patients with NEQ health problems treated in outpatient care that started from day five were not reported in the present study. The follow-up interviews included relatively low proportion of the patients, hindering the ability to draw firm conclusions especially on 90 days mortality. The study included patients treated at only one hospital, and thus the results may not be truly representative at the population level. However, to date we are not aware of any study that has reported the patient burden in a local hospital from 2015 earthquake in Nepal. However, studies with large samples that assess systematic disaster preparedness to evaluate cost-effective

interventions in low-resource settings are warranted, and further studies to investigate post-disaster health outcomes, social conditions, disabilities and psychiatric health should be prioritized.

Final remarks

Most EQIs arrived at the hospital within the first days after the first earthquake, and the local hospital treated a very high number of cases. Thus, the burden of emergency cases was high before the international field hospitals could be established. Our study result underline the importance of developing consistent and robust local health services capable of managing natural disasters such as an earthquake while also maintaining adequate medical care for other patients. The hospital staffs rapidly initiated systematic screening of patients arriving at the hospital using a simplified triage system, and prioritized effective surgical services.

Supporting information

S1 Table. Characteristics of non-earthquake related health problems for patients presenting to Dhulikhel Hospital, Nepal during a 21 day period after an earthquake on 25th April 2015, including a second earthquake on day 17 (12th May 2015). NCD, Non-communicable disease. RDS, includes three districts (Ramechap, Dolakha and Sindhuli). NEQ, Non-earthquake related health problems. Number and percentages of patients' characteristics among 396 NEQ patients during 21 days of earthquake. ‡95% CI provided for percentage for each categories. †Other NEQ, Patients having health problems related to medicine, ear nose throat, surgery, gynecology, neurology and psychiatric. §missing information in the patients records.
(DOCX)

S2 Table. Types of fracture in 624 fractures by body region presenting to Dhulikhel Hospital during a 21-day period after an earthquake on 25th April 2015. NOS, Not otherwise specified. Number and percentage of fracture types by body region in 625 fractures.
(DOCX)

S3 Table. Characteristics of interviewed and non-interviewed patients that had been treated in Dhulikhel Hospital during a 21-day period after an earthquake. RDS, Ramechap, Dolakha and Sindhuli districts. Number and percentages of patients characteristics among interviewed and non-interviewed. *Interviewed. **Not Interviewed. §missing information in the patients records.
(DOCX)

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References

1. Doocy S, Daniels A, Packer C, Dick A, Kirsch TD. The human impact of earthquakes: a historical review of events 1980–2009 and systematic literature review. PLOS Currents. 2013; 5.
2. Briggs SM. Earthquakes. The Surgical Clinics of North America. 2006; 86:537–44. https://doi.org/10.1016/j.suc.2006.02.003 PMID: 16781268
3. EM-DAT. The International Disaster Database. Belgium: Centre for Research on the Epidemiology of Disasters; 2017 [34]; Available from: http://www.emdat.be/
4. MacKenzie JS, Banskota B, Sirisreetreerux N, Shafiq B, Hasenboehler EA. A review of the epidemiology and treatment of orthopedic injuries after earthquakes in developing countries. World J Emergency Surgery. 2017; 12:9.
5. UNDP. Nepal Country Report, Global Assessment of Risk. United Nations Development Programme. 2009 [34]; Available from: http://www.undp.org/content/dam/nepal/docs/reports/UNDP_NP_Nepal%20Country%20Report.pdf.
6. Government Nepal. Nepal Earthquake 2015: Post Disaster Recovery Framework 2016–2020. National Reconstruction Authority, Government of Nepal, 2016.
7. WHO. Humanitarian crisis after the Nepal earthquakes 2015. Nepal. [34]; Available from: http://www.searo.who.int/entity/emergencies/phra_nepal_may2015.pdf?ua=1
8. The Ministry of Home Affairs, Government of Nepal. Nepal Earthquake 2015: Disaster Relief and Recovery Information Platform (NDRRIP) Disaster Recovery and Reconstruction Information Platform: Country Profile, 2015.
9. Adhikari B MS, Raut S. Rebuilding earthquake struck Nepal through community engagement. Front Public Health. 2016; 4:121. https://doi.org/10.3389/fpubh.2016.00121 PMID: 27379225
10. Nielsen MJ, Ferguson S, Joshi AK, Rimal S, Shrestha I, Magar SR. Post-earthquake recovery in Nepal. Lancet Glob Health. 2016; 4:e161. https://doi.org/10.1016/S2214-109X(15)00279-X PMID: 26670036
11. Government of Nepal. Nepal Earthquake 2015: Post Disaster Needs Assessment 2015. National Planning Commission, Government of Nepal, 2015.
12. Hall ML, Lee AC, Cartwright C, Marahatta S, Karki J, Simkhada P. The 2015 Nepal earthquake disaster: lessons learned one year on. Public Health. 2017; 145:39–44. https://doi.org/10.1016/j.puhe.2016.12.031 PMID: 28359388
13. Bar-On E, Blumberg N, Joshi A, Gam A, Peyser A, Lee E, et al. Orthopedic Activity in Field Hospitals Following Earthquakes in Nepal and Haiti: Variability in Injuries Encountered and Collaboration with Local Available Resources Drive Optimal Response. World J of Surgery. 2016; 40:2117–22.
14. Ho ML, Lim JZ, Tan MZ, Kok WL, Zhang JR, Tan MY, et al. Humanitarian Assistance and Disaster Relief mission by a tripartite medical team led by the Singapore Armed Forces after the 2015 Nepal earthquake. Singapore Med Journal. 2016; 57:426–31.
15. Ding S, Hu Y, Zhang Z, Wang T. A contrast study of the traumatic condition between the wounded in 5.12 Wenchuan earthquake and 4.25 Nepal earthquake. Chinese J of Traumatology. 2015; 18:157–60.

16. Dai ZY, Li Y, Lu MP, Chen L, Jiang DM. Clinical profile of musculoskeletal injuries associated with the 2008 Wenchuan earthquake in China. Ulus Travma Acil Cerrahi Derg. 2010; 16:503–7. PMID: 21153941
17. Cartwright C, Hall M, Lee ACK. The changing health priorities of earthquake response and implications for preparedness: a scoping review. Public Health. 2017; 150:60–70. https://doi.org/10.1016/j.puhe.2017.04.024 PMID: 28645042
18. UN/ISDR. Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters. Geneva: Inter-Agency Secretariat of the International Strategy for Disaster Reduction. Geneva: United Nation, International Strategy for Disaster Reduction, 2005.
19. Matsuoka Y, Shaw R. Chapter 7. Linking Resilience Planning to Hyogo Framework for Action in Cities. Climate and Disaster Resilience in Cities. Emerald Group Publishing Limited 2011:129–47.
20. Lee AC, Phillips W, Challen K, Goodacre S. Emergency management in health: key issues and challenges in the UK. BMC Public Health. 2012; 12:884. https://doi.org/10.1186/1471-2458-12-884 PMID: 23083332
21. Lee AC, Booth A, Challen K, Gardois P, Goodacre S. Disaster management in low- and middle-income countries: scoping review of the evidence base. Emergency Medicine J. 2014; 31:e78–83.
22. Landry MD, Sheppard PS, Leung K, Retis C, Salvador EC, Raman SR. The 2015 Nepal Earthquake(s): Lessons Learned From the Disability and Rehabilitation Sector's Preparation for, and Response to, Natural Disasters. Phys Ther. 2016; 96(11):1714–23. https://doi.org/10.2522/ptj.20150677 PMID: 27277496
23. Hospital D. Dhulikhel Hospital Kathmandu University Hospital. Dhulikhel, Nepal: Dhulikhel Hospital. [34]; Available from: http://www.dhulikhelhospital.org.
24. Globefeed.com. Nepal Distance Calculator. [34]; Available from: http://distancecalculator.globefeed.com/Nepal_Distance_Calculator.asp.
25. UNHCR. Nepal: 2015 Earthquakes. Nepal. [34]; Available from: http://data.unhcr.org/nepal/.
26. Dønnem M, Eid K. Introduction of systematic triage in the emergency room at Dhulikhel Hospital, Nepal: Evaluation of a quality improvement project [dissertation]. NTNU, 2016.
27. Gennarelli TA, Wodzin E. AIS 2005-Abbreviated Injury Scale. Barrington, IL Association for the Advancement of Automotive Medicine (AAAM) 2005.
28. NDHS. Nepal Demographic and Health Survey. Nepal: Ministry of Health and Population, Government of Nepal, 2011.
29. Bennett L, Dahal DR, Govindasamy P. Caste, Ethnic and Regional Identity in Nepal Further Analysis of the 2006 Nepal Demographic and Health Survey Nepal: USAID, Macro International Inc 2008.
30. Kang P, Tang B, Liu Y, Liu X, Liu Z, Lv Y, et al. Medical efforts and injury patterns of military hospital patients following the 2013 Lushan earthquake in China: a retrospective study. International J of Environmental Research and Public Health. 2015; 12:10723–38.
31. Report WD. World Disasters Report, Focus on Discrimination: International Federation of Red Cross and Red Crescent Societies 2007.
32. BBC. Nepal earthquake: People flee as landslide blocks river. BBC. [34]; Available from: http://www.bbc.com/news/world-asia-32859353.
33. Sharma DC. Nepal earthquake exposes gaps in disaster preparedness. Lancet. 2015; 385:1819–20. https://doi.org/10.1016/S0140-6736(15)60913-8 PMID: 25987142
34. Lee ACK. Barriers to evidence-based disaster management in Nepal: a qualitative study. Public Health. 2016; 133:99–106. https://doi.org/10.1016/j.puhe.2016.01.007 PMID: 26877066
35. Groves CC, Poudel MK, Thapa BP, Baniya MM. Spinal Cord Injuries Related to 2015 Nepal Earthquakes. PM R. 2016; 8:S154.
36. Kang P, Tang B, Liu Y, Liu X, Shen Y, Liu Z, et al. Profile and procedures for fractures among 1323 fracture patients from the 2010 Yushu earthquake, China. American J Emergency Medicine. 2016; 34:2132–39.
37. WHO. Rapid Hospital Needs Assessment Report–Mega-earthquake in Nepal. Nepal: World Health Organization, 2015.
38. Clover AJ, Jemec B, Redmond AD. The extent of soft tissue and musculoskeletal injuries after earthquakes; describing a role for reconstructive surgeons in an emergency response. World J Surgery. 2014; 38:2543–50.
39. ReliefWeb. The Human Cost of Natural Disasters 2015: A Global Perspective ReliefWeb, 2015.
40. Karki RK. Mortality Patterns among Hospital Deaths. Kathmandu University Medical J (KUMJ). 2016; 14:65–68.

41. Kumar A, Singh MD, Roy LS. Field evidence of Gorkha earthquake of 25 April (7.8 M) and Kodari earthquake of 12 May 2015 (7.2 M) in Nepal. Geomatics, Natural Hazards and Risk Published Online First: 10 May 2016. https://doi.org/10.1080/19475705.2016.1181677

42. Amundsen MS, Kirkeby TM, Giri S, Koju R, Krishna SS, Ystgaard B, et al. Non-communicable diseases at a regional hospital in Nepal: Findings of a high burden of alcohol-related disease. Alcohol. 2016; 57:9–14. https://doi.org/10.1016/j.alcohol.2016.10.008 PMID: 27916144

43. Cousins S. Nepal's silent epidemic of suicide. Lancet 2016; 387:16–7. https://doi.org/10.1016/S0140-6736(15)01352-5 PMID: 26766336

S1 Table. Characteristics of non-earthquake related health problems for patients presenting to Dhulikhel Hospital, during a 21-day period after an earthquake on 25th April 2015.

Demographic Characteristics	Total, n (%)	Infectious Diseases, n(%)	95%CI‡	NCD, n(%)	95%CI‡	Transport Accident, n(%)	95%CI‡	Physical Assault, n(%)	95%CI‡	Poisoning, n(%)	95%CI‡	Other NEQ†, n(%)	95%CI‡
Total	396	120 (30)		107 (27)		32 (8)		15 (4)		12 (3)		110 (28)	
Sex													
Male	213 (54)	66 (55)	46-64	57 (53)	44-63	21 (66)	48-80	9 (60)	34-81	4 (33)	12-64	56 (51)	42-60
Female	183 (46)	54 (45)	36-54	50 (47)	37-56	11 (34)	20-52	6 (40)	19-66	8 (67)	36-88	54 (49)	40-58
Age (years)													
<15	74 (19)	39 (33)	25-41	3 (3)	1-8	5 (16)	7-33	2 (13)	3-42	2 (17)	4-50	23 (21)	14-30
15-35	104 (26)	38 (32)	24-41	8 (7)	4-14	13 (41)	25-58	6 (40)	19-66	4 (33)	12-64	35 (32)	24-41
35-65	146 (37)	25 (21)	14-29	54 (50)	41-60	11 (34)	20-52	6 (40)	19-66	6 (50)	23-77	44 (40)	31-49
>65	72 (18)	18 (15)	10-23	42 (39)	30-49	3 (9)	3-26	1 (7)	1-37	-	-	8 (7)	4-14
Median (IQR)		26 (7-46)		60 (45-72)		30 (21-46)		30 (18-40)		34 (18-45)		32 (17-46)	
Ethnicity													
Janajati	176 (44)	50 (42)	33-51	53 (50)	40-59	14 (44)	28-61	5 (33)	14-60	3 (25)	8-57	51 (46)	37-56
Brahmin & Chhetri	154 (39)	52 (43)	35-52	37 (34)	26-44	12 (38)	22-55	7 (47)	23-71	5 (42)	18-70	41 (37)	29-47
Dalit	44 (11)	10 (8)	5-15	15 (14)	9-22	3 (9)	3-26	2 (13)	3-42	3 (25)	8-57	11 (10)	6-17
Others & Unknown§	22 (6)	8 (7)	3-13	2 (2)	0.4-7	3 (9)	3-26	1 (7)	1-37	1 (8)	1-44	7 (6)	3-13
Arrival Week													
First Week	76 (19)	31 (26)	19-34	14 (13)	8-21	6 (19)	9-36	2 (13)	3-42	3 (25)	8-57	20 (18)	12-27
Second Week	149 (38)	40 (33)	25-42	49 (46)	37-55	12 (37)	22-55	7 (47)	23-71	6 (50)	23-77	35 (32)	24-41
Third Week	166 (42)	49 (41)	32-50	44 (41)	32-51	12 (37)	22-55	6 (40)	19-66	3 (25)	8-57	52 (47)	38-57
Unknown§	5 (1)	-	-	-	-	2 (6)	2-22	-	-	-	-	3 (3)	1-8
District													
Sindhupalchok	78 (20)	22 (18)	12-26	25 (23)	16-32	3 (9)	3-26	1 (7)	1-37	1 (8)	1-44	26 (24)	17-33
Kavrepalanchok	203 (51)	64 (53)	44-62	57 (53)	44-63	15 (47)	30-64	10 (66)	40-86	8 (67)	36-88	49 (45)	35-54
Kathmandu Valley	29 (7)	8 (7)	3-13	5 (5)	2-11	4 (13)	5-29	-	-	-	-	12 (11)	6-18
RDS	23 (6)	8 (7)	3-13	4 (4)	1-10	3 (9)	3-26	1 (7)	1-37	1 (8)	1-44	6 (5)	2-12
Others & Unknown§	63 (16)	18 (15)	10-23	16 (15)	9-23	7 (22)	11-40	3 (20)	6-48	2 (17)	4-50	17 (15)	10-24
Death	6 (2)	2 (2)		3 (3)		-		-		-		1 (1)	

NCD, Non-communicable disease. RDS, includes three districts (Ramechap, Dolakha and Sindhuli)

Number and percentages of patients characteristics among 396 NEQ patients during 21 days of earthquake. ‡95% CI provided for percentage for each categories. †Other NEQ, Patients having health problems related to medicine, ear nose throat, surgery, gynecology, neurology and psychiatric. §missing information in the patients records

S2 Table. Types of fracture in 624 fractures by body region presenting to Dhulikhel Hospital during a 21-day period after an earthquake on 25th April 2015.

Body region	Type of Fracture	Number	Total, n(%)
Head	Skull	6	6 (1)
Face	Nose Orbit Zygoma Mandible	2 2 3 2	9 (1)
Neck/Spine	Cervical Thoracic Lumbar NOS	2 24 53 7	86 (14)
Thorax	Rib	20	20 (3)
Upper extremity	Clavicle Scapula Humerus Radius Ulna Hand Finger NOS	11 3 48 33 24 17 14 2	152 (24)
Lower extremity	Pelvis Femur Patella Tibia Fibula Calcaneus Foot NOS	44 96 2 126 45 12 11 12	348 (56)
Unknown region	NOS	3	3 (0.4)
Total			624

NOS, Not otherwise specified

S3 Table. Characteristics of interviewed and non-interviewed patients that had been treated in Dhulikhel Hospital during a 21-day period after an earthquake.

Demographic Characteristics	Total,n(%)	Int*, n(%)	95%CI‡	No Int**, n(%)	95%CI‡
Total	1791	346 (19)		1445 (81)	
Sex					
Male	790 (44)	135 (39)	34-44	655 (45)	43-48
Female	1001 (56)	211 (61)	56-66	790 (55)	52-57
Age					
<15	326 (18)	48 (14)	11-18	278 (19)	17-21
15-35	563 (31)	121 (35)	30-40	442 (31)	28-33
35-65	659 (37)	136 (39)	34-45	523 (36)	34-39
>65	243 (14)	41 (12)	9-16	202 (14)	12-16
Ethnicity					
Janajati	779 (44)	138 (40)	35-45	641 (44)	42-47
Brahmin & Chhetri	707 (39)	163 (47)	41-52	544 (38)	35-40
Dalit	229 (13)	35 (10)	7-14	194 (13)	12-15
Others & Unknown§	76 (4)	10 (3)	2-5	66 (5)	4-6
Arrival Week					
First Week	896 (50)	186 (54)	48-59	710 (49)	47-52
Second Week	411 (23)	71 (21)	17-25	340 (24)	21-26
Third Week	442 (25)	88 (25)	21-30	354 (25)	22-27
Unknown§	42 (2)	1 (0.2)	0-2	41 (3)	2-4
District					
Sindhupalchok	841 (47)	167 (48)	43-54	674 (47)	44-49
Kavrepalanchok	666 (37)	145 (42)	37-47	521 (36)	34-39
Kathmandu Valley	75 (4)	11 (3)	2-6	64 (4)	3-6
RDS	70 (4)	18 (5)	3-8	52 (4)	3-5
Others & Unknown§	139 (8)	5 (1)	1-3	134 (9)	8-11

RDS, Ramechap, Dolakha and Sindhuli districts.

Number and percentages of patients characteristics among interviewed and non-interviewed. *Interviewed. **Not Interviewed. ‡95% confidence interval for the percentages. §missing information in the patients records.

Paper II

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Presenting complaints and mortality in a cohort of 22,000 adult emergency patients at a local hospital in Nepal

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Paper II

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Presenting complaints and mortality in a cohort of 22 000 adult emergency patients at a local hospital in Nepal

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Background There is a need to develop sustainable emergency health care systems in low-resource settings, but data that analyses emergency health care needs in these settings are scarce. We aimed at assessing presenting complaints (PCs) and post-discharge mortality in a large emergency department population in Nepal.

Methods Characteristics of adult patients who entered the emergency department (ED) in a hospital in Nepal were prospectively recorded in the local emergency registry from September 2013 until December 2016. To assess post-ED mortality, patient households were followed-up by telephone interviews at 90 days.

Results In 21892 included adults, the major PC categories were injuries (29%), abdominal complaints (23%), and infections (16%). Median age was 40 years and sex distribution was balanced. Among 3793 patients followed at 90 days, 8% had died. For respiratory and cardiovascular PCs, 90-days mortality were 25% and 23%. The highest mortality was in individuals with known chronic lung disease, in this group 32% had died by 90 days of ED discharge, regardless of PC. In women, illiteracy compared to literacy (adjusted odds ratio (aOR) = 7.0, 95% confidence interval (CI)=2.1-23.6) and being both exposed to tobacco-smoking and traditional cooking stove compared to no smoke (aOR=2.8, 95% CI=1.6-4.9) were associated with mortality. The mortality was much higher among family-initiated discharged patients (17%, aOR=5.4, 95% CI=3.3-8.9) compared to doctor-initiated discharged (3%).

Conclusions Our report suggests that nearly one in ten patients seeking emergency health care died within 90 days. This finding is alarming and novel. Post-discharge studies need to be replicated and appropriate follow-up programs in low-resource settings where primary health care is underdeveloped are urgently needed.

The Disease Control Priorities project has estimated that almost half of the deaths and over a third of the disabilities in low- and middle-income countries (LMICs) could be addressed through effective emergency care [1]. Top priority to emergency care has been recognized by the World Health Assembly [2]. A recent study reported that death rates and disability-adjusted life-years (DALYs) attribut-

able to emergency conditions are three times higher in low-income countries (LICs) than high-income countries (HICs) [3]. Nevertheless, emergency health services are still underfunded and underdeveloped in LMICs [4], and it has been argued that improvement is particularly needed in emergency care systems [1,5]. However, a recent systematic review of emergency care in 59 LMICs has pinpointed the scarcity of relevant data that makes clinical and policy priorities difficult [6]. Another systematic review performed in 139 LMICs showed that patient outcomes from emergency care were poorly reported. There were 3-4 times more studies reporting mortality during emergency care compared to reporting outcomes after emergency discharge [7].

In Nepal, emergency care systems are underdeveloped [8,9]. Patients often directly access emergency care irrespective of the type of health complaints, and primary care physicians in emergency department (ED) are often the first contact point with healthcare. Previous studies from Nepal have focused on certain groups of emergency patients such as injuries and infections, and reported that patient volumes have increased in recent years [10-12]. A systematic review among traffic injuries in Nepal reported that the mortality rate had almost doubled from 2001 to 2013 [13], and that the burden of non-communicable diseases (NCDs) had almost doubled [14,15]. These reports, however, provide only fragments of the picture of emergency health care needs and understanding morbidity patterns may aid health administrators in resource allocation and planning of training needs [16,17]. Descriptive information about ED patients is scarce in Nepal. Surprisingly little is known about mortality after emergency care and studies in Nepal have reported hospital and ED mortality to one percent or less [18-20]. Mortality after ED visit is usually not documented, although discharge to home should not be regarded as a completion of patient management [21].

To add knowledge in this area, we aimed to describe 1) characteristics of adult ED patients across presenting complaints (PCs) in a hospital in Nepal; 2) mortality until 90 days after presentation and assess factors that are associated with mortality in this population. We took advantage of increasing access to mobile phones in Nepal and follow-up information was assessed by telephone interviews.

MATERIALS AND METHODS

Study design and setting

A prospective observational study was conducted in the ED of a non-government university hospital with 375 beds [22]. The hospital is located in semi-urban region in Dhulikhel, in Kavrepalanchok district 30 km northeast of Kathmandu. Kavrepalanchok district has a total population of nearly 400 000 and 51% are female [23]. The median age in this region is 23 years, and 30% are 0-15 years old. The corresponding figures for Nepal as a whole are: 23 years median age and 35% are less than 20 years. The three main ethnic groups in the district are Brahmin/Chheti (36%) followed by Janajati (51%) and Dalit (7%). The majority (78%) of the population in this district use wood as a main type of cooking fuel.

Data collection and participants

Demographic and clinical information was prospectively registered in systematic emergency forms by ED nurses, paramedics and doctors, and was extracted into an electronic database by a research nurse (Appendix S1 in **Online Supplementary Document**). All adults (>16 years) presenting at the ED between September 2013 to December 2016 were included in the study. However, data collection was interrupted three times during the study period because of; failure to continue data collection (Sept 2014-Feb 2015), earthquakes (April 25-May 16 2015) and missing ED files (Sept and Nov 2016). Data from the earthquake period has been described previously [19].

Variables

Research nurses used the patients' home addresses to categorize their residence into rural (living outside a municipality) or urban (living inside a municipality). Ethnicity was categorized into four groups recognized by Nepali authorities; Brahmin and Chhetri, Janajati, Dalit, and others. Brahmin and Chhetri are generally considered as a group having a higher socioeconomic status and Dalit typically have a lower socioeconomic status [24].

Time of presentation at ED was categorized into; daytime (08-16 weekdays) and after working hours (16-08) or holidays. ED disposition was categorized into; hospitalized, non-hospitalized or dead in the ED.

Hospitalizations were further categorized: admitted to general wards, directly transferred to ICU (Intensive Care Unit) or OT (Operating Theatre), or referred to other hospitals from ED. Non-hospitalized patients were categorized into; doctor-initiated discharge or family-initiated discharge (FID).

Presenting complaints classification

The presenting complaints from the emergency forms were translated into "International Classification of Primary Care-2 (ICPC-2)" codes [25], and classified accordingly into nine main categories and each patient was assigned a primary PC category; self-harm, injuries, infections, unconsciousness, CVD (cardiovascular related complaints and diseases), respiratory complaints, OBGYN (obstetrics and gynecology), abdominal complaints and other complaints (**Figure 1**). Patients that had information on any NCDs at ED presentation in addition to the PC was given a NCD category; COPD (chronic obstructive pulmonary disease) or asthma, CVD and other NCDs (cancer, diabetes or chronic liver disease) in addition to the PC. The strategy for presenting complaint categorization and use of ICPC-2 codes is presented in the Annex S2 and Table S1 **Online Supplementary Document**.

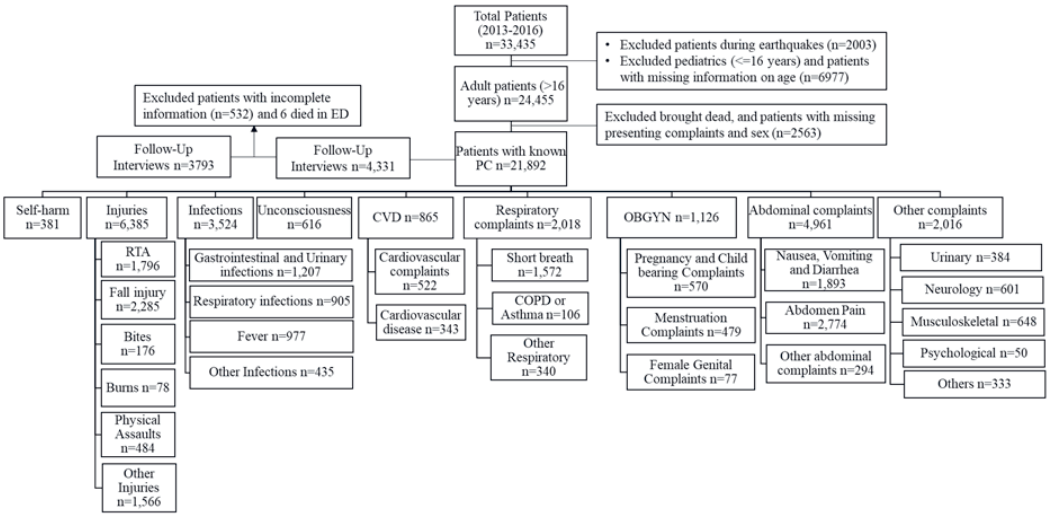


Figure 1. Flow diagram of cohort and distribution of presenting complaints. ED – emergency department, PC – presenting complaint, RTA – road traffic accidents, CVD-cardiovascular diseases or complaints, COPD – chronic obstructive pulmonary disease, OBGYN – obstetrics or gynecology.

Follow-up interviews

At ED disposition all patients were asked for consent to be telephone-interviewed at 90 days after initial presentation to the ED, and trained research nurses called and interviewed the patient or a family member (Annex S2 in **Online Supplementary Document**). The telephone interview was structured, and questions were about death or hospitalizations during last 90 days, and demographic information (literacy, occupation, number of family members living together, exposure level to smoke) (Annex S3 in **Online Supplementary Document**).

Data analysis

Descriptive data is presented by numbers and percentages. Associations between patient characteristics and mortality at 90 days were assessed by logistic regression models. Age and sex adjusted odds ratios (aORs) and unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) are presented. Data analyses were performed using STATA 13.1 (StataCorp LP, College Station Texas, USA).

Ethics

The study was approved by the institutional ethical review committee of Kathmandu University School of Medical Sciences in Nepal (58/13) and the Regional Committee for Medical and Health Research Ethics in South East Norway (2014/1246). As this study is based on routinely collected pseudo anonymized patient information in the hospital, informed consent from the patients was not obtained in individuals, as approved by the local ethical committee. Verbal consent was taken for information on telephone numbers, and at the beginning of the telephone interviews.

RESULTS

Patient characteristics

During the study period, 33435 patients were enrolled. In total 21892 patients were included in the analysis (**Figure 1**). The most common presenting complaints were injuries (29%), abdominal complaints (23%), and infections (16%) (**Table 1**). The median age of ED patients was 40 years (interquartile range IQR 26-60), and men and women were equally represented. Almost two thirds of the patients lived in rural areas.

One third (35%) of the patients were hospitalized (**Table 2**). Of the 12101 (65%) non-hospitalized, 10% were FID (discharged by own or family's wish although hospitalization was required according to medical evaluation), and 51% of FID were 17-45 years (**Figure S1** in the **Online Supplementary Document**). The reported overall mortality in the emergency room was very low (0.3%).

Characteristics by presenting complaint categories

Among injuries, 65% were 17-45 years, and the majority (63%) were men (**Table 1**). Falls from heights were the most common cause of injury (36%) followed by traffic injuries (28%) (**Figure S2** in the **Online Supplementary Document**). Physical assaults accounted for 8% of injured patients, and 36% of these were women (**Table 1**). The majority of the patients (70%) in injury group were discharged from ED without further hospitalization (**Table 2**).

Infections accounted for 16% of the ED population, and women were slightly overrepresented in this group (57%) (**Table 1**). Respiratory and cardiovascular complaints accounted for 9% and 4% respectively and were similar distributed in both sexes. The proportion of patients with cardiovascular complaints that lived in urban areas was higher (46%) compared to the total ED population (32%). Patients with

Table 1. Baseline characteristics by categories of presenting complaints in 21,892 patients presenting to emergency department in Dhulikhel Hospital from Sept 2013- Dec 2016

Characteristics	Total	Injuries	Abdominal complaints	Infections*	Respiratory complaints	OBGYN	CVD	Unconsciousness	Self-harm	Other complaints†
Total patients, n (%)	**21892**	**6385 (29)**	**4961 (23)**	**3524 (16)**	**2018 (9)**	**1126 (5)**	**865 (4)**	**616 (3)**	**381 (2)**	**2016 (9)**
Age, median (IQR)	40 (26-60)	35 (25-50)	37 (26-53)	43 (26-62)	65 (52-73)	25 (21-30)	60 (42-71)	40 (25-60)	32 (23-45)	45 (28-64)
Age (years), n (%):										
7-45	12 220 (56)	4144 (65)	3041 (61)	1802 (51)	327 (16)	1051 (93)	238 (28)	339 (55)	278 (73)	1000 (50)
45-60	4125 (19)	1256 (20)	949 (19)	673 (19)	389 (19)	61 (6)	193 (22)	122 (20)	80 (21)	402 (20)
≥60	5547 (25)	985 (15)	971 (20)	1049 (30)	1302 (65)	14 (1)	434 (50)	155 (25)	23 (6)	614 (30)
Female, n (%)	11 365 (52)	2379 (37)	2809 (57)	2019 (57)	1037 (51)	1126 (100)	444 (51)	336 (55)	239 (63)	976 (48)
Patient location, n(%):										
Rural	13 150 (60)	4153(65)	2803 (57)	2062(58)	1149(57)	718(64)	424(49)	388(63)	250(66)	1203 (60)
Urban	7030 (32)	1663(26)	1833 (37)	1228 (35)	680 (34)	272 (24)	398 (46)	170 (28)	76 (20)	710 (35)
Information NA	1712 (8)	569 (9)	325 (6)	234 (7)	189 (9)	136 (12)	43 (5)	58 (9)	55 (14)	103 (5)
Ethnicity, n (%):										
Brahmin and Chhetri	9470 (43)	2627 (41)	2125 (43)	1625 (46)	907 (45)	517 (46)	372 (43)	261 (42)	135 (36)	901 (45)
Janajati	10 060 (46)	3001 (47)	2302 (46)	1566 (45)	930 (46)	466 (41)	412 (48)	277 (45)	183 (48)	923 (46)
Dalit	1798 (8)	565 (9)	380 (8)	249 (7)	149 (7)	123 (11)	67 (8)	65 (11)	54 (14)	146 (7)
Other	564 (3)	192 (3)	154 (3)	84 (2)	32 (2)	20 (2)	14 (2)	13 (2)	9 (2)	46 (2)

OBGYN – obstetrics or gynecology, CVD – cardiovascular diseases or complaints, IQR – inter-quartile range, NA – not available
*Infections and fever.
†Other complaints included musculoskeletal, neurology, urinary, psychology and other general complaints (Table S1 in **Online Supplementary Document**).

Table 2. Time of presentation and emergency department disposition presented by categories of presenting complaints among adults presenting to emergency department in Dhulikhel Hospital form Sept 2013-Dec 2016

Characteristics	Total	Injuries	Abdominal complaints	Infections*	Respiratory complaints	OBGYN	CVD	Unconsciousness	Self-harm	Other complaints†
Total patients, n (%)	**21892**	**6385 (29)**	**4961 (23)**	**3524 (16)**	**2018 (9)**	**1126 (5)**	**865 (4)**	**616 (3)**	**381 (2)**	**2016 (9)**
Presentation to ED (n=19 789)‡, n (%):										
08:00-16:00 weekdays	7510 (38)	2056 (36)	1568 (35)	1279 (40)	884 (48)	315 (33)	349 (45)	233 (41)	109 (32)	717 (39)
16:00-08:00 or holidays	12 279 (62)	3659 (64)	2976 (65)	1938 (60)	945 (52)	640 (67)	434 (55)	335 (59)	229 (68)	1123 (61)
ED disposition (n=18 598)‡, n (%):										
Non-hospitalized	12 101 (65)	3944 (70)	3045 (73)	1965 (66)	807 (48)	250 (29)	399 (58)	302 (59)	105 (31)	1284 (75)
Hospitalized	6429 (35)	1655 (30)	1145 (27)	1024 (34)	862 (51)	607 (71)	281 (41)	190 (37)	234 (68)	431 (25)
Died in ED	59 (0.3)	10 (0.2)	2 (0.04)	6 (0.2)	8 (0.4)	1 (0.1)	3 (0.4)	23 (4)	5 (1)	1 (0.1)
Non-hospitalized (n=12 101)‡, n (%):										
Doctor-initiated discharge§	10 951 (90)	3615 (92)	2839 (93)	1817 (92)	667 (83)	188 (75)	334 (84)	241 (80)	59 (56)	1191 (93)
Family-initiated discharge‖	1150 (10)	329 (8)	206 (7)	148 (8)	140 (17)	62 (25)	65 (16)	61 (20)	46 (44)	93 (7)
Hospitalized (n=6429)‡, n(%):										
General wards¶	4756 (74)	1171 (71)	839 (73)	840 (82)	703 (82)	596 (98)	178 (63)	80 (42)	44 (19)	305 (71)
ICU or OT	489 (8)	50 (3)	188 (17)	76 (7)	54 (6)	8 (1)	22 (8)	12 (6)	62 (27)	17 (4)
Reffered to other hospitals	1184 (18)	434 (26)	118 (10)	108 (11)	105 (12)	3 (0.5)	81 (29)	98 (52)	128 (55)	109 (25)

OBGYN – obstetrics or gynecology related complaints, CVD – cardiovascular diseases or complaints, ED – emergency department, ICU – intensive care unit, OT – operation theater.

*Infections and fever.

†Other complaints included musculoskeletal, neurology, urinary, psychology and other general complaints.

‡Analysis done with smaller denominators than the total shown at the top due to missing information.

§Discharge done by responsible doctor after completion of treatment.

‖Discharge requested by patient or family members against completion of medical treatment.

¶Admitted for observation and further treatment.

respiratory and cardiovascular complaints had higher hospitalization rates (51% and 41% respectively) than the average for the ED population (35%) (**Table 2**). Of the hospitalized patients with cardiovascular complaints, more than one in four were referred to other hospitals. The non-hospitalized patients with respiratory and cardiovascular complaints had higher FID rates (17% and 16% respectively) compared to 10% in the ED population.

Self-harm was the main PC for 381 patients (**Table 1**). The most notable findings in this group were the relatively low age and that women were over- represented; the majority (73%) of these patients were young (17-45 years) and the majority were women (63%). The Dalit ethnic groups were overrepresented among self-harm patients (14% versus 8% in the total ED population). The hospitalization rate was high (68%) and 27% needed ICU treatment. FID from emergency room was common (44%) in this group (**Table**).

90-days mortality

Of the 21892 included patients, a total of 12540 household phone numbers were recorded in the patient registry. Of these 12540 patients, 4331 households (20% of total) participated in the structured telephone interview at 90 days (**Figure 1**). Among the interviews, we had complete information on 3793 (88%) patients and these were included in the further analysis. The patient demographic characteristics and presenting complaints in interviewed patients did, however, not meaningfully differ between those who were lost to follow-up (**Figure 2, panel A** and **Figure 2, panel B**).

Results for mortality at 90 days are presented in **Table 3**. The 90-days mortality in the cohort was 8% (n=309), and mortality was higher in men (9%) compared to women (7%). The mortality was much higher in the older age group (23% in ≥60 years) compared to the younger groups (1% in 17-45 years). Compared to infections (7% 90-days mortality), corresponding mortality for injuries was 3% (aOR=0.6, 95% CI=0.4-1.0), for cardiovascular complaints 23% (aOR=2.5, 95% CI=1.5-4.1) and for respiratory complaints 25% (aOR=2.4, 95% CI=1.6-3.6). Patients who did not re-visit the hospital had higher mortality (10%) compared to those who had a second vis-

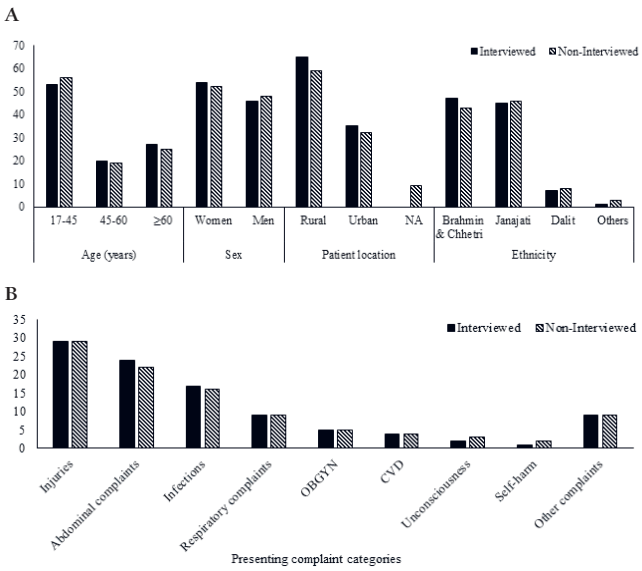


Figure 2. Panel A. Patient's characteristics in the interviewed patients compared with non-interviewed patients. NA – information not available. **Panel B.** Presenting complaint categories in the interviewed compared with non-interviewed patients. OBGYN – obstetrics and gynecology, CVD – cardiovascular diseases and complaints.

it (7%), aOR=1.4 (95% CI=1.1-1.9). FID was strongly associated with mortality at 90 days (aOR=5.4, 95% CI=3.3-8.9) compared to doctor-initiated discharge. We assessed the associations of presenting complaints with 90 days mortality, taking NCDs into account. The results for these analyses show that mortality was particularly high for those with a NCD diagnosis, regardless of PC (COPD/asthma: 32%, CVD: 21% and other NCDs: 24%).

Associations between patient characteristics, based on follow-up interviews, and 90-days mortality are presented in **Table 4**. Just above half of the patients were illiterate (53%) and the majority worked in own house or in agriculture (55%). The proportion exposed to smoke (tobacco and/or traditional stoves) was high (67%). There was no strong evidence of association between factors such as patient location, ethnicity, occupation or number of people in household and 90-days mortality.

We assessed evidence of interactions by sex for associations between demographic factors and 90-days mortality. Thus, results for

Table 3. Associations between presenting complaints and disposition characteristics, and 90 days mortality among 3793 patients interviewed by telephone after 90 days of emergency department visit

Characteristics	Total interviewed	90 days mortality	Unadjusted OR (95%CI)	Adjusted*OR (95%CI)
Presenting complaints, n(%)	**3793**	**309 (8)**		
Injuries	1085 (29)	34 (3)	0.4 (0.3-0.7)	0.6 (0.4-1.0)
Abdominal complaints	910 (24)	58 (6)	0.9 (0.6-1.3)	1.2 (0.8-1.8)
Infections	624 (17)	44 (7)	Ref	Ref
Respiratory complaints	343 (9)	87 (25)	4.5 (3.0-6.6)	2.4 (1.6-3.6)
OBGYN	200 (5)	0		
CVD	165 (4)	38 (23)	3.9 (2.5-6.3)	2.5 (1.5-4.1)
Unconsciousness	71 (2)	10 (14)	2.1 (1.0-4.5)	2.2 (1.0-4.8)
Selfharm	37 (1)	0		
Other complaints	358 (9)	38 (11)	1.6 (1.0-2.5)	1.5 (0.9-2.4)
Presention to ED (n=3561), n (%):†				
08:00-16:00 weekdays	1527 (43)	163 (11)	Ref	Ref
16:00-08:00 and holidays	2034 (57)	123 (6)	0.5 (0.4-0.7)	0.7 (0.5-0.9)
Hospital revisit, n (%):				
Yes	2486 (66)	184 (7)	Ref	Ref
No	1307 (34)	125 (10)	1.3 (1.0-1.7)	1.4 (1.1-1.9)
ED disposition (n=3223), n (%):†				
Non-hospitalized	1948 (60)	84 (4)	Ref	Ref
Hospitalized	1275 (40)	159 (12)	3.2 (2.4-4.2)	2.5 (1.9-3.3)
Non-hospitalized (n=1948), n (%):†				
Doctor-initiated discharge‡	1744 (90)	50 (3)	Ref	Ref
Family-initiated discharge§	204 (10)	34 (17)	6.8 (4.3-10-8)	5.4 (3.3-8.9)
Hospitalized (n=1275), n (%):†				
General wards‖	1037 (81)	122 (12)	Ref	Ref
ICU or OT	103 (8)	6 (6)	0.5 (0.2-1.1)	0.5 (0.2-1.3)
Referred to other hospitals	135 (11)	31 (23)	2.2 (1.4-3.5)	2.0 (1.3-3.3)

CI – confidence interval, OR – odds ratio, OBGYN – obstetrics or gynecology related complaints, CVD – cardiovascular diseases or complaints, ED – emergency department, ICU – intensive care unit, OT – operation theater

*Adjusted for sex and age in category.

†Analysis done with smaller denominators than the total shown at the top.

‡Discharge done by responsible doctor after completion of treatment.

§Discharge requested by patient or family members against completion of medical treatment.

‖Admitted for observation and further treatment.

associations between demographic factors and 90-days mortality are presented separately for men and women. In women, literacy was strongly associated with 90-days mortality (aOR for illiteracy=7.0, 95% CI=2.1-23.6) compared to literate group (**Table 5**). No such association was found in men (interaction

Table 4. Associations between demographic factors and 90 days mortality among 3793 patients interviewed by telephone after 90 days of emergency department visit

Characteristics	Total interviewed	90 days mortality	90 days mortality	Women (n=2038)		Men (n=1755)		
				Unadjusted	Adjusted*	90 days mortality	Unadjusted	Adjusted*
				OR 95% CI	OR 95%CI		OR 95%CI	OR 95%CI
Total, n(%)	**3793**	**309 (8)**	**143 (7)**			**166 (9)**		
Age, (years), n (%):								
17-45	2022 (53)	28 (1)	8 (1)	0.1 (0.04-0.2)		20 (2)	0.5 (0.3-1.0)	
45-60	755 (20)	43 (6)	27 (7)	Ref		16 (4)	Ref	
≥60	1016 (27)	238 (23)	108 (21)	3.5 (2.3-5.5)		130 (26)	8.0 (4.5-13.3)	
Patient location, n (%):								
Urban	1338 (35)	105 (8)	53 (7)	Ref	Ref	52 (9)	Ref	Ref
Rural	2455 (65)	204 (8)	90 (7)	1.0 (0.7-1.4)	1.0 (0.7-1.4)	114 (10)	1.1 (0.8-1.6)	1.2 (0.8-1.7)
Ethnicity, n (%)								
Brahmin and Chhetri	1772 (47)	143 (8)	68 (7)	Ref	Ref	75 (9)	Ref	Ref
Janajati	1690 (45)	140 (8)	63 (7)	1.0 (0.7-1.4)	0.9 (0.6-1.3)	77 (10)	1.0 (0.8-1.4)	1.1 (0.8-1.6)
Dalit	281 (7)	24 (9)	12 (8)	1.1 (0.6-2.1)	1.3 (0.7-2.7)	12 (9)	1.0 (0.5-1.9)	1.6 (0.8-3.2)
Others	50 (1)	2 (4)	0			2 (6)	0.6 (0.1-2.8)	1.5 (0.3-7.1)
Education, n (%):								
Literate	1765 (47)	48 (3)	3 (0.4)	Ref	Ref	45 (5)	Ref	Ref
Illiterate†	2028 (53)	261 (13)	140 (11)	33.9 (10.8-106.9)	7.0 (2.1-23.6)	121 (15)	3.7 (2.6-5.3)	1.0 (0.7-1.6)
Occupation, n (%):								
Paid job or business	933 (25)	56 (6)	10 (3)	Ref	Ref	46 (7)	Ref	Ref
Agriculture or housewives	2101 (55)	210 (10)	110 (8)	2.3 (1.2-4.5)	0.9 (0.4-1.9)	100 (15)	2.3 (1.6-3.2)	0.7 (0.4-1.0)
Student	264 (7)	1 (0.4)	1 (1)	0.2 (0.03-1.9)	1.2 (0.1-10.0)	0		
Elderly or sick‡	495 (13)	42 (8)	22 (11)	3.3 (1.5-7.1)	0.5 (0.2-1.1)	20 (7)	1.0 (0.6-1.7)	0.2 (0.1-0.3)
No. of members in house, n (%):								
≤5 members	2169 (57)	158 (7)	71 (6)	Ref	Ref	87 (9)	Ref	Ref
>5 members	1624 (43)	151 (9)	72 (8)	1.4 (1.0-2.0)	0.9 (0.7-1.4)	79 (11)	1.3 (0.9-1.7)	0.8 (0.6-1.2)
Exposure to smoke, n (%):								
None	1254 (33)	72 (6)	31 (4)	Ref	Ref	41 (8)	Ref	Ref
Traditional stove only§	1511 (40)	109 (7)	52 (6)	1.5 (0.9-2.3)	1.2 (0.7-1.9)	57 (9)	1.1 (0.7-1.7)	0.9 (0.6-1.4)
Tobacco only	559 (15)	62 (11)	26 (10)	2.4 (1.4-4.1)	1.8 (1.0-3.2)	36 (13)	1.7 (1.0-2.7)	1.5 (0.9-2.6)
Tobacco and traditional stove‖	469 (12)	66 (14)	34 (19)	5.2 (3.1-8.8)	2.8 (1.6-4.9)	32 (11)	1.5 (0.9-2.4)	1.4 (0.8-2.4)

OR – odds ratio, CI – confidence interval
*Adjusted for age in category.
†Interaction *P*<0.0001.
‡Cannot work because of being old or sick.
§Traditional stoves do not have proper smoke outlet.
‖Interaction *P*=0.09.

Table 5. Associations between presenting complaints, including NCD information at presentation, and 90 days mortality among 3793 patients interviewed by telephone after 90 days of emergency department visit

Presenting complaints and NCD information, n (%)	Total interviewed	90 days mortality	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Total	**3793**	**309 (8)**		
-Injuries, no NCD†	1048 (28)	24 (2)	0.5 (0.3-0.8)	0.6 (0.3-1.0)
-Infections, no NCD†	650 (17)	30 (5)	Ref	Ref
-Other PCs, no NCD*†	1583 (42)	119 (8)	1.7 (1.1-2.5)	1.7 (1.1-2.7)
-Any PC and COPD/Asthma	214 (6)	69 (32)	9.8 (6.2-15.7)	3.7 (2.3-6.0)
-Any PC and CVD	161 (4)	34 (21)	5.5 (3.3-9.4)	2.7 (1.6-4.8)
-Any PC and other NCDs	137 (4)	33 (24)	6.6 (3.8-11.2)	4.5 (2.5-7.9)

NCD – non communicable disease, CI – confidence interval, OR – odds ratio, PC – presenting complaints, COPD – chronic obstructive pulmonary disease, CVD – cardiovascular diseases. Other PCs – includes other presenting complaints such as; self-harm, obstetrics and gynecology, abdominal complaints, urinary, neurology, musculoskeletal and psychological. Other NCDs – include liver disease (n=81), cancer (n=19) and diabetes (n=37).
*Adjusted for sex and age in category.
†Does not include NCD.

P<0.001). In women, the association between exposure to smoke and 90-days mortality was strong: aORs for mortality in women exposed to traditional cooking stoves, tobacco smoking, and tobacco plus traditional cooking stove compared to no smoking exposure were 1.2 (95% CI=0.7-1.9), 1.8 (95% CI=1.0-3.2) and 2.8 (95% CI=1.6-4.9) respectively.

DISCUSSION

Population

Our study is in line with a systematic review in LMICs [6] and studies from Nepal [26] and Cambodia [27], showing that the majority of emergency patients are young adults. Injury was the main presenting complaint followed by abdominal complaints and infections, similar to reports from other LMICs [28,29].

Hospitalization rate from ED in the present study was lower (29%) than reported in other studies from Cambodia (60%) [27] and Pakistan (36%) [30]. This is probably due to different health care systems in these countries, and the fact that the study hospital receives unselected patients. Direct transfers from ED to ICU or OT were less frequent (8%) than reported in Pakistan (13%) [30]. However, these proportions do not depend only on severity, but also on the capacity of ICU and OT in the hospital. These observations indicate important variations in practice, and may complement the findings from a systematic review and reports from Nepal and Pakistan that reported a need for specialty trained ED providers [6], patient management protocols [8], availability of essential emergency equipment and knowledge among providers [31].

The rate of FID was high (10%). A study from India found this proportion to be (4%) [32] and in that study the majority were female and majority reported financial reason for the discharge request [32]. Sex differences for FID were not observed in our study, but over 50% were young (17-45 years), only one-third were ≥60 years. Information on reasons for FID was not available for this study, but based on local knowledge, it is often related to financial reasons, or a wish to continue medication at home. Especially in the elderly and severely ill population, terminal care at home is often preferred. In a study from USA, delay in care and inadequate patient-provider communication was the reason for FID [33]. We observed a very high 90-days mortality among patients after FID, much higher than in a population-based study in Manitoba [34]. The high mortality in this group can be explained by the Nepalese culture favoring dying at home. However, further investigations are required to understand reasons for FID or leaving hospital against medical advice.

Injuries

Road traffic injuries in Sub-Saharan Africa and Southeast Asia have increased by 10-50%, and are projected to be the sixth-leading cause of deaths and third-highest cause of DALYs in this region [4]. In Nepal, road traffic injury ranks 8th among the causes of premature deaths [35]. In the current study, the proportion of injury has increased compared to a report from the same hospital in 2013 [36]. We found fall injuries as the most common injury type, followed by traffic injuries. Young men were mostly affected by injuries, consistent with comparable settings [13,26,36-40]. The 90-days mortality in this group was 3%, a very high number when taking into account that the most severely injured patients may never have reached hospital. These findings indicate a need to establish robust trauma services and underline the importance of strengthening the health response capacity and health infrastructure in the rural regions. Moreover, prevention of injuries should be a national priority, and is achievable as evidenced from other developed countries in the past decades that has reported significant decrease in traffic related deaths [41].

Self-harm

Although a relatively small proportion of ED patients, self-harm and suicide are increasingly recognized as a health problem in LICs, particularly in women. The maternal mortality and morbidity report from Nepal in 2008/09 had reported that suicide was the single leading cause of death among women of reproductive age (16%) compared to maternal related issues (12%) [42]. Suicide in Nepal is stigmatized and many could be reported as accidents. In the present study, more than two thirds of self-harm patients were women less than 45 years of age. In line with another study from Nepal [43], we found that these patients were seriously ill, and the majority were admitted to an ICU. These findings indicate that self-harm is a serious health problem especially among young women. Further studies and effective preventions are warranted.

Mortality

Mortality by 90 days after emergency health care in the current study was more than 20-fold the ED mortality. The ED mortality in the current study was lower (0.3%) than previously reported from Pakistan (1.3%), and a systematic review in LMICs reported a median ED mortality of 1.8% (IQR 0.2-5.1%) [6,44].

Very little evidence exists on mortality after emergency care in LMIC's. To the best of our knowledge, only one study has previously attempted to assess mortality after emergency care. The study from a tertiary level Vietnamese hospital assessed 30-days mortality in two much smaller ED populations and reported mortality of 9.8% and 7.8%, respectively [45]. However, that study is different from ours since they did not include trauma and surgical cases, and the cohorts were recruited from a selected population in three months periods not taking into account seasonal variations [45].

Patients with respiratory and cardiovascular complaints had particularly high mortality. Thus, nearly one in four patients with these complaints died within 90-days. This is much higher than reports from HICs. The 60-days mortality among patients with respiratory complaints in a Spanish study was 6.3% [46]. Safwenberg and coworkers reported from a Swedish hospital that patients with cardiovascular complaints were at high risk for ten-year mortality (42% for chest pain and 67% for stroke-like symptoms), and suggested that the ED complaints are equally important as diagnosis in predicting long-term mortality [17].

Many factors may contribute to the high post-discharge mortality that we observed. We suspect that patients in the present study presented to health care at a late stage of chronic diseases, since health services are unaffordable for many of these patients [15,47]. Typically, availability of long-term treatments for COPD and CVD patients is very low, and follow-up systems for chronically ill patients are underdeveloped [15,48]. Also, local systems and transport systems that can handle quick and adequate responses to acute illness are underdeveloped, and contribute to a high post-discharge mortality in these patients. These results suggest a need to develop post-discharge care systems that would likely reduce long-term mortality in emergency patients.

Interestingly, we found illiteracy independently associated with increased mortality at 90 days in women but not in men. Secondary analysis of 2011 Nepal Demographic and Health Survey reports that illiterate Nepalese women are less aware of health risks, and that could result in less health seeking behavior [49]. Further, a higher mortality was observed with increasing dose of smoke exposure in women but not in men. A high burden of chronic lung disease in Nepalese women has been reported earlier, one study reported that COPD was nearly half of the NCD burden in Nepal [14]. Another study reported that the prevalence and incidence of COPD in men was high, but corresponding mortality and DALYs were higher in women [50]. Nepalese women typically spend much time cooking and many are exposed to traditional cooking stoves affecting respiratory health and symptoms of respiratory problems are often long-standing without seeking health care [51,52].

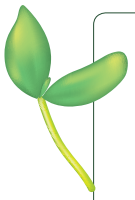
Strengths and limitations

This is a single-center study, thus generalizations should be done with caution. However, the cohort comprised a large population from both rural and urban regions and the distribution of patient characteristics show that the patient population is highly representative for the region in respect to age, gender, geography and ethnicity. Also, the long data collection period is a strength; the study includes data from a three year period, covering possible seasonal variations. However, it is a limitation that the study had a low follow-up rate for the 90 days telephone interviews. For the interviews, the results should interpreted with caution, although we show that those lost to follow-up have similar characteristics and PCs. We cannot rule out the possibility of selection bias in the interviewed patients, leading to possible underestimation of mortality and a higher follow-up in healthier and more resourceful families. Patients who did not provide their telephone number were not interviewed and these patients might not have had a phone due to economic conditions, and could also be frailer than the ones available for interviews. Also, it is possible that those who were called and did not answer were more likely to have died.

Classification of presenting complaints was performed using a hierarchy approach which may result in an underestimation of frequency of complaints lower in the hierarchy (e.g. if a patient had pneumonia and COPD then he/she would be allocated to the infection category).

CONCLUSIONS

The study revealed that nearly one in ten died within 90-days of emergency care. However, follow-up rates were low and findings suggest a need for replication of post-discharge mortality studies with adequate systems that limit loss to follow-up. These studies should be performed as multi-center studies and include information on local health care systems that may affect post-discharge mortality. It will be important to study factors that affect post-discharge mortality, such as availability of follow-up systems, transportation and affordable medication. We argue that post-discharge mortality is a particularly important indicator on quality of care in low-resource settings, where primary care health systems are limited, and transportation and economic issues may halter adequate follow-up and treatment for complications or chronic diseases.



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Additional material
Online Supplementary Document

REFERENCES

1 Kobusingye OC, Hyder AA, Bishai D, Joshipura M, Hicks ER, Mock C. Disease Control Priorities in Developing Countries 2nd edition. New York: Oxford University Press; 2006.

2 World Health Organization. Emergency care systems, 2018. Available: http://www.who.int/emergencycare/en/. Assessed: 16 March 2018.

3 Chang CY, Abujaber S, Reynolds TA, Camargo CA Jr, Obermeyer Z. Burden of emergency conditions and emergency care usage: new estimates from 40 countries. Emerg Med J. 2016;33:794-800. Medline:27334758 doi:10.1136/emermed-2016-205709

4 Hsia R, Razzak J, Tsai AC, Hirshon JM. Placing Emergency Care on the Global Agenda. Ann Emerg Med. 2010;56:142-9. Medline:20138398 doi:10.1016/j.annemergmed.2010.01.013

5 Moresky RT, Bisanzo M, Rubenstein BL, Hubbard SJ, Cohen H, Ouyang H, et al. A research agenda for acute care services delivery in low- and middle-income countries. Acad Emerg Med. 2013;20:1264-71. Medline:24283791 doi:10.1111/acem.12259

6 Obermeyer Z, Abujaber S, Makar M, Stoll S, Kayden SR, Wallis LA, et al. Emergency care in 59 low- and middle-income countries: a systematic review. Bull World Health Organ. 2015;93:577-586G. Medline:26478615 doi:10.2471/BLT.14.148338

7 Abujaber S, Chang CY, Reynolds TA, Mowafi H, Obermeyer Z. Developing metrics for emergency care research in low- and middle-income countries. Afr J Emerg Med. 2016;6:116-24. Medline:30456077 doi:10.1016/j.afjem.2016.06.003

8 Pandey NR. Emergency medicine in Nepal: present practice and direction for future. Int J Emerg Med. 2016;9:20. Medline:27416937 doi:10.1186/s12245-016-0118-3

9 World Health Organization. Health System in Nepal: Challenges and Strategic Options, 2007. Available: https://apps.who.int/iris/handle/10665/205257. Accessed: 5 May 2018.

10 Dulal P, Khadka SB. Victims of road traffic crashes attending the emergency department of Kathmandu Medical College Teaching Hospital. Kathmandu Univ Med J (KUMJ). 2004;2:301-6. Medline:16388241

11 Murdoch DR, Woods CW, Zimmerman MD, Dull PM, Belbase RH, Keenan AJ, et al. The etiology of febrile illness in adults presenting to Patan hospital in Kathmandu, Nepal. Am J Trop Med Hyg. 2004;70:670-5. Medline:15211012 doi:10.4269/ajtmh.2004.70.670

12 B.P Koirala Institute of Health Sciences. Emergency Hospital Services. Available: http://www.bpkihs.edu/?hospital-services.html. Accessed: 17 March 2018.

REFERENCES

13 Karkee R, Lee AH. Epidemiology of road traffic injuries in Nepal, 2001-2013: systematic review and secondary data analysis. BMJ Open. 2016;6:e010757. Medline:27084283 doi:10.1136/bmjopen-2015-010757

14 Bhandari GP, Angdembe MR, Dhimal M, Neupane S, Bhusal C. State of non-communicable diseases in Nepal. BMC Public Health. 2014;14:23. Medline:24405646 doi:10.1186/1471-2458-14-23

15 The Nepal NCDI Poverty Commission. The Nepal NCDI Poverty Commission; An Equity Initiative to Address Non-communicable Diseases and Injuries, National Report, 2018. Available: http://www.ncdipoverty.org/nepal-report/. Accessed: 12 Nov 2018).

16 Mowafi H, Dworkis D, Bisanzo M, Hansoti B, Seidenberg P, Obermeyer Z, et al. Making recording and analysis of chief complaint a priority for global emergency care research in low-income countries. Acad Emerg Med. 2013;20:1241-5. Medline:24283813 doi:10.1111/acem.12262

17 Safwenberg U, Terent A, Lind L. Differences in long-term mortality for different emergency department presenting complaints. Acad Emerg Med. 2008;15:9-16. Medline:18211307 doi:10.1111/j.1553-2712.2007.00004.x

18 Karki RK. Mortality patterns among hospital deaths. Kathmandu Univ Med J (KUMJ). 2016;14:65-8. Medline:27892444

19 Giri S, Risnes K, Uleberg O, Rogne T, Shrestha SK, Nygaard OP, et al. Impact of 2015 earthquakes on a local hospital in Nepal: A prospective hospital-based study. PLoS One. 2018;13:e0192076. Medline:29394265 doi:10.1371/journal.pone.0192076

20 Bharati U, Shrestha S. Mortality in Emergency Department of Nepal Medical College Teaching Hospital, a tertiary care centre in Kathmandu, Nepal. J Inst Med. 2017;39:94-8.

21 Couturier B, Carrat F, Hejblum G. A systematic review on the effect of the organisation of hospital discharge on patient health outcomes. BMJ Open. 2016;6:e012287. Medline:28003282 doi:10.1136/bmjopen-2016-012287

22 Dhulikhel Hospital. Dhulikhel Hospital Kathmandu University Hospital, Nepal. Available: http://www.dhulikhelhospital.org. Accessed: 1 Jan 2018.

23 Government of Nepal. National Population and Housing Census 2011, National Planning Commission, Central Bureau of Statistics 2012. Available: https://unstats.un.org/unsd/demographic/sources/census/wphc/Nepal/Nepal-Census-2011-Vol1.pdf. Accessed: 3 March 2019.

24 Bennett L, Dahal DR, Govindasamy P. Caste, Ethnic and Regional Identity in Nepal Further Analysis of the 2006 Nepal Demographic and Health Survey, USAID, 2008. Available: http://pdf.usaid.gov/pdf_docs/Pnadm638.pdf. Accessed: 23 Feb 2017.

25 World Organization of Family Doctors. International Classification of Primary Care (ICPC): Wonca International Classification Committee, 2017. Available: www.globalfamilydoctor.com. Accessed: 25 Aug 2017.

26 Basnet B, Bhandari R, Moore M. Initial resuscitation for Australasian Triage Scale 2 patients in a Nepalese emergency department. Emerg Med Australas. 2012;24:430-4. Medline:22862761 doi:10.1111/j.1742-6723.2012.01554.x

27 Yan LD, Mahadevan SV, Yore M, Pirrotta EA, Woods J, Somontha K, et al. An observational study of adults seeking emergency care in Cambodia. Bull World Health Organ. 2015;93:84-92. Medline:25883401 doi:10.2471/BLT.14.143917

28 Myers JG, Hunold KM, Ekernas K, Wangara A, Maingi A, Mutiso V, et al. Patient characteristics of the Accident and Emergency Department of Kenyatta National Hospital, Nairobi, Kenya: a cross-sectional, prospective analysis. BMJ Open. 2017;7:e014974. Medline:29025826 doi:10.1136/bmjopen-2016-014974

29 Hodkinson PW, Wallis LA. Cross-sectional survey of patients presenting to a South African urban emergency centre. Emerg Med J. 2009;26:635-40. Medline:19700577 doi:10.1136/emj.2008.063362

30 Khan BA, Shakeel N, Siddiqui EU, Kazi G, Khan IQ, Khursheed M, et al. Impact of delay in admission on the outcome of critically ill patients presenting to the emergency department of a tertiary care hospital from low income country. J Pak Med Assoc. 2016;66:509-16. Medline:27183926

31 Razzak JA, Baqir SM, Khan UR, Heller D, Bhatti J, Hyder AA. Emergency and trauma care in Pakistan: a cross-sectional study of healthcare levels. Emerg Med J. 2015;32:207-13. Medline:24157684 doi:10.1136/emermed-2013-202590

32 Naderi S, Acerra JR, Bailey K, Mukherji P, Taraphdar T, Mukherjee T, et al. Patients in a private hospital in India leave the emergency department against medical advice for financial reasons. Int J Emerg Med. 2014;7:13. Medline:24568343 doi:10.1186/1865-1380-7-13

33 Southern WN, Nahvi S, Arnsten JH. Increased risk of mortality and readmission among patients discharged against medical advice. Am J Med. 2012;125:594-602. Medline:22513194 doi:10.1016/j.amjmed.2011.12.017

34 Garland A, Ramsey CD, Fransoo R, Olafson K, Chateau D, Yogendran M, et al. Rates of readmission and death associated with leaving hospital against medical advice: a population-based study. CMAJ. 2013;185:1207-14. Medline:23979869 doi:10.1503/cmaj.130029

35 Institute for Health Metrics and Evaluation. Global Burden of disease, Nepal country profile, University of Washington 2018. Available: http://www.healthdata.org/nepal. Accessed 23 May 2018.

36 Shrestha R, Shrestha SK, Kayastha SR, Parajuli N, Dhoju D, Shrestha D. A comparative study on epidemiology, spectrum and outcome analysis of physical trauma cases presenting to emergency department of Dhulikhel Hospital, Kathmandu University Hospital and its outreach centers in rural area. Kathmandu Univ Med J (KUMJ). 2013;11:241-6. Medline:24442174 doi:10.3126/kumj.v11i3.12513

37 Gupta S, Gupta SK, Devkota S, Ranjit A, Swaroop M, Kushner AL, et al. Fall Injuries in Nepal: A Countrywide Population-based Survey. Ann Glob Health. 2015;81:487-94. Medline:26709280 doi:10.1016/j.aogh.2015.07.004

38 Bhatta S, Pant PR, Mytton J. Usefulness of hospital emergency department records to explore access to injury care in Nepal. Int J Emerg Med. 2016;9:21. Medline:27431800 doi:10.1186/s12245-016-0120-9

39 Oteng RA, Whiteside LK, Rominski SD, Amuasi JH, Carter PM, Donkor P, et al. Individual and Medical Characteristics of Adults Presenting to an Urban Emergency Department in Ghana. Ghana Med J. 2015;49:136-41. Medline:26693187 doi:10.4314/gmj.v49i3.2

REFERENCES

40 Sawe HR, Mfinanga JA, Mbaya KR, Koka PM, Kilindimo SS, Runyon MS, et al. Trauma burden in Tanzania: a one-day survey of all district and regional public hospitals. BMC Emerg Med. 2017;17:30. Medline:29029604 doi:10.1186/s12873-017-0141-6
41 World Health Organization. World report on road traffic injury prevention, 2004. Available: http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/. Accessed 22 Aug 2018.
42 Suvedi BK, Pradhan A, Barnett S, Puri M, Chitrakar SR, Poudel P, et al. Nepal Maternal mortality and morbidity study 2008/2009: Summary of Preliminary Findings. Department of Health Services, 2009. Available: http://www.dpiap.org/resources/pdf/nepal_maternal_mortality_2011_04_22.pdf. Accessed: 24 May 2018.
43 Paudyal BP. Poisoning: pattern and profile of admitted cases in a hospital in central Nepal. JNMA J Nepal Med Assoc. 2005;44:92-6. Medline:16554862
44 Rehmani R. Emergency section and overcrowding in a university hospital of Karachi, Pakistan. J Pak Med Assoc. 2004;54:233-7. Medline:15270179
45 Ha DT, Dang TQ, Tran NV, Pham TN, Nguyen ND, Nguyen TV. Development and validation of a prognostic model for predicting 30-day mortality risk in medical patients in emergency department. Sci Rep. 2017;7:46474. Medline:28401961 doi:10.1038/srep46474
46 Esteban C, Arostegui I, Garcia-Gutierrez S, Gonzalez N, Lafuente I, Bare M, et al. A decision tree to assess short-term mortality after an emergency department visit for an exacerbation of COPD: a cohort study. Respir Res. 2015;16:151. Medline:26695935 doi:10.1186/s12931-015-0313-4
47 Khanal S, Veerman L, Nissen L, Hollingworth S. Use of Healthcare Services by Patients with Non-Communicable Diseases in Nepal: A Qualitative Study with Healthcare Providers. J Clin Diagn Res. 2017;11:LC01-05. Medline:28764203 doi:10.7860/JCDR/2017/25021.9970
48 Checkley W, Ghannem H, Irazola V, Kimaiyo S, Levitt NS, Miranda JJ, et al. Management of NCD in low- and middle-income countries. Glob Heart. 2014;9:431-43. Medline:25592798 doi:10.1016/j.gheart.2014.11.003
49 Lam Y, Broaddus ET, Surkan PJ. Literacy and healthcare-seeking among women with low educational attainment: analysis of cross-sectional data from the 2011 Nepal Demographic and Health Survey. Int J Equity Health. 2013;12:95. Medline:24330671 doi:10.1186/1475-9276-12-95
50 Adhikari TB, Neupane D, Kallestrup P. Burden of COPD in Nepal. Int J Chron Obstruct Pulmon Dis. 2018;13:583-9. Medline:29445275 doi:10.2147/COPD.S154319
51 Po JYT, FitzGerald JM, Carlsten C. Respiratory disease associated with solid biomass fuel exposure in rural women and children: systematic review and meta-analysis. Thorax. 2011;66:232-9. Medline:21248322 doi:10.1136/thx.2010.147884
52 Smith-Sivertsen T, Diaz E, Pope D, Lie RT, Diaz A, McCracken J, et al. Effect of reducing indoor air pollution on women's respiratory symptoms and lung function: the RESPIRE Randomized Trial, Guatemala. Am J Epidemiol. 2009;170:211-20. Medline:19443665 doi:10.1093/aje/kwp100

Presenting complaints and mortality in a cohort of 22,000 adult emergency patients at a local hospital in Nepal

Supplementary appendix, Table of contents

Annex S1. List of variables included: Emergency Department registration/variables

1. Study Number
2. Hospital Number
3. Date of Admittance (DD/MM/YR)
4. Age (Years)
5. Sex (M/F)
6. Ethnicity
7. Time of Presentation
8. Temperature (Celsius)
9. Pulse (Beats per minute)
10. Respiration rate
11. Systolic Blood Pressure
12. Diastolic Blood Pressure
13. Oxygen Saturation
14. Glasgow Coma Scale (GCS)
15. Triage done (Yes/No)
16. Triage Code (Red/Orange/yellow/green)
17. Time of Triage
18. Time of Treatment
19. Presenting Complaint
20. Action in Emergency Room (Medication, Fluids, Oxygen, Antibiotics etc.)
21. Transfer to (General wards, ICU, OT)
22. ED disposition (Admitted, Discharged, LAMA/DOR, Referred)
23. Death (Yes/No)
24. Diagnosis at Discharge

Annex S2. Presenting Complaints Classification

The presenting complaints were recorded by an emergency nurse in the emergency form. The presenting complaint was recorded in free text format (for example; a lady with chest pain and fever). The complaints were retrospectively classified into nine main categories. The process of categorizations was performed in three phases using STATA software. In the first phase, in total 761"presenting complaint texts" (e.g. fever, chest pain, abdominal pain, limb fracture etc.) were generated and scored as 0 (no) or 1 (yes). In the second phase one or more "International Classification of Primary Care-2 (ICPC-2)" codes, were allocated to each patient based on the complaint categories first generated. In the third phase, one main presenting complaint was identified for each patient. Obvious related complaints were combined into one single group (e.g. fever and chills). The categories of nine main presenting complaints were; self-harm, injuries, infections, unconsciousness, CVD (cardiovascular related complaints and diseases), respiratory complaints, OBGYN (obstetrics and gynecology), abdominal complaints and other complaints. These categories were arranged in hierarchical order as shown in Fig 1 ("self-harm" at first and "other complaints" at last; i.e. if a patient had suicidal attempt irrespective to other complaints then he/she will be in self-harm category). Self-harm implicates attempted suicide; either poisoning or hanging. Infections complaint category included infections and also when presenting complaint was fever with no specification of organ system involved. The category "other complaints" included musculoskeletal, neurology, urinary, psychological and other complaints (general pain, feeling ill, male genital, eye/ear complaints etc.).

Follow-up interviews

Two trained research nurses conducted a structured telephone interview 90 days following the ED visit. The research nurse contacted all patients (n=12,540) who provided phone numbers during the ED disposition. The research nurse contacted twice when patients were not reachable the first time. The telephone interview included information on 90-days mortality, and demographics (literacy, occupation, number of family members living together, exposure level to smoke and hospital visit for the second time). Literacy was categorized as illiterate (no formal education) and literate (formal education). Occupation was categorized into; paid job or business, agriculture or housewives (women taking care of own house and family), student and elderly or sick (cannot work because of being old or sick). Exposure to smoke was categorized into four groups; none, traditional stove (no outlet for smoke coming out from the stoves), tobacco (cigarette or any kind of tobacco) and tobacco plus traditional stove.

Annex S3. Telephone interview guide: Follow-Up at 90 days after emergency department disposition

1. Study Number
2. Hospital Number
3. Date of Interview
4. Visited Dhulikhel Hospital (DH) for same condition after the last visit (Yes/No)
5. Visited other health facility for same condition after the last visit to DH (Yes/No)
6. How long did you wait in ED before seeing a doctor (in minutes)
7. How do you like the services/patient management provided from ED (Very poor, Poor, OK/Fair, Good, very Good)
8. Health status now (Better, Unchanged, Worse, Died)
9. If died, Date of dead (DD,MM,YR)
10. Information given by (Patient, Relatives, Others)
11. a) In Labor case, if baby alive (Yes/No)
11. b) Number of baby delivered
12. Number of members in house living together
13. Main occupation
14. Education (Literate/Illiterate)
14. Completed education level
15. Smoking Tobacco (Yes/No)
15. If smoking tobacco, number per day
16. Fuel for Cooking (traditional cooking stove, improved cooking stove, gas stove, electricity)
17. Additional Information

Table S1: Categories of presenting complaints and use of ICPC-2 codes

ICPC complaint Categories	Included ICPC-2 Codes
Self harm	P77
Injuries	
Fall Injury	A80_b*
Transport Accident	A80_a*
Physical Assault	Z25
Bite	A86, S12, S13
Burn	S14
Other Injury	A85, A88, N80, B77, D79, D80, R87, R88, X82, Y80, H76, H78, H79, F76, F79, A80_c*, A80_d*, L73, L74, L75, L76, L77, L78, L79, L80, L81, S16, S17, S18, S19
Infections	
Gastrointestinal/Urinary Infection	D70, U70, U71
Respiratory Infection	R74, R75, R76, R78, R81, R82, R83, A70
Fever (only)	A02, A03
Other Infection	A78, A87, B70, H71, N71, S11, S71, W70, W71, X72
Unconsciousness & Seizure	A06, N07
Cardiovascular (CVD)	
CVD complaints	A11/K01, K04, K05, K07
CVD disease	K71, K73, K75, K76, K77, K78, K84, K86, K90, K96
Respiratory complaints	
Short Breath	R02
COPD/Asthma	R95, R96
Other Respiratory	R03, R04, R05, R06, R07, R21, R24, R29, R84, R85, R99
Obstretic & Gynaecology (OBGYN)	
Pregnancy and Childbearing	W03, W05, W17, W18, W19, W27, W29, W80, W82, W83, W94, W96, W99
Menstruation Complaints	X02, X06, X07
Female Genital Complaints	X01, X14, X15, X18, X19, X21, X29, X87, X77, X99
Abdomen and Digestive	
Nausea, Vomiting & Diarrhoea	D09, D10, D11
Abdomen Pain	D01, D02, D03, D06, D12, D25, D88
Other Digestive	D04, D08, D13, D14, D15, D16, D17, D19, D20, D21, D24, D29, D74, D75, D76, D77, D78, D84, D85, D86, D89, D91, D95, D97, D98, D99
Other Complaints	
Urinary	U01, U02, U04, U05, U06, U07, U08, U14, U77, U88, U95, U99
Neurology	N01, N05, N06, N08, N17, N18, N19, N28, N29, N74, N85, N87, N88, N89, N99
Musculoskeletal	L01, L02, L03, L05, L07, L08, L09, L12, L13, L14, L15, L17, L18, L19, L29, L71, L82, L88
Psychosocial Complaints	P04, P06, P16, P19, P20, P29, P74, P76, P85, P86, P99
Other Complaints, NOS	A01, A04, A05, A08, A10, A29, A91, A92, B73, B82, F02, F05, F29, H01, H02, H04, S02, S06, S07, S29, S77, S91, T01, T03, T08, T11, T85, T86, T89, T90, T99, Y01, Y02, Y04, Y05, Y06, Y29, Y85, Y86, A66*

A80_b-Fall Injuries, A80_a-Road Transport Accidents, A80_c-Animal Injuries, A66-Referred to study hospital for intensive care unit.

*New codes that does not comply with ICPC-2 codes.

Table S2: Characteristics of adult population presenting to emergency department before and after the earthquake during the study period

Characteristics	Total	Before EQ	After EQ
Total Patients, n (%)	21892	7898 (36)	13994 (63)
Age, median (IQR)	40 (26-60)	40 (26-60)	40 (26-60)
Age (years), n (%)			
17-45	12220 (56)	4457 (56)	7763 (56)
45-60	4125 (19)	1432 (18)	2693 (19)
≥60	5547 (25)	2009 (26)	3538 (25)
Female, n (%)	11365 (52)	4241 (54)	7124 (51)
Patient location n, (%)			
Rural	13150 (60)	4367 (55)	8783 (63)
Urban	7030 (32)	2357 (30)	4673 (33)
Information NA	1712 (8)	1174 (15)	538 (4)
Ethnicity, n (%)			
Brahmin and Chhetri	9470 (43)	3571 (45)	5899 (42)
Janajati	10060 (46)	3545 (45)	6515 (47)
Dalit	1798 (8)	534 (7)	1264 (9)
Others	564 (3)	248 (3)	316 (2)
ED disposition, n (%)			
Non-Hospitalized	12101 (55)	3680 (47)	8421 (60)
Hospitalized	6429 (29)	3243 (41)	3186 (23)
Mortality at ED	59 (0.3)	7 (0.1)	52 (0.4)
Information NA	3303 (15)	968 (12)	2335 (17)
Non-Hospitalized (n=12104) , n (%)			
Doctor-initiated discharge	10951 (90)	3389 (92)	7562 (90)
Family-initiated discharge	1150 (10)	291 (8)	859 (10)
Hospitalized (n=6437) , n (%)			
General wards	4756 (74)	2563 (79)	2193 (69)
ICU or OT	489 (8)	272 (8)	217 (7)
Reffered to other hospitals	1184 (18)	408 (13)	776 (24)
Presenting Complaints, n (%)			
Injuries	6385 (29)	2182 (28)	4203 (30)
Abdominal complaints	4961 (23)	1763 (22)	3198 (23)
Infections	3524 (16)	1236 (16)	2288 (16)
Respiratory complaints	2018 (9)	808 (10)	1210 (9)
OBGYN	1126 (5)	590 (7)	536 (4)
CVD	865 (4)	234 (3)	631 (5)
Unconsciousness	616 (3)	223 (3)	393 (3)
Self-harm	381 (2)	166 (2)	215 (2)
Other complaints	2016 (9)	696 (9)	1320 (9)

EQ-earthquake, IQR-inter quartile range, NA-not available, ED-emergency department, ICU-intensive care unit, OT-Operational Theater, OBGYN-obstetrics and gynecology related complaints, CVD-cardiovascular diseases or complaints.

Figure S1: Distribution of family-initiated discharge by sex and age group in years

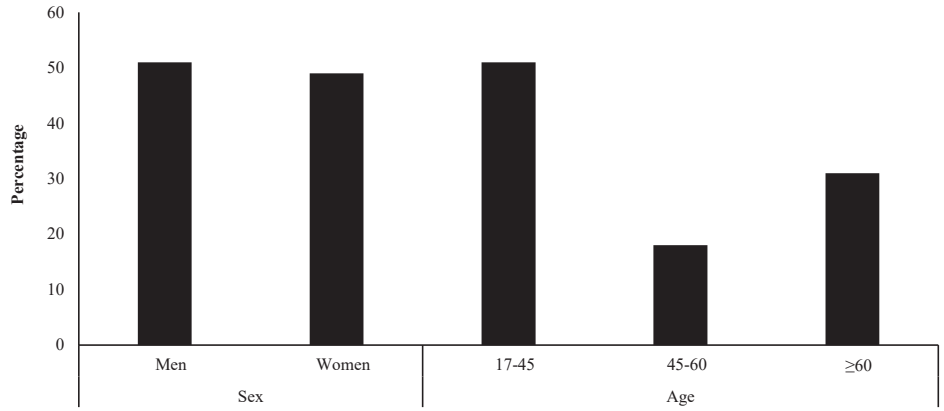
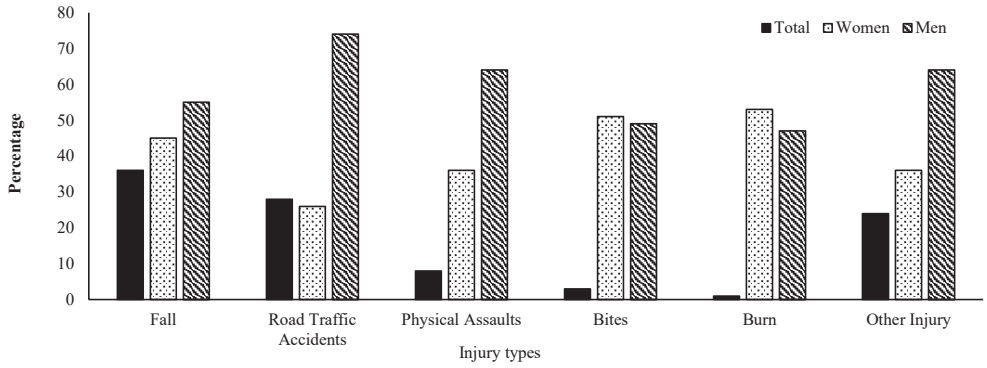


Figure S2: Distribution of types of injuries by sex



Paper III

Samita Giri, Tine Halvas-Svendsen, Tormod Rogne, Sanu Krishna Shrestha, Henrik Døllner, Erik Solligård, Kari Risnes

Paediatric patients in a local Nepali emergency department: Presenting complaints, triage and post-discharge mortality

Paper III

Pediatric patients in a local Nepali emergency department: Presenting complaints, triage and post-discharge mortality

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Keywords: pediatric, emergency, presenting complaints, mortality, Nepal

Abstract

Background: In low-income countries, pediatric emergency facilities are largely underdeveloped: child mortality in emergency care is more than twice that of adults, and pediatric post-discharge mortality (PPDM) is as high as in-hospital mortality. More knowledge is needed to improve services and reduce mortality in pediatric emergencies. We assessed characteristics, triage validity and post-discharge mortality in an unselected pediatric emergency population in Nepal.

Methods: Characteristics of pediatric patients who entered the emergency department in a local hospital were prospectively recorded. Triage assessment was included for a part of the study period. To assess PPDM mortality, patient households were followed-up by telephone interviews at 90 days.

Results: Among the 5740 children included in the analyses, presenting complaints categories were dominated by infections and injuries (~40% each). The majority were boys, and 62% were discharged without hospital admission. Information on triage was available for 1248 children. Among those triaged red, 28% were hospitalized in general wards (adjusted odds ratio (aOR) 4.1, 95% CI 1.9-8.9)) and 42% were transferred to intensive care or other higher levels of care (aOR 32.1, 95% CI 13.5-76.6) compared to green triage. PPDM was assessed for 961 children, of whom 1.3% had died (2.1% girls and 0.8% boys). Two out of three PPDM presented as infections. Children <1 year had higher risk of PPDM compared to children 5-16 years old (aOR 4.3, 95% CI 1.2-15.5). Nearly 16% of those triaged red had died at time of interview (aOR compared to green: 56.5, 95% CI 4.6-687.3). Exposure to traditional stove at home was strongly associated with mortality risk (aOR 13.8, 95% CI 1.8-108.3 compared to none exposure).

Conclusion: The majority of pediatric emergency patients were injuries and infections. Girls were attended less frequent than boys, but displayed higher risk of death after discharge. High triage priority categories were strong indicators for intensive care need and for mortality after discharge. The study supports the use of triage systems and the need for interventions that can reduce PPDM. Such interventions should emphasize effective treatment of infections and injuries, and identification of children at risk for complications after discharge.

INTRODUCTION

More than 6 million children under 15 years died worldwide in 2017, 5.4 million of them were under the age of 5 years (1). UNICEF reported that 80% of under-5 mortality were in South Asia and Sub-Sahara Africa (2). More than half of these deaths could be prevented and treated with low-cost interventions (1-3).

It is warranted that pediatric emergency health care services are addressed to effectively reduce child mortality (4, 5). The Disease Control Priorities project has estimated that almost 45% of deaths and 36% of disability-adjusted life years (DALYs) in low and middle income countries (LMICs) are compounded with diseases and injuries that need to be addressed by emergency health care services (6). The situation for pediatric emergency care seems to be a particular target for improvements (4): A systematic review from emergency departments (EDs) in 59 LMICs reported an overall median mortality of 1.8%, and mortality was much higher in pediatric facilities (4.8%) compared to adult or general facilities (0.7%) (7). In line with this, the World Health Organization (WHO) has concluded that strengthening pediatric capacity and competence in health systems would effectively reduce many unwanted child deaths (1). However, pediatric emergency care is typically underdeveloped in LMICs. Nepal is one such example: Although under-5 child mortality is unacceptably high (39 deaths per 1,000 live births) (8), there is no system for pediatric emergency care (9).

A remarkable knowledge gap in pediatric emergency epidemiology in LMICs makes appropriate planning of emergency services challenging (7, 10). Pediatric post-discharge mortality (PPDM) in developing countries is high, and a systematic review concluded recently that PPDM occurs in similar numbers or exceeds the in-hospital mortality (11). To reduce child mortality, one must therefore emphasize interventions that can reduce both hospital mortality and PPDM. We have previously described characteristics and post-discharge mortality among adults in a Nepalese hospital (*manuscript in press*). The post-discharge mortality in adult population was more than 20-fold the ED mortality, and was particularly high among patients with respiratory and cardiovascular complaints. Similar studies relevant to pediatric emergency care are scarce.

The present study aims to describe characteristics, presenting complaints (PCs) and indicators of severity, including triage categories in a pediatric emergency population and to explore associations with post-discharge mortality. Thus, in a sub set of the population, follow-up

information was assessed by telephone interviews with family members 90 days after discharge from emergency care.

MATERIALS AND METHODS

Study design and setting

A prospective observational study was conducted in the ED of Dhulikhel Hospital (DH), a 375 bedded non-government university hospital in Nepal. The hospital has a neonatal and a pediatric intensive care unit, and a pediatric ward with 45 beds in total. This hospital is located in semi-urban region in Dhulikhel, in Kavrepalanchok district 30 km northeast of Kathmandu.

Kavrepalanchok district has a total population of nearly 400,000, of them 51% are female (12). The median age in this region is 23 years, and 20% are 0-15 years old (12). The three main ethnic groups in the district are Brahmin or Chhetri (36%) followed by Janajati (51%) and Dalit (7%) (12). The living conditions in Kavrepalanchok district are generally quite basic; one example is that 78% of the population use wood as a main type of cooking fuel (12).

Data collection and participants

Demographic and clinical information was prospectively registered on systematic emergency forms by ED staffs for all patients who sought care at the ED from September 2013 to December 2016 (supplementary material). Patients 16 years and under were included in the current study (Figure 1A). Data collection was interrupted by infrastructure challenges (Sept 2014-Feb 2015) and (Sept and Nov 2016), and earthquakes (April 25-May 16 2015). Data from the earthquake period has been described previously (13).

The pediatric version of Rapid Emergency Triage and Treatment System (RETTS-P) (14) with four color codes: red, orange, yellow and green for very high, high, medium and low risk, respectively was used to assess all pediatric patients at presentation in the ED from March 2015 to April 2016. We used the English version of RETTS-P (supplementary material). RETTS was developed in Sweden and has been increasingly used in the Scandinavian countries. RETTS-P has been described in previous studies and reliability has been reported as good (15-17). RETTS-P has not been reported used in low-resource settings. Patients that were triaged and were eligible for the telephone interviews (Figure 1B) were further assessed for mortality at 90 days.

Follow-up interviews

At ED disposition, a family member was asked for consent for a telephone-interview at 90 days after initial presentation to the ED. Trained research nurses called those who consented and performed the structured telephone interview with the family members of pediatric patients. The structured questionnaire (supplementary material) included information on death during last 90 days and living conditions (use of traditional stove for cooking).

Variables

Research nurses with detailed knowledge of the area used the patient's home addresses to categorize their residence into rural (living outside a municipality) or urban (living inside a municipality). Ethnicity is closely related to socio-economic status in Nepal and was categorized into four groups recognized by Nepali authorities; Brahmin and Chhetri, Janajati, Dalit, and others. Brahmin and Chhetri are generally considered as a group having a more privileged socioeconomic status and Dalit typically have a less privileged socioeconomic status (18).

Time of presentation at ED was categorized: daytime (08-16 weekdays) or after working hours (16-08, and holidays). ED disposition was categorized as follows: admission to pediatric or general wards; admission to intensive care unit (ICU), operating theatre (OT) or referral to other hospitals; discharge from ED; death in ED. Admission to ICU or OT, and referral to other hospital were grouped together because these were considered in need of advanced care directly from the ED. Referrals from ED typically constitute those in need of intensive care or surgery when there was not enough capacity or when specific care was not available at study hospital (typically neurosurgery).

Presenting complaints classification

The PCs from the emergency forms were translated into "International Classification of Primary Care-2 (ICPC-2)" codes (19), and classified into seven main categories; injuries, suspected infections, abdominal complaints, respiratory complaints, poisoning, unconsciousness and seizures, and other complaints (Figure 1A). The strategy for presenting complaint categorization and use of ICPC-2 codes is presented in the supplemental material Table S1.

Data analysis

Data analyses were performed using STATA 15 (StataCorp LP, College Station Texas, USA). Descriptive data is presented by numbers and percentages. Associations between patient

characteristics and outcome variables (mortality at 90 days and ED disposition) were assessed by logistic regression. Unadjusted odds ratios (ORs) and ORs adjusted for age in years and sex (aOR) are presented with 95% confidence intervals (CIs).

Sensitivity analyses were performed to assess possible selection bias related to those that could be followed for interviews after discharge (Table S2 to Table S6 in supplementary material). Thus, we assessed whether characteristics in the subpopulations who could be followed by interview and those that were assessed by triage were different from those who were not included in these analyses by comparing distributions of characteristics in these groups. We also assessed possible differences in population characteristics before and after the earthquake period (Table S7 in supplementary material).

Ethics

The Regional Committee for Medical and Health Research Ethics in South East Norway evaluated the project in 2014 and later in 2018 with amendments regarding planned publications (2014/1246) and (2018/163). The Committee concluded that the project was not within Norwegian health research regulations. Thus, the project is under Nepali regulations and the study was approved by the institutional ethical review committee of Kathmandu University School of Medical Sciences in Nepal (58/13). As this study is based on routinely collected pseudo-anonymized patient information in the hospital, informed consent from the patients was not obtained in individuals, as approved by the local ethical committee of Kathmandu University School of Medical Sciences in Nepal. Verbal consent was taken for information on telephone numbers, and at the beginning of the telephone interviews.

RESULTS

Figure 1A and Figure 1B shows the population and subsets of the population that were included in the analyses. We analyzed two sets of the population. First, we assessed all pediatric patients that were registered in the ED during the whole study period (Figure 1A). Next, we restricted our population to those who had information on triage (Figure 1B).

Among 6317 pediatric patients registered in ED during the study period, 5740 (90%) had complete information on presenting complaints and demographic information (Figure 1A), and 4296 could be included in analyses of hospital disposition. Of the 5740 included patients, a total of 2951 patient's consented to be called after discharge for interview and phone numbers

to be recorded in the patient registry. Of these 2951 patients, 961 (33%) households were reached for the follow-up telephone interviews at 90 days.

The triaged population numbered 1462 children: 1248 (85%) of these had complete information and 497 (34%) were telephone interviewed 90 days after discharge (Figure 1B).

Analyses comparing characteristics of those included and not included in the sub populations are presented in supplemental tables S2-S6. Overall, these analyses show no meaningful differences between those included in the sub-set analyses and those who were not.

The distribution of presenting complaints and demographic variables according to the main categories of presenting complaints are presented in table 1A. The median age of the population was 7 years, and 61% were 5 years or older. Boys were over represented in the total ED population; 63% of the children were male, and this proportion was similar in most presenting complaints groups. The children typically lived in rural areas (61%), and similar within the PC groups. The distribution of ethnicity was remarkably similar for the different PC groups, and typically 40-50% of the children were from the more privileged groups Brahmin and Chhetri. The PCs were dominated by injuries and infections, each accounting for ~40%. Children with infection were typically younger (median 4 years) than injured children (median 9 years).

Roughly 80% of children presented in the ED after office hours and during holidays (Table 1B). Over 60% were discharged home without hospitalization, and 8% were directly admitted to ICU or OT or were referred to other health facility. Less than 1% died in ED. The patterns of demographic characteristics and disposition were similar for most PC groups. However, among unconscious and poisoned children some different patterns were displayed. There was a larger proportion of girls than boys who were brought unconscious, and 30 % of poisoned children were admitted directly to higher levels of care.

Results for the population that was interviewed 90 days after discharge from ED is shown in table 2. Post-discharge mortality was low; only 12 (1.3%) of the 961 interviewed patients had died. Risk of PPDM was higher in children under 1 year compared to children 5-16 years, (sex-adjusted OR 4.3, 95% CI 1.2-15.5). Also, there was a tendency towards higher risk of PPDM in girls (2.1%) than boys (0.8%), (age-adjusted OR 2.6, 95% CI 0.8-8.4)). Mortality tended to be higher in rural populations compared with urban populations (age and sex adjusted (aOR) 5.9, 95% CI 0.8-46.5). Children from homes with a traditional stove had an increased mortality risk (aOR 13.8, 95% CI 1.8-108.3). When assessing mortality in different PC categories, two

out of three PPDM deaths had presented as suspected infections (aOR for mortality in infections compared to other complaints was 2.7, 95% CI 0.8-9.4).

Results for the triaged population is shown in the table's 3A, 3B and 3C. Distribution of triage categories by presenting complaint categories is shown in table 3A. Overall, 4% of children had a red triage category, 15% orange, 49% yellow, and 32% green. Considering red and orange cases as high severity with need of urgent care, these two categories added up to 60% of the poisoned patients, 23% of the infections, 13% of the injured and 14% of abdominal complaints. Within infections, suspected respiratory tract infections had the highest severity (red or orange) indicated by 32% (Table 3B).

Associations between triage category and hospital disposition is shown in table 3C. For red category, 28% were admitted in the general wards (aOR was 4.1, 95% CI 1.9-8.9 compared to discharge from ED), and 42% were admitted to ICU or OT or were referred to other hospitals (aOR was 32.1, 95% CI 13.5-76.6 compared to discharge from ED).

Associations for PPDM in the interviewed population that had received a triage code is presented in table 4. Nearly 16% of those triaged red had died at time of interview and aOR for death in red category was 56.5 (95% CI 4.6-687.3). Mortality in orange category (2.6%) was also high compared to green category (0.7%), but with low numbers and low precision.

DISCUSSION

Infections and injuries dominated in the pediatric emergency population. Urgency, identified by orange or red triage code at presentation, was particularly high in children with infections. Also, red triage code was strongly associated with more use of advanced care and increased post-discharge mortality risk.

Strengths and limitations

This is a single-center study; thus generalizations should be done with caution. However, the cohort comprised a large population from both rural and urban regions and the distribution of patient characteristics show that the patient population is highly representative for the region in respect to age, gender, geography and ethnicity. Also, the long data collection period is a strength; the study includes data from a three-year period, covering possible seasonal variations. However, it is a limitation that the study had low follow-up rates for the 90 days telephone interviews. Therefore, the results related to interview information should be interpreted with caution. However, again, we show that those lost to follow-up have similar

characteristics and PCs. We cannot rule out the possibility of selection bias in the interviewed patients with higher follow-up in healthier and more resourceful families, which may lead to possible underestimation of mortality. Patients who did not provide their telephone number were not interviewed and these patients might not have had a phone due to economic conditions and could also be frailer than the ones available for interviews. Also, it is possible that families who were called and did not answer were more likely to have lost a child.

Characteristics of patients

In our study injuries and suspected infections dominated the presenting complaints in children<16 year of age. We have identified six studies (20-25) that have described the disease spectrum of pediatric emergency patients in Asian LMICs, and some patterns are remarkably similar across studies. Broadly, infections and injuries are dominating in unselected pediatric emergency patients, and typically children in these EDs are young with a median age 2-7 years in studies including children up to 13 or 18 years (23, 25). Interestingly, several pediatric studies reported that boys are considerably overrepresented: in Pakistan 60% were boys (20), a study from Malaysia reported male to female ratio of 1.5:1 (22), a Cambodian study reported 54% boys (25), and a large study from India reported a male to female ratio of 3:1 (21). Few suggestions to explain this has been forwarded in the mentioned literature. Singhi et al (21) suggested that a possible explanation could be increased vulnerability of boys to ill health. Another explanation may be that boys are more valued in these societies and, therefore, receive preferential attention from the family during illnesses, possibly particularly when resources are limited. In our study, 63% of the ED population were boys, while statistics from the Nepali population for 2017 shows that approximately 51% were boys in age groups 0-9 years and there were no meaningful sex-difference in age 10-19 years (26). It has been suggested that in Nepal, boys are more valued than girls and receive advantageous attention and are prioritized for health care during illness (18, 27, 28), but there are also possible roles of biological sex-differences in disease vulnerability. Interestingly, different studies have reported different sex-specific patterns for specific diseases. A study from Mauritania in children <5 years with diarrhea and respiratory diseases (29) found higher risk for diarrhea-associated deaths among females while respiratory disease-associated deaths were more common in males. The patterns for injuries is more consistent: several studies have shown that the proportion of injured pediatric patients is higher in males than in females (20, 22, 30, 31). The assumption of gender inequality in our study may also be strengthened by the observation of more girls than boys in the categories unconsciousness and poisoning, possibly indicating that girls were taken to hospital when they were critical or life threateningly sick. This observation is novel, and needs to be

replicated in larger studies and similar settings. Also, our findings for distribution of mortality after ED discharge indicates higher mortality in girls.

Disposition and pediatric ED

In our study, the proportion of hospitalized children was 37% compared to 9%, 51% and 25% in studies in similar age groups from Pakistan (20), Cambodia (25), and Malaysia (22) respectively. In two other studies from Pakistan (23) and India (21) with younger populations, the proportions of hospitalization were higher, (45%) and (42%) respectively. The high proportion of discharge home from ED in LMICs are in contrast with countries where the primary health care system screens the majority of patients before they eventually present to the hospital ED (32). Non-pediatric EDs in LMICs are typically crowded and receive patients for assessment with a wide spectrum of severity, hence, pediatric competence and systems that can specifically evaluate and prioritize pediatric patients seem to be essential. The WHO conducted a study in 21 hospitals in low income settings to assess quality of care for seriously ill children (33), and found heterogeneity in pediatric critical care and competence in assessing pediatric illnesses and treatment. The main recommendations for improvements in LMIC pediatric emergency care include systematic triage, regular monitoring of patients and strengthen pediatric emergency care competence (4, 33-35). A review of emergency medicine in Nepal concludes that the country has critical shortage of emergency health service providers, and that the field of emergency medicine has largely been neglected in terms of health system development and specialist training (9).

Pediatric triage in LMIC

Various triage systems have been developed to help emergency health care providers to make accurate priority decisions. The RETTS triage system was developed in Sweden and has been increasingly used in the Scandinavian countries (15-17).

Pediatric emergency triage system was recently systematically assessed (36), and only one of the 18 studies of triage system reliability identified in the systematic review (36) was from a LIC (37). Thus, the present report of triage priority categories in a pediatric population in a low income setting is unique. We also report associations between triage category and indicators of disease severity such as hospital admittance, ICU treatment and post-discharge mortality. We have identified no previous study that has assessed whether PPDM could be associated with severity at presentation. Further studies are needed to identify triage systems that can operate well in low-resource settings. It will be important to validate such systems.

Pediatric post-discharge mortality (PPDM)

PPDM in LIC was recently reviewed (11). In that systematic review of 24 individual studies, post-discharge mortality was often higher than in-hospital mortality. In our study, in-hospital mortality was less than 1%, and PPDM was two times higher. In previous studies, PPDM varied between 1-2% for anemia and malaria subpopulations and higher for those with malnutrition and pneumonia (3%-20%) (11). Our study is based on an unselected emergency population, where more than half of the children were discharged without hospitalization and this can explain the low hospital mortality. It is important to note that the great majority of the studies included are from Africa, typically including only specific diagnostic groups (11). Only two of the studies (38, 39), both from Africa, included all hospital admissions. Ours, however, assessed an emergency population where <40% were admitted. In those studies, infant age was associated with higher mortality than higher ages and this is in line with our findings. In-addition, PPDM was higher in females than males. Similar sex-specific analyses were only performed in few previous studies, and the patterns are not conclusive. Higher PPDM for girls (about two times than for boys) were found in a diarrheal study from Bangladesh (40), and for respiratory tract infections from Kenya (41). In our study, girls were under represented among the children seeking emergency care although the mortality was higher in girls. However, present findings related to triage categories do not support a hypothesis that girls were more severely sick at admittance to ED attendance (data not shown).

In our study, we found that post discharge mortality in children with infections was about 3-fold that of all other complaints combined. In other studies, specific diagnosis has been main target for the analyses (11, 39, 42). Thus, in those studies, typically malnutrition and respiratory tract infections had the highest PPDM risk.

We explored the usefulness of triage codes in indicating risk of PPDM and found a very strong association, were PPDM in the red category was 16% and with a gradual reduction in risk by lower triage category. We are not aware of other studies that have assessed triage and PPDM. In the reviewed post-discharge mortality studies, lower oxygen saturation on admission was associated with higher mortality risk after discharge (38, 43) but hypoxemia (<90%) was not associated with post-discharge mortality in malnourished patients (44).

The present study assessed factors related to socioeconomic conditions and housing and we found that PPDM was higher for those that lived in rural compared to urban areas. We also found that living in a house with traditional stove was a strong indicator of higher mortality risk. Houses with traditional wooden stoves are typical for rural areas and low income, and

could also relate to low indoor temperatures and high smoke exposure, that in turn, could negatively influence specifically respiratory health. Our finding is supported by a meta-analysis of 24 studies by Dherani et al (45) that concluded increased risk of pneumonia in young children by exposure to unprocessed solid fuel by a factor of 1.8.

FINAL REMARKS

The study is observational and the follow-up was not powered to reach firm conclusions. Nevertheless, our findings in this unselected pediatric emergency population highlighted that pediatric emergency patients typically present with infections and injuries, and that less girls than boys presented to ED. Moreover, post discharge mortality in girls was two-fold that of boys, and it is particularly high in infants and in children that presented with suspected infections. Finally, we found that high triage priority levels at ED presentation was strongly associated with need of advanced care and increased mortality risk after discharge. These findings support that triage assessment systems should be implemented in low resource settings, and the need for interventions that can reduce mortality after discharge. We suggest that such interventions should emphasize effective treatment of infections and injuries, and identification of children at risk for complications after discharge.

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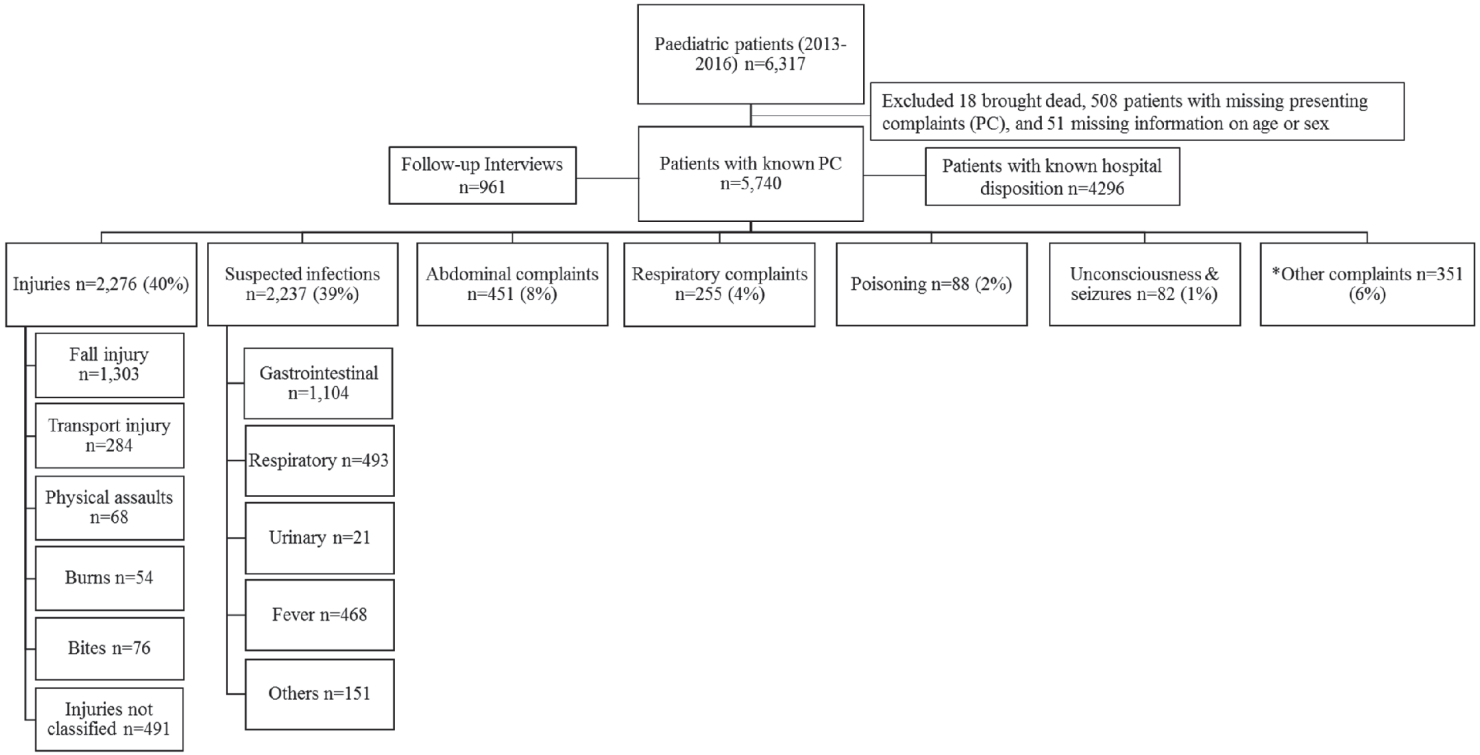
References

1. WHO data. (2018). *Children: reducing mortality*. Retrived from http://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality. (Accessed October 31, 2018).
2. UNICEF. (2016).*The State of the World's Children 2016; A fair chance for every child*. Retrived from https://www.unicef.org/publications/files/UNICEF_SOWC_2016.pdf. (Accessed October 9, 2018).
3. Duke T, Cheema B. Paediatric emergency and acute care in resource poor settings. (2016). *Journal of paediatrics and child health.* 2:221-6. doi: 10.1111/jpc.13105
4. Turner EL, Nielsen KR, Jamal SM, von Saint Andre-von Arnim A, Musa NL. (2016). A Review of Pediatric Critical Care in Resource-Limited Settings: A Look at Past, Present, and Future Directions. *Frontiers in pediatrics.* 4:5. doi: 10.3389/fped.2016.00005
5. Pollock L, Anderson STB, Kampmann B. Paediatric emergency care in resource-limited settings. (2013). *Lancet.* 9875:1357. doi: 10.1016/s0140-6736(13)60879-x
6. Kobusingye OC, Hyder AA, Bishai D, Joshipura M, Hicks ER, Mock C. (2006). Disease Control Priorities in Developing Countries 2nd edition. New York: Oxford University Press. Chapter 68: 1261–79.
7. Obermeyer Z, Abujaber S, Makar M, Stoll S, Kayden SR, Wallis LA, et al. (2015). Emergency care in 59 low- and middle-income countries: a systematic review. *Bulletin of the World Health Organization.* 8:577-86g. doi: 10.2471/blt.14.148338
8. Ministry of Health, Nepal. (2016). Nepal Demogrphic and Health Survey. Retrived from https://www.dhsprogram.com/pubs/pdf/fr336/fr336.pdf. (Accessed August 8, 2018).
9. Pandey NR. (2016). Emergency medicine in Nepal: present practice and direction for future. *International journal of emergency medicine.* 1:20. doi: 10.1186/s12245-016-0118-3
10. Mowafi H, Dworkis D, Bisanzo M, Hansoti B, Seidenberg P, Obermeyer Z, et al. (2013). Making recording and analysis of chief complaint a priority for global emergency care research in low-income countries. *Acad Emerg Med* 12:1241-5. doi: 10.1111/acem.12262
11. Nemetchek B, English L, Kissoon N, Ansermino JM, Moschovis PP, Kabakyenga J, et al (2018). Paediatric postdischarge mortality in developing countries: a systematic review. *BMJ open.* 12:e023445. doi: 10.1136/bmjopen-2018-023445
12. Central Bureau of Statistics, Nepal. (2012). National Population and Housing Census 2011. Retrived from https://unstats.un.org/unsd/demographic-social/census/documents/ Nepal/Nepal-Census-2011-Vol1.pdf. (Accessed June 1, 2018).
13. Giri S, Risnes K, Uleberg O, Rogne T, Shrestha SK, Nygaard OP, et al. (2018). Impact of 2015 earthquakes on a local hospital in Nepal: A prospective hospital-based study. *PloS one* 2:e0192076. doi: 10.1371/journal.pone.0192076
14. RETTS. Retrived from https://predicare.se/. (Accessed June 27, 2018).
15. Henning B, Lydersen S, Dollner H (2016). A reliability study of the rapid emergency triage and treatment system for children. *Scandinavian journal of trauma, resuscitation and emergency medicine.* 24:19. doi: 10.1186/s13049-016-0207-6
16. Farrokhnia N, Goransson KE. (2011). Swedish emergency department triage and interventions for improved patient flows: a national update. *Scandinavian journal of trauma, resuscitation and emergency medicine*. 19:72. doi: 10.1186/1757-7241-19-72

17. Nissen L, Kirkegaard H, Perez N, Horlyk U, Larsen LP. (2014). Inter-rater agreement of the triage system RETTS-HEV. *European journal of emergency medicine : official journal of the European Society for Emergency Medicine*. 1:37-41. doi: 10.1097/MEJ.0b013e32836397d9
18. Bennett L DD, Govindasamy P. (2008). Caste, Ethnic and Regional Identity in Nepal Further Analysis of the 2006 Nepal Demographic and Health Survey. Nepal: USAID, Macro International Inc. Retrived from http://pdf.usaid.gov/pdf_docs/Pnadm638.pdf. (Accessed Feburary 23, 2018)
19. WONCA. (2017). International Classification of Primary Care (ICPC): Wonca International Classification Committee. Retrived from www.globalfamilydoctor.com (Accessed August 25, 2017).
20. Atiq H, Siddiqui E, Bano S, Feroze A, Kazi G, Fayyaz J, et al. (2015). The pediatric disease spectrum in emergency departments across Pakistan: data from a pilot surveillance system. *BMC emergency medicine.* 15 Suppl 2:S11. doi: 10.1186/1471-227x-15-s2-s11
21. Singhi S, Jain V, Gupta G. (2003). Pediatric emergencies at a tertiary care hospital in India. *Journal of tropical pediatrics.* 4:207-11. doi: 10.1093/tropej/49.4.207
22. Goh AY, Chan TL, Abdel-Latiff ME. (2003). Paediatric utilization of a general emergency department in a developing country. *Acta paediatrica.* 8:965-9.
23. Ijaz N, Strehlow M, Ewen Wang N, Pirrotta E, Tariq A, Mahmood N, et al. (2018). Epidemiology of patients presenting to a pediatric emergency department in Karachi, Pakistan. *BMC emergency medicine.* 1:22. doi: 10.1186/s12873-018-0175-4
24. Gupta PP, Malla GB, Bhandari R, Shah Kalawar RP, Mandal M (2017). Patterns of Injury and Mortality in Pediatric Patients Attending Emergency Department in a Tertiary Care Center in Eastern Nepal. *JNMA; journal of the Nepal Medical Association.* 207:331-4
25. Yore MA, Strehlow MC, Yan LD, Pirrotta EA, Woods JL, Somontha K, et al. (2018). Characteristics and outcomes of pediatric patients presenting at Cambodian referral hospitals without appointments: an observational study. *International journal of emergency medicine* 1:17. doi: 10.1186/s12245-018-0172-0
26. Population Pyramids of the world from 1950-2100: PopulationPyramid.net. (2017). Retrived from https://www.populationpyramid.net/nepal/. (Accessed June 18, 2019).
27. Pokhrel S, Snow R, Dong H, Hidayat B, Flessa S, Sauerborn R. (2005). Gender role and child health care utilization in Nepal. *Health policy.* 1:100-9. doi: 10.1016/j.healthpol.2004.12.013
28. United Nations. Sustainable Development Goals, Achieve gender equality and empower all women and girls. Available from https://www.un.org/sustainabledevelopment/gender-equality/. (Accessed March 6, 2019)
29. Ahmed M, Weddih A, Benhafid M, Bollahi MA, Sidatt M, Makhalla K, et al. (2018). Hospitalizations and Deaths Associated with Diarrhea and Respiratory Diseases among Children Aged 0(-)5 Years in a Referral Hospital of Mauritania. *Tropical medicine and infectious disease* 3:103. doi: 10.3390/tropicalmed3030103
30. Gupta PP, Malla GB, Bhandari R, Kalawar RPS, Mandal M (2017). Patterns of Injury and Mortality in Pediatric Patients Attending Emergency Department in a Tertiary Care Center in Eastern Nepal. *JNMA; journal of the Nepal Medical Association.* 207:331-4
31. Bhatta S, Pant PR, Mytton J (2016). Usefulness of hospital emergency department records to explore access to injury care in Nepal. *International journal of emergency medicine.* 1:21. doi: 10.1186/s12245-016-0120-9

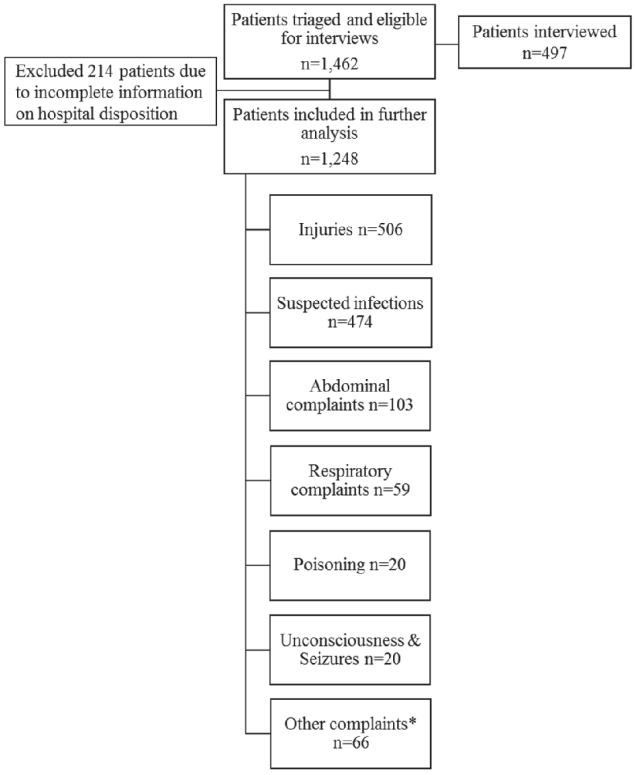
32. Langlo NM, Orvik AB, Dale J, Uleberg O, Bjornsen LP. (2014). The acute sick and injured patients: an overview of the emergency department patient population at a Norwegian University Hospital Emergency Department. *European journal of emergency medicine: official journal of the European Society for Emergency Medicine.* 3:175-80. doi: 10.1097/MEJ.0b013e3283629c18
33. Nolan T, Angos P, Cunha AJ, Muhe L, Qazi S, Simoes EA, et al. (2001). Quality of hospital care for seriously ill children in less-developed countries. *Lancet.* 9250:106-10. doi: 10.1016/s0140-6736(00)03542-x
34. Baker T. (2009). Pediatric emergency and critical care in low-income countries. *Paediatric anaesthesia*. 1:23-7. doi: 10.1111/j.1460-9592.2008.02868.x
35. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C, Joshipura M. (2005). Emergency medical systems in low- and middle-income countries: recommendations for action. *Bulletin of the World Health Organization*. 8:626-31. doi: /S0042-96862005000800017
36. Magalhaes-Barbosa MC, Robaina JR, Prata-Barbosa A, Lopes CS (2019). Reliability of triage systems for paediatric emergency care: a systematic review. *Emergency medicine journal : EMJ*. 4:231-8. doi: 10.1136/emermed-2018-207781
37. Twomey M, Mullan PC, Torrey SB, wallis L, Kestler A. (2012). The Princess Marina Hospital accident and emergency triage scale provides highly reliable triage acuity ratings. *Emergency medicine journal: EMJ.* 8:650-3. doi: 10.1136/emermed-2011-200503
38. Veirum JE, Sodeman M, Biai S, Hedegard K, Aaby P. (2007). Increased mortality in the year following discharge from a paediatric ward in Bissau, Guinea-Bissau. *Acta paediatrica.* 12:1832-8. doi: 10.1111/j.1651-2227.2007.00562.x
39. Moisi JC, Gatakaa H, Berkley JA, Maitland K, Mturi N, Newton CR, et al. (2011). Excess child mortality after discharge from hospital in Kilifi, Kenya: a retrospective cohort analysis. *Bulletin of the World Health Organization.* 10:725-32, 32a. doi: 10.2471/blt.11.089235 P
40. Islam MA, Rahman MM, Mahalanabis D, Rahman AK. (1996). Death in a diarrhoeal cohort of infants and young children soon after discharge from hospital: risk factors and causes by verbal autopsy. *Journal of tropical pediatrics.* 6:342-7. doi: 10.1093/tropej/42.6.342.
41. Ngari MM, Fegan G, Mwangome MK, Ngama MJ, Mturi N, Scott JAG, et al. (2017). Mortality after Inpatient Treatment for Severe Pneumonia in Children: a Cohort Study. *Paediatric and perinatal epidemiology.* 3:233-42. doi: 10.1111/ppe.12348
42. Nair H, Simoes EA, Rudan I, Gessner BD, Azziz-Baumgartner E, Zhang JSF, et al. (2013). Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. *Lancet.* 9875:1380-90. doi: 10.1016/s0140-6736(12)61901-1
43. Wiens MO, Kumbakumba E, Larson CP, Ansermino JM, Singer J, Kissoon N, et al. (2015). Postdischarge mortality in children with acute infectious diseases: derivation of postdischarge mortality prediction models. *BMJ open.* 11:e009449. doi: 10.1136/bmjopen-2015-009449
44. Chisti MJ, Graham SM, Duke T, Ahmed T, Faruque AS, Ashraf H, et al. (2014). Post-discharge mortality in children with severe malnutrition and pneumonia in Bangladesh. *PloS one.* 9:e107663. doi: 10.1371/journal.pone.0107663
45. Dherani M, Pope D, Mascarenhas M, Smith KR, Weber M, Bruce N. (2008). Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. *Bulletin of the World Health Organization.* 5:390-8c. doi: 10.2471/blt.07.044529

Figure 1A. Flow diagram of cohort and distribution of presenting complaints



PC=presenting complaint. *Other complaints included musculoskeletal, neurology, urinary, cardiovascular diseases or complaints, psychology and other general complaints.

Figure 1B. Flow diagram of triaged patients and interviewed



*Other complaints included musculoskeletal, neurology, urinary, cardiovascular diseases or complaints, psychology and other general complaints.

Table 1A: Baseline characteristics by categories of presenting complaints in 5740 children presenting to emergency department in Dhulikhel Hospital from Sept 2013- Dec 2016

Characteristics	Total	Injuries	Suspected Infections[†]	Abdominal complaints	Respiratory complaints	Poisoning	Unconsciousness & Seizures	Other complaints[‡]
Total Patients, n (%)	**5740**	**2276 (40)**	**2237 (39)**	**451 (8)**	**255 (4)**	**88 (2)**	**82 (1)**	**351 (6)**
Age, (years) median (IQR)	7 (2-12)	9 (5-13)	4 (1-10)	11 (5-15)	2 (1-9)	5 (2-14)	13 (6-15)	7 (1-14)
Age (years), n (%)[**]								
<1	521 (9)	26 (1)	319 (14)	36 (8)	68 (27)	4 (5)	1 (1)	67 (19)
1-<5	1740 (30)	506 (22)	936 (42)	68 (15)	95 (37)	39 (44)	18 (22)	78 (22)
5-16	3479 (61)	1744 (77)	982 (44)	347 (77)	92 (36)	45 (51)	63 (77)	206 (59)
Sex, n(%)								
Female	2110 (37)	718 (32)	870 (39)	183 (41)	101 (40)	40 (45)	54 (66)	144 (41)
Male	3630 (63)	1558 (68)	1367 (61)	268 (59)	154 (60)	48 (55)	28 (34)	207 (59)
Patient location, n(%)								
Rural	3522 (61)	1499 (66)	1304 (58)	256 (57)	144 (56)	54 (61)	53 (65)	212 (60)
Urban	1709 (30)	566 (25)	757 (34)	165 (37)	81 (32)	27 (31)	16 (20)	97 (28)
Information NA	509 (9)	211 (9)	176 (8)	30 (7)	30 (12)	7 (8)	13 (16)	42 (12)
Ethnicity, n (%)								
Brahmin and Chhetri	2573 (45)	944 (41)	1072 (48)	222 (49)	113 (44)	33 (38)	40 (49)	149 (42)
Janajati	2546 (44)	1068 (47)	932 (42)	193 (43)	117 (46)	44 (50)	31 (38)	161 (46)
Dalit	507 (9)	219 (10)	193 (9)	30 (7)	19 (7)	8 (9)	9 (11)	29 (8)
Other	114 (2)	45 (2)	40 (2)	6 (1)	6 (2)	3 (3)	2 (2)	12 (3)

[†]Suspected infections and fever. [‡]Other complaints included musculoskeletal, neurology, urinary, cardiovascular diseases or complaints, psychology and other general complaints (Table S3). [**]Percentages for total is column percentage and others are row percentage. IQR=Inter Quartile Range. NA=not available

Table 1B: Distribution of time of presentation and emergency department disposition by categories of presenting complaints among 4296 children presenting to emergency department in Dhulikhel Hospital from September 2013 to December 2016.

Characteristics	Total	Injuries	Suspected Infections[†]	Abdominal complaints	Respiratory complaints	Poisoning	Unconsciousness & Seizures	Other complaints[‡]
Total Patients, n (%)[*]	**4296**	**1740 (41)**	**1659 (39)**	**343 (8)**	**187 (4)**	**60 (1)**	**60 (1)**	**247 (6)**
Presentation to ED, n (%)[**]								
08:00-16:00 weekdays	1037 (24)	481 (28)	322 (19)	96 (28)	37 (20)	23 (38)	24 (40)	54 (22)
16:00-08:00 or holidays	3259 (76)	1258 (72)	1337 (81)	247 (72)	151 (80)	37 (62)	36 (60)	193 (78)
ED disposition, n(%)								
Pediatric/other ward	1267 (29)	465 (27)	567 (34)	76 (22)	56 (30)	19 (32)	17 (28)	67 (27)
ICU or OT or Referred	341 (8)	126 (7)	117 (7)	26 (8)	26 (14)	18 (30)	7 (12)	21 (9)
Discharged	2682 (62)	1145 (66)	975 (59)	241 (70)	105 (56)	23 (38)	35 (58)	158 (64)
Died in ED	6 (0.1)	3 (0.2)	0	0	1 (0.5)	0	1 (2)	1 (0.4)

[*]n=4296 (75%) has complete information and included in the analysis. [†]Suspected infections and fever. [‡]Other complaints included musculoskeletal, neurology, urinary, cardiovascular diseases or complaints, psychology and other general complaints. [**]Percentages for total is column percentage and others are row percentage. ED=emergency department. ICU=intensive care unit. OT=operation theater.

Table 2: Association between patient's characteristics and presenting complaint categories, and 90 days mortality among 961 children interviewed by telephone 90 days after emergency department visit from September 2013-December 2016

Characteristics	Total Interviewed	90-days mortality	Unadjusted	Adjusted[¶]
			OR 95%CI	OR 95%CI
Total, n(%)	**961**	**12 (1.3)**		
Sex, n(%)				
Female	340 (35)	7 (2.1)	2.6 (0.8-8.2)	2.6 (0.8-8.4)
Male	621 (65)	5 (0.8)	Ref	Ref
Age, (years), n(%)				
<1	96 (10)	4 (4.2)	4.2 (1.2-15.3)	4.3 (1.2-15.5)
1-<5	275 (29)	2 (0.7)	0.7 (0.1-3.6)	0.7 (0.1-3.5)
5-16	590 (61)	6 (1.0)	Ref	Ref
Patient location, n(%)				
Urban	313 (33)	1 (0.3)	Ref	Ref
Rural	648 (67)	11 (1.7)	5.4 (0.7-41.9)	5.9 (0.8-46.5)
Exposure to traditional stove				
No	505 (53)	1 (0.2)	Ref	Ref
Yes	456 (47)	11 (2.4)	12.5 (1.6-96.9)	13.8 (1.8-108.3)
Presenting Complaints, n(%)				
Suspected infections	380 (40)	8 (2.1)	3.1 (0.9-10.4)	2.7 (0.8-9.4)
Other complaints	581 (60)	4 (0.7)	Ref	Ref
ED disposition, n(%)[*]				
General wards	298 (36)	2 (0.7)	Ref	Ref
ICU or OT or Referred	61 (7)	2 (3.3)	5.0 (0.7-36.3)	4.7 (0.6-34.5)
Discharged	466 (57)	6 (1.3)	1.9 (0.4-9.6)	1.9 (0.4-9.6)

[¶]Adjusted for sex and age in continuous. CI=Confidence Interval. [*]Analysis done with smaller denominators.

Table 3A: Distribution of triage categories by categories of presenting complaints among children presenting to emergency department in Dhulikhel Hospital from March 2015-April 2016.

Characteristics	Total	Injuries	Suspected Infections[†]	Abdominal complaints	Respiratory complaints	Poisoning	Unconsciousness & Seizures	Other complaints[‡]
Total Patients, n (%)	**1248**	**505 (40)**	**474 (38)**	**103 (8)**	**60 (5)**	**20 (2)**	**20 (2)**	**66 (5)**
Triage (Yes) , n (%)								
Red	50 (4)	12 (2)	20 (4)	3 (3)	5 (8)	6 (30)	2 (10)	2 (3)
Orange	183 (15)	56 (11)	88 (19)	11 (11)	10 (17)	6 (30)	4 (20)	8 (12)
Yellow	617 (49)	218 (43)	266 (56)	57 (55)	30 (50)	8 (40)	11 (55)	27 (41)
Green	398 (32)	219 (43)	100 (21)	32 (31)	15 (25)	0	3 (15)	29 (44)

[†]Suspected infections and fever. [‡]Other complaints included musculoskeletal, neurology, urinary, cardiovascular diseases or complaints, psychology and other general complaints.

Table 3B: Distribution of RETTS triage categories by categories of infections among children presenting to emergency department in Dhulikhel Hospital from March 2015-April 2016.

Characteristics	Total	Gastrointestinal infections	Urinary infections	Respiratory infections	Fever	Other infections*
Total Patients, n (%)	**474**	**233 (49)**	**2 (0.4)**	**119 (25)**	**89 (19)**	**31 (7)**
Triage, n (%)						
Red	20 (4)	7 (3)	0	9 (8)	2 (2)	2 (6)
Orange	88 (19)	37 (16)	0	28 (24)	15 (17)	8 (26)
Yellow	266 (56)	134 (58)	0	63 (53)	52 (58)	17 (55)
Green	100 (21)	55 (23)	2 (100)	19 (16)	20 (22)	4 (13)

*Other infections included otitis media, skin infection, discharge from wound and other infections

Table 3C: Triage priority levels and disposition (admission to ward, and admission to ICU or OT or referred to other hospitals) in the emergency department among 1248 children presenting to Dhulikhel Hospital from March 2015 to April 2016.

Characteristics	Triage	Total	Ward vs Discharged	Unadjusted	Adjusted¶	ICU/OT/Referred vs Discharged	Unadjusted	Adjusted¶
				OR 95%CI	OR 95%CI		OR 95%CI	OR 95%CI
Total Patients, n (%)		1248	294 (24)			83 (7)		
Triage code n(%)**	Red	50 (4)	14 (28)	4.1 (1.9-8.9)	4.1 (1.9-8.9)	21 (42)	33.8 (14.3-80.2)	32.1 (13.5-76.6)
	Orange	183 (15)	57 (31)	2.5 (1.7-3.8)	2.5 (1.6-3.7)	27 (15)	6.6 (3.3-13.3)	6.4 (3.2-12.8)
	Yellow	617 (49)	152 (25)	1.5 (1.1-2.1)	1.5 (1.1-2.0)	22 (4)	1.2 (0.6-2.4)	1.1 (0.6-2.3)
	Green	398 (32)	71 (18)	Ref	Ref	13 (3)	Ref	Ref

¶Adjusted for sex and age in continuous. *Percentages for total is column percentage and others are row percentage.

Table 4: Triage priority levels and 90 days mortality among 497 children presenting to the emergency department at Dhulikhel Hospital from March 2015 to April 2016.

Characteristics	Triage	Total	90-days mortality	Unadjusted	Adjusted[¶]
				OR 95%CI	OR 95%CI
Total Patients, n (%)		497	9 (1.8)		
Triage code (n=497), n(%)	Red	19 (3.8)	3 (15.8)	28.5 (3.0-290.3)	56.5 (4.6-687.3)
	Orange	78 (15.7)	2 (2.6)	4.0 (0.4-44.8)	3.7 (0.3-43.2)
	Yellow	247 (49.7)	3 (1.2)	1.9 (0.2-18.1)	1.6 (0.2-16.1)
	Green	153 (30.8)	1 (0.7)	Ref	Ref

[¶]Adjusted for sex and age in continuous.

Supplementary Material

1 Supplementary: List of variables at emergency department (ED)

1. Study Number
2. Hospital Number
3. Date of Admittance (DD/MM/YR)
4. Age (Years)
5. Sex (M/F)
6. Ethnicity
7. Time of Presentation
8. Temperature (Celsius)
9. Pulse (Beats per minute)
10. Respiration rate
11. Systolic Blood Pressure
12. Diastolic Blood Pressure
13. Oxygen Saturation
14. Glasgow Coma Scale (GCS)
15. Triage done (Yes/No)
16. Triage Code (Red/Orange/yellow/green)
17. Time of Triage
18. Time of Treatment
19. Presenting Complaint
20. Action in Emergency Room (Medication, Fluids, Oxygen, Antibiotics etc.)
21. Transfer to (General wards, ICU, OT)
22. ED disposition (Admitted, Discharged, LAMA/DOR, Referred)
23. Death (Yes/No)
24. Diagnosis at Discharge

2 Supplementary: Telephone interview guide at 90 days of ED disposition

1. Study Number
2. Hospital Number
3. Date of Interview
4. Visited Dhulikhel Hospital (DH) for same condition after the last visit (Yes/No)
5. Visited other health facility for same condition after the last visit to DH (Yes/No)
6. How long did you wait in ED before seeing a doctor (in minutes)
7. How do you like the services/patient management provided from ED (Very poor, Poor, OK/Fair, Good, very Good)
8. Health status now (Better, Unchanged, Worse, Died)
9. If died, Date of dead (DD,MM,YR)
10. Information given by (Patient, Relatives, Others)
11. a) In Labor case, if baby alive (Yes/No)
11. b) Number of baby delivered
12. Number of members in house living together
13. Main occupation
14. Education (Literate/Illiterate)
15. Completed education level
16. Smoking Tobacco (Yes/No)
17. If smoking tobacco, number per day
18. Fuel for Cooking (traditional cooking stove, improved cooking stove, gas stove, electricity)
19. Additional Information

3 Supplementary descriptions

3.1 Presenting Complaints Classification

The presenting complaints were recorded by an emergency nurse in the emergency form. The presenting complaint was recorded in free text format (for example; a lady with chest pain and fever). The complaints were retrospectively classified into seven main categories. The process of categorizations was performed in three phases using STATA software. In the first phase, in total 761"presenting complaint texts" (e.g. fever, chest pain, abdominal pain, limb fracture etc.) were generated and scored as 0 (no) or 1 (yes). In the second phase one or more "International Classification of Primary Care-2 (ICPC-2)" codes, were allocated to each patient based on the complaint categories first generated. In the third phase, one main presenting complaint was identified for each patient. Obvious related complaints were combined into one single group (e.g. fever and chills). The categories of seven main presenting complaints were; injuries, suspected infections, abdominal complaints, respiratory complaints, poisoning, unconsciousness and seizures, and other complaints. These categories were arranged in hierarchical order as shown in Figure 1A ("injuries" at first and "other complaints" at last; i.e. if a patient had injury irrespective to other complaints then he/she will be in injury category). Suspected infections complaint category included infections and also when presenting complaint was fever with no specification of organ system involved. The category "other complaints" included musculoskeletal, neurology, urinary, psychological and other complaints (general pain, eye/ear complaints etc.).

3.2 Follow-up interviews

Two trained research nurses conducted a structured telephone interview 90 days following the ED visit. The research nurse contacted all patients (n=2951) who provided phone numbers during the ED disposition. The research nurse contacted twice when patients were not reachable the first time. The telephone interview included information on 90-days mortality and exposure level to smoke.

4. Supplementary Tables

Table S1: Categories of presenting complaints and use of ICPC-2 codes

ICPC complaint Categories	Included ICPC-2 Codes
Poisoning	A86
Injuries	
Fall Injury	A80 b*
Transport Accident	A80 a*
Physical Assault	Z25
Bite	S12, S13
Burn	S14
Other Injury	A88, N80, D79, D80, R87, Y80, H76, H78, H79, F76, F79,
Infections	
Gastrointestinal Infection	D70
Urinary Infection	U71
Respiratory Infection	R74, R75, R76, R78, R81, R83, A70
Fever (only)	A02, A03
Other Infection	A78, A87, B70, N71, N73, S11
Unconsciousness & Seizure	A06, N07
Cardiovascular (CVD)	
CVD complaints	A11/K01, K04, K07
CVD disease	K71, K73, K86
Respiratory complaints	
Short Breath	R02
Asthma	R96
Other Respiratory	R03, R04, R05, R06, R07, R21, R24, R29, R99
Gynaecology complaints	
Pregnancy and Childbearing Complications	W03, W05, W29
Menstruation Complaints	X02, X06, X07
Female Genital Complaints	X01, X14, X21, X29, X77
Abdomen and Digestive	
Nausea, Vomiting & Diarrhoea	D09, D10, D11
Abdomen Pain	D01, D02, D06, D12, D25, D88
Other Digestive	D08, D13, D14, D15, D16, D17, D19, D20, D21, D24,
Other Complaints	
Urinary	U01, U02, U04, U05, U06, U07, U08, U95, U99
Neurology	N01, N05, N06, N08, N17, N19, N28, N29, N85, N88, N89
Musculoskeletal	L01, L02, L03, L05, L07, L09, L12, L14, L17, L18, L19,
Psychosocial Complaints	P04, P16, P19, P20, P29, P85, P86, P99
Other Complaints, NOS	A01, A04, A05, A08, A10, A16, A29, A92, A93, A94,

A80_b-Fall Injuries, A80_a-Road Transport Accidents, A80_c-Animal Injuries, A66-Referred to study hospital for intensive care unit. *New codes that does not comply with ICPC-2 codes.

Table S2. Characteristics of total patients (n=6317) and included patients (n=5740) in the analysis of Table1A

Characteristics	Total patients	Not Included	Included
Total Patients, n (%)	**6317**	**577**	**5740**
Age, median (IQR)*	7 (2-12)	8 (4-12)	7 (2-12)
Age (years), n (%)			
<1	544 (9)	23 (4)	521 (9)
1-<5	1871 (30)	131 (23)	1740 (30)
5-16	3862 (61)	383 (66)	3479 (61)
Information NA	40 (1)	40 (7)	0
Female, n (%)	2337 (37)	227 (39)	2110 (37)
Patient location, n(%)			
Rural	3662 (58)	140 (24)	3522 (61)
Urban	1767 (28)	58 (10)	1709 (30)
Information NA	888 (14)	379 (66)	509 (9)
Ethnicity, n (%)			
Brahmin and Chhetri	2828 (45)	255 (44)	2573 (45)
Janajati	2797 (44)	251 (44)	2546 (44)
Dalit	548 (9)	41 (7)	507 (9)
Other	144 (2)	30 (5)	114 (2)
Presenting Complaints, n(%)			
Injuries	2284 (36)	7 (1)	2277 (40)
Suspected Infections	2256 (36)	19 (3)	2237 (39)
Abdominal complaints	453 (7)	2 (0.4)	451 (8)
Respiratory complaints	257 (4)	3 (1)	254 (4)
Poisoning	89 (1)	1 (0.2)	88 (2)
Unconsciousness and Seizures	86 (1)	4 (1)	82 (1)
Other complaints	375 (6)	24 (4)	351 (6)
Information NA	517 (8)	517 (90)	0

*Within available information. IQR=Interquartile range. NA=Information not available.

Table S3. Characteristics of total patients (n=5740) and included patients (n=4296) in the analysis of Table1B

Characteristics	Total patients	Not Included	Included
Total Patients, n (%)	**5740**	**1444**	**4296**
Age, median (IQR)	7 (2-12)	6 (2-12)	7 (2-12)
Age (years), n (%)			
<1	521 (9)	155 (11)	366 (9)
1-<5	1740 (30)	465 (32)	1275 (30)
5-16	3479 (61)	824 (57)	2655 (62)
Female, n (%)	2110 (37)	550 (38)	1560 (36)
Patient location, n(%)			
Rural	3522 (61)	845 (59)	2677 (62)
Urban	1709 (30)	389 (27)	1320 (31)
Information NA	509 (9)	210 (15)	299 (7)
Ethnicity, n (%)			
Brahmin and Chhetri	2573 (45)	643 (45)	1930 (45)
Janajati	2546 (44)	659 (46)	1887 (44)
Dalit	507 (9)	114 (8)	393 (9)
Other	114 (2)	28 (2)	86 (2)
Presenting Complaints, n(%)			
Injuries	2277 (40)	537 (37)	1740 (41)
Suspected Infections	2237 (39)	578 (40)	1659 (39)
Abdominal complaints	451 (8)	108 (7)	343 (8)
Respiratory complaints	254 (4)	67 (5)	187 (4)
Poisoning	88 (2)	28 (2)	60 (1)
Unconsciousness and Seizures	82 (1)	22 (2)	60 (1)
Other complaints	351 (6)	104 (7)	247 (6)

IQR=Interquartile range. NA=Information not available.

Table S4. Characteristics of total patients (n=5740) and interviewed patients (n=961) included in the analysis of Table2

Characteristics	Total patients	Not Included	Included
Total Patients, n (%)	**5740**	**4779**	**961**
Age, median (IQR)	7 (2-12)	7 (2-12)	7 (2-12)
Age (years), n (%)			
<1	521 (9)	425 (9)	96 (10)
1-<5	1740 (30)	1465 (31)	275 (29)
5-16	3479 (61)	2889 (60)	590 (61)
Female, n (%)	2110 (37)	1770 (37)	340 (35)
Patient location, n(%)			
Rural	3522 (61)	2874 (60)	648 (67)
Urban	1709 (30)	1396 (29)	313 (33)
Information NA	509 (9)	509 (11)	0
Ethnicity, n (%)			
Brahmin and Chhetri	2573 (45)	2128 (45)	445 (46)
Janajati	2546 (44)	2130 (45)	416 (43)
Dalit	507 (9)	413 (9)	94 (10)
Other	114 (2)	108 (2)	6 (1)
Presenting Complaints, n(%)			
Injuries	2277 (40)	1911 (40)	366 (38)
Suspected Infections	2237 (39)	1857 (39)	380 (40)
Abdominal complaints	451 (8)	361 (8)	90 (9)
Respiratory complaints	254 (4)	198 (4)	56 (6)
Poisoning	88 (2)	75 (2)	13 (1)
Unconsciousness and Seizures	82 (1)	73 (2)	9 (1)
Other complaints	351 (6)	304 (6)	47 (5)

IQR=Interquartile range. NA=Information not available.

Table S5. Characteristics of total patients (n=5740) and triaged patients (n=1248) included in the analysis of Table 3A

Characteristics	Total patients	Not Included	Included
Total Patients, n (%)	**5740**	**4492**	**1248**
Age, median (IQR)	7 (2-12)	7 (2-12)	7 (2-13)
Age (years), n (%)			
<1	521 (9)	411 (9)	110 (9)
1-<5	1740 (30)	1379 (31)	361 (29)
5-16	3479 (61)	2702 (60)	777 (62)
Female, n (%)	2110 (37)	1644 (37)	466 (37)
Patient location, n(%)			
Rural	3522 (61)	2702 (60)	820 (66)
Urban	1709 (30)	1323 (29)	386 (31)
Information NA	509 (9)	467 (10)	42 (3)
Ethnicity, n (%)			
Brahmin and Chhetri	2573 (45)	2033 (45)	540 (43)
Janajati	2546 (44)	1967 (44)	579 (46)
Dalit	507 (9)	396 (9)	111 (9)
Other	114 (2)	96 (2)	18 (1)
Presenting Complaints, n(%)			
Injuries	2277 (40)	1771 (39)	506 (41)
Suspected Infections	2237 (39)	1763 (39)	474 (38)
Abdominal complaints	451 (8)	348 (8)	103 (8)
Respiratory complaints	254 (4)	195 (4)	59 (5)
Poisoning	88 (2)	68 (2)	20 (2)
Unconsciousness and Seizures	82 (1)	62 (1)	20 (2)
Other complaints	351 (6)	285 (6)	66 (5)

IQR=Interquartile range. NA=Information not available.

Table S6. Characteristics of total triaged patients (n=1462) and those included interviews (n=497) that are included in the analysis of Table 4

Characteristics	Total patients	Not Included	Included
Total Patients, n (%)	**1462**	**965**	**497**
Age, median (IQR)	7 (2-13)	7 (2-13)	8 (2-12)
Age (years), n (%)			
<1	135 (9)	87 (9)	48 (10)
1-<5	420 (29)	294 (30)	126 (25)
5-16	907 (62)	584 (61)	323 (65)
Female, n (%)	550 (38)	366 (38)	184 (37)
Patient location, n(%)			
Rural	972 (66)	636 (66)	336 (68)
Urban	442 (30)	281 (29)	161 (32)
Information NA	48 (3)	48 (5)	0
Ethnicity, n (%)			
Brahmin and Chhetri	630 (43)	397 (41)	233 (47)
Janajati	676 (46)	459 (48)	217 (44)
Dalit	135 (9)	89 (9)	46 (9)
Other	21 (1)	20 (2)	1 (0.2)
Presenting Complaints, n(%)			
Injuries	575 (39)	395 (41)	180 (36)
Suspected Infections	571 (39)	366 (38)	205 (41)
Abdominal complaints	120 (8)	72 (7)	48 (10)
Respiratory complaints	66 (5)	41 (4)	25 (5)
Poisoning	24 (2)	17 (2)	7 (1)
Unconsciousness and Seizures	23 (2)	18 (2)	5 (1)
Other complaints	83 (6)	56 (6)	27 (5)

IQR=Interquartile range. NA=Information not available.

Table S7. Characteristics of patients before earthquakes and after earthquakes

Characteristics	Total	Before EQ	After EQ
Total Patients, n (%)	**5740**	**2239 (39)**	**2501 (61)**
Age, median (IQR)	7 (2-12)	7 (3-12)	6 (2-12)
Age (years), n (%)			
<1	521 (9)	115 (5)	406 (12)
1-<5	1740 (30)	685 (31)	1055 (30)
5-16	3479 (61)	1439 (64)	2040 (58)
Female, n (%)	2110 (37)	814 (36)	1296 (37)
Patient location, n(%)			
Rural	3522 (61)	1298 (58)	2224 (64)
Urban	1709 (30)	611 (27)	1098 (31)
Information NA	509 (9)	330 (15)	179 (5)
Ethnicity, n (%)			
Brahmin and Chhetri	2573 (45)	1082 (48)	1491 (43)
Janajati	2546 (44)	942 (42)	1604 (46)
Dalit	507 (9)	161 (7)	346 (10)
Other	114 (2)	54 (2)	60 (2)
Presenting Complaints, n(%)			
Injuries	2277 (40)	917 (41)	1360 (39)
Suspected Infections	2237 (39)	877 (39)	1360 (39)
Abdominal complaints	451 (8)	158 (7)	293 (8)
Respiratory complaints	254 (4)	97 (4)	157 (4)
Poisoning	88 (2)	31 (2)	57 (2)
Unconsciousness and Seizures	82 (1)	30 (1)	52 (2)
Other complaints	351 (6)	129 (6)	222 (6)

EQ=Eathquake period. IQR=Interquartile range. NA=Information not available.

EMERGENCY ASSESSMENT AND TREATMENT RECORD

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-661497
Fax. (977)-11-661707

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

Regd No. _____ Date _____

Name _____ Age _____ Sex _____

Address _____ Accompanied by _____ Contact No. _____

Time at Presentation _____ Triage Level (1) (2) (3) (4) (5)

TRIAGE

A		☐ Obstructed airway			☐ No comment
B	O_2 SAT: RR:	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR
C	Pulse: BT (map): Pulse korr: Cap.time:	☐ Pulse	☐ Pulse	☐ Pulse	☐ Pulse
D	GCS: V M	☐ Unconscious ☐ Seizures	☐ Somnolence ☐ Tired/unwilling to feed	☐ Tired/week ☐ Alert 0-2 months	☐ Alert
E	Temp: Pain		☐ Temp	☐ Temp	☐ Temp
ESS Retts-p:		☐ Red ESS	☐ ESS	☐ ESS	☐ ESS
Triage level		☐ *Red priority*	☐ *Orange priority*	☐ *Yellow priority*	☐ *Green priority*

Other observations:

Retractions: jug./sub./inter.	Moaning ☐	Dry skin ☐	Skin colour:
	Wheezing ☐	Sunken eyes ☐	
Stridor: Expir./inspi	Stuffed nose ☐	Dry mucus membrance ☐	
Cough: Dry/mucus/«barking»	Nasal flaining ☐	Sunken fontanelle ☐	Skin temp:
Rash			

RETTS-p vitale signs

Heart rate should be corrected for temperature.
Pulse by rebel child should generally not be used as the basis for triage

0 - 2 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<20 or >80 SpO2 <93% With O2	RR<30 or >65 SpO2 <93% Without O2	RR30-65 SpO2 93-100%	-
C	Pulse < 80 or >210	Pulse < 100 or >180	Pulse 100-180	(Pulse 100-165)*
D	GCS <11 Ongoing seizures	GCS <11-13 Tired/unwilling to feed	Alert	-
E	-	<36°C or >38°C	Temp 36°C-38°C	-

1 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<15 or >55 SpO2 <93% With O2	RR<20 or >65 SpO2 <93% Without O2	RR <20 or > 45 SpO2 93-94%	RR 25-40 SpO2 95-100%
C	Pulse < 60 or >190	Pulse < 75 or >170	Pulse <90 o >140	Pulse 90-140
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C-41°C

3 - 5 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<20 or >75 SpO2 <93% With O2	RR<25 or >65 SpO2 <93% Without O2	RR <30 or >55 SpO2 93-94%	RR 30-55 SpO2 95-100%
C	Pulse < 70 eller >210	Pulse < 80 or >180	Pulse <100 or >160	Pulse 100-165
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<36°C or >39°C	-	36°C - 39°C

2 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<12 or >45 SpO2 <93% With O2	RR<18 or >40 SpO2 <93% Without O2	RR <20 or > 35 SpO2 93-94%	RR 20-35 SpO2 95-100%
C	Pulse < 60 or >175	Pulse < 75 or >145	Pulse <85 eller >135	Pulse 85-135
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C-41°C

6 - 12 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<15 eller >70 SpO2 <93% With O2	RR<20 or >60 SpO2 <93% Without O2	RR <25 or >50 SpO2 93-94%	RR 25-50 SpO2 95-100%
C	Pulse < 70 eller >210	Pulse < 80 or >170	Pulse <90 or >150	Pulse 90-150
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C - 41°C

3-5 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RF<10 or >40 SpO2 <93% With O2	RR<14 or >30 SpO2 <93% Without O2	RR <18 or > 28 SpO2 93-94%	RR 18-28 SpO2 95-100%
C	Pulse < 60 or >175	Pulse < 60 or >140	Pulse <85 eller >125	Pulse 85-125
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C-41°C

12 - 18 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<8 or >30 SpO2 <93% With O2	RR<10 or >24 SpO2 <93% Without O2	RR <12 or >20 SpO2 93-94%	RR 12-20 SpO2 95-100%
C	Pulse < 40 or >130	Pulse < 45 or >120	Pulse <55 or >110	Pulse 55-110
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C - 41°C

6-11 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RF<8 or >32 SpO2 <93% With O2	RR<12 or >28 SpO2 <93% Without O2	RR <15 or > 24 SpO2 93-94%	RR 15-24 SpO2 95-100%
C	Pulse < 45 or >140	Pulse < 55 or >130	Pulse <65 eller >115	Pulse 65-110
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35°C or >41°C	-	35°C-41°C

APPENDICES I-IX

Appendix I: Example of an ESS algorithm (no.5 of 43) specific for RETTS

Appendix II: Emergency patient record at ED before the project intervention

Appendix III: Emergency patient record at ED during intervention (5 pages)

Appendix IV: Emergency patient record at ED during intervention (2 pages)

Appendix V: List of variables included: Emergency Department registration and telephone interview guide

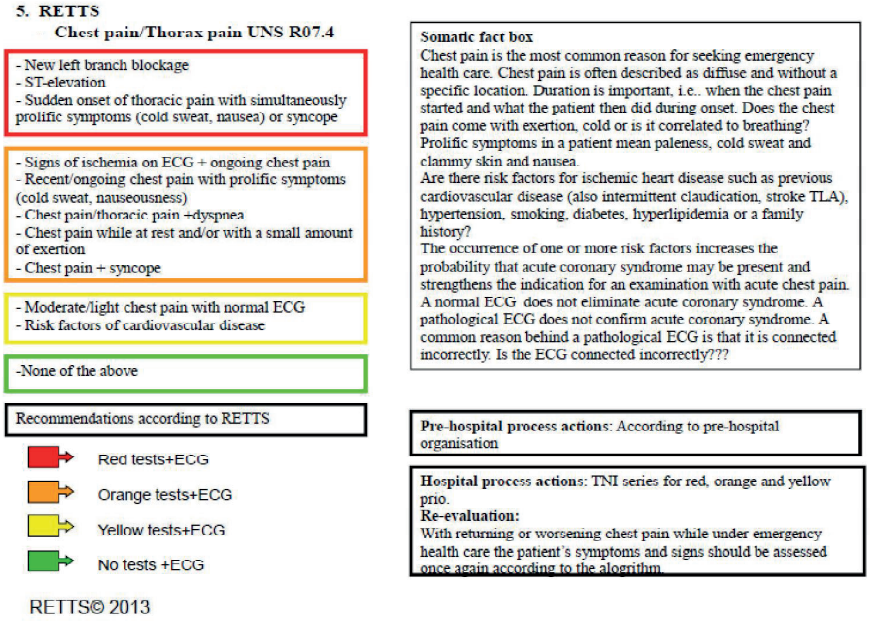
Appendix VI: Categories of presenting complaints and use of ICPC-2 codes (adult and paediatric)

Appendix VII: ICPC-2 classification

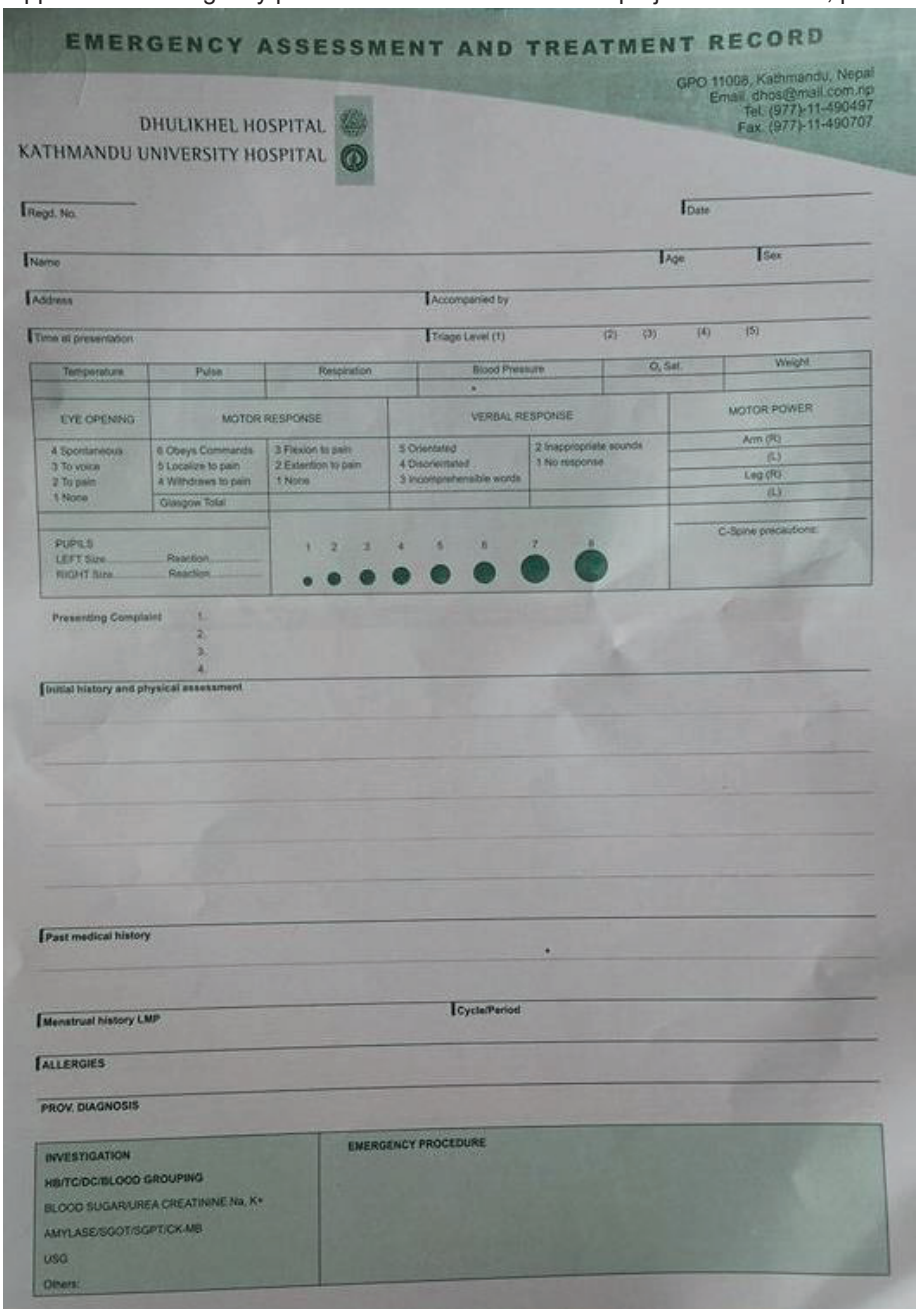
Appendix VIII: Steps in categorization of free text presenting complaints into nine broad categories

Appendix IX: Triage categories by patient's complaints or symptoms used during 2015 earthquakes

Appendix I. Example of an ESS algorithm (no.5 of 43) specific for RETTS



Appendix II. Emergency patient record at ED before the project intervention, p. 1a/2



EMERGENCY ASSESSMENT AND TREATMENT RECORD

GPO 11008, Kathmandu, Nepal
Email: dhos@mail.com.np
Tel: (977)-11-490497
Fax: (977)-11-490707

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

Regd. No. | Date

Name | Age | Sex

Address | Accompanied by

Time at presentation | Triage Level (1) (2) (3) (4) (5)

Temperature	Pulse	Respiration	Blood Pressure	O_2 Sat.	Weight

EYE OPENING	MOTOR RESPONSE		VERBAL RESPONSE		MOTOR POWER
4 Spontaneous 3 To voice 2 To pain 1 None	6 Obeys Commands 5 Localize to pain 4 Withdraws to pain	3 Flexion to pain 2 Extention to pain 1 None	5 Orientated 4 Disoriented 3 Incomprehensible words	2 Inappropriate sounds 1 No response	Arm (R) (L) Leg (R) (L)
	Glasgow Total				

PUPILS
LEFT Size ____ Reaction ____
RIGHT Size ____ Reaction ____

1 2 3 4 5 6 7 8

C-Spine precautions:

Presenting Complaint 1.
2.
3.
4.

Initial history and physical assessment

Past medical history

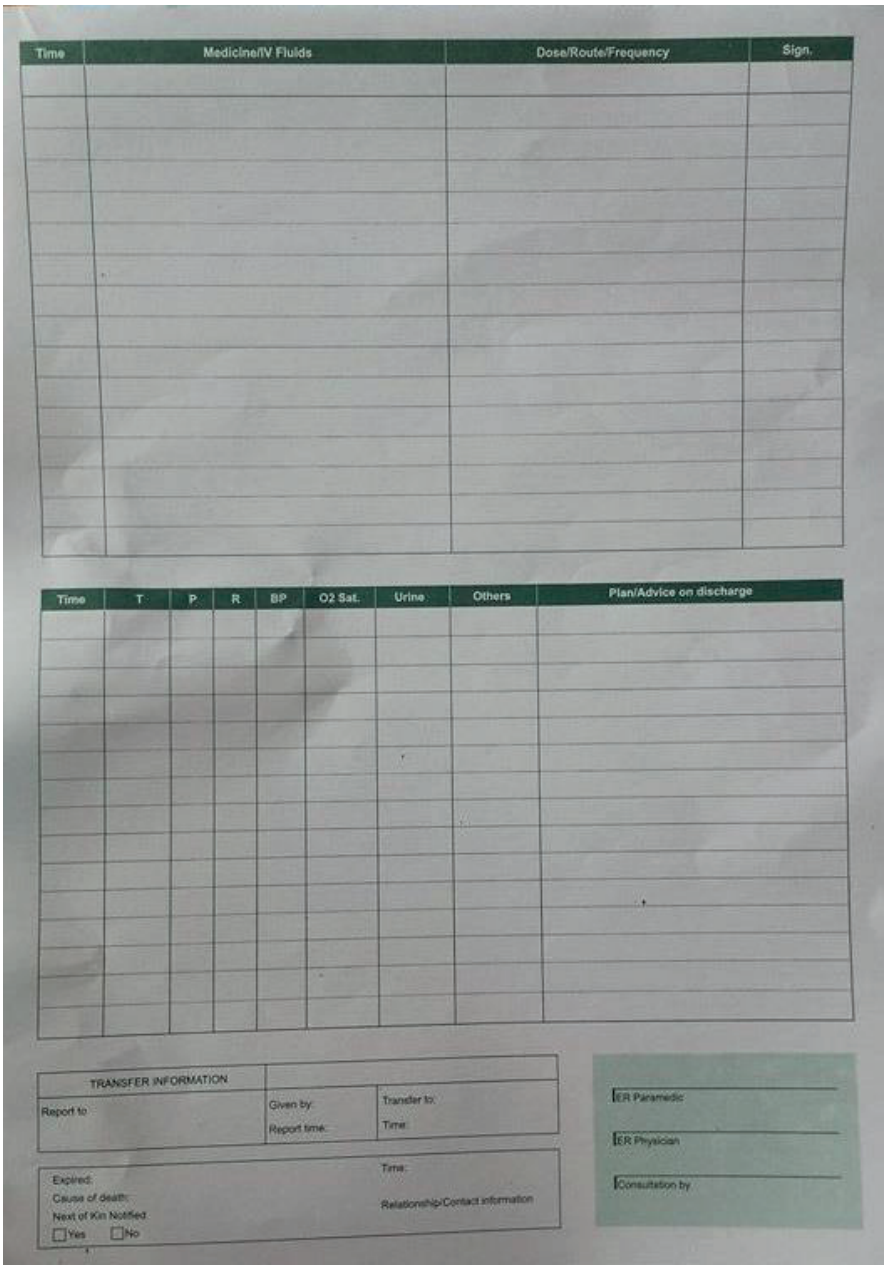
Menstrual history LMP | Cycle/Period

ALLERGIES

PROV. DIAGNOSIS

INVESTIGATION	EMERGENCY PROCEDURE
HB/TC/DC/BLOOD GROUPING BLOOD SUGAR/UREA CREATININE Na, K+ AMYLASE/SGOT/SGPT/CK-MB USG Others:	

Appendix II. Emergency patient record at ED before the project intervention, p.2a/2



Time	Medicine/IV Fluids	Dose/Route/Frequency	Sign.

Time	T	P	R	BP	O2 Sat.	Urine	Others	Plan/Advice on discharge

TRANSFER INFORMATION

Report to

Given by:

Report time:

Transfer to:

Time:

Expired:

Cause of death:

Next of Kin Notified

☐ Yes ☐ No

Time:

Relationship/Contact information

ER Paramedic

ER Physician

Consultation by

Appendix II. Emergency patient record at ED before the project intervention, p.1b/2

EMERGENCY TRAUMA ASSESSMENT AND TREATMENT RECORD

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-490497
Fax. (977)-11-490707

Regd.No: _____ Date: _____
Name: _____ Age: _____ Sex: _____
Address: _____ Accompanied by: _____
Time at presentation: _____ Time of accident: _____
Primary treatment outside Dhulikhel: _____
Occupation: _____ Mode of transport to Hospital: _____

Respiration: Blood Pressure: Pulse: O_2 sat.: Temperature: Weight:

Eye opening — Motor response — Verbal response

4.Spontaneous	6.Obeys commands	3.Flexion to pain	5.Orientated	2.Inappropriate sounds
3.To voice	5.Localize to pain	2.Extention to pain	4.Disorientated	1.No response
2.To pain	4.Withdraws to pain	1.None	3.Incomprehensible words	
1.None				

GCS score: ☐☐ Triage:

Motor Power

	Arm	R/L	Leg	R/L
Ext.				
Flex.				

C-Spine precautions

Pupils, Size and Reaction — Left: S..... R..... Right: S..... R.....

1 2 3 4 5 6 7 8

Loss of consciousness?	☐ YES	☐ NO	☐ Unknown	Duration.....
Amnesia?	☐ YES	☐ NO	☐ Impossible to asses	
Seizure	☐ YES	☐ NO	☐ Unknown	
Influenced by alcohol?	☐ YES	☐ NO	☐ Suspected	☐ Unknown
Influenced by drugs?	☐ YES	☐ NO	☐ Suspected	☐ Unknown

Normal bowel function ☐ Yes ☐ No

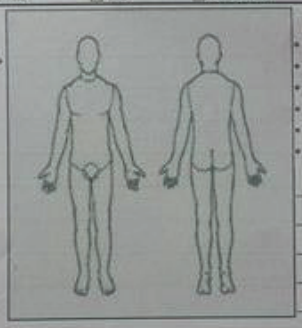
Normal bladder function ☐ Yes ☐ No

Mechanism of injury:

- ☐ Road Traffic accident
  - Hit and run? YES ☐ NO ☐,
  - ☐ Pedestrian
  - ☐ Bicycle
  - ☐ Moped/Scooter
  - ☐ Motorcycle
  - ☐ Car/Jeep/Delivery van
  - ☐ Minibus
  - ☐ Minitruck
  - ☐ Tractor
  - ☐ Bus/truck/Lorry/Tipper
  - ☐ Other .....
- ☐ Fall
  - ☐ From own hight and <2m
  - ☐ From a height >2m
- ☐ Fighting/ aussault
- ☐ Burns
- ☐ Work accident
- ☐ Other .....

Where did the injury occur?

- ☐ Home
- ☐ Work
- ☐ Street
- ☐ Leisure activity
- ☐ Other .....



Exposure, history and physical assessment

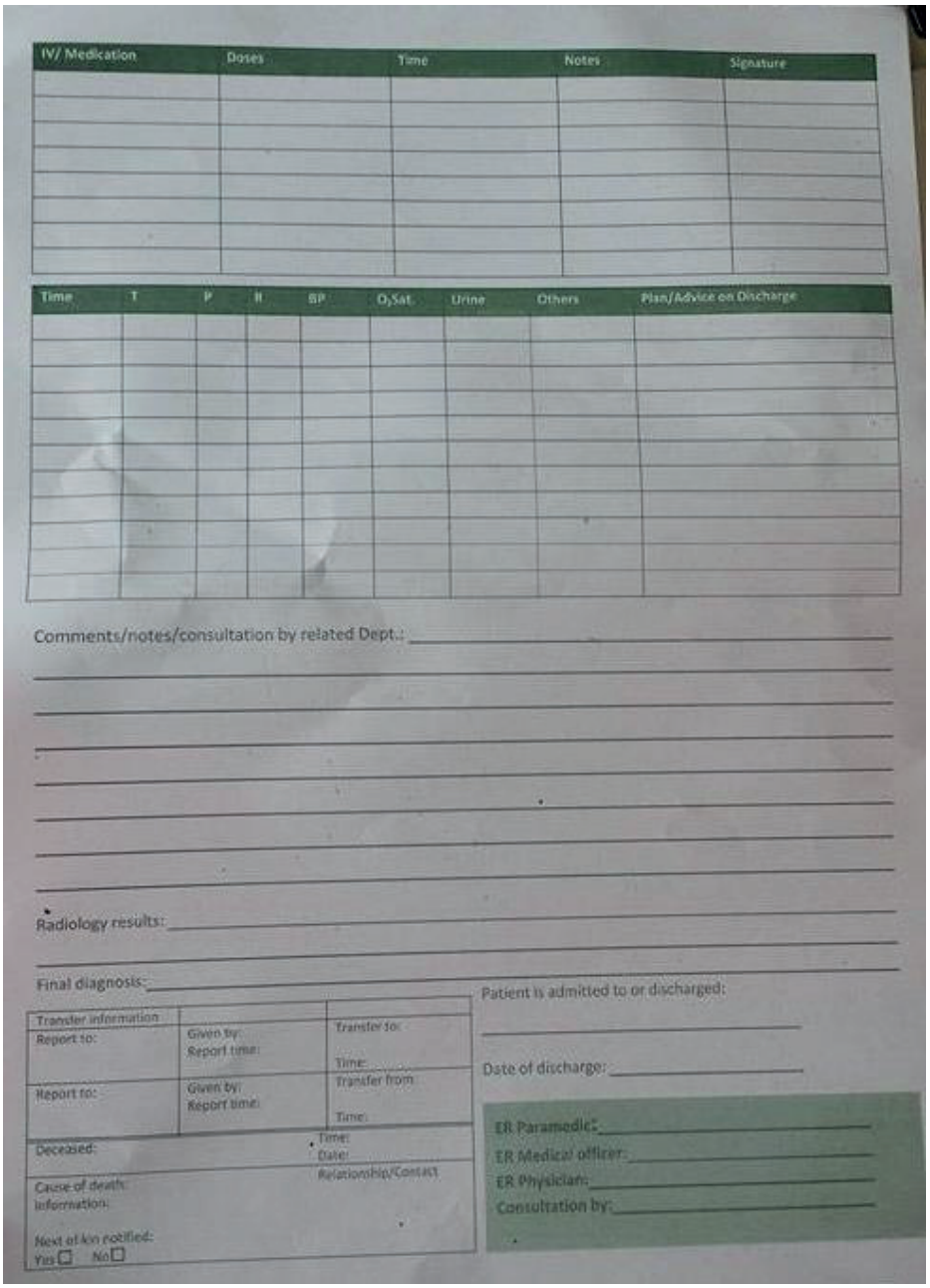
• Head	☐ No	☐ Yes	.....
• Thorax	☐ No	☐ Yes	.....
• Abdomen	☐ No	☐ Yes	.....
• Pelvis	☐ No	☐ Yes	.....
• Extremity	☐ No	☐ Yes	.....
• Spine	☐ No	☐ Yes	.....

Prov diagnosis: _____
Investigations requested: _____

Emergency procedures

- ☐ Dressing
- ☐ Suturing
- ☐ Splinting
- ☐ Bladder catheter
- ☐ IV connection
- ☐ CVP
- ☐ Blood gas
- ☐ Intubation
- ☐ Tracheotomy
- ☐ Thoracic drain
- ☐ Abdominal paracentesis
- ☐ Diagnostic thorcocentesis
- ☐ Relocation of joints
- ☐ Other: .....

Appendix II. Emergency patient record at ED before the project intervention, p.2b/2



IV/ Medication	Doses	Time	Notes	Signature

Time	T	P	R	BP	O_2Sat	Urine	Others	Plan/Advice on Discharge

Comments/notes/consultation by related Dept.: _____

Radiology results: _____

Final diagnosis: _____

Transfer information		
Report to:	Given by: Report time:	Transfer to: Time:
Report to:	Given by: Report time:	Transfer from: Time:

Deceased: Time: Date:

Cause of death information: Relationship/Contact

Next of kin notified: Yes ☐ No ☐

Patient is admitted to or discharged: _____

Date of discharge: _____

ER Paramedic: _____

ER Medical officer: _____

ER Physician: _____

Consultation by: _____

EMERGENCY ASSESSMENT AND TREATMENT RECORD

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-661497
Fax. (977)-11-661707

Regd No. _____ Date _____

Name _____ Age _____ Sex _____

Address _____ Accompanied by _____ Contact No. _____

Time at Presentation _____

TRIAGE

A	Airways:		☐ Obstructed airway ☐ Stridor			☐ No comment
B	O_2 SAT:	RR:	☐ RR>30 or <8 ☐ SpO_2 <90% with O_2	☐ RR>25 ☐ SpO_2 <90% without O_2	☐ SpO_2 90-95% without O_2	☐ RR8-25 ☐ SpO_2 <95% without O_2
C	Pulse:	BP:	☐ Pulse > 130r. or >150irs. ☐ BP <90mm Hg	☐ Pulse > 120 or <40	☐ Pulse > 110 or <50	☐ Pulse 50-110
D	GCS:		☐ Unconscious/GCS<9 ☐ Seizures	☐ Somnolence/GSC 9-14	☐ Acute desoriented	☐ Alert
E	Temp:	☐ ECG	.....	☐ Temp. >41° or <35°	☐ Temp. >38.5°	☐ Temp. 35-38.5° .....
ESS-algorithm RETTS			☐ ESS	☐ ESS	☐ ESS	☐ ESS
NRS-pain	Triage level		☐ *Red priority*	☐ *Orange priority*	☐ *Yellow priority*	☐ *Green priority*

Triage:	Time:	Sign:

Retriage:

	Time:	Sign:	Time:	Sign:
■ ■ ■ ■		■ ■ ■ ■		

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EMERGENCY ASSESSMENT AND TREATMENT RECORD

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-661497
Fax. (977)-11-661707

Regd No. | Date

Name | Age | Sex

Address | Accompanied by | Contact No.

Time at Presentation

TRIAGE

A		☐ Obstructed airway			☐ No comment
B	O_2 SAT: RR:	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR
C	Pulse: BT (map): Pulse korr: Cap.time:	☐ Pulse	☐ Pulse	☐ Pulse	☐ Pulse
D	GCS: V M	☐ Unconscious ☐ Seizures	☐ Somnolence ☐ Tired/unwilling to feed	☐ Tired/week ☐ Alert 0-2 months	☐ Alert
E	Temp: Pain		☐ Temp	☐ Temp	☐ Temp
ESS Retts-p:		☐ Red ESS	☐ Orange ESS	☐ Yellow ESS	☐ Green ESS
Triage level					

Other observations:

Retractions: jug./sub./inter.	Moaning ☐	Dry skin ☐	Skin colour:
	Wheezing ☐	Sunken eyes ☐	
Stridor: Expir./inspi	Stuffed nose ☐	Dry mucus membrance ☐	
Cough: Dry/mucus/«barking»	Nasal flaining ☐	Sunken fontanelle ☐	Skin temp:
Rash			

RETTS-p vitale signs

Heart rate should be corrected for temperature.
Pulse by rebel child should generally not be used as the basis for triage

0 - 2 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<20 or >80 SpO2 <93% With O2	RR<30 or >65 SpO2 <93% Without O2	RR30-65 SpO2 93-100%	-
C	Pulse < 80 or >210	Pulse < 100 or >180	Pulse 100-180	(Pulse 100-165)*
D	GCS <11 Ongoing seizures	GCS <11-13 Tired/unwilling to feed	Alert	-
E	-	<36ºC or >38ºC	Temp 36ºC-38ºC	-

1 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<15 or >55 SpO2 <93% With O2	RR<20 or >65 SpO2 <93% Without O2	RR <20 or > 45 SpO2 93-94%	RR 25-40 SpO2 95-100%
C	Pulse < 60 or >190	Pulse < 75 or >170	Pulse <90 o >140	Pulse 90-140
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC-41ºC

3 - 5 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<20 or >75 SpO2 <93% With O2	RR<25 or >65 SpO2 <93% Without O2	RR <30 or >55 SpO2 93-94%	RR 30-55 SpO2 95-100%
C	Pulse < 70 eller >210	Pulse < 80 or >180	Pulse <100 or >160	Pulse 100-165
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<36ºC or >39ºC	-	36ºC - 39ºC

2 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<12 or >45 SpO2 <93% With O2	RR<18 or >40 SpO2 <93% Without O2	RR <20 or > 35 SpO2 93-94%	RR 20-35 SpO2 95-100%
C	Pulse < 60 or >175	Pulse < 75 or >145	Pulse <85 eller >135	Pulse 85-135
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC-41ºC

6 - 12 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<15 eller >70 SpO2 <93% With O2	RR<20 or >60 SpO2 <93% Without O2	RR <25 or >50 SpO2 93-94%	RR 25-50 SpO2 95-100%
C	Pulse < 70 eller >210	Pulse < 80 or >170	Pulse <90 or >150	Pulse 90-150
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC - 41ºC

3-5 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RF<10 or >40 SpO2 <93% With O2	RR<14 or >30 SpO2 <93% Without O2	RR <18 or > 28 SpO2 93-94%	RR 18-28 SpO2 95-100%
C	Pulse < 60 or >175	Pulse < 60 or >140	Pulse <85 eller >125	Pulse 85-125
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC-41ºC

12 - 18 months

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RR<8 or >30 SpO2 <93% With O2	RR<10 or >24 SpO2 <93% Without O2	RR <12 or >20 SpO2 93-94%	RR 12-20 SpO2 95-100%
C	Pulse < 40 or >130	Pulse < 45 or >120	Pulse <55 or >110	Pulse 55-110
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC - 41ºC

6-11 year

	RED	ORANGE	YELLOW	GREEN
A	Obstructed airway	-	-	-
B	RF<8 or >32 SpO2 <93% With O2	RR<12 or >28 SpO2 <93% Without O2	RR <15 or > 24 SpO2 93-94%	RR 15-24 SpO2 95-100%
C	Pulse < 45 or >140	Pulse < 55 or >130	Pulse <65 eller >115	Pulse 65-110
D	GCS <11 Ongoing seizures	GCS <11-13	Tired/week	Alert
E	-	<35ºC or >41ºC	-	35ºC-41ºC

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Tel. (977)-11-661497
Fax. (977)-11-661707

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

Regd No. _____ Date _____

Name _____ Age _____ Sex _____

Address _____ Accompanied by _____ Contact No. _____

Time at Presentation _____ Triage Level (1) (2) (3) (4) (5)

Temperature	Pulse	Respiration	Blood Pressure	O_2 Sat.	Weight

EYE OPENING	MOTOR RESPONSE		VERBAL RESPONSE		MOTOR POWER
4 Spontaneous	6 Obeys Commands	3 Flexion to pain	5 Orientated	2 Inappropriate sounds	Arm (R)
3 To voice	5 Localize to pain	2 Extention to pain	4 Disorientated	1 No response	(L)
2 To pain	4 Withdraws to pain	1 None	3 Incomprehensible words		Leg (R)
1 None					(L)

PUPILS
LEFT Size .....Reaction.....
RIGHT Size .....Reaction.....

1 2 3 4 5 6 7 8

C-Spine Precautions:

Presenting Complaint
1.
2.
3.
4.

Initial history and physical assessment

Past medical history

Menstrual history LMP _____ Cycle/Period _____

ALLERGIES

PROV. DIAGNOSIS

INVESTIGATION	EMERGENCY PROCEDURE
HB/TC/DC/BLOOD GROUPING	
BLOOD SUGAR/UREA CREATININE/Na, K+	
AMYLASE/SGOT/SGPT/CK-MB	
ECG/CXR/X-RayABD./KUB	
USG	
Others:	

DH 18

Appendix III. Emergency patient record at ED during intervention (5 pages), p. 5a/5

Time	Medicine/IV Fluids	Dose/Route/Frequency	Sign.

Time	T	P	R	BP	O2 Sat.	Urine	Others	Plan/Advice on discharge

TRANSFER INFORMATION		
Report to	Given by: Report time:	Transfer to: Time:

Expired:	Time :
Cause of death :	
Next of kin Notified ☐Yes ☐No	Relationship/Contact information

ER Paramedic

ER Physician

Consultation by

EMERGENCY TRAUMA ASSESSMENT AND TREATMENT RECORD

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-661497
Fax. (977)-11-661707

Regd No. _____ Date _____

Name _____ Age _____ Sex _____

Address _____ Accompanied by _____ Contact No. _____

Time at Presentation _____ Time of transport accident _____

Primary treatment outside Dhulikhel _____

Occupation (Farmer, driver, School, etc.) _____ Mode of transport to hospital (Ambulance, car, motorcycle, etc.) _____

Temperature	Pulse	Respiration	Blood Pressure	O_2 Sat.	Weight

EYE OPENING	MOTOR RESPONSE		VERBAL RESPONSE		MOTOR POWER	
					Arm R/L	Leg R/L
4 Spontaneous	6 Obeys Commands	3 Flexion to pain	5 Orientated	2 Inappropriate sounds	Ext.	
3 To voice	5 Localize to pain	2 Extention to pain	4 Disorientated	1 No response	Flex.	
2 To pain	4 Withdraws to pain	1 None	3 Incomprehensible words		GCE score ☐☐	
1 None					Triage	

PUPILS
LEFT Size .....Reaction.....
RIGHT Size .....Reaction.....

1 2 3 4 5 6 7 8

C-Spine Precautions:

Loss of consciousness?	☐ YES	☐ No	☐ Unknown	Duration .....
Amnesia?	☐ YES	☐ No	☐ Impossible to asses	
Seizure	☐ YES	☐ No	☐ Unknown	
Influenced by alcohol?	☐ YES	☐ No	☐ Suspected	☐ Unknown
Influenced by drugs?	☐ YES	☐ No	☐ Suspected	☐ Unknown

Normal bowel function ☐ Yes ☐ No

Normal bladder function ☐ Yes ☐ No

Mechanism of injury:

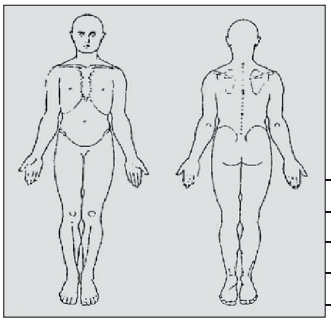
- ☐ Road Traffic accident
  - Hit and run? ☐ Yes ☐ No
  - ☐ Pedestrian
  - ☐ Bicycle
  - ☐ Moped/Scooter
  - ☐ Motorcycle
  - ☐ Car/Jeep/delivery Van
  - ☐ Minibus
  - ☐ Mini Truck
  - ☐ Bus/Truck/Lorry/Tipper
  - ☐ Other .....
- ☐ Fall
  - ☐ From own height and <2m
  - ☐ From a height >2m
- ☐ Fighting/aussalt
- ☐ Burns
- ☐ Work accident
- ☐ Other .....

Where did the injury occur?

- ☐ Home
- ☐ Work
- ☐ Street
- ☐ Leisure activity
- ☐ Other .....

Emergency procedures

- ☐ Dressing
- ☐ Suturing
- ☐ Spliting
- ☐ Bladder catheter



Exposure, history and physical assessment

• Head	☐ No	☐ Yes	.....
• Thorax	☐ No	☐ Yes	.....
• Abdomen	☐ No	☐ Yes	.....
• Pelvis	☐ No	☐ Yes	.....
• Extremity	☐ No	☐ Yes	.....
• Spine	☐ No	☐ Yes	.....

Prov diagnosis: _____

Investigation requested: _____

- ☐ IV connection
- ☐ CVP
- ☐ Blood gas
- ☐ Intubation
- ☐ Tracheotomy
- ☐ Thoracic drain
- ☐ Abdominal paracentesis
- ☐ Diagnostic thorcocentesis
- ☐ Relocation of joints
- ☐ Other:.....

IV/Medication	Doses	Time	Notes	Signature

Time	T	P	R	BP	O2 Sat.	Urine	Others	Plan/Advice on discharge

Comment/notes/consultation by related Department:

Radiology results:

Final diagnosis:

TRANSFER INFORMATION		
Report to	Given by: Report time:	Transfer to: Time:
Report to	Given by: Report time:	Transfer to: Time:
Deceased:		Time: Date:

Cause of death :
Information:

Relationship/Contact

Next of kin Notified
☐ Yes ☐ No

Patient is admitted to or discharge

Date of discharge

ER Paramedic

ER Medical Officer

ER Physician

Consultation by

EMERGENCY ASSESSMENT AND TREATMENT RECORD

DHULIKHEL HOSPITAL
KATHMANDU UNIVERSITY HOSPITAL

GPO 11008, Kathmandu, Nepal
Email. dhos@mail.com.np
Tel. (977)-11-490497
Fax. (977)-11-490707

Regd No. _____ Date _____

Name _____ Age _____ Sex _____

Address _____ Accompanied by _____ Contact No. _____

Time at Presentation _____ Triage Level (1) (2) (3) (4) (5)

TRIAGE-A

A			☐ Obstructed airway ☐ Stridor			☐ No comment
B	O_2 SAT:	RR:	☐ RR>30 or <8 ☐ SpO_2 <90% with O_2	☐ RR>25 ☐ SpO_2 <90% without O_2	☐ SpO_2 90-95% without O_2	☐ RR8-25 ☐ SpO_2 <95% without O_2
C	Pulse:	BP:	☐ Pulse > 130r. or >150irs. ☐ BP <90mm Hg	☐ Pulse > 120 or <40	☐ Pulse > 110 or <50	☐ Pulse 50-110
D	GCS:		☐ Unconscious/GCS<9 ☐ Seizures	☐ Somnolence/GSC 9-14	☐ Acute desoriented	☐ Alert
E	Temp:	Pain	.....	☐ Temp. >41° or <35°	☐ Temp. >38.5°	☐ Temp. 35-38.5° .....
ESS-algorithm RETTS			☐ ESS	☐ ESS	☐ ESS	☐ ESS
NRS-pain	Triage level		☐ *Red priority*	☐ *Orange priority*	☐ *Yellow priority*	☐ *Green priority*

Triage:	Time:	Sign:

Retriage:

	Time: Sign:	Time: Sign:

TRIAGE-P

A	Airways:		☐ Obstructed airway			☐ No comment
B	O_2 SAT:	RR:	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR	☐ SpO_2 ☐ RR
C	Pulse: Pulse korr:	BT (map): Cap.time:	☐ Pulse	☐ Pulse	☐ Pulse	☐ Pulse
D	GCS:	V M	☐ Unconscious ☐ Seizures	☐ Somnolence ☐ Tired/unwilling to feed	☐ Tired/week ☐ Alert 0-2 months	☐ Alert
E	Temp:	Pain		☐ Temp	☐ Temp	☐ Temp
ESS Retts-p:			☐ Red ESS	☐ ESS	☐ ESS	☐ ESS
Triage level			☐ *Red priority*	☐ *Orange priority*	☐ *Yellow priority*	☐ *Green priority*

Other observations:

Retractions: jug./sub./inter.	Moaning ☐ Wheezing ☐	Dry skin ☐ Sunken eyes ☐	Skin colour:
Stridor: Expir./inspi	Stuffed nose ☐	Dry mucus membrance ☐	
Cough: Dry/mucus/«barking»	Nasal flaining ☐	Sunken fontanelle ☐	Skin temp:
Rash			

DH 18

Appendix IV. Emergency patient record at ED during intervention (2 pages), p. 2/2

Time at treatment: Weight:

EYE OPENING	MOTOR RESPONSE		VERBAL RESPONSE		MOTOR POWER
4 Spontaneous	6 Obeys Commands	3 Flexion to pain	5 Orientated	2 Inappropriate sounds	Arm (R)
3 To voice	5 Localize to pain	2 Extention to pain	4 Disorientated	1 No response	(L)
2 To pain	4 Withdraws to pain	1 None	3 Incomprehensible words		Leg (R)
1 None					(L)
	1 2 3 4 5 6 7 8				
PUPILS LEFT Size .....Reaction..... RIGHT Size .....Reaction.....					C-Spine Precautions:

Presenting Complaint 1. 2. 3. 4.

Initial history and physical assessment

Past medical history

Menstrual history LMP Cycle/Period

ALLERGIES

PROV. DIAGNOSIS

INVESTIGATION	**EMERGENCY PROCEDURE**
HB/TC/DC/BLOOD GROUPING	
BLOOD SUGAR/UREA CREATININE/Na, K+	
AMYLASE/SGOT/SGPT/CK-MB	
ECG/CXR/X-RayABD./KUB	
USG	
Others:	

Time	Medicine/IV Fluids	Dose/Route/Frequency	Sign.

Time	T	P	R	BP	O2 Sat.	Urine	Others

Comment/notes/consultation by related Department:

Radiology results:

Final diagnosis:

Plan/Advice on discharge

TRANSFER INFORMATION		
Report to	Given by: Report time:	Transfer to: Time:

Expired: Time :

Cause of death :

Next of kin Notified Relationship/Contact information

☐Yes ☐No

ER Paramedic

ER Physician

Consultation by

Appendix V. List of variables included: Emergency Department registration

1. Study Number
2. Hospital Number
3. Date of Admittance (DD/MM/YR)
4. Age (Years)
5. Sex (M/F)
6. Ethnicity
7. Time of Presentation
8. Temperature (Celsius)
9. Pulse (Beats per minute)
10. Respiration rate
11. Systolic Blood Pressure
12. Diastolic Blood Pressure
13. Oxygen Saturation
14. Glasgow Coma Scale (GCS)
15. Triage done (Yes/No)
16. Triage Code (Red/Orange/yellow/green)
17. Time of Triage
18. Time of Treatment
19. Presenting Complaint
20. Action in Emergency Room (Medication, Fluids, Oxygen, Antibiotics etc.)
21. Transfer to (General wards, ICU, OT)
22. ED disposition (Admitted, Discharged, LAMA/DOR, Referred)
23. Death (Yes/No)
24. Diagnosis at Discharge

Appendix V. Telephone interview guide: follow-up at 90 days after emergency department disposition

1. Study Number
2. Hospital Number
3. Date of Interview
4. Visited Dhulikhel Hospital (DH) for same condition after the last visit (Yes/No)
5. Visited other health facility for same condition after the last visit to DH (Yes/No)
6. How long did you wait in ED before seeing a doctor (in minutes)
7. How do you like the services/patient management provided from ED (Very poor, Poor, OK/Fair, Good, very Good)
8. Health status now (Better, Unchanged, Worse, Died)
9. If died, Date of dead (DD,MM,YR)
10. Information given by (Patient, Relatives, Others)
11. a) In Labor case, if baby alive (Yes/No)
11. b) Number of baby delivered
12. Number of members in house living together
13. Main occupation
14. Education (Literate/Illiterate)
14. Completed education level
15. Smoking Tobacco (Yes/No)
15. If smoking tobacco, number per day
16. Fuel for Cooking (traditional cooking stove, improved cooking stove, gas stove, electricity)
17. Additional Information

Appendix VI. Categories of presenting complaints and use of ICPC-2 codes (adult)

ICPC complaint Categories	Included ICPC-2 Codes
Self harm	P77
Injuries	
Fall Injury	A80_a*
Transport Accident	A80_b*
Physical Assault	Z25
Bite	A86, S12, S13
Burn	S14
Other Injury	A85, A88, N80, B77, D79, D80, R87, R88, X82, Y80, H76, H78, H79, F76, F79, A80_c*, A80_d*, L73, L74, L75, L76, L77, L78, L79, L80, L81, S16, S17, S18, S19
Infections	
Gastrointestinal/Urinary Infection	D70, U70, U71
Respiratory Infection	R74, R75, R76, R78, R81, R82, R83, A70
Fever (only)	A02, A03
Other Infection	A78, A87, B70, H71, N71, S11, S71, W70, W71, X72
Unconsciousness & Seizure	A06, N07
Cardiovascular (CVD)	
CVD complaints	A11/K01, K04, K05, K07
CVD disease	K71, K73, K75, K76, K77, K78, K84, K86, K90, K96
Respiratory complaints	
Short Breath	R02
COPD/Asthma	R95, R96
Other Respiratory	R03, R04, R05, R06, R07, R21, R24, R29, R84, R85, R99
Obstretic & Gynaecology (OBGYN)	
Pregnancy and Childbearing	W03, W05, W17, W18, W19, W27, W29, W80, W82, W83, W94, W96, W99
Menstruation Complaints	X02, X06, X07
Female Genital Complaints	X01, X14, X15, X18, X19, X21, X29, X87, X77, X99
Abdomen and Digestive	
Nausea, Vomiting & Diarrhoea	D09, D10, D11
Abdomein Pain	D01, D02, D03, D06, D12, D25, D88
Other Digestive	D04, D08, D13, D14, D15, D16, D17, D19, D20, D21, D24, D29, D74, D75, D76, D77, D78, D84, D85, D86, D89, D91, D95, D97, D98, D99
Other Complaints	
Urinary	U01, U02, U04, U05, U06, U07, U08, U14, U77, U88, U95, U99
Neurology	N01, N05, N06, N08, N17, N18, N19, N28, N29, N74, N85, N87, N88, N89, N99
Musculoskeletal	L01, L02, L03, L05, L07, L08, L09, L12, L13, L14, L15, L17, L18, L19, L29, L71, L82, L88
Psychosocial Complaints	P04, P06, P16, P19, P20, P29, P74, P76, P85, P86, P99
Other Complaints, NOS	A01, A04, A05, A08, A10, A29, A91, A92, B73, B82, F02, F05, F29, H01, H02, H04, S02, S06, S07, S29, S77, S91, T01, T03, T08, T11, T85, T86, T89, T90, T99, Y01, Y02, Y04, Y05, Y06, Y29, Y85, Y86, A66*

*New codes that does not comply with ICPC-2 codes. A80_a=Fall Injuries. A80_b=Road Transport Accidents. A80_c=Animal Injuries. A66=Referred to study hospital for intensive care unit.

Appendix VI. Categories of presenting complaints and use of ICPC-2 codes (pediatric)

ICPC complaint Categories	Included ICPC-2 Codes
Poisoning	A86
Injuries	
Fall Injury	A80_b*
Transport Accident	A80_a*
Physical Assault	Z25
Bite	S12, S13
Burn	S14
Other Injury	A88, N80, D79, D80, R87, Y80, H76, H78, H79, F76, F79, A80_c*, A80_d*, L76, L77, L78, L80, L81, S16, S17, S18, S19
Infections	
Gastrointestinal Infection	D70
Urinary Infection	U71
Respiratory Infection	R74, R75, R76, R78, R81, R83, A70
Fever (only)	A02, A03
Other Infection	A78, A87, B70, N71, N73, S11
Unconsciousness & Seizure	A06, N07
Cardiovascular (CVD)	
CVD complaints	A11/K01, K04, K07
CVD disease	K71, K73, K86
Respiratory complaints	
Short Breath	R02
Asthma	R96
Other Respiratory	R03, R04, R05, R06, R07, R21, R24, R29, R99
Gynaecology complaints	
Pregnancy and Childbearing Complications	W03, W05, W29
Menstruation Complaints	X02, X06, X07
Female Genital Complaints	X01, X14, X21, X29, X77
Abdomen and Digestive	
Nausea, Vomiting & Diarrhoea	D09, D10, D11
Abdomen Pain	D01, D02, D06, D12, D25, D88
Other Digestive	D08, D13, D14, D15, D16, D17, D19, D20, D21, D24, D29, D74, D78, D81, D82, D89, D91, D98, D99
Other Complaints	
Urinary	U01, U02, U04, U05, U06, U07, U08, U95, U99
Neurology	N01, N05, N06, N08, N17, N19, N28, N29, N85, N88, N89
Musculoskeletal	L01, L02, L03, L05, L07, L09, L12, L14, L17, L18, L19, L29, L82, L88
Psychosocial Complaints	P04, P16, P19, P20, P29, P85, P86, P99
Other Complaints, NOS	A01, A04, A05, A08, A10, A16, A29, A92, A93, A94, B02, F02, F05, F29, H01, H04, S02, S06, S07, S29, T03, T08, T11, T99, Y01, Y02, Y03, Y04, Y05, Y06, Y29, A66*

*New codes that does not comply with ICPC-2 codes. A80_b-Fall Injuries, A80_a-Road Transport Accidents, A80_c-Animal Injuries, A66-Referred to study hospital for intensive care unit.

Appendix VII. ICPC-2 classification

ICPC-2 – English

International Classification of Primary Care – 2nd Edition

Wonca International Classification Committee (WICC)

Process codes

-30	Medical Exam/Eval-Complete
-31	Medical Examination/Health Evaluation-Partial/Pre-op check
-32	Sensitivity Test
-33	Microbiological/Immunological Test
-34	Blood Test
-35	Urine Test
-36	Faeces Test
-37	Histological/Exfoliative Cytology
-38	Other Laboratory Test NEC
-39	Physical Function Test
-40	Diagnostic Endoscopy
-41	Diagnostic Radiology/Imaging
-42	Electrical Tracings
-43	Other Diagnostic Procedures
-44	Preventive Imunisations/Medications
-45	Observe/Educate/Advice/Diet
-46	Consult with Primary Care Provider
-47	Consultation with Specialist
-48	Clarification/Discuss Patient's RFE
-49	Other Preventive Procedures
-50	Medicat-Script/Reqst/Renew/Inject
-51	Incise/Drain/Flush/Aspirate
-52	Excise/Remove/Biopsy/Destruction/Debride
-53	Instrument/Catheter/Intubate/Dilate
-54	Repair/Fixate-Suture/Cast/Prosthetic
-55	Local Injection/Infiltration
-56	Dress/Press/Compress/Tamponade
-57	Physical Medicine/Rehabilitation
-58	Therapeutic Counselling/Listening
-59	Other Therapeutic Procedure NEC
-60	Results Tests/Procedures
-61	Results Exam/Test/Record
-62	Administrative Procedure
-63	Follow-up Encounter Unspecified
-64	Encounter Initiated by Provider
-65	Encounter Initiated third person
-66	Refer to Other Provider (EXCL. M.D.)
-67	Referral to Physician/Specialist/Clinic/Hospital
-68	Other Referrals NEC
-69	Other Reason for Encounter NEC

General and Unspecified A

A01	Pain general/multiple sites
A02	Chills
A03	Fever
A04	Weakness/tiredness general
A05	Feeling ill
A06	Fainting/syncope
A07	Coma
A08	Swelling
A09	Sweating problem
A10	Bleeding/haemorrhage NOS
A11	Chest pain NOS
A13	Concern/fear medical treatment
A16	Irritable infant
A18	Concern about appearance
A20	Euthanasia request/discussion
A21	Risk factor for malignancy
A23	Risk factor NOS
A25	Fear of death/dying
A26	Fear of cancer NOS
A27	Fear of other disease NOS
A28	Limited function/disability NOS
A29	General symptom/complaint other
A70	Tuberculosis
A71	Measles
A72	Chickenpox
A73	Malaria
A74	Rubella
A75	Infectious mononucleosis
A76	Viral exanthem other
A77	Viral disease other/NOS
A78	Infectious disease other/NOS
A79	Malignancy NOS
A80	Trauma/injury NOS
A81	Multiple trauma/injuries
A82	Secondary effect of trauma
A84	Poisoning by medical agent
A85	Adverse effect medical agent
A86	Toxic effect non-medicinal substance
A87	Complication of medical treatment
A88	Adverse effect physical factor
A89	Effect prosthetic device
A90	Congenital anomaly OS/multiple
A91	Abnormal result investigation NOS
A92	Allergy/allergic reaction NOS
A93	Premature newborn
A94	Perinatal morbidity other
A95	Perinatal mortality
A96	Death
A97	No disease
A98	Health maintenance/prevention
A99	General disease NOS

Blood, Blood Forming Organs and Immune Mechanism B

B02	Lymph gland(s) enlarged/painful
B04	Blood symptom/complaint
B25	Fear of aids/HIV
B26	Fear cancer blood/lymph
B27	Fear blood/lymph disease other
B28	Limited function/disability
B29	Sympt/complt lymph/immune other
B70	Lymphadenitis acute
B71	Lymphadenitis non-specific
B72	Hodgkin's disease/lymphoma
B73	Leukaemia
B74	Malignant neoplasm blood other
B75	Benign/unspecified neoplasm blood
B76	Ruptured spleen traumatic
B77	Injury blood/lymph/spleen other
B78	Hereditary haemolytic anaemia
B79	Congen.anom. blood/lymph other
B80	Iron deficiency anaemia
B81	Anaemia, Vitamin B12/folate def.
B82	Anaemia other/unspecified
B83	Purpura/coagulation defect
B84	Unexplained abnormal white cells
B87	Splenomegaly
B90	HIV-infection/aids
B99	Blood/lymph/spleen disease other

PROCESS CODES

SYMPTOMS/COMPLAINTS

INFECTIONS

NEOPLASMS

INJURIES

CONGENITAL ANOMALIES

OTHER DIAGNOSES

Digestive D

D01	Abdominal pain/cramps general
D02	Abdominal pain epigastric
D03	Heartburn
D04	Rectal/anal pain
D05	Perianal itching
D06	Abdominal pain localized other
D07	Dyspepsia/indigestion
D08	Flatulence/gas/belching
D09	Nausea
D10	Vomiting
D11	Diarrhoea
D12	Constipation
D13	Jaundice
D14	Haematemesis/vomiting blood
D15	Melaena
D16	Rectal bleeding
D17	Incontinence of bowel
D18	Change faeces/bowel movements
D19	Teeth/gum symptom/complaint
D20	Mouth/tongue/lip symptom/complt.
D21	Swallowing problem
D23	Hepatomegaly
D24	Abdominal mass NOS
D25	Abdominal distension
D26	Fear of cancer of digestive system
D27	Fear of digestive disease other
D28	Limited function/disability (d)
D29	Digestive symptom/complaint other
D70	Gastrointestinal infection
D71	Mumps
D72	Viral hepatitis
D73	Gastroenteritis presumed infection
D74	Malignant neoplasm stomach
D75	Malignant neoplasm colon/rectum
D76	Malignant neoplasm pancreas
D77	Malig. neoplasm digest other/NOS
D78	Neoplasm digest benign/uncertain
D79	Foreign body digestive system
D80	Injury digestive system other
D81	Congen. anomaly digestive system
D82	Teeth/gum disease
D83	Mouth/tongue/lip disease
D84	Oesophagus disease
D85	Duodenal ulcer
D86	Peptic ulcer other
D87	Stomach function disorder
D88	Appendicitis
D89	Inguinal hernia
D90	Hiatus hernia
D91	Abdominal hernia other
D92	Diverticular disease
D93	Irritable bowel syndrome
D94	Chronic enteritis/ulcerative colitis
D95	Anal fissure/perianal abscess
D96	Worms/other parasites
D97	Liver disease NOS
D98	Cholecystitis/cholelithiasis
D99	Disease digestive system, other

Eye F

F01	Eye pain
F02	Red eye
F03	Eye discharge
F04	Visual floaters/spots
F05	Visual disturbance other
F13	Eye sensation abnormal
F14	Eye movements abnormal
F15	Eye appearance abnormal
F16	Eyelid symptom/complaint
F17	Glasses symptom/complaint
F18	Contact lens symptom/complaint
F27	Fear of eye disease
F28	Limited function/disability (f)
F29	Eye symptom/complaint other
F70	Conjunctivitis infectious
F71	Conjunctivitis allergic
F72	Blepharitis/stye/chalazion
F73	Eye infection/inflammation other
F74	Neoplasm of eye/adnexa
F75	Contusion/haemorrhage eye
F76	Foreign body in eye
F79	Injury eye other
F80	Blocked lacrimal duct of infant
F81	Congenital anomaly eye other
F82	Detached retina
F83	Retinopathy
F84	Macular degeneration
F85	Corneal ulcer
F86	Trachoma
F91	Refractive error
F92	Cataract
F93	Glaucoma
F94	Blindness
F95	Strabismus
F99	Eye/adnexa disease, other

Ear H

H01	Ear pain/earache
H02	Hearing complaint
H03	Tinnitus, ringing/buzzing ear
H04	Ear discharge
H05	Bleeding ear
H13	Plugged feeling ear
H15	Concern with appearance of ears
H27	Fear of ear disease
H28	Limited function/disability ear
H29	Ear symptom/complaint other
H70	Otitis externa
H71	Acute otitis media/myringitis
H72	Serous otitis media
H73	Eustachian salpingitis
H74	Chronic otitis media
H75	Neoplasm of ear
H76	Foreign body in ear
H77	Perforation ear drum
H78	Superficial injury of ear
H79	Ear injury other
H80	Congenital anomaly of ear
H81	Excessive ear wax
H82	Vertiginous syndrome
H83	Otosclerosis
H84	Presbyacusis
H85	Acoustic trauma
H86	Deafness
H99	Ear/mastoid disease, other

Cardiovascular K

K01	Heart pain
K02	Pressure/tightness of heart
K03	Cardiovascular pain NOS
K04	Palpitations/awareness of heart
K05	Irregular heartbeat other
K06	Prominent veins
K07	Swollen ankles/oedema
K22	Risk factor cardiovascular disease
K24	Fear of heart disease
K25	Fear of hypertension
K27	Fear cardiovascular disease other
K28	Limited function/disability (k)
K29	Cardiovascular sympt./complt. other
K70	Infection of circulatory system
K71	Rheumatic fever/heart disease
K72	Neoplasm cardiovascular
K73	Congenital anomaly cardiovascular
K74	Ischaemic heart disease w. angina
K75	Acute myocardial infarction
K76	Ischaemic heart disease w/o angina
K77	Heart failure
K78	Atrial fibrillation/flutter
K79	Paroxysmal tachycardia
K80	Cardiac arrhythmia NOS
K81	Heart/arterial murmur NOS
K82	Pulmonary heart disease
K83	Heart valve disease NOS
K84	Heart disease other
K85	Elevated blood pressure
K86	Hypertension uncomplicated
K87	Hypertension complicated
K88	Postural hypotension
K89	Transient cerebral ischaemia
K90	Stroke/cerebrovascular accident
K91	Cerebrovascular disease
K92	Atherosclerosis/PVD
K93	Pulmonary embolism
K94	Phlebitis/thrombophlebitis
K95	Varicose veins of leg
K96	Haemorrhoids
K99	Cardiovascular disease other

Musculoskeletal L

L01	Neck symptom/complain
L02	Back symptom/complaint
L03	Low back symptom/complaint
L04	Chest symptom/complaint
L05	Flank/axilla symptom/complaint
L07	Jaw symptom/complaint
L08	Shoulder symptom/complaint
L09	Arm symptom/complaint
L10	Elbow symptom/complaint
L11	Wrist symptom/complaint
L12	Hand/finger symptom/complaint
L13	Hip symptom/complaint
L14	Leg/thigh symptom/complaint
L15	Knee symptom/complaint
L16	Ankle symptom/complaint
L17	Foot/toe symptom/complaint
L18	Muscle pain
L19	Muscle symptom/complaint NOS
L20	Joint symptom/complaint NOS
L26	Fear of cancer musculoskeletal
L27	Fear musculoskeletal disease other
L28	Limited function/disability (l)
L29	Sympt/complt. Musculoskeletal other
L70	Infections musculoskeletal system
L71	Malignant neoplasm musculoskeletal
L72	Fracture: radius/ulna
L73	Fracture: tibia/fibula
L74	Fracture: hand/foot bone
L75	Fracture: femur
L76	Fracture: other
L77	Sprain/strain of ankle
L78	Sprain/strain of knee
L79	Sprain/strain of joint NOS
L80	Dislocation/subluxation
L81	Injury musculoskeletal NOS
L82	Congenital anomaly musculoskeletal
L83	Neck syndrome
L84	Back syndrome w/o radiating pain
L85	Acquired deformity of spine
L86	Back syndrome with radiating pain
L87	Bursitis/tendinitis/synovitis NOS
L88	Rheumatoid/seropositive arthritis
L89	Osteoarthrosis of hip
L90	Osteoarthrosis of knee
L91	Osteoarthrosis other
L92	Shoulder syndrome
L93	Tennis elbow
L94	Osteochondrosis
L95	Osteoporosis
L96	Acute internal damage knee
L97	Neoplasm benign/unspec musculo.
L98	Acquired deformity of limb
L99	Musculoskeletal disease, other

Neurological N

N01	Headache
N03	Pain face
N04	Restless legs
N05	Tingling fingers/feet/toes
N06	Sensation disturbance other
N07	Convulsion/seizure
N08	Abnormal involuntary movements
N16	Disturbance of smell/taste
N17	Vertigo/dizziness
N18	Paralysis/weakness
N19	Speech disorder
N26	Fear cancer neurological system
N27	Fear of neurological disease other
N28	Limited function/disability (n)
N29	Neurological symptom/complt. other
N70	Poliomyelitis
N71	Meningitis/encephalitis
N72	Tetanus
N73	Neurological infection other
N74	Malignant neoplasm nervous system
N75	Benign neoplasm nervous system
N76	Neoplasm nervous system unspec.
N79	Concussion
N80	Head injury other
N81	Injury nervous system other
N85	Congenital anomaly neurological
N86	Multiple sclerosis
N87	Parkinsonism
N88	Epilepsy
N89	Migraine
N90	Cluster headache
N91	Facial paralysis/bell's palsy
N92	Trigeminal neuralgia
N93	Carpal tunnel syndrome
N94	Peripheral neuritis/neuropathy
N95	Tension headache
N99	Neurological disease, other

Psychological P

P01 Feeling anxious/nervous/tense
P02 Acute stress reaction
P03 Feeling depressed
P04 Feeling/behaving irritable/angry
P05 Senility, feeling/behaving old
P06 Sleep disturbance
P07 Sexual desire reduced
P08 Sexual fulfilment reduced
P09 Sexual preference concern
P10 Stammering/stuttering/tic
P11 Eating problem in child
P12 Bedwetting/enuresis
P13 Encopresis/bowel training problem
P15 Chronic alcohol abuse
P16 Acute alcohol abuse
P17 Tobacco abuse
P18 Medication abuse
P19 Drug abuse
P20 Memory disturbance
P22 Child behaviour symptom/complaint
P23 Adolescent behav. Symptom/complt.
P24 Specific learning problem
P25 Phase of life problem adult
P27 Fear of mental disorder
P28 Limited function/disability (p)
P29 Psychological symptom/complt other
P70 Dementia
P71 Organic psychosis other
P72 Schizophrenia
P73 Affective psychosis
P74 Anxiety disorder/anxiety state
P75 Somatization disorder
P76 Depressive disorder
P77 Suicide/suicide attempt
P78 Neuraesthenia/surmenage
P79 Phobia/compulsive disorder
P80 Personality disorder
P81 Hyperkinetic disorder
P82 Post-traumatic stress disorder
P85 Mental retardation
P86 Anorexia nervosa/bulimia
P98 Psychosis NOS/other
P99 Psychological disorders, other

Respiratory R

R01 Pain respiratory system
R02 Shortness of breath/dyspnoea
R03 Wheezing
R04 Breathing problem, other
R05 Cough
R06 Nose bleed/epistaxis
R07 Sneezing/nasal congestion
R08 Nose symptom/complaint other
R09 Sinus symptom/complaint
R21 Throat symptom/complaint
R23 Voice symptom/complaint
R24 Haemoptysis
R25 Sputum/phlegm abnormal
R26 Fear of cancer respiratory system
R27 Fear of respiratory disease, other
R28 Limited function/disability (r)
R29 Respiratory symptom/complaint oth.
R71 Whooping cough
R72 Strep throat
R73 Boil/abscess nose
R74 Upper respiratory infection acute
R75 Sinusitis acute/chronic
R76 Tonsillitis acute
R77 Laryngitis/tracheitis acute
R78 Acute bronchitis/bronchiolitis
R79 Chronic bronchitis
R80 Influenza
R81 Pneumonia
R82 Pleurisy/pleural effusion
R83 Respiratory infection other
R84 Malignant neoplasm bronchus/lung
R85 Malinant neoplasm respiratory, other
R86 Benign neoplasm respiratory
R87 Foreign body nose/larynx/bronch
R88 Injury respiratory other
R89 Congenital anomaly respiratory
R90 Hypertrophy tonsils/adenoids
R92 Neoplasm respiratory unspecified
R95 Chronic obstructive pulmonary dis
R96 Asthma
R97 Allergic rhinitis
R98 Hyperventilation syndrome
R99 Respiratory disease other

PROCESS CODES
SYMPTOMS/COMPLAINTS
INFECTIONS
NEOPLASMS
INJURIES
CONGENITAL ANOMALIES
OTHER DIAGNOSES

Skin S

S01 Pain/tenderness of skin
S02 Pruritus
S03 Warts
S04 Lump/swelling localized
S05 Lumps/swellings generalized
S06 Rash localized
S07 Rash generalized
S08 Skin colour change
S09 Infected finger/toe
S10 Boil/carbuncle
S11 Skin infection post-traumatic
S12 Insect bite/sting
S13 Animal/human bite
S14 Burn/scald
S15 Foreign body in skin
S16 Bruise/contusion
S17 Abrasion/scratch/blister
S18 Laceration/cut
S19 Skin injury other
S20 Corn/callosity
S21 Skin texture symptom/complaint
S22 Nail symptom/complaint
S23 Hair loss/baldness
S24 Hair/scalp symptom/complaint
S26 Fear of cancer of skin
S27 Fear of skin disease other
S28 Limited function/disability (s)
S29 Skin symptom/complaint other
S70 Herpes zoster
S71 Herpes simplex
S72 Scabies/other acariasis
S73 Pediculosis/skin infestation other
S74 Dermatophytosis
S75 Moniliasis/candidiasis skin
S76 Skin infection other
S77 Malignant neoplasm of skin
S78 Lipoma
S79 Neoplasm skin benign/unspecified
S80 Solar keratosis/sunburn
S81 Haemangioma/lymphangioma
S82 Naevus/mole
S83 Congenital skin anomaly other
S84 Impetigo
S85 Pilonidal cyst/fistula
S86 Dermatitis seborrhoeic
S87 Dermatitis/atopic eczema
S88 Dermatitis contact/allergic
S89 Diaper rash
S90 Pityriasis rosea
S91 Psoriasis
S92 Sweat gland disease
S93 Sebaceous cyst
S94 Ingrowing nail
S95 Molluscum contagiosum
S96 Acne
S97 Chronic ulcer skin
S98 Urticaria
S99 Skin disease, other

Endocrine/Metabolic and Nutritional T

T01 Excessive thirst
T02 Excessive appetite
T03 Loss of appetite
T04 Feeding problem of infant/child
T05 Feeding problem of adult
T07 Weight gain
T08 Weight loss
T10 Growth delay
T11 Dehydration
T26 Fear of cancer of endocrine system
T27 Fear endocrine/metabolic dis other
T28 Limited function/disability (t)
T29 Endocrine/met./sympt/complt other
T70 Endocrine infection
T71 Malignant neoplasm thyroid
T72 Benign neoplasm thyroid
T73 Neoplasm endocrine oth/unspecified
T78 Thyroglossal duct/cyst
T80 Congenital anom endocrine/metab.
T81 Goitre
T82 Obesity
T83 Overweight
T85 Hyperthyroidism/thyrotoxicosis
T86 Hypothyroidism/myxoedema
T87 Hypoglycaemia
T89 Diabetes insulin dependent
T90 Diabetes non-insulin dependent
T91 Vitamin/nutritional deficiency
T92 Gout
T93 Lipid disorder
T99 Endocrine/metab/nutrit. dis. other

Urological U

U01 Dysuria/painful urination
U02 Urinary frequency/urgency
U04 Incontinence urine
U05 Urination problems other
U06 Haematuria
U07 Urine symptom/complaint other
U08 Urinary retention
U13 Bladder symptom/complaint other
U14 Kidney symptom/complaint
U26 Fear of cancer of urinary system
U27 Fear of urinary disease other
U28 Limited function/disability urinary
U29 Urinary symptom/complaint other
U70 Pyelonephritis/pyelitis
U71 Cystitis/urinary infection other
U72 Urethritis
U75 Malignant neoplasm of kidney
U76 Malignant neoplasm of bladder
U77 Malignant neoplasm urinary other
U78 Benign neoplasm urinary tract
U79 Neoplasm urinary tract NOS
U80 Injury urinary tract
U85 Congenital anomaly urinary tract
U88 Glomerulonephritis/nephrosis
U90 Orthostatic albumin./proteinuria
U95 Urinary calculus
U98 Abnormal urine test NOS
U99 Urinary disease, other

Pregnancy, Childbearing, Family Planning W

W01 Question of pregnancy
W02 Fear of pregnancy
W03 Antepartum bleeding
W05 Pregnancy vomiting/nausea
W10 Contraception postcoital
W11 Contraception oral
W12 Contraception intrauterine
W13 Sterilization
W14 Contraception other
W15 Infertility/subfertility
W17 Post-partum bleeding
W18 Post-partum symptom/complaint oth.
W19 Breast/lactation symptom/complaint
W21 Concern body image in pregnancy
W27 Fear complications of pregnancy
W28 Limited function/disability (w)
W29 Pregnancy symptom/complaint other
W70 Puerperal infection/sepsis
W71 Infection complicating pregnancy
W72 Malignant neoplasm relate to preg.
W73 Benign/unspec. neoplasm/pregnancy
W75 Injury complicating pregnancy
W76 Congenital anomaly complicate preg.
W78 Pregnancy
W79 Unwanted pregnancy
W80 Ectopic pregnancy
W81 Toxaemia of pregnancy
W82 Abortion spontaneous
W83 Abortion induced
W84 Pregnancy high risk
W85 Gestational diabetes
W90 Uncomplicate labour/delivery live
W91 Uncomplicate labour/delivery still
W92 Complicate labour/ delivery livebirth
W93 Complicate labour/delivery stillbirth
W94 Puerperal mastitis
W95 Breast disorder in pregnancy other
W96 Complications of puerperium other
W99 Disorder pregnancy/delivery, other

Female Genital X

X01 Genital pain female
X02 Menstrual pain
X03 Intermenstrual pain
X04 Painful intercourse female
X05 Menstruation absent/scanty
X06 Menstruation excessive
X07 Menstruation irregular/frequent
X08 Intermenstrual bleeding
X09 Premenstrual symptom/complaint
X10 Postponement of menstruation
X11 Menopausal symptom/complaint
X12 Postmenopausal bleeding
X13 Postcoital bleeding
X14 Vaginal discharge
X15 Vaginal symptom/complaint other
X16 Vulval symptom/complaint
X17 Pelvis symptom/complaint female
X18 Breast pain female
X19 Breast lump/mass female
X20 Nipple symptom/complaint female
X21 Breast symptom/complt. female other
X22 Concern breast appearance female
X23 Fear sexually transmitted disease (f)
X24 Fear of sexual dysfunction female
X25 Fear of genital cancer female
X26 Fear of breast cancer female
X27 Fear genital/breast disease other (f)
X28 Limited function/disability (x)
X29 Genital symptom/complt female oth.
X70 Syphilis female
X71 Gonorrhoea female
X72 Genital candidiasis female
X73 Genital trichomoniasis female
X74 Pelvic inflammatory disease
X75 Malignant neoplasm cervix
X76 Malignant neoplasm breast female
X77 Malignant neoplasm genital other (f)
X78 Fibromyoma uterus
X79 Benign neoplasm breast female
X80 Benign neoplasm female genital
X81 Genital neoplasm oth/unspecied (f)
X82 Injury genital female
X83 Congenital anomaly genital female
X84 Vaginitis/vulvitis NOS
X85 Cervical disease NOS
X86 Abnormal cervix smear
X87 Uterovaginal prolapse
X88 Fibrocystic disease breast
X89 Premenstrual tension syndrome
X90 Genital herpes female
X91 Condylomata acuminata female
X92 Chlamydia infection genital (f)
X99 Genital disease female, other

Male Genital Y

Y01 Pain in penis
Y02 Pain in testis/scrotum
Y03 Urethral discharge
Y04 Penis symptom/complaint other
Y05 Scrotum/testis sympt/complt. other
Y06 Prostate symptom/complaint
Y07 Impotence NOS
Y08 Sexual function sympt./complt.(m)
Y10 Infertility/subfertility male
Y13 Sterilization male
Y14 Family planning male other
Y16 Breast symptom/complaint male
Y24 Fear of sexual dysfunction male
Y25 Fear sexually transmitted dis. male
Y26 Fear of genital cancer male
Y27 Fear of genital disease male other
Y28 Limited function/disability (y)
Y29 Genital sympt./complt.male other
Y70 Syphilis male
Y71 Gonorrhoea male
Y72 Genital herpes male
Y73 Prostatitis/seminal vesiculitis
Y74 Orchitis/epididymitis
Y75 Balanitis
Y76 Condylomata acuminata male
Y77 Malignant neoplasm prostate
Y78 Malign neoplasm male genital other
Y79 Benign/unspec. neoplasm gen. (m)
Y80 Injury male genital
Y81 Phimosis/redundant prepuce
Y82 Hypospadias
Y83 Undescended testicle
Y84 Congenital genl anomaly (m) other
Y85 Benign prostatic hypertrophy
Y86 Hydrocoele
Y99 Genital disease male, other

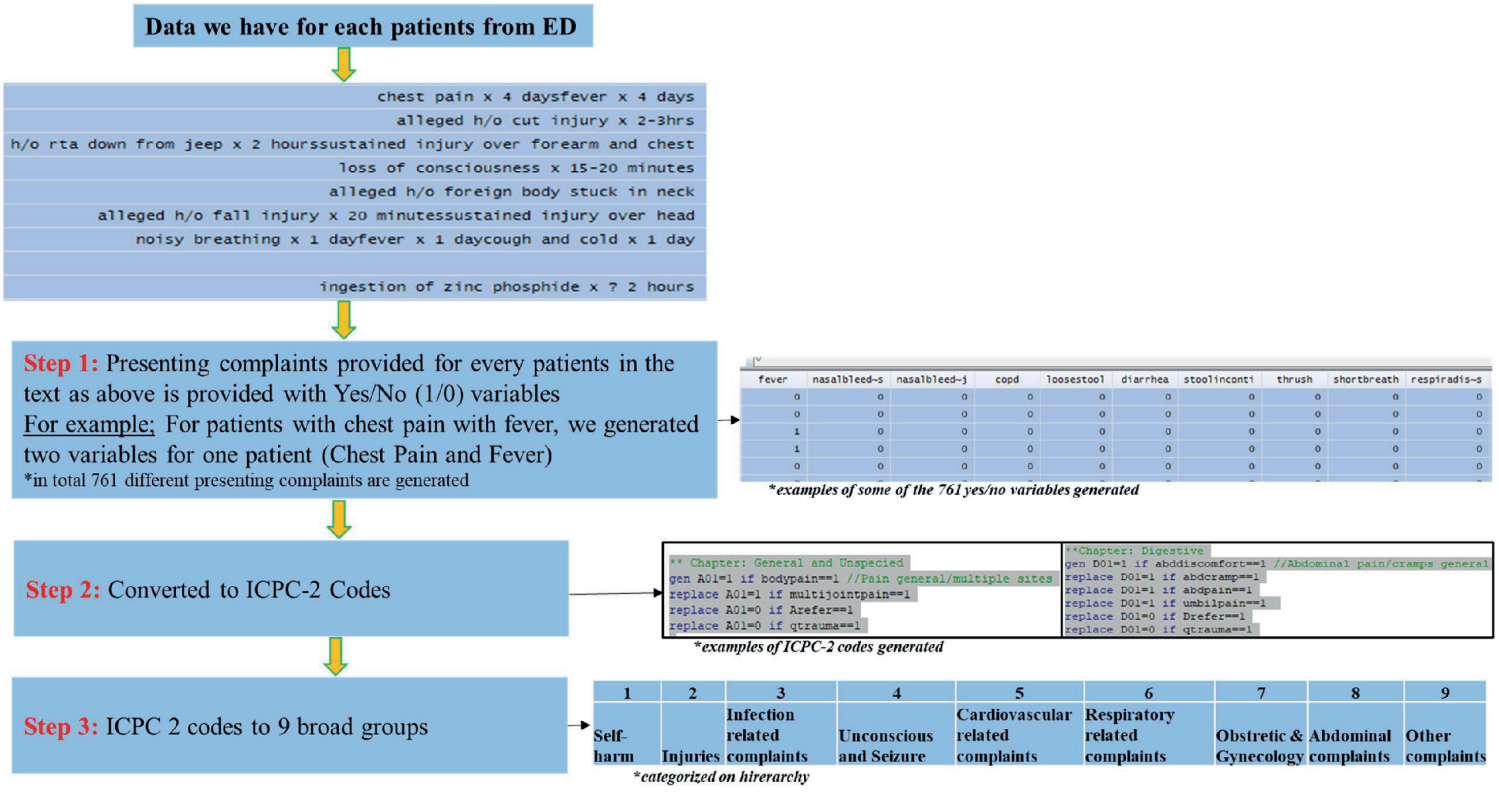
Social Problems Z

Z01 Poverty/financial problem
Z02 Food/water problem
Z03 Housing/neighbourhood problem
Z04 Social cultural problem
Z05 Work problem
Z06 Unemployment problem
Z07 Education problem
Z08 Social welfare problem
Z09 Legal problem
Z10 Health care system problem
Z11 Compliance/being ill problem
Z12 Relationship problem with partner
Z13 Partner's behaviour problem
Z14 Partner illness problem
Z15 Loss/death of partner problem
Z16 Relationship problem with child
Z18 Illness problem with child
Z19 Loss/death of child problem
Z20 Relationship prob. parent/family
Z21 Behaviour problem parent/family
Z22 Illness problem parent/family
Z23 Loss/death parent/family member
Z24 Relationship problem friend
Z25 Assault/harmful event problem
Z27 Fear of a social problem
Z28 Limited function/disability (z)
Z29 Social problem NOS

Abbreviations

Anom	anomaly
behav.	behaviour
bronch.	bronchus
complicat.	complication
congen.	congenital
dis.	disease
eval.	evaluation
exam.	examination
gen.	genital
malig.	malignant
metab.	metabolic
musculo.	musculoskeletal
NEC	not elsewhere classified
NOS	not otherwise specified
nutrit.	nutrition
oth	other
preg.	pregnancy
prob.	problem
RFE	reason for encounter
sympt.	symptom
unspec.	unspecified
w	with
w/o	without

Appendix VIII. Steps in categorization of free text presenting complaints into nine broad categories



Appendix IX. Triage categories by patient's complaints or symptoms used during 2015 earthquakes

Triage Category	Complaints
Red	Flail chest
	Patient in shock
	Unstable pelvic fracture
	Patient with airway obstruction
	Patient who need immediate CPR
	C-Spine Injury
	Tension pneumothorax
Orange	Femur fracture
	Chest trauma without airway compromise
	Stable pelvic Fracture
Yellow	Close fracture of limbs
	Open fracture with infection
	Patient with suspected spinal injury
Green	Minor laceration/abrasaion
	Sprains
	Minor soft tissue injury