Graduate thesis

NTNU
Norwegian University of Science and Technology
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Is treatment by a relevant subspecialist prospectively associated with outcome for patients in a general internal medicine department?

A study of patient outcome at SI Tynset

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Supervisors: Aslak Steinsbekk & Ulf Hurtig
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Abstract

Background

Studies on treatment of patients in hospital with specific diagnoses show that physicians with a subspecialisation relevant to this diagnosis can provide a better quality of care. However, studies including patients with various diagnoses, show less effect of being attended by a relevant subspecialist. The aim of this study was to investigate if being attended by a physician with a subspeciality relevant to the patient's primary diagnosis, compared to a physician with subspeciality not relevant to the patient's primary diagnosis, was prospectively associated with patient's overall outcome.

Methods

A retrospective register-based study of 11059 hospital admissions across a period of ten years at a local hospital in south-eastern Norway where it was possible to identify the physician attending the patients in the beginning of the stay. The outcomes studied was emergency readmissions to the same ward within 30 days, in-hospital mortality and total length of stay. Patients admitted were matched with the consultant responsible for their treatment. Then, the admissions were divided into two groups according to their primary diagnosis; was their diagnosis within the subspeciality of the attending consultant (relevant subspecialist) or not (not-relevant subspecialist). The two groups were then compared using bivariable and multivariable models adjusted for patient characteristics, comorbidities, diagnostic group and physician sex.

Results

A relevant subspecialist was present during first three days in 8058 (73%) of the 11059 patient cases. Patients attended to by a relevant subspecialist had an odds ratio (OR) of 0.91 (95% confidence interval 0.76 to 1.09) for being readmitted, 0.71 (0.48 to 1.04) for dying in the hospital and having a length of stay that was 0.18 (-0.07 to 0.42) days longer than for those attended to by a not-relevant subspecialist.

Conclusions

Patients attended by a relevant subspecialist did not have a significantly different outcome than those attended by a not-relevant subspecialist, however, the direction of the findings indicate that patients attended by a relevant subspecialist have reduced readmission and in-hospital mortality rates, yet albeit an increased total length of stay in hospital.

Sammendrag

Bakgrunn

Studier på spesifikke diagnoser blant innlagte pasienter har vist at leger med en subspesialisering relevant for pasientens diagnose kan gi bedre behandling for enkelte tilstander. Når man studerer flere diagnoser, viser studiene mindre effekt av behandling fra en relevant subspesialist. Disse studiene har brukt ulike metoder for å identifisere den behandlende legen og hvilke diagnoser som dekkes av en subspesialitet. Denne studien hadde som mål å undersøke om behandling fra en lege med relevant subspesialitet var prospektivt assosiert med utfall for pasienten, sammenlignet med behandling fra lege med annen subspesialitet.

Metode

En retrospektiv registerstudie av 11059 sykehusinnleggelser over ti år på et lokalsykehus i Sørøst-Norge hvor behandlende lege i starten av innleggelsen kunne identifiseres. Utfall var akutte reinnleggelser til samme avdeling innen 30 dager, sykehusmortalitet og total liggelengde. Innlagte pasienter ble koblet med behandlende overleger de første dagene av sykehusoppholdet. Innleggelsene ble så delt i to grupper etter hoveddiagnose; ble hoveddiagnosen dekket av spesialiteten til overlegen (relevant subspesialist) eller ikke (ikke-relevant subspesialist). De to gruppene ble så sammenlignet ved hjelp av bivariable og multivariable modeller justert for pasientkarakteristika, komorbiditet, diagnosegruppe og kjønn på vakthavende lege ved innkomst.

Resultater

En relevant subspesialist var til stede i løpet av første tre liggedøgn ved 8058 (73%) av de 11059 innleggelsene. Pasienter behandlet av relevant subspesialist hadde en odds ratio (OR) på 0,91 (95% konfidensintervall: 0,76 til 1,09) for reinnleggelse, 0,71 (0,49 til 1,04) for å dø på sykehuset og en liggelengde som var 0,18 (-0,07 til 0,42) dager lengre enn pasientene som ble behandlet av ikke-relevant subspesialist.

Konklusjon

Pasienter behandlet av relevant subspesialist hadde ikke signifikan annet utfall enn de som ble behandlet av ikke-relevant subspesialist. Funnenes retning indikerer imidlertid at behandling fra relevant subspesialist reduserte reinnleggelsesrate og sykehusdødelighet, men ga en økt liggelengde.

Acknowledgements

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1 Introduction

With increasing specialisation and subspecialisation, physicians gain increased knowledge in their specific field. Since the early 1980s, the consequences of this development, which is due to increased medical knowledge, have been discussed [1, 2]. Being attended by a physician with a speciality covering the patient's current diagnosis has been shown to give favourable outcome for certain diagnoses [3, 4]. One reason can be that the more specialised physicians tend to use a more specific approach when practising within their field of speciality [5]. Conversely, when practising outside their areas of speciality, the subspecialists might be less efficient and provide a lower quality of care [5, 6]. Thus, the question arises how this affects patients when the physicians cover a broader field than their subspeciality, e.g. on call at nights, weekends or on general wards.

A lower specialist intensity was hypothesised to be the reason for the worse patient outcome found among patients admitted in weekends [7-9]. However, a more recent study found no correlation between specialist intensity and mortality [10]. Another study from the USA even found lower mortality for acute cardiac conditions during dates of national cardiology meetings when the specialist intensity presumably was lower [11].

Physician experience and patient outcome have been studied by amongst others McAlister et al., without finding a relation between these [12]. Bai et al. studied patient outcome when the attending physician at discharge/death was a general internist, compared to a specialist, and found that the generalists' patients had shorter hospitalisations, but the same rates of readmission and mortality. Weingarten et al. studied four subspecialities treating four conditions, each relevant for their subspeciality [6]. They found that when the "physician of record" was practising within their field of subspeciality, there was shorter length of stay and lower mortality, than when practising outside their field of subspeciality.

Identifying the causal relationship between being attended by a specialist and patient outcome can be challenging. In the studies referred to above, there is some variation in methods used to achieve this. One example is the variables adjusted for. These include patient characteristics [3, 4, 6, 7, 11-13], diagnosis [6, 13] and comorbidities [4, 7, 11-13].

There is also a difference in the breadth of diagnoses studied. Several studies focus on one or a few diagnoses and one speciality [3, 4, 11]. Weingarten et al. selected four subspecialities and four associated diagnoses [6]. A few have included all patients admitted within internal medicine [7, 12, 13].

Taken together, there is still a need for more studies in this area, and especially with a design which more consistently matches the diagnosis of the patient and the subspeciality of the attending physician who is likely to be most influential for the outcome.

The aim of this study was therefore to investigate if being attended at the start of the stay by a physician with a subspeciality relevant to the patient's primary diagnosis, compared to a physician with subspeciality not relevant to the patient's primary diagnosis, was prospectively associated with readmission rate, length of stay and in-hospital mortality.

2 Method

2.1 Design

This study was a retrospective cohort study using register data about patient admissions and rosters of physicians from a small-sized local hospital for the period 2005-2017.

The Regional Committee for Medical and Health Research Mid Norway approved the study (application #96104 appendix 1) and gave exemption from the requirement to gather consent from physicians and patient. The exemption was both due to the size of the study and the nature of the data gathered.

2.2 Setting

The hospital is a small-sized rural local hospital in the interior part of south-eastern Norway with emergency functions within orthopaedics, general surgery and internal medicine. It covers a population of around 25000 persons [14]. Elective treatment and outpatient services are offered within urology and plastic surgery. Uncomplicated multiparous can give birth at the midwife-run birth care centre, which also offers post-natal care.

In 2017, there were 6,2 full-time equivalent positions for consultants in medicine, 8,5 in general surgery and orthopaedics, 3 in anaesthesia and 3 in radiology. Also, one position as a speciality registrar in internal medicine and eight as foundation doctors, rotating between medicine and surgery.

The internal medicine department had 20 ordinary beds and 4 beds in a high dependency unit (HDU). In November 2017 this was reduced to 16 ordinary beds and 4 HDU-beds. The medical outpatient clinic covers cardiology, lung medicine, gastroenterology, rheumatology and haematology and nurse-led outpatient clinics for diabetes and chemotherapy [15]. Outpatient clinics not covered by subspecialities present among the regular consultants is staffed from larger hospitals some days per month. The yearly inpatient admission at this department has been around 1700 patients, the past ten years.

As a solution to difficulties of attracting specialists to live and work in rural Norway, the hospital has for more than twenty years employed consultants who work for “1-2 weeks with clinical activity and continuous duty at the hospital, and 2-4 weeks of independent working time for administrative duties, professional updating and holiday/spare time" [16].

The internal medicine department is staffed with one consultant on weekends and holidays, and two on weekdays. The consultants either work a 5-days shift or a 7-days shift. The two types of shift might be consecutively ordered. The consultant on the 5-days shift works at the hospital Monday-Friday with two 24h shifts on call. The 7-days shift works Friday-Friday and is continuously on call Friday-Monday in addition to two 24h shifts. In weekends the consultant present attends the ward and is on call. In weekdays the two consultants divide the ward between them and work the outpatient clinic in addition to one of them being on call.

A patient admitted as emergency to the hospital is seen by a foundation doctor (the same for surgery and internal medicine) in the emergency room. For a medical patient, the foundation doctor confers patient, preliminary diagnosis and treatment with the medical consultant on call before admitting the patient. After admission to the ward the patient will be assigned to one out of two consultants on weekdays, or the one present on weekdays. According to the chief of medicine, the admitted patients are usually assigned to the consultant physician most competent on the primary diagnosis/complaint. On the ward there will also be foundation doctors present, but as this study focuses on subspeciality only the consultants are included.

With fewer physicians working prolonged periods, they are more continuously involved in diagnostics and treatment of the same patient than in other larger Norwegian hospitals. This was utilised to connect the patient to the physician responsible for the treatment at the beginning of the stay and gave opportunity for the selected design (procedure).

2.3 Participants

Two types of participants, patients and physicians, were included. The eligible criteria were:

Patients were included if:

- They were admitted to the internal medicine ward between 2005-2017
- The physician in charge of the patient could be identified
- The admission was an emergency

Patients were excluded if:

- They lacked diagnostic code within internal medicine at discharge
- Physician in charge of the patient could not be identified.

- They were admitted for elective treatment

Physicians were included if:

- They worked shifts as consultants at the internal medicine ward between 2005-2017
- They could be matched to a patient admitted to the internal medicine ward by either being on call at admission or attending the ward at least one of the first three days of stay.

2.4 Sample size calculation

The hospital as a whole has had a readmission rate of 15-17% [17]. To find a difference of ±1% in readmission between two groups, a total of 10004 patients had to be enrolled to have a power of 80% and alpha of 0.05 [18]. Yearly admission rate in internal medicine has been around 1700. To reach 10004 after exclusion, it was decided to include data for the 12 years from 2005 to 2017.

2.5 Data collection and variables

The hospital provided data for patients admitted to the internal medicine ward and the consultants' rosters for the study period. Patient data was gathered and de-identified by personnel at the hospital. The connection key for reidentification was held by one hospital employee. The deidentified data has been stored on an encrypted hard-drive and will be stored for 5 years after completion of the study according to the requirement in the ethics approval.

The patient data included a de-identified ID, patients age, gender, state at discharge (dead or alive), urgency (elective or emergency) and primary and secondary diagnoses at discharge as well as the time of admission and discharge.

As the object of interest is subspeciality only the consultants' rosters were gathered. These stated which consultants had the 5-days shift and the 7-days shift (see setting). The hospital's chief of medicine, who has been working at the hospital the whole study period, helped identify the subspeciality and sex of each consultant. Rosters were then used to state which subspecialties were on call and present at the hospital any day.

Rosters were acquired first. The rosters for 2010 and 2011 were not found by the staff at the hospital, and thus no data from these years could be included. For 2009, only what seemed like an early proposal for a roster was found, and it was decided to exclude all data also from this year.

Patient data were therefore collected for 2005-2008 and 2012-2017. The available variables differed somewhat. All years, except 2005, 2006 and 2007, had all required data. For 2005, age, sex, time of admission and discharge, and state at discharge was missing. For 2006 and 2007 state at discharge was missing, and for 2007 also information about urgency was missing. The available data were used where relevant for specific analysis.

2.6 Matching patients with attending consultants

A patient was coded as attended by a relevant subspecialist if there was a match between patient's diagnosis at discharge and the subspeciality of the consultant on call at admission or one of the consultants attending the ward the following first days of admission.

More specifically, two steps were taken to match patients and the attending consultants: 1) identifying which diagnoses were within a subspeciality and 2) identifying the consultant likely to be most in contact with each patient at the start of the hospital stay, as described in detail below.

2.6.1 Diagnoses within a subspeciality

To our knowledge, there exists no consensus about a system for sorting diagnoses according to subspeciality. Therefore, a system for categorisation was made for this project to stratify patients to inside or outside of the different subspecialties according to their primary diagnosis at discharge [table 1, the full list in appendix 1. In the material, 365 unique 3-digit ICD codes were used as the primary diagnosis at discharge.

Table 1. The ten most frequent ICD codes in each category

ICD-code	Admissions	Diagnosis	
General internal medicine			
R07	986	Pain in throat and chest	
J18	550	Pneumonia, unspecified organism	
J15	527	Bacterial pneumonia	
I63	335	Cerebral infarction	
N39	331	Other disorders of urinary system (mainly UTI)	
R55	328	Syncope and collapse	
G45	301	Transient cerebral ischemic attacks and related symptoms	
A46	184	Erysipelas	
J20	162	Acute bronchitis	
A41	114	Other sepsis	
Subspecialised medicine			**Subspeciality**
I48	718	Atrial fibrillation and flutter	Cardiology
J44	704	Other COPD	Lung Medicine
I21	566	Acute myocardial infarction	Cardiology
I50	292	Heart failure	Cardiology
I20	263	Angina pectoris	Cardiology
Z95	134	Presence of cardiac and vascular implants and grafts	Cardiology
R06	108	Abnormalities of breathing	Lung Medicine
R10	102	Abdominal and pelvic pain	Gastroenterology
I47	101	Paroxysmal tachycardia	Cardiology
E11	91	Type 2 Diabetes Mellitus	Endocrinology
Outside internal medicine			
R42	214	Dizziness and giddiness	
F10	199	Alcohol related disorders	
H81	98	Disorders of vestibular function	
R51	79	Headache	
G40	62	Epilepsy and recurrent seizures	
M79	57	Other and unspecified soft tissue disorders, not elsewhere classified	
R41	44	Other symptoms and signs involving cognitive functions and awareness	
C61	36	Malignant neoplasm of prostate	
G43	33	Migraine	
F41	31	Other anxiety disorders	

It was decided to make a list categorising all ICD-10 diagnosis on a three-digit level (excluding decimal codes) according to whether they belong to general internal medicine, the different subspecialties (infectious diseases, cardiology, pulmonary medicine, gastroenterology, haematology, endocrinology, nephrology, oncology and rheumatology) or outside internal medicine. To do so, the first author (medical student) made a suggestion. Diagnoses hard to place was discussed with the chief of medicine at the hospital and sorted in line with their practice of allocating patients. Diagnoses considered to be so common that all specialists in internal medicine should be able to treat them equally good (e.g. D50 – iron deficiency anaemia, J15 – bacterial pneumonia and N39 – other disorders of the urinary system (mainly UTIs)), were coded as general internal medicine [19]. Diagnoses which were difficult to connect to a subspeciality (e.g. E86 - volume depletion and I63 – cerebral infarction) and unspecific diagnoses (e.g. R11 – nausea and vomiting and R07 – pain in throat and chest) were also coded as general internal medicine.

Patients with cancer/tumours are usually diagnosed and treatment started at other hospitals than the one in this study. When they are admitted to the hospital in this study, the practice is that the organ specialist will be in charge as this is the one best qualified to treat complications from the cancer and the treatment. Therefore, cancers/tumours were mainly sorted after which organ they have origin in, not as oncological diagnoses.

2.6.2 Consultant likely to be most in contact with the patient at the start

During a hospital stay, the patient can be in contact with several health care providers of differing significance to the patient outcome. As this study assess the importance of subspeciality it only considers the consultants, not foundation doctors or other health care providers. Other studies have used physician of record or physician responsible for treatment at discharge/death as attending physician[6, 13]. At the studied hospital, there is, as described above, a limited number of consultants the patient can be in contact with, and patients are typically assigned to the relevant subspecialist if present.

It was assumed that most of the treatment was planned and started during the first days of stay so that the consultants present early in the hospitalisation was more influential in deciding on the treatment and consequently to the patient outcome than the one responsible at discharge. Therefore, it was chosen to connect the patients with the consultant on call at the time of admission and the consultants present the first days after admission, limited to at most three days. Using the time of admission and discharge, the subspecialities present at the hospital during this time were identified.

The critical points are the periods with changes in consultants according to the roster. Consultant on call changes at a fixed time point once each weekday (08:00 on Mon-Thurs and 15:00 on Friday). These time points were used to decide if a relevant subspecialist was present or not. Example: for a patient admitted at noon Wednesday and discharged at noon Friday, both the consultant on call on Wednesday and the other consultant present at 08:00 on Thursday was registered as attending consultants (i.e. potentially two consultants). It was then assumed that if it was two different consultants, the one with the relevant subspeciality was in charge of the patient. If at least one consultant had the relevant subspeciality, the patient was coded as being treated by a relevant subspecialist. If not, the patient was considered to have been attended by a not-relevant subspecialist.

2.6.3 Protection of consultants' privacy

To prevent identification of individual consultants due to the small environment, they were analysed as a group. Instead of analysing specific subspecialities (example: treated by cardiologist) the analysis compared "attended by relevant subspecialist" and "attended by not relevant subspecialist". Each consultant could be present in both groups depending on the diagnosis of the patient treated.

2.7 Variables

2.7.1 Outcome variables

There were three outcome variables: readmission, length of stay and in-hospital mortality.

Readmissions were identified as a new emergency admission to the same ward within 30 days of discharge from the prior admission for the same patient regardless of diagnosis [20]. First, patients with admissions meeting the eligibility criteria were identified. As a readmission is considered an indicator of quality for the original admission, also those with admissions not meeting the eligibility criteria were included as potential readmissions. This meant that if an eligible admission was followed within 30 days by a not-eligible admission, the first admission was grouped as readmitted, even after the not-eligible admission was excluded. Example: A patient admitted for a pneumonia was discharged to the home. 14 days after discharge he was readmitted, but at the readmission a diagnostic code was not registered. The original admission was coded as readmitted even though the second admission was excluded from further analysis.

Some patient groups are frequently sent to other hospitals for procedures before returning to the local hospital again, most typically for myocardial infarction and cerebral infarctions. Such transfers could wrongly be coded as readmissions. Thus, patients with diagnosis likely to indicate such a transfer (ICD-codes: I21, I22, I61, I62, I63 and I64), were identified. A total of 206 admissions with these diagnoses had registered readmissions. After consultation with the local hospital, 136 were recoded as transfers, leaving 73 readmissions.

Length of stay was measured as the actual time between admission and discharge.

In-hospital mortality was identified when the patient was registered as dead upon discharge.

2.7.2 Independent variables

Some variables were used to describe the patients and consultants and used as independent variables in multivariable analysis.

- Patient sex: the reported sex; only codes for males and females were present in the data.
- Age: the reported age at admission, categorised into groups; 0-39, 40-59, 60-79 and ≥80.
- Consultant sex: the sex of the consultant on call at admission.
- Diagnostic group: the subspeciality which would be relevant for the patient's ICD-code at discharge following the system made for this study [appendix 2]. The categories were general internal medicine, cardiology, lung medicine, gastroenterology, haematology, endocrinology, nephrology, oncology or rheumatology.
- Comorbidities: quantified with Charlson Comorbidity-score [21]. Using the patients primary and secondary diagnosis at discharge, they were given a weighted score in 17 disease categories using the ICD10-adaption described by Quan et al.[22]. A score at a previous admission followed the patient if no new diagnostic code in the same category were added at the newer admission. The patients' score for each admission was then categorised into groups with 0, 1, 2 and ≥3 points.

2.8 Analysis

All statistical procedures were performed with IBM SPSS Statistics for macOS (version 27; IBM SPSS, Armonk, NY, USA).

The patient and consultant characteristics were presented using descriptive statistics.

The analysis of the influence of being attended by a relevant subspecialist for the three outcomes was similar. First, a descriptive analysis of the bivariable (unadjusted) prospective association between the dependent and independent variable was conducted. Then a multivariable regression analysis was conducted. The models were adjusted for patient age, patient sex, sex of consultant on call at admission, diagnostic group and Charlson score.

For the dependent categorical variables coded as yes/no, readmission and in-hospital death, logistic regression analysis was done. Odds ratios are reported both as crude odds ratio and adjusted odds ratio with 95% confidence interval.

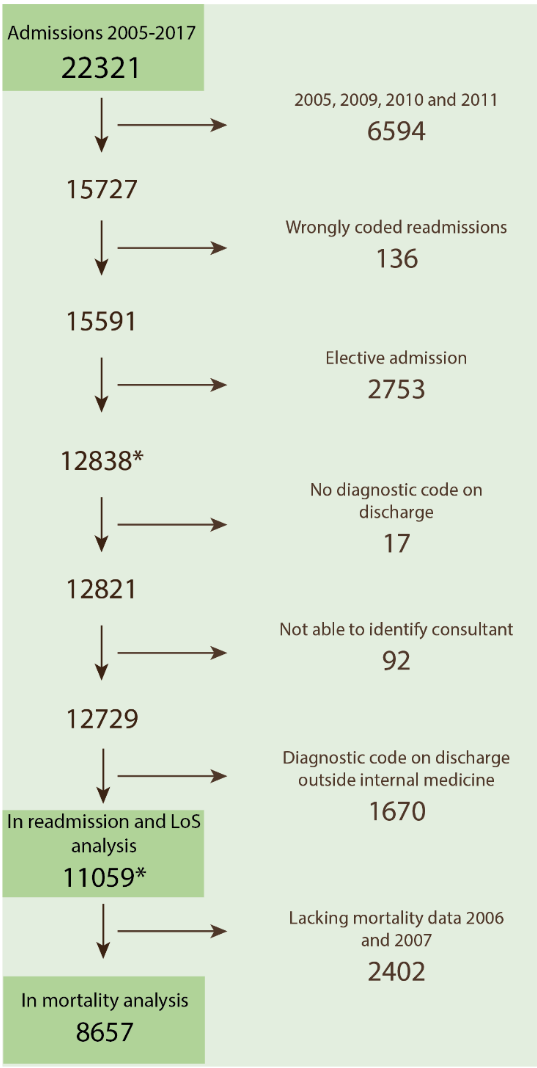
Length of stay was analysed using linear regression, and dummy variables were coded for categorical variables with more than two groups (age groups, diagnostic group and Charlson). Unstandardised coefficients are reported both as crude coefficients and adjusted coefficients with a 95% confidence interval.

3 Results

In total, there were 22321 admissions in the period 2005 to 2017 [figure 1]. Of these, 11059 were included in analyses on readmissions and length of stay, whereas 8657 were included in analysis on in-hospital mortality. The difference of 2402 admissions between the analyses were due to the data from 2006-2007 lacking information about the patients' state (dead or alive) at discharge. Therefore, 2006-2007 could not be analysed for in-hospital mortality but were included in the analysis on readmission and length of stay.

Data from 2007 also lacked information about whether the admission was elective or an emergency. Over half of elective admissions in the material were due to polysomnography (226 out of 424 (53%) elective admissions and 0 emergency admissions in 2006 were coded G47 or R06.5). Those diagnoses (201 G47 and 26 R06.5) were excluded for the 2007 data, but the remaining likely elective admissions were included as they could not be identified, and they were considered to make only a small impact on the results compared to excluding all 2007 data.

Figure 1. Flowchart of admissions included in the different analysis



*** Readmissions were calculated for all emergency admissions (N=12838), even when the following admission did not fulfil inclusion criteria as the readmission was considered a feature of the original admission**

3.1 Characteristics of admissions, patients and consultants

As one person could have more than one admission any year, some characteristics of both patients and admissions are given. Out of the included patients with admission data allowing for analysis on readmissions (N= 5774 patients), 2984 (51.7%) were male. And out of the included admissions with data on readmissions (N=11059 admission), 5682 (51.4%) were male. Median age at admission was 70.4 years old (SD=17.2).

In total, 41 consultants were included and 33 were male [table 2]. Three of these were speciality registrars, and one was general internist, the rest subspecialists. Two of the consultants worked at the hospital for the entire study period. Five were only present in less than one year. Specialists in infectious diseases, oncology or rheumatology were not present in the study period.

Table 2. Description of the consultants (N=41)

Characteristics	Consultants	
	Number	%
Male	33	80.5
Female	8	19.5
Cardiologists	16	39.0
Gastroenterologists	10	24.4
Nephrologists	2	4.9
Pulmonologist	1	2.4
Endocrinologist	6	14.6
Haematologists	1	2.4
Other (registrar, generalist, A&E)	5	12.2

The consultants were on call for a total of 3288 24h shifts in the period included [table 3]. Male consultants covered 8 out of 10 shifts, and there was a cardiologist present on 4 out of 10 shifts. The consultant on call could not be identified for 9 of the shifts; patients affected by this (N=92) were excluded as they could not be connected to the attending consultants.

Table 3. Specialist on call per 24h shift (N=3288)

Characteristics	24h shifts	
	Number	%
Male	2598	79.0
Female	690	21.0
Cardiologists	1337	40.7
Gastroenterologists	805	24.5
Nephrologists	507	15.4
Pulmonologist	314	9.5
Endocrinologist	143	4.3
Haematologists	107	3.3
Other (registrar, generalist, A&E)	66	2.0
Not able to identify consultant	9	0.2

3.2 Readmission

In total, 1273 (11.5%) of the 11059 admissions led to an emergency readmission at the same ward within 30 days [table 4].

Table 4. Sample characteristics and bivariable analysis comparing admissions being followed by a readmission or not (N=11059 admissions).

Variable		Admissions (%)	Readmitted		P-value
			No	Yes	
Total		11059 (100.0)	9786 (88.5)	1273 (11.5)	
Attended by relevant subspecialist	No	3001 (27.1)	2548 (84.9)	453 (15.1)	<0.001
	Yes	8058 (72.9)	7238 (89.8)	820 (10.2)	
Consultant sex	Male	8780 (79.4)	7771 (88.5)	1009 (11.5)	0.902
	Female	2279 (20.6)	2015 (88.4)	264 (11.6)	
Patient sex	Male	5682 (51.4)	5025 (88.4)	657 (11.6)	0.861
	Female	5377 (48.6)	4761 (88.5)	616 (11.5)	
Patient age	0-39	705 (6.4)	636 (90.2)	69 (9.8)	0.241
	40-59	1736 (15.7)	1572 (90.6)	191 (11.0)	
	60-79	4663 (42.2)	4101 (87.9)	562 (12.1)	
	≥ 80	3928 (35.5)	3477 (88.5)	451 (11.5)	
Diagnostic group	General	5840 (52.8)	5311 (90.9)	529 (9.1)	<0.001
	Infectious Diseases	35 (0.3)	33 (94.3)	2 (5.7)	
	Cardiology	2426 (21.9)	2107 (86.9)	319 (13.1)	
	Lung Medicine	1177 (10.6)	971 (82.5)	206 (17.5)	
	Gastroenterology	892 (8.1)	772 (86.5)	120 (13.5)	
	Haematology	166 (1.5)	117 (70.5)	49 (29.5)	
	Endocrinology	202 (1.8)	193 (95.5)	9 (4.5)	
	Nephrology	187 (1.7)	171 (91.4)	16 (8.6)	
	Oncology	50 (0.5)	36 (72.0)	14 (28.0)	
	Rheumatology	84 (0.8)	75 (89.3)	9 (10.7)	
Charlson score	0	3895 (35.2)	3605 (92.6)	290 (7.4)	<0.001
	1	3409 (30.8)	3074 (90.2)	335 (9.8)	
	2	1927 (17.4)	1613 (83.7)	314 (16.3)	
	≥3	1828 (16.5)	1494 (81.7)	334 (18.3)	

In the bivariable analysis, being attended by a consultant with a subspeciality relevant for the patient's diagnosis was associated with reduced readmission (10.2% vs 15.1%, p<0.001).

Readmission was also associated with the diagnostic group and the comorbidity score (Charlson score). Oncology (28.0%) and haematology (29.5%) had the highest readmission rate, whereas endocrinology (4.5%) and infectious diseases (5.7%) the lowest. For the largest group of patients, general internal medicine, the readmission rate was 9.1%. The association between Charlson score and readmission showed a clear gradient, with increased readmission rates with increasing Charlson scores.

The multivariable logistic regression changed the findings from the bivariable analysis [table 5]. After adjusting for the variables in the table, being attended by a consultant with a subspeciality relevant for the patient's diagnosis was no longer associated with reduced readmission (odds ratio (OR) 0.91, 95% confidence interval (CI) 0.76 to 1.09).

Table 5. Crude and adjusted odds ratio (OR) for variables associated with readmissions (N=11059 admissions [1]

Variable		Readmissions				
		Crude OR	Adjusted OR	95% CI		P-value
				Lower	Upper	
Attended by relevant subspecialist	No (ref)	1.00	1.00			
	Yes	0.64	0.91	0.76	1.09	0.308
Consultant sex	Male (ref)	1.00	1.00			
	Female	1.01	1.00	0.86	1.16	0.989
Patient sex	Male (ref)	1.00	1.00			
	Female	0.99	1.03	0.91	1.16	0.633
Patient age	0-39 (ref)	1.00	1.00			
	40-59	1.12	0.88	0.65	1.18	0.378
	60-79	1.26	0.75*	0.56	0.99	0.041
	≥ 80	1.19	0.68*	0.51	0.91	0.009
Diagnostic group	General (ref)	1.00	1.00			
	Infectious Diseases	0.61	0.64	0.15	2.71	0.543
	Cardiology	1.52	1.43*	1.21	1.69	<0.001
	Lung Medicine	2.13	1.67*	1.33	2.11	<0.001
	Gastroenterology	1.56	1.37*	1.08	1.74	0.009
	Haematology	4.21	2.75*	1.86	4.07	<0.001
	Endocrinology	0.47	0.36*	0.18	0.71	0.004
	Nephrology	0.94	0.80	0.47	1.37	0.418
	Oncology	3.90	2.07*	1.07	4.00	0.030
	Rheumatology	1.21	1.05	0.51	2.16	0.903
Charlson score	0 (ref)	1.00	1.00			
	1	1.36	1.34*	1.13	1.60	0.001
	2	2.42	2.33*	1.94	2.81	<0.001
	≥3	2.78	2.72*	2.26	3.27	<0.001

*** p < 0.05**

[1] The model contained six independent variables (gender, age, diagnostic group, treatment by relevant subspecialist, gender of specialist on call at admission and comorbidity score). The full model containing all predictors had a chi squared-value: χ^2 (8, N=11059)=8.841, p=0.356. As a whole the model explained between 2.7% (Cox & Snell R Square) and 5.2% (Nagelkerke R Square) of the variance in readmissions, correctly classifying 88.5% of cases.

The Charlson score and some diagnostic groups were most prominently associated with higher readmission in the multivariable logistic regression model [table 5]. The Charlson score showed a clear gradient also in the adjusted analysis, with higher score associated with higher readmission rates. Compared to general internal medicine, the diagnostic groups with higher readmission were cardiology, lung medicine, gastroenterology, haematology and oncology, while endocrinology was associated with lower readmission rate. Patients aged 60 years and older had reduced readmission rate.

3.3 In-hospital mortality

Data about mortality lacked in 2006 and 2007. In the years where data were available, 281 out of 8657 admitted patients were discharged as dead, giving an in-hospital mortality rate of 3.2%.

Table 6. Sample characteristics and bivariable analysis comparing admissions discharged alive and discharged dead (N=8657 admissions)

Variable		Admissions (%)	Discharged alive		P-value
			Yes	No	
Total		8657 (100)	8376 (96.8)	281 (3.2)	
Attended by relevant subspecialist	No	2313 (26.7)	2215 (95.8)	98 (4.2)	0.002
	Yes	6344 (73.3)	6161 (97.1)	183 (2.9)	
Consultant sex	Male	6727 (77.7)	6516 (96.9)	211 (3.1	0.284
	Female	1930 (22.3)	1860 (96.4)	70 (3.6)	
Patient sex	Male	4449 (51.4)	4313 (96.9)	136 (3.1)	0.307
	Female	4208 (48.6)	4063 (96.6)	145 (3.4)	
Patient age	0-39	512 (5.9)	511 (99.8)	1 (0.2)	<0.001
	40-59	1373 (15.9)	1359 (99.0)	14 (1.0)	
	60-79	3779 (43.7)	3679 (97.4)	100 (2.6)	
	≥ 80	2993 (34.6)	2827 (94.5)	166 (5.5)	
Diagnostic group	General	4626 (53.4)	4494 (97.1)	132 (2.9)	<0.001
	Infectious Diseases	29 (0.3)	29 (100.0)	0 (0.0)	
	Cardiology	1857 (21.5)	1798 (96.8)	59 (3.2)	
	Lung Medicine	951 (11.0)	909 (95.6)	42 (4.4)	
	Gastroenterology	668 (7.7)	640 (95.8)	28 (4.2)	
	Haematology	121 (1.4)	109 (90.1)	12 (9.9)	
	Endocrinology	147 (1.7)	145 (98.6)	2 (1.4)	
	Nephrology	158 (1.8)	157 (99.4)	1 (0.6)	
	Oncology	39 (0.5)	34 (87.2)	5 (12.8)	
	Rheumatology	61 (0.7)	61 (100.0)	0 (0.0)	
Charlson score	0	3084 (35.6)	3059 (99.2)	24 (0.8)	<0.001
	1	2621 (30.3)	2558 (97.6)	63 (2.4)	
	2	1436 (16.6)	1360 (94.7)	76 (5.3)	
	≥3	1517 (17.5)	1399 (92.2)	118 (7.8)	

In the bivariable analysis, being attended by a consultant with a subspeciality relevant for the patient's diagnosis was associated with lower mortality (2.9% vs 4.2%, p=0.002).

Mortality was also associated with patient age, diagnostic group and comorbidity score. Oncology (12.8%) and haematology (9.9%) had the highest rates, whereas both infectious diseases and rheumatology had 0 deaths. The largest group, general internal medicine, had a mortality rate of 2.9%. The association between mortality and both age and Charlson score showed a clear gradient, with increased mortality with both increasing age and Charlson score.

In the multivariable logistic regression, it was adjusted for the variables stated in table 7. Those attended by a consultant whose subspeciality was relevant for the patients' diagnosis had an odds ratio of dying in hospital of 0,71 (95% CI: 0,48 to 1,04).

Table 7. Crude and adjusted odds ratio (OR) for variables associated with in-hospital mortality (N=8657 admissions)[2]

Variable		In-hospital mortality				
		Crude OR	Adjusted OR	95% CI Lower	95% CI Upper	P-value
Attended by relevant subspecialist	No (ref)	1.00	1.00			
	Yes	0.67	0.71	0.48	1.04	0.077
Consultant sex	Male (ref)	1.00	1.00			
	Female	1.16	1.13	0.85	1.50	0.390
Patient sex	Male (ref)	1.00	1.00			
	Female	1.13	1.17	0.92	1.49	0.213
Patient age	0-39 (ref)	1.00	1.00			
	40-59	5.26	3.34	0.43	25.63	0.247
	60-79	13.89	5.88	0.81	42.82	0.081
	≥ 80	30.01	11.80*	1.63	85.74	0.015
Diagnostic group	General (ref)	1.00	1.00			
	Infectious Diseases	0.00	0.00	0.00	-	0.998
	Cardiology	1.12	0.87	0.61	1.24	0.430
	Lung Medicine	1.57	0.91	0.56	1.47	0.692
	Gastroenterology	1.49	1.09	0.66	1.81	0.727
	Haematology	3.75	1.66	0.79	3.45	0.178
	Endocrinology	0.47	0.31	0.07	1.35	0.119
	Nephrology	0.22	0.13*	0.02	0.94	0.043
	Oncology	5.01	1.66	0.58	4.76	0.347
	Rheumatology	0.00	0.00	0.00	-	0.997
Charlson score	0 (ref)	1.00	1.00			
	1	3.14	2.43*	1.50	3.92	<0.001
	2	7.12	4.96*	3.08	7.99	<0.001
	≥3	10.75	7.45*	4.72	11.77	<0.001

*** p < 0.05**

The Charlson score and age ≥80 years were most prominently associated with higher mortality in the multivariable logistic regression model. The Charlson score showed a clear gradient, with higher score associated with higher mortality rate. Patients admitted with

[2] The full model containing all predictors had a chi-squared-value: χ^2 (8, N=8657)=16.240, p=0,039. As a whole the model explained between 2,9% and 11,8% of the variance in in-hospital mortality (Cox & Snell and Nagelkerke R Square), correctly classifying 96,8% of cases.

nephrological diagnoses had lower odds ratio for dying in hospital than the reference population with general medical diagnoses.

3.4 Length of stay

All patients included in the readmission analysis were also analysed for length of stay.

Table 8. Sample characteristics and bivariable analysis on length of stay in number of days (N=11059)

Variable		N	Median	Percentiles 25	Percentiles 75	P-value
Total		11059	2.4	1.0	4.9	
Attended by relevant subspecialist	No	3001	2.6	1.1	4.9	0.170
	Yes	8058	2.3	1.0	4.9	
Consultant sex	Male	8780	2.5	1.0	5.0	0.022
	Female	2279	2.2	1.0	4.7	
Patient sex	Male	5682	2.2	1.0	4.8	0.006
	Female	5377	2.6	1.0	5.0	
Patient age	0-39	705	1.0	0.5	2.0	<0.001
	40-59	1763	1.2	0.7	3.0	
	60-79	4663	2.5	1.0	4.9	
	≥ 80	3928	3.3	1.9	5.9	
Diagnostic group	General	5840	2.5	1.0	5.0	<0.001
	Infectious Diseases	35	2.9	1.5	5.9	
	Cardiology	2427	1.9	0.9	3.9	
	Lung Medicine	1177	3.0	1.7	5.2	
	Gastroenterology	892	2.4	1.1	5.0	
	Haematology	166	2.8	1.1	5.8	
	Endocrinology	202	3.0	1.5	5.9	
	Nephrology	187	3.9	2.1	5.9	
	Oncology	50	5.4	2.3	7.3	
	Rheumatology	84	3.4	2.4	6.9	
Charlson score	0	3895	1.4	0.8	3.1	<0.001
	1	3409	2.6	1.1	4.9	
	2	1927	3.2	1.8	5.9	
	≥3	1828	3.9	2.0	6.0	

In the bivariable analysis, being attended by a consultant with a subspeciality relevant for the patient's diagnosis was not associated with length of stay (median length of stay 2.3 days vs 2.6 days, p=0.170).

Length of stay was associated with patient age, diagnostic group and comorbidity score. Oncology (5.4 days) and nephrology (3.9 days) had the longest median stay time. Cardiology (1.9 days) and gastroenterology (2.4 days) had the shortest median stay time.

Both increasing age and increasing Charlson score were associated with longer hospital stays.

In the multivariable linear regression, it was adjusted for the variables stated in table 9. Being attended by a consultant with a subspeciality relevant for the patient's diagnosis was not associated with length of stay (adjusted coefficient 0.18 days, 95% CI: -0.07 to 0.42).

Table 9. Crude and adjusted coefficients for variables associated with length of stay in number of days (N=11059)[3]

Variable		Crude coefficient	Adjusted coefficient	95% CI Lower	95% CI Upper	P-value
Attended by relevant subspecialist	No (ref)	0.00	0.00			
	Yes	-0.13	0.18	-0.07	0.42	0.158
Consultant sex	Male (ref)	0.00	0.00			
	Female	-0.23	-0.23*	-0.42	-0.04	0.020
Patient sex	Male (ref)	0.00	0.00			
	Female	0.23	0.11	-0.02	0.29	0.097
Patient age	0-39 (ref)	0.00	0.00			
	40-59	0.63	0.70*	0.33	1.06	<0.001
	60-79	1.92	1.86*	1.52	2.20	<0.001
	≥ 80	2.77	2.61*	2.26	2.95	<0.001
Diagnostic group	General (ref)	0.00	0.00			
	Infectious	0.36	1.20	-0.21	2.60	0.096
	Cardiology	-0.85	-0.99*	-1.20	-0.77	<0.001
	Lung Medicine	0.37	0.22	-0.11	0.55	0.139
	Gastroenterology	0.21	0.36*	0.04	0.68	0.029
	Haematology	1.10	0.74*	0.05	1.43	0.035
	Endocrinology	0.92	1.14*	0.51	1.76	<0.001
	Nephrology	1.52	1.48*	0.85	2.11	<0.001
	Oncology	2.96	3.10*	1.91	4.28	<0.001
	Rheumatology	-	-	-	-	
Charlson	0 (ref)	0.00	0.00			
	1	0.54	0.25*	0.06	0.44	0.010
	2	1.43	0.93*	0.70	1.17	<0.001
	≥3	1.77	1.23*	0.93	1.53	<0.001

*** p < 0.05**

[3] The multivariable linear regression-model as a whole explained 7.0% of the variance in length of stay, F (17, 11059) = 38.276, p<0,001. Rheumatology was excluded during regression due to missing correlation. In the final model, all remaining variables were significant except relevant subspecialist, patient sex, infectious diseases and lung medicine.

Increasing age showed the strongest association to length of stay, with a clear gradient. Charlson score also showed association with higher scores leading to longer hospitalisation. Lung medicine and infectious diseases showed no significant association. Female consultant on call at admission was associated with shorter stays than when men were on call. Cardiological patients had shorter stays than general medical patients. All other diagnostic categories were longer hospitalised than the reference.

4 Discussion

4.1 Summary of findings

In this study, being attended by a subspecialist covering the patient's primary diagnosis was not clearly prospectively associated with readmission, length of stay and in-hospital mortality. The direction of the point estimates was towards less readmission and lower in-hospital mortality for those attended by a subspecialist relevant to the patient's primary diagnosis, but with longer length of stay. Patients with more comorbidities had consistently worse outcome after the hospital stay.

4.2 Strengths and limitations

The main strength of this study is that the hospital staffing model made it possible to link the patients and the attending consultants at the start of the stay, due to the rotation system and few consultants present at any time. The inclusion of data from ten years, more than 40 physicians and 11000 admissions, is another strength, suppressing the effect of single physicians which would otherwise be a problem in a small environment like this.

Several factors limit the study. It is an observational register-based study and relies on administrative data manually registered through many years. The missing data and high numbers of exclusions illustrates these limitations. Four years with missing rosters and the admissions without diagnostic code on discharge had to be excluded as it was not possible to connect patient with treating consultant. However, it is not likely that these excluded admissions would change the overall results beyond increasing the power of the study.

Other admissions were omitted on purpose to ensure correct analysis. The elective admissions were excluded as they are often planned to a time where the relevant consultant is present, and the patient is often already diagnosed and only admitted for treatment. This decreases the complexity and the likelihood of being attended by not-relevant subspecialist, and could thereby have affected results. Patients with diagnostic codes outside of internal medicine were excluded as they are more likely to be readmitted or transferred to other wards. In total, the population left for analysis were likely to be the ones most suitable to answer the aim of the study.

The readmission rate in the study data was lower than the one found using data from the Norwegian Directorate of Health [17] (11.5% in this study compared to 15-17%). One reason could be that the data from the national register contains readmissions to all Norwegian hospitals of any cause [23], whereas in this study only readmissions to the same ward was included. Nevertheless, the same criterion was used for both groups and the comparison of the groups on readmissions should thus not be biased.

In the study material, only diagnoses at discharge were available, and these might be affected by the attending consultant. Other studies have adjusted for the physician-diagnose-connection by using an interaction term between physician speciality and principal diagnosis [24], this was not done in this study.

The amount of data about the consultants was also limited, and information about factors that might influence the quality of the treatment given, such as their duration of practise and experience working at smaller hospitals, was not available. Furthermore, no conclusive information about which consultant attended which patient was available, and the study relies on the assumption that the best qualified was the one attending the patient.

4.3 Was the patient matched to the right physicianatient?

In a study like this, the validity of the matching of patient admission and attending physician is a crucial point as it influences the two groups compared. Inpatients often see several physicians, and for the study to be accurate, the physician most influential on treatment, and thereby outcome, should be identified with a high level of certainty. The matching of patient and physician has been done in several ways in similar studies. As reported in the introduction, Bai et al. used the physician responsible for the patient at discharge or death [13], while Weingarten et al. used "physician of record" without further description [6]. Others have used "attending physician" without specifying this [12, 24].

In the present study, it was chosen to connect the patients with the consultant on call and present at the hospital the first three days after admission. With a median stay time of 2.4 days, all consultants present during the stay for well above 50% of admissions are included.

The matching is based on an assumption that most treatment is planned and initiated by the physicians present the first days of the hospitalisation. The ones present at discharge might start their period of work late in the hospital stay, and therefore have little impact on patient outcome. In addition it was expected that sometimes a foundation doctor could wrongly be classified as discharging physician because they are often given the responsibility of writing the discharge papers [25]. Thus, it is likely that the matching of physician and patient in this study had some clear advantages over other studies in this area.

4.4 Was the subspecialist matched to the right diagnoses?

It was wanted to study the full breadth of medical inpatients and therefore chosen to make a system connecting all diagnostic codes to either a medical subspeciality, general medicine or diagnoses outside of medicine. This has not been done in any study we have found. Bai et al. compare generalists to specialists, regardless of diagnosis[13]. Weingarten et al. include only patients admitted with community-acquired pneumonia (lung medicine/infectious diseases), upper gastrointestinal haemorrhage (gastroenterology), congestive heart failure (cardiology) and myocardial infarction (cardiology) and match these patients to being treated by a relevant specialist (mentioned in parentheses) [6]. Lindenauer et al. also use a limited selection of diagnoses and commented:

> Although the seven conditions we studied are extremely common, they make up a relatively small percentage of the annual caseload for physicians who care for hospitalised patients. Consequently, there is a risk that our findings may not be generalisable to the full spectrum of inpatient medicine. [24]

As the study aimed to include all types of patients, the patients were matched on diagnosis with a specialist using a self-developed list. Although this list was discussed with experienced clinicians from a range of specialities, there was no further validation, and it is recognised that part of the classification can be discussed. Especially the distinction between diagnoses that are covered by general internal medicine and a specific subspecialist medicine has been an issue. To address this, two professors in cardiology and haematology at the Norwegian University of Science and Technology were asked which diagnoses falling within their subspeciality they felt all specialists in internal medicine should be able to treat equally good, and which diagnoses a patient could expect significantly better treatment from a subspecialist. This input was, together with feedback from the hospital's chief of medicine, used to draw the line.

Despite measures taken it is still uncertainties connected to the categorisation. Still, what was done is transparent as full categorisation is available in the appendix and can be discussed and tested.

4.5 Causal effects or not

To say that there is a causal effect one would have to know that a given exposure leads to a given outcome and that in the absence of the exposure, the outcome is also absent [26]. The best model to study the causal effect in a clinical setting would be a randomised controlled trial (RCT), randomising patients to being attended, either by a relevant or a not-relevant subspecialist. However, that would not be practically nor ethically possible. When McAlister et al. studies patient outcome based on physician experience they "quasirandomises" patients between attendings by taking advantage of patients in Alberta being admitted to wards based in bed availability and attending physicians rotating the wards every 1-4 weeks [12]. Bai et al. look at only one general internal medicine ward with a staff consisting of both internist and specialist [13]. The current study does as Bai et al.; however, an added benefit in the current study was the staffing model with only a few rotating consultants present for longer timespans combined with patients admitted as emergencies.

However, it is not only this exposure which affects patient outcome. Also, other factors (confounders) have an impact on readmissions, mortality and length of stay. From the literature, it is known that low age, male sex, comorbidities (especially neoplasms and severe liver disease) and longer hospital stay are associated with increased readmission risk [27, 28]. For in-hospital mortality, prior admissions, comorbidities (especially neoplasms) and the admission diagnosis, are associated with increased risk [29]. Prolonged length of stay is associated with male sex and lower age [30]. This study's multivariable analyses were therefore adjusted for patient sex, age, diagnostic group and Charlson comorbidity score. In addition, they were adjusted for sex of consultant, which is also shown to impact on patient outcome [31]. Other studies have solved this using propensity matching on age, sex, comorbidities (Charlson score) and top 7 admission diagnoses [13], adjusting multivariable models for principal diagnosis, patient and hospital characteristics and annualised physician case volume [24] or age, sex and LACE-score (predictive score containing Charlson score, length of stay, acuity of admission and visits in emergency rooms last six months) [12].

Another issue is the attending consultants influence on the discharge diagnosis, which might be confounding by indication [32] as subspecialist are more likely to diagnose the patient within own field of speciality [5]. This would in theory lead to more misdiagnosed patients in the group attended by relevant subspecialist, which could lead to a worse outcome. It is assumed this might have happened in the study, but that the overall impact is small. Besides, one could argue that this effect is part of how a general medical ward staffed by subspecialists work and that the impact is reflecting reality.

4.6 Does the relevant subspecialist lead to better outcome?

In this study, it was found that – at least in this hospital – the patient outcome after being attended by a specialist in internal medicine, with a subspecialisation relevant for the patient's primary diagnosis, was not significantly different to after being attended by a specialist in internal medicine with a subspecialisation not relevant for the patient's primary diagnosis. However, the direction of the point estimates was towards lower mortality rate and readmission rate for those attended by a relevant subspecialist. This is in line with Weingarten et al. who found a lower mortality odds ratio, when treated by relevant subspecialist, of 0.68 (p=0.047) [6].

Before adjusting for the other variables in the regression models, treatment from relevant subspecialist was significantly reducing both readmission and mortality, but the effect became insignificant after adjustment. Whereas patient characteristics are assumed to be evenly distributed between the groups, a large portion of the diagnoses were not. All admissions considered to be general internal medicine were grouped as treated by the relevant subspecialist. This was a large group; over half the admissions were due to a general internal medicine diagnosis [table 4]. This group had a lower readmission rate and a lower mortality rate than the total study population [table 4 and table 6]. A measure for disease severity was not available; this might explain why the group attended by a relevant subspecialist had a better outcome in bivariable and unadjusted analyses.

David Epstein has popularised a theory stating that sub- and subsubspecialisation has gone too far and that the generalist and outsider viewpoints are needed to connect the subspecialists' deep, but limited, knowledge [33]. His theory applies more to society in general than only to health care. Nevertheless, it might help explain why the subspecialists advantage in studies on individual diagnoses seems to be neutralised in the more complex environment in this study. Perhaps the multidisciplinary team consisting of a consultant, a foundation doctor and the nursing staff is well functioning, regardless of the consultant's subspeciality.

How is this translated into optimal care? Should generalists staff the emergency room (ER) and the subspecialists the wards? In larger hospitals, this is the trend with the new specialisation in acute- and emergency medicine [34]. In smaller hospitals, as the one studied here, this is not an option. The consultants must cover both ER, inpatient wards and outpatient clinic. This requires them to be broad thinkers in the ER, updated on treatment outside their speciality on the ward and upfront on treatment within their speciality in the clinic. The results in this study with small/no effect of being attended by a relevant subspecialist could be due to the consultants becoming specialised in this way of working.

4.7 Is it the physician or the diagnosis or other things?

In the multivariable analyses, the most consistent factor associated with the outcomes was the Charlson comorbidities score. It was found a clear gradient where higher level of comorbidity was associated with increased readmission rate, in-hospital mortality-rate and length of stay in both adjusted and unadjusted analysis. Comorbidities are mentioned in literature as an important factor for all of these outcomes [27-29, 35], as it increases complexity and often requires coordination of treatment for the present and the underlying diseases.

Age shows a clear gradient where higher age leads to increasing readmission rate, in-hospital mortality rate and length of stay in all unadjusted analyses. Age only retains the gradient in adjusted analyses for mortality, where it is insignificant for those under 80 years, and length of stay. In adjusted analyses for readmission rate, the gradient turns around showing a lower rate with increased age. This is in line with the literature mentioning young age as a risk for readmissions [27].

Patient sex does not affect any of the outcome variables, despite literature mentioning it as a factor in both readmissions and in-hospital mortality [27-29].

Sex of the consultant does not affect mortality or readmission rates. However, a shorter length of stay was associated with a female consultant being on call at admission. There is no further data in this study to explain this, but some suggestions can be made. One reason could be that the female consultants are more stable through the study period, the locum consultants are mainly men, and that the female consultant on average might have been more accustomed to the local practise. But if this were the case, an effect on readmission and mortality would also be expected.

Patients with diagnoses within haematology and oncology had a poorer outcome than the other groups. This could originate from the sorting of diagnoses. The most common haematological diagnoses such as lung embolisms, distal venous thrombosis and anaemias are considered to be general internal medicine. More complicated haematology is most often treated at larger hospitals. The group subsequently classified as haematological in this study is more often multimorbid and older than the total population.

Oncology is, as mentioned earlier, mostly placed under the organ specialist. The diagnoses left as oncological are mainly metastatic diseases, which is often in a palliative phase with frequent readmissions and high in-hospital mortality.

4.8 Conclusion

In a small-sized hospital where physicians are used to treating patients with a broad spectrum of medical diseases, there is not a clear, prospective association between being attended by a relevant subspecialist and better patient outcome, measured as readmissions, in-hospital mortality and length of stay. The direction of point estimates was towards lower readmission and in-hospital mortality rates, but these are of uncertain clinical significance.

Further studies are needed to evaluate if the findings also can be applied in larger hospitals with more specialised personnel and to evaluate other factors with influence, e.g. teamwork, nursing staff, physician's experience and disease severity.

4.9 Implications for practice and research

It seems that in this hospital, the patients' outcome is not significantly affected by the subspeciality of attending consultant. Therefore, there is no argument for changing staffing policy.

Further studies are needed, especially in a broader selection of diagnoses and causes of admissions. These should also investigate other factors with influence, e.g. more specialised wards, physician's experience, disease severity and composition of the team attending the patient.

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Appendix

1: Approval from Regional Ethical Committee

2: List of diagnoses within each category

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK midt	Ramunas Kazakauskas		18.05.2020	96104
			Deres referanse:	

Aslak Steinsbekk

96104 Hvor god er indremedisinske subspesialister på problemstillinger utenfor egen subspesialitet?

Forskningsansvarlig: Norges teknisk-naturvitenskapelige universitet

Søker: Aslak Steinsbekk

Søkers beskrivelse av formål:

Formålet med prosjektet er å se om pasientutfall påvirkes av at behandlende lege er subspesialisert i diagnosen pasienten legges inn med. Studien blir en retrospektiv kohortstudie hvor innlagte pasienter ved SI Tynset i perioden 2005-2017 grupperes etter om deres hoveddiagnose var innenfor eller utenfor subspesialiteten til en av de to overlegene som var tilstede uken pasienten ble lagt inn.
SI Tynset bemannes med "off-shore turnus" (overlegene går 2 uker på/3 uker av) og man kan derfor anta at pasienten behandles av de samme legene som var på vakt ved innkomst i store deler av pasientforløpet.

REKs vurdering

Komiteen har vurdert søknad, forskningsprotokoll, målsetting og plan for gjennomføring. Du søker om fritak fra samtykkekravet for både pasientene og legene i studien. Vi viser til helseforskningsloven § 35 og gir herved dispensasjon fra taushetsplikt, slik at opplysninger kan gis fra helsepersonell og registre uten hinder av taushetsplikt, til bruk i det beskrevne prosjektet. Vi godkjenner også at du behandler personopplysninger uten samtykke fra den enkelte deltaker. Du kan delegere nødvendig tilgang til de andre personene som er nevnt i søknadens liste over medarbeidere. Vi begrunner vårt vedtak med at dataene som du skal innhente er lite sensitive. Studieresultatene som gjelder legene skal ikke brytes ned til deres spesialitet som videre ivaretar legenes anonymitet. Hensynet til deltakernes velferd og integritet er ivaretatt. Det ville være vanskelig å innhente samtykke på grunn av studiens omfang. Vi vurderer at forskningsprosjektet er av vesentlig interesse for samfunnet.

Under forutsetning av at du tar vilkårene nedenfor følge vurderer vi at prosjektet er forsvarlig, og at hensynet til deltakernes velferd og integritet er ivaretatt.

Vilkår for godkjenning

1. Dispensasjonen fra taushetsplikt gjelder kun for de opplysningene som er relevante for studien.

2. Komiteen forutsetter at ingen personidentifiserbare opplysninger kan framkomme ved publisering eller annen offentliggjøring.
3. Komiteen forutsetter at du og alle prosjektmedarbeiderne følger institusjonens bestemmelser for å ivareta informasjonssikkerhet og personvern ved innsamling, bruk, oppbevaring, deling og utlevering av personopplysninger.
4. Av dokumentasjonshensyn må du oppbevare opplysningene i 5 år etter prosjektslutt. Opplysningene skal oppbevares avidentifisert, dvs. atskilt i en nøkkel- og en datafil. Opplysningene skal deretter slettes eller anonymiseres.

Vedtak

Godkjent med vilkår

Med vennlig hilsen

Vibeke Videm
Dr. med.
Leder, REK midt

Ramunas Kazakauskas
Rådgiver

Sluttmelding
Søker skal sende sluttmelding til REK midt på eget skjema senest seks måneder etter godkjenningsperioden er utløpt, jf. hfl. § 12.

Søknad om å foreta vesentlige endringer
Dersom man ønsker å foreta vesentlige endringer i forhold til formål, metode, tidsløp eller organisering, skal søknad sendes til den regionale komiteen for medisinsk og helsefaglig forskningsetikk som har gitt forhåndsgodkjenning. Søknaden skal beskrive hvilke endringer som ønskes foretatt og begrunnelsen for disse, jf. hfl. § 11.

Klageadgang
Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK midt. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK midt, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering.

Diagnoses within each diagnostic category

General Internal Medicine
A04 A05 A08 A09 A35 A36 A37 A38 A39 A40 A41 A46 B00 B01 B02 B06 B07 B08 B09 B25 B26 B27 B30 B37 D50 D51 D52 E40 E41 E42 E43 E44 E45 E46 E50 E51 E52 E53 E54 E55 E56 E58 E59 E60 E61 E63 E64 E65 E66 E67 E68 E86 G45 G47 H34 H60 H65 H66 H67 H92 I26 I61 I62 I63 I64 I65 I66 I69 I80 I81 I82 I83 I84 I85 I86 I87 I88 I89 J00 J01 J02 J05 J06 J09 J10 J11 J12 J13 J14 J15 J16 J17 J18 J20 J21 J22 J30 J93 M53 M54 N30 N39 O25 R02 R03 R07 R45 R46 R50 R52 R53 R55 R56 R57 R58 R59 R60 R61 R62 R63 R64 R65 R68 R69 R74 R77 R78 R79 R80 R81 R82 R84 R89 R93 R94 R96 R98 R99 S06 S20 T4N T51 T68 T78 T81 T88 Z00 Z03 Z04 Z48

Infectious Diseases
A00 A01 A02 A03 A06 A07 A15 A16 A17 A18 A19 A20 A21 A22 A23 A24 A25 A26 A27 A28 A30 A31 A32 A42 A43 A44 A48 A49 A75 A77 A78 A79 A80 A81 A82 A83 A84 A85 A86 A87 A88 A89 A92 A93 A94 A95 A96 A97 A98 A99 B03 B04 B05 B20 B21 B22 B23 B24 B33 B34 B38 B39 B40 B41 B42 B43 B44 B45 B46 B47 B48 B49 B50 B51 B52 B53 B54 B55 B56 B57 B58 B60 B64 B65 B66 B67 B68 B69 B70 B71 B72 B73 B74 B75 B76 B77 B78 B79 B81 B82 B83 B89 B90 B91 B92 B94 B99 G00 G01 G02 G03 G04 G05 G06 G07 G08 R75 R76

Cardiology
C38 D15 I01 I02 I05 I06 I07 I08 I09 I10 I11 I13 I20 I21 I22 I23 I24 I25 I27 I28 I30 I31 I32 I33 I34 I35 I36 I37 I38 I39 I40 I41 I42 I43 I44 I45 I46 I47 I48 I49 I50 I51 I52 I70 I71 I72 I73 I74 I77 I78 I79 I95 I97 I98 I99 R00 R01 Z95

Pulmonary Medicine
C34 D02 D14 D38 D86 E84 J04 J37 J39 J40 J41 J42 J43 J44 J45 J46 J47 J60 J61 J62 J63 J64 J65 J66 J67 J68 J69 J70 J80 J81 J82 J84 J85 J86 J90 J91 J92 J94 J95 J96 J98 J99 R04 R05 R06 R09 R91

Gastroenterology
B15 B16 B17 B18 B19 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C48 D01 D12 D13 D19 D20 D37 E73 K20 K21 K22 K23 K25 K26 K27 K28 K29 K30 K31 K50 K51 K52 K55 K58 K59 K62 K63 K64 K66 K67 K70 K71 K72 K73 K74 K75 K76 K77 K82 K83 K85 K86 K87 K90 K91 K92 K93 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R85

Haematology
C81 C82 C83 C84 C85 C86 C88 C90 C91 C92 C93 C94 C95 C96 D45 D46 D47 D53 D55 D56 D57 D58 D59 D60 D61 D62 D63 D64 D65 D66 D67 D68 D69 D70 D71 D72 D73 D74 D75 D76 D77 D80 D81 D82 D83 D84 D89 R70 R71 R72

Endocrinology
C37 C73 C74 C75 D34 D35 D44 E00 E01 E02 E03 E04 E05 E06 E07 E10 E11 E12 E13 E14 E15 E16 E20 E21 E22 E23 E24 E25 E26 E27 E28 E29 E30 E31 E32 E34 E35 E70 E71 E72 E74 E75 E76 E77 E78 E79 E80 E83 E88 E89 E90 M80 M81 M82 M83 O24 R73

Nephrology
E87 I12 I15 N00 N01 N02 N03 N04 N05 N06 N07 N08 N10 N11 N12 N14 N15 N16 N17 N18 N19 N25 N26 N27 N28 N29 R31 R33 R34 R35

Rheumatology
E85 I00 M05 M06 M07 M08 M09 M10 M11 M12 M13 M14 M30 M31 M32 M33 M34 M35 M36 M45 M46 M60 M61 M65

Oncology
C39 C45 C49 C76 C77 C78 C79 C80 C97 D21 D36 D48

Outside internal medicine

Dermatology
A51 A52 A53 A54 A55 A56 A57 A58 A59 A60 A63 A64 A65 A66 A67 A68 A69 A70 A71 A74 B35 B36 B85 B86 B87 B88 C43 C44 D03 D04 D17 D18 D22 D23 L00 L01 L02 L03 L04 L05 L08 L10 L11 L12 L13 L14 L20 L21 L22 L23 L24 L25 L26 L27 L28 L29 L30 L40 L41 L42 L43 L44 L45 L50 L51 L52 L53 L54 L55 L56 L57 L58 L59 L60 L62 L63 L64 L65 L66 L67 L68 L69 L70 L71 L72 L73 L74 L75 L80 L81 L82 L83 L84 L85 L86 L87 L88 L89 L90 L91 L92 L93 L94 L95 L97 L98 L99 R21 R22 R23

Paediatrics
A33 A50 B80 P00 P01 P02 P03 P04 P05 P07 P08 P10 P11 P12 P13 P14 P15 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29 P35 P36 P37 P38 P39 P50 P51 P52 P53 P54 P55 P56 P57 P58 P59 P60 P61 P70 P71 P72 P74 P75 P76 P77 P78 P80 P81 P83 P90 P91 P92 P93 P94 P95 P96 R95

Gyneacology
A34 C51 C52 C53 C54 C55 C56 C57 C58 D06 D07 D09 D25 D26 D27 D28 D39 N61 N70 N71 N72 N73 N74 N75 N76 N77 N80 N81 N82 N83 N84 N85 N86 N87 N88 N89 N90 N91 N92 N93 N94 N95 N96 N97 N98 N99 O00 O01 O02 O03 O04 O05 O06 O07 O08 O10 O11 O12 O13 O14 O15 O16 O20 O21 O22 O23 O26 O27 O28 O29 O30 O31 O32 O33 O34 O35 O36 O40 O41 O42 O43 O44 O45 O46 O47 O48 O60 O61 O62 O63 O64 O65 O66 O67 O68 O69 O70 O71 O72 O73 O74 O75 O80 O81 O82 O83 O84 O85 O86 O87 O88 O89 O90 O91 O92 O94 O95 O96 O97 O98 O99 R87

Ophthalmology
C69 D31 H00 H01 H02 H03 H04 H05 H06 H10 H11 H13 H15 H16 H17 H18 H19 H20 H21 H22 H25 H26 H27 H28 H30 H31 H32 H33 H35 H36 H40 H42 H43 H44 H45 H46 H47 H48 H49 H50 H51 H52 H53 H54 H55 H57 H58 H59

Orthopaedics
C40 C41 C46 D16 M00 M01 M02 M03 M15 M16 M17 M18 M19 M20 M21 M22 M23 M24 M25 M40 M41 M42 M43 M47 M48 M49 M50 M51 M62 M63 M66 M67 M68 M70 M71 M72 M73 M75 M76 M77 M79 M84 M85 M86 M87 M88 M89 M90 M91 M92 M93 M94 M95 M96 M99 T84

ENT
C00 C01 C02 C03 C04 C05 C06 C07 C08 C09 C10 C11 C12 C13 C14 C30 C31 C32 C33 D00 D10 D11 H61 H62 H68 H69 H70 H71 H72 H73 H74 H75 H80 H81 H82 H83 H90 H91 H93 H94 H95 J03 J31 J32 J33 J34 J35 J36 J38 K00 K01 K02 K03 K04 K05 K06 K07 K08 K09 K10 K11 K12 K13 K14 R42 R43 R49

Breast- and endocrine surgery
C50 D05 D24 N60 N62 N63 N64 R92

Urology
C60 C61 C62 C63 C64 C65 C66 C67 C68 D29 D30 D40 D41 N13 N20 N21 N22 N23 N31 N32 N33 N34 N35 N36 N37 N40 N41 N42 N43 N44 N45 N46 N47 N48 N49 N50 N51 R30 R32 R36 R39 R86

Neurosurgery
C70 C71 C72 D32 D33 D42 D43 G91 I60 I67

Neurology
C47 G09 G10 G11 G12 G13 G14 G20 G21 G22 G23 G24 G25 G26 G30 G31 G32 G35 G36 G37 G40 G41 G43 G44 G46 G50 G51 G52 G53 G54 G55 G56 G57 G58 G59 G60 G61 G62 G63 G64 G70 G71 G72 G73 G80 G81 G82 G83 G90 G92 G93 G94 G95 G96 G97 G98 G99 I68 R20 R25 R26 R27 R29 R40 R41 R44 R47 R51 R54 R83 R90

Gastrointestinal Surgery
K35 K36 K37 K38 K40 K41 K42 K43 K44 K45 K46 K56 K57 K60 K61 K65 K80 K81

Psychiatry
F00 F01 F02 F03 F04 F05 F06 F07 F08 F09 F10 F11 F12 F13 F14 F15 F16 F17 F18 F19 F20 F21 F22 F23 F24 F25 F26 F27 F28 F29 F30 F31 F32 F33 F34 F35 F36 F37 F38 F39 F40 F41 F42 F43 F44 F45 F46 F47 F48 F49 F50 F51 F52 F53 F54 F55 F56 F57 F58 F59 F60 F61 F62 F63 F64 F65 F66 F67 F68 F69 F70 F71 F72 F73 F74 F75 F76 F77 F78 F79 F80 F81 F82 F83 F84 F85 F86 F87 F88 F89 F90 F91 F92 F93 F94 F95 F96 F97 F98 F99 R48

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