ABSTRACT:

Aims and objectives: To contribute in-depth knowledge of the characteristics of medication administration and interruptions in nursing homes. The following research questions guided the study: *How can the medication administration process in nursing homes be described? How can interruptions during the medication administration process in nursing homes be characterized?*

Background: Medication administration is a vital process across health care settings, and earlier research in nursing homes is sparse. The medication administration process is prone to interruptions that may lead to adverse drug events. On the other hand, interruptions may also have positive effects on patient safety.

Design: A qualitative observational study design was applied.

Methods: Data were collected using partial participant observations. An inductive content analysis was performed.

Results: Factors that contributed to the observed complexity of medication administration in nursing homes were the high number of single tasks, varying degree of linearity, the variability of technological solutions, demands regarding documentation, and staff's apparent freedom as to how and where to perform medication-related activities. Interruptions during medication administration are prevalent and can be characterized as passive (e.g., alarm and background noises), active (e.g., discussions), or technological interruptions (e.g., use of mobile applications). Most interruptions have negative outcomes, while some have positive outcomes.

Conclusions:

A process of normalization has taken place whereby staff put up with second-rate technological solutions, noise and interruptions when they are performing medication-related tasks. Before seeking to minimize interruptions during the medication administration process, it is important to understand the interconnectivity of the elements using a systems approach.

Relevance to clinical practice

Staff and management need to be aware of the normalization of interruptions. Knowledge of the complexity of medication administration may raise awareness and highlight the importance of maintaining and enhancing staff competence.

WHAT DOES THIS PAPER CONTRIBUTE TO THE WIDER GLOBAL CLINICAL COMMUNITY?

- The study presents an original description and categorization of interruptions that occur in daily practice at nursing homes.
- It expands the knowledge of medication administration in nursing homes, demonstrating that complexity in the medication administration process seems universal, and that interruptions are normalized and may have both positive and negative outcomes.
- It highlights that a deeper understanding of the underlying work-system is important before implementing interventions to remedy adverse drug events associated with interruptions.

Keywords: complexity, interruptions, medication administration, nursing homes, patient safety, primary care

MEDICATION ADMINISTRATION AND INTERRUPTIONS IN NURSING HOMES: A QUALITATIVE OBSERVATIONAL STUDY

INTRODUCTION

Alongside a growing elderly population, there are demands for increased collaboration between primary care and specialist healthcare (Cardoso, Oliveira, Barbosa-Póvoa & Nickel, 2012; Monkerud & Tjerbo, 2016). This has led to nursing homes caring for patients who often have multiple and complex diagnoses and a high prevalence of polypharmacy (Herr et al. 2017). This is also the case in Norwegian nursing homes where increased collaboration with the specialist healthcare service has led to nursing homes being required to receive patients from hospitals as soon as they are ready for discharge, and incurring punitive economic sanctions if failing to meet those demands. This has led to increased pressure for nursing homes to receive patients with ongoing medical treatment and complex diagnoses (Syse & Gautun, 2013).

The most common types of adverse events in primary care are those related to diagnosis and medication (Makeham, Dovey, Runciman & Larizgoitia, 2008; Marchon & Mendes, 2014). The World Health Organization (WHO) (2014; 2016) supports this, designating medication administration as a major source of adverse events.

Medication administration is a complex process, consisting of different stages depending on workflow and workplace conditions. Six stages are often described in the literature: (1) ordering, (2) transcribing, (3) preparing, (4) dispensing, (5) administering, and (6) monitoring and reporting (Carayon, Wetterneck, Cartmill et al., 2014). It has been estimated that healthcare

personnel perform a total of 50–200 tasks, from the doctor prescribing a drug to the drug being administered, and possible effects observed and documented (Kliger, Blegen, Gootee & O'Neil, 2009; Moyen, Camiré & Stelfox, 2008).

The medication administration process is prone to different kinds of interruptions. Estimates document that nurses are interrupted at a rate of 0.4–14 times an hour when performing tasks related to medication administration (Alvarez & Coiera, 2005; Biron, Loiselle & Lavoie-Tremblay, 2009; Lee, Tiu, Charm & Wong, 2015; Monteiro, Avelar & Pedreira, 2015). The risk of adverse events may increase by 60% if nurses are disrupted in their workflow during the preparation stage (Biron, Loiselle et al., 2009). Others have found that both the dosing and administering of medications are particularly vulnerable stages at which adverse events are more likely to occur (Kunac & Reith, 2008; Leape et al., 1995).

Medication administration is an interwoven process inseparable from other nursing activities, and some researchers claim that to investigate it properly, there must be greater understanding of the underlying process and the work system in which it takes place (Hopkinson & Jennings, 2013; Jennings, Sandelowski & Mark, 2011; Tucker & Spear, 2006).

The WHO (2017) recommends using a Human Factors approach and has set a worldwide target of reducing severe, avoidable medication-related adverse events by 50% over the next five years. The Human Factors literature mentions interruptions as a vital contributing factor to adverse drug events, linking it to underlying factors in the physical environment such as noise and layout, and attributes associated with tasks such as cognitive load and workload. Central in Human Factors literature is the work system in which a person or persons perform tasks in a physical environment using different tools and technology under certain organizational conditions. These factors in the work system interact and affect processes being performed (Carayon et al., 2006).

Due to the complexity of medication administration and the acknowledgment of interruptions as a potential source of adverse medication events, the objective of this paper is to expand our knowledge of the medication administration process in the context of nursing homes.

BACKGROUND

Overall, research suggests that interruptions are a vital contributor to unsafe clinical practices and may lead to adverse drug events (Biron, Lavoie-Tremblay & Loiselle, 2009; Bower, Jackson & Manning, 2015; WHO, 2016). At the same time, some researchers argue that interruptions may have positive effects on patient safety, and are a necessary part of conducting safe clinical practices (Anthony, Wiencek, Bauer, Daly & Anthony, 2010; Hopkinson & Jennings, 2013; Rivera & Karsh, 2010).

The research literature uses terms like interruptions, distractions, and disruptions interchangeably and with varying definitions. The use of different terms has led to some ambiguity when comparing numbers and results (Hopkinson & Jennings, 2013). This study defines interruptions as a halt or break in a primary work task; alternatively engaging in a secondary task that takes attention away from and stops interaction with the primary task (Biron, Loiselle et al., 2009; Li, Magrabi & Coiera, 2012).

Several reviews on interruptions during medication administration have focused on acute medical care and hospital settings (Biron, Loiselle et al., 2009; Grundgeiger & Sanderson, 2009; Hopkinson & Jennings, 2013; Keers, Williams, Cooke & Ashcroft, 2013; Li, Magrabi & Coiera, 2012; Monteiro et al., 2015; Moyen, Camiré & Stelfox, 2008; Raban & Westbrook, 2014; Rivera & Karsh, 2010). Knowledge of what characterizes the medication administration process in nursing homes is sparse. Al-Jumaili & Doucette (2017) indicate that work system factors such as

patient characteristics, nursing staff knowledge of medication administration, staff/patient ratio, and technology in use may affect medication safety. Lee et al., (2015) explicitly examined interruptions during medication administration in nursing homes and found suboptimal conditions. They reported four to five such interruptions an hour, mostly from patients. Interventions to reduce interruptions document varying results depending on the context in which they are implemented (Dall'Oglio et al., 2017; Lapkin, Levett-Jones, Chenoweth & Johnson, 2016; Westbrook et al., 2017). A review of the current literature indicates a knowledge gap related to medication administration and interruptions in the nursing home context.

The aim of this study is, therefore, to contribute in-depth knowledge of the characteristics of medication administration and interruptions in nursing homes. The following research questions guided the study:

How can the medication administration process in nursing homes be described?

How can interruptions during the medication administration process in nursing homes be characterized?

METHODS

Design

The study had a qualitative observational design (Maxwell, 2008) and was carried out in two nursing homes in Eastern Norway in 2016. This was the most appropriate design due to the lack of in-depth studies on medication administration and interruptions in the nursing home setting, and a lack of observational studies to systematically map the surrounding work system.

Study setting, recruitment, and participating wards

As in many other countries, Norwegian nursing homes differ in style of management, size and patient types. They are managed independently in each municipality, and a common task for Norwegian nursing homes is active treatment in addition to ensuring that the basic needs of the residents are satisfied (Malmedal, 2014).

When recruiting nursing homes, the goal was to acquire variation through purposeful sampling. Therefore two different nursing homes in two different municipalities in Eastern Norway were approached (Maxwell, 2008). In one nursing home, an urban-based palliative care centered nursing ward (Ward A) was included. In the other nursing home, a rural-based nursing ward with patients primarily suffering from dementia (Ward B) was included.

Initial contact with the nursing homes was made by telephone during December 2015. Senior managers at both nursing homes were briefly informed of the intent and form of the study, whereupon they agreed to participate and contacted the wards they deemed appropriate for inclusion. The first author then contacted the local management of the two wards and briefed them in person. They agreed to participate in the study, and the first author arranged a preparatory meeting with the staff at the wards. The meetings took place at the respective wards, and staff were informed of the study and given the opportunity to ask questions.

Common for both participating wards is that medicine rooms are distant from the rest of the ward, the nurses' station, and common rooms. Both wards, therefore, employ medication trolleys, placed in the nurses' stations, for the everyday administration of medications. Nurses' stations and common rooms are physical environments with a high level of activity and background noise. Stationary computers for documentation tasks are available at the nurses' station, as well

as procedures, journals, paper documentation, guidelines and papers and equipment relevant for day-to-day clinical practices.

Ward A conducts pre-visitations in the nurses' station. Ward B conducts pre-visitations in a dedicated office, largely secluded from the rest of the ward, with less interference from other activity and background noise. Wireless network access is good in Ward A and intermittent in Ward B. Key characteristics of Ward A and Ward B are listed in Table 1.

INSERT TABLE 1

Data collection

The first author, a male registered nurse, conducted fieldwork through partial participant observations (Hammersley & Atkinson, 2007). A guide for observations in line with Human Factors theory was based on the following keywords: "Tools & technology," "Tasks," "Organization," "Physical environment" and "Persons" (Carayon et al., 2006). Using this guide helped the researcher to focus on the different elements of the work system in which the process of medication administration takes place. A pilot study was performed in January 2016 in a nursing home ward different from the included wards but in a comparable contextual setting in order to test data collection methods and the observation guide. This led to a more detailed observation guide. Data from the pilot study were not used in the analysis of the current study.

Observations took place twice a week, 2−6 hours a day totaling 140 hours from April to November 2016. Most observations took place in the daytime shift, and a few on the evening shift and initial hours of the night shift. Data collection was centered on scheduled critical aspects of medication administration; e.g., pre-visitation (ordering and transcribing), and activities in the medicine room (dispensing). Staff members were observed during the entire medication

administration process. The researcher did not actively partake in clinical work but was dressed in work attire like the rest of the staff. Awareness of the importance of reflexivity during the research process was ever present to minimize researcher influence (Maxwell, 2008). The researcher wrote field notes and transcribed them immediately afterward. When necessary, conversations with staff to clarify aspects of medication administration and to explore the process were conducted. These were not digitally recorded, but citations and excerpts from conversations were noted verbatim during observations.

Analysis

Shortly after the data-collection had been finalized, the co-authors convened and discussed transcribed observational notes after a thorough read-through to ascertain a common understanding of the data. The analysis was performed in two parts. In the first part, information from the six stages of the medication administration process was obtained from analysis of the observational notes and the researchers' field experience. The process was documented as a chronological narrative, presented as a functional flowchart depicting the commonalities and key differences in the two wards. In the second part, the qualitative inductive content analysis in line with Elo and Kyngäs (2008) was performed in three phases. The preparation phase involved re-reading the material several times and selecting the individual wards as units of analysis. An important step was making sense of the data as a whole. After that followed an organization phase with open coding in the margin of transcribed notes, and grouping by similarities and subsequent categorization. Altogether 248 units of meaning were grouped in 10 descriptive sub-categories based on content similarities. Examples of sub-categories are "incoming calls" and "use of mobile applications." The sub-categories were abstracted to three categories, for example

"technological interruptions," that were classified under one main category. An excerpt from the analysis exemplifies how units of meaning were categorized as shown in table 2.

INSERT TABLE 2

Grouping, categorization, and abstraction were carried out in NVIVO 11. Analytical triangulation with co-authors led to the organization phase being repeated several times before reaching a conceptual model in the reporting phase (Elo & Kyngäs, 2008). Excerpts from observational notes were chosen to illustrate the categories and reported in italics throughout the results section. The paper has been prepared according to the SRQR guidelines (O'Brien, Harris, Beckman, Reed & Cook, 2014).

Ethics

The Norwegian Social Science Data Service (NSD) (No. 45389) approved the study. A form was distributed for participants to give their informed consent. Participants were informed of data confidentiality and of the opportunity to withdraw at any time. No one chose to withdraw during or after data collection. The study did not require approval from the Norwegian Regional Committees for Medical and Health Research Ethics since no patients or patients' information were involved.

The first author performed all observations, and management of both nursing homes was informed that professional ethics overrode researcher neutrality (Guillemin & Gillam, 2004). This entailed more specifically that if the observer identified situations with the potentiality for unwanted incidents, staff would be alerted. No such incidents occurred.

RESULTS

Common medication administration processes

The study documented medication administration in the current nursing homes as complex processes, involving continuous interprofessional collaboration. Contributing factors to the observed complexity were the high number of single tasks, varying degree of linearity, the variability of technological solutions, demands regarding documentation and staff's apparent freedom as to how and where to perform medication-related activities. There were many commonalities in the two wards and observations of practice were used to construct a simplified flowchart on the basis of the six stages of medication administration as depicted in Figure 1:

INSERT FIGURE 1

The standard medication administration process begins with the ordering (1) of specific drugs to patients during pre-visitation; this takes place in the nurses′ station (Ward A) or a dedicated office (Ward B). Doctor and nurse examine patient charts and discuss changes of prescription. Where computers and documentation software are readily available (Ward A), the doctor or nurse directly transcribes (2) changes to the Electronic Medication Administration Records (eMAR). If not (Ward B), changes are noted on paper for later alteration in documentation software (eMAR). For long-term patients using multi-dosage medications, the doctor needs to fill in a prescription, which is later faxed to the pharmacy by the nurse. Updated multi-dosage medications arrive within one or two weeks. An updated medicine-chart is then printed and placed in an indexed folder in the medication trolley serving as paper MAR. Short-term changes are effectuated by altering the content of pill organizers (See figure 1: 3 Dispensing) in the medicine room or near

the medication trolley if the necessary drugs are available there. If change entails removing medications from multi-dosage packages, these plastic bags are opened and their content transferred to pillboxes.

Preparing (4) medications entails removing drugs from pill organizers to medicine cups, while double-checking content against printed MAR. This takes place around the medication trolley placed in the nurses′ station or a common room. Ward A employs primary patient care and a RN or NA prepares and administers medicines only to one or two patients under their care. Ward B uses a group-based patient care system, where a RN or a NA prepares and administers drugs to all patients on the ward. Some drugs are crushed, and injections or liquid medicines for oral ingestion are prepared on top of the medication trolley. Medicine cups and eventual additional medications are administered (5) to patients in situ in common rooms, corridors, or patient rooms. Most patients in Ward A receive their medications in their room, while patients in Ward B often receive the medications in the common rooms. The staff are to oversee patients ingesting administered drugs. When drugs have been administered, this is documented in MAR and eMAR. The last step in the medication process is to observe the effects of administered drugs and document this in eMAR (6).

Complexity and interruptions made normal

The data analysis revealed ten sub-categories, three categories, and one main category: Complexity and interruptions made normal, as documented in Figure 2.

INSERT FIGURE 2

The study findings indicate that interruptions are normal and give rise to both positive and negative outcomes. Interruptions with different characteristics occur during all stages of the

medication administration process and are categorized as “active interruptions,” “passive interruptions” and “technological interruptions.”

Active interruptions

Active interruptions were instances where work on a primary medication task was disrupted. These were interruptions caused by staff asking direct questions, staff answering incoming calls or when staff spontaneously engaged in conversations. Most frequently, disruption of the primary task would lead to a break before resuming. On a few occasions, a break in the primary task would lead to taking on a secondary task. The primary task did not always resume thereafter. One could observe active interruptions taking place in environments where staff congregated, such as nurses’ stations and common rooms. Active interruptions had two outcomes for the person who was interrupted: A) those with a negative impact, leading to a halt in the primary work task, and B) those facilitating work tasks, manifested for example as interruptions in the form of spontaneous informal conversations where staff discussed medical issues, leading to changes in medication or treatment plans. An excerpt from the observation notes illustrates an active interruption with a positive outcome:

Nurse and doctor are interrupted during pre-visitation by another nurse, asking if the patient in room X should still get medicine Y. This led to a change in a prescription that would probably otherwise not have taken place.

Excerpt from observational notes illustrating active interruptions with negative outcomes:

During pre-visitation, the nurse is interrupted three times, being asked different questions. Each time the nurse and doctor have to recapitulate before commencing discussion.

Dispensing, preparing, and administering medications were stages in the medication process in which many people were involved simultaneously in Ward A, due to their primary patient approach to care. Often two or more healthcare workers were engaged in conversations around the medication trolley while dispensing or preparing medications. Staff mostly administered medications in private in patients′ rooms. Ward B had a single RN or AN preparing and administering medicines for the entire ward and that person was more often left alone in the nurses′ station when preparing medications. On the other hand, when staff from Ward B administered medicines to the patients, it was often in the common rooms, typically with a high level of activity, background noises, and inquisitive patients. Active interruptions from both patients and colleagues during the administering of medications were thus more prevalent in Ward B.

Incoming calls from stationary phones or handheld phones led to interruptions when the nurses chose to answer. The RN with responsibility for medication administration in Ward B was obliged to carry a mobile phone and had to answer all calls. Otherwise, when phones were far away from staff, calls were not answered and became background noise or passive interruptions. On several occasions, incoming calls caused interruptions during all stages of the medication administration process. This could lead to a break in the primary task while answering the phone as a secondary task, before re-commencing the primary task. If an incoming call occurred during preparation or dispensing of medications, the primary task sometimes continued while the nurse talked on the phone.

Passive interruptions

Passive interruptions are cognitive stimuli with the potential to reduce concentration or affect cognitive faculties, but not necessarily breaking workflow. Another term for passive interruptions could simply be distractions or "background noise and activity". Examples of passive interruptions include staff retrieving medical equipment or medicines, performing clinical tasks in the proximity, using office equipment, nearby conversations, or alarms**.** On occasions when these stimuli obviously disrupted staff, the interruptions would transform into being active interruptions. Passive interruptions were either technological or human in nature. Technological passive interruptions could be alarms or phones in the background, while human passive interruptions were voices, conversations, and commotion caused by staff clinical activity.

Most passive interruptions seemed to be caused by colleagues. In both wards, despite its mobility the medication trolley was most often placed inside the nurses' station. Members of staff entered the nurses' station during pre-visitations or while other tasks related to medication administration were being performed such as retrieval of equipment, medicines, guidelines, post, requisitions, or other documents. Some staff members entered the nurses' station to use the printer, stationary computers, or the phones. Discussions and use of office equipment sometimes led to high levels of perceived background activity for those performing primary tasks related to medication administration. Sometimes staff took the medication trolley out of the nurses' station, and typically placed it in a common room with patients and colleagues present, and thus in an environment with a similarly high level of activity. An excerpt from the observational notes documents the normalization of passive interruptions as a common part of the daily medication work task:

I asked the nurse how she experienced performing complex tasks while in the nurses' station. The nurse answered that sometimes it was hectic and there was a lot going on, but this was how it was and one just had to learn to cope with it as best one could.

This behavior seemed symptomatic in that staff very seldom asked for quiet or sought conditions where they could perform medication administration in peace.

Technological interruptions

Technological interruptions are different from passive interruptions of a technological nature in that they arise from the use of tools and technology rather than as an endpoint such as incoming calls or buzzing alarms.

The use of technology was observed as a disrupting element at several stages of the medication administration process. Three different variations on the use of technology seemed disruptive to the workflow.

Firstly**,** the use of documentation software (eMAR) was often perceived as overly complex and disrupting the workflow as this excerpt from the observational notes documents:

A nurse at PC documenting actions. She says to the researcher "You need to click a lot to do what you want to do, but things go reasonably well once you know how. Not everything is directly user-friendly. To write some type of reports, you need to access a Word document, and then cut and paste into the documentation software. This is cumbersome."

Personal competence in the use of eMAR seemed to affect how effective staff perceived it to be. At the same time, a few said, "*You just have to do your best. It is not always possible to do things the way you want. Then you have to find other ways to get around it."*

Staff said that the eMAR was not designed according to how they were supposed to document medication administration, and using alternative solutions stole time. One example was that if patients needed additional medications, staff had to open a new window and document this in free text.

Another element disrupting workflow was caused by lengthy logins when staff were switching between software. This was apparent in situations where personnel came into the nurses' station to document actions at a stage in the medication administration process. Sometimes a staff member had forgotten to log out of the stationary computer, and login time became extended because of that. Login time and switching between software could cause up to several minutes of resumption lag. Some nurses explained that they preferred to wait until the end of their shift, and then document everything. In the meantime, they kept notes on scraps of paper in their uniform pockets.

Secondly, nurses used paper documents and notebooks in addition to eMAR throughout all stages of the medication administration process. Some of these documents were formal, and some of them were informal. Formal documents were patient charts and medication charts printed directly from eMAR, serving as an analog backup to document the dispensing, preparing and administration of medications. Some staff members documented medications as ingested while they prepared the medications, to avoid this task later. Others came back after patients had ingested their medicines and documented this action on the paper chart. Afterwards, they also documented the medications given in eMAR and noted any effects or side effects. Some staff members mentioned that these demands regarding documentation felt disruptive to their workflow.

The staff used informal notes as mnemonic devices for meetings and social activity as well as clinical activity in the ward. Some notes were scraps of papers kept in their uniform pockets, and sometimes the staff used a joint notebook kept in the nurses′ station. This notebook contained information on various aspects of clinical activity such as planned alteration of medications, appointments to remember or points to bring up on pre-visitation. Information on patients and medications was documented multiple places, and some stated that it was difficult to know exactly where to find information. The use of a notebook in which everyday clinical activity was recorded seemed to supplement the use of documentation software. This alteration between modes of documentation caused interruptions in workflow.

Thirdly, the staff used mobile applications to assist them in various tasks. When these applications worked flawlessly, they could be beneficial, but most applications are dependent on a wireless connection that is not always available. In parts of both Ward A and Ward B connectivity dropped so much that the use of mobile applications was nearly impossible.

For example, when adjusting drug dosages or changing medications, the doctors used an online medical encyclopedia, which was dependent on a wireless connection as seen in this excerpt:

The doctor looks down at the phone, searching for the correct dosage...the internet connection is too slow and the doctor looks up after a while, saying he will adjust dosages later instead.

The staff always used their private phones when consulting mobile applications and individual variations may have factored in, influencing the frequency of use, type of applications and fluency of interface.

DISCUSSION

The aim of this study was to contribute in-depth knowledge of the characteristics of medication administration and interruptions in nursing homes. The main findings indicate that medication administration is a complex process consisting of many separate tasks (see figure 1) and that colleagues often interrupt work tasks related to medication administration, either actively or passively. Many of the interruptions are caused by factors in the physical environment and/or the technology.

Interruptions are normalized

The study points to the normalization of active, passive and technological interruptions during the workday by all the staff involved in medication administration. More concretely, this entails that the staff put up with working in noisy, often cramped environments, where they are likely to be interrupted. They also accept that the technological solutions they employ are not tailored to meet their needs, forcing them to constantly adapt solutions and workarounds to facilitate medication administration. Due to the complexity of the medication administration process, it may be the case that interruptions are ingrained in the work system, making it difficult for the staff to recognize them as such. This conforms with normalization process theory in that sustainment of unfavorable practices may become normalized within complex work systems over time (Banja, 2010; May & Finch, 2009).

Human interaction

The study shows that human interaction with colleagues was the most likely cause of active interruptions and this is supported in the literature (Hall et al., 2010; Hedberg & Larsson, 2004;

Lyons, Brown & Wears, 2007). Moreover, active interruptions may also affect communication and teamwork, having detrimental effects on decision-making processes (Jett & George, 2003). Since medication administration seems an interwoven part of nursing activities (Jennings et al., 2011), this implies that interruptions may have unforeseen consequences for a wide range of clinical and administrative activities. This study found instances where interruptions had positive outcomes, resulting in, for example, a change in treatment benefitting patients. One may argue that this is an indication of the need for constant communication and coordination in order to promote safe practices. Removing all sources of active interruption in the clinical environment may, therefore, be unwise, a finding confirmed by Rivera & Karsh (2010). However, most of the time the active interruptions had only negative effects by halting the primary task being performed. Active negative interruptions may cause staff to lack focus, increase feelings of stress and frustration, and impact memory. This can lead to cognitive impairment and staff forgetting other tasks or committing failures of omission (Bower et al., 2015).

There are further distinctions in active interruptions. If interruptions are goal oriented, the closer the interruptions are in nature to the primary task being interrupted, the less resumption lag one can expect. On the other hand, similarity between the interruption and the primary task may also cause cognitive confusion when resuming the primary task and thus increase the likelihood of making mistakes (Li et al., 2012). Observations often showed that during the preparation stage, staff members congregated around the medication trolley and active negative interruptions were frequent. These interruptions could be questions related to medication administration, and thus be similar in nature to the primary task being performed. These interruptions had a clear goal for the person interrupting and often proved helpful for them in completing their current task. So, the person interrupting benefits, while the person being interrupted experiences a negative outcome.

Furthermore, the findings of this study suggest that one member of the staff will be viewed as more competent by other staff members. The person with more experience and competence will have more responsibility and perform more complex tasks with higher cognitive demands. This may result in the person with more responsibility receiving more attention and questions than the others, and thus being more susceptible to being interrupted. Evidence from the literature further suggests that interruptions that are not goal oriented should be weeded out using appropriate interventions (Rivera & Karsh, 2010). This is especially true for interruptions occurring during complex tasks with high memory demands (Li et al., 2012). This complexity suggests that a deeper understanding of the underlying work-system is vital before elaborate interventions are implemented (Carayon, Wetterneck, Rivera-Rodriguez et al., 2014; Raban & Westbrook, 2014).

The physical environment

What appears most significant in the physical environment is the use of the medicine room when distant from the rest of the ward and clinical and administrative activity. Some nursing homes share internal resources, and multiple wards often share a single medicine room. This has led to some wards employing medication trolleys and consequently moving some stages of the medication administration process closer to where the patient-related clinical activity takes place. This may have increased the chance of adverse events due to a higher level of passive and active interruptions. This mobility is not one-sidedly negative; being closer to the patients means more time for observation and care-related activity, and may prove beneficial in other areas.

Another aspect related to the physical conditions in the work system was the general use of nurses' stations. Most stationary computers used for documentation were located there. This also led to printers, copy machines, and phones being in proximity of the computers, as well as

printouts of guidelines, protocols, order sheets, etc. The nurses' station was thus the hub in which administrative activity and several stages of the medication administration process took place. This concentration of activity may have led to nurses' stations being aggregators of latent factors, with the inherent potential of becoming active threats. This contrasts somewhat with the finding of Biron, Loiselle et al. (2009) that the medicine room was the location with most frequent interruptions. On the other hand, nursing also seems to be about social interaction; the staff talk to each other, share work-related information, or get tips when needed. These informal meeting places during the staff's workday may, therefore, be essential for the necessary communication and teamwork needed to conduct safe practices (Anthony et al., 2010; Hopkinson & Jennings, 2013; Rivera & Karsh, 2010).

The tools and technology

Technological interruptions were mostly related to the active use of different technology, and how it affected the workflow of the staff when they performed tasks related to medication administration. Biron, Loieselle et al. (2009) use the term technical sources of interruptions, including alarms or operational failure due to missing or malfunctioning equipment. In this study however, these types of interruptions were termed passive interruptions. Others define passive interruptions as distractions that can be ignored or processed simultaneously with the primary task (Biron, Lavoie-Tremblay, et al., 2009). Most strikingly in this study was how the staff perceived eMAR as both an effective tool and a tool that gave rise to glitches in that some functions were missing or cumbersome. This may have led staff to find workarounds, using paper documentation instead. Alenius and Graf (2016) suggest that the use of eMAR may reduce the perceived risk of committing errors related to medication administration if it exclusively replaces

the use of paper documentation. Others indicate that eMAR does not necessarily contribute to documentation efficiency, but can increase staff documentation compliance (Qian, Yu, & Hailey, 2015). Our findings indicate that eMAR should be tailored to meet the needs of the staff, to prevent unnecessary breaks or workarounds and thus avoid double documentation and perceived interruption of workflow.

During the ordering, transcription and dispensing stages of medication administration, staff often used mobile applications to verify pillbox content or to check correct dosages of medications. Sometimes a lack of wireless connection led to a complete break in the task being performed. This suggests a vulnerability in the work system whereby the staff are dependent on unstable technical solutions, and may contribute to the fact that paper documentation was prevalent despite the availability of digital solutions.

Limitations

Limitations in this study are the use of a sole observer throughout the research process, introducing potential bias. This was countered by using a research team consisting of three nurses and one engineer, allowing for different viewpoints and analytical triangulation throughout the research process. The first author is a registered nurse and observations may, therefore, be biased because of preconditioning in a similar field. On the other hand, familiarity in the field (nursing) allows insights to be gained more quickly. A sample including only two nursing homes is small, but a purposeful sampling was chosen aiming for variation allowing for in-depth investigation of the medication administration process. Some conditions observed may be special for the two wards selected, yet medication administration is a universal process, and the findings and insights are easily transferable across settings.

CONCLUSION

Medication administration and interruptions are interwoven elements in the complex work system of nursing homes. Interruptions seem to have different characteristics and may play a significant role in the process of medication administration. Findings indicate that there are three main categories of interruptions: active, passive, and technological. A process of normalization seems to have taken place, where staff put up with second-rate technological solutions, noise, and disruptions when they are performing medication-related tasks, without complaint. Interruptions are not always negative and can have both unforeseen and positive consequences. Before seeking to minimize interruptions during the medication administration process, it is, therefore, important to understand the interconnectivity of the elements within the medication administration work system. Using a Human Factors approach in further studies seems a reasonable way of encompassing this complexity, and finding or developing and employing appropriate interventions to reduce the risk of adverse medication events caused by negative interruptions.

Relevance to clinical practice:

Staff and management need to be aware of the normalization of interruptions. Knowledge of the complexity of medication administration may raise awareness and highlight the importance of maintaining and enhancing staff competence.

LITERATURE

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Tables:

Table 1: Characteristics of Ward A and Ward B

	Ward A	Ward B
Type of patients	Palliative care, cancer care, complex illnesses. High degree of pain management and nutritional management.	Light to severe degree of dementia and varying degree of disabilities and chronic diseases.
Number of patients	6	10
Total number of staff	25 healthcare workers, a mix of RNs, specialist nurses (SRN), NAs and other professions covering two wards	29 health healthcare workers, a mix of registered nurses (RN), nurse assistants (NA), and unlicensed nurse assistants (UNA) covering two wards
Dayshift staff	3–4 (mostly SRNs)	3 (mix of RNs and NAs)
Evening shift staff	2 (at least one RN)	2 (not always a RN)
Night shift staff	1 (always a RN)	½ (not always a RN)
Team structure	Primary based. All patients are allocated among staff, and each staff member has medication responsibility for their patient.	Group-based. One staff member per shift in charge of medications for all patients.
Number of observations	16	15
Hours of observations	70	70

Table 2: Example of analysis

Unit of meaning	Sub-category	Category	Main-category
While the nurse is preparing the medications at the medication trolley, a colleague passes by, and they engage in informal conversation, updating each other on the status of the patients they are taking care of.	Discussions	Active interruptions	Complexity and interruptions made normal
During pre-visitation, the door opens on five occasions, and staff enter to copy some papers.	Using office equipment	Passive interruptions	
Two nurses are in front of the stationary computers, there has been a software update and they are unable to log in. Documentation has to be postponed.	Use of eMAR	Technological interruptions	

Figures:

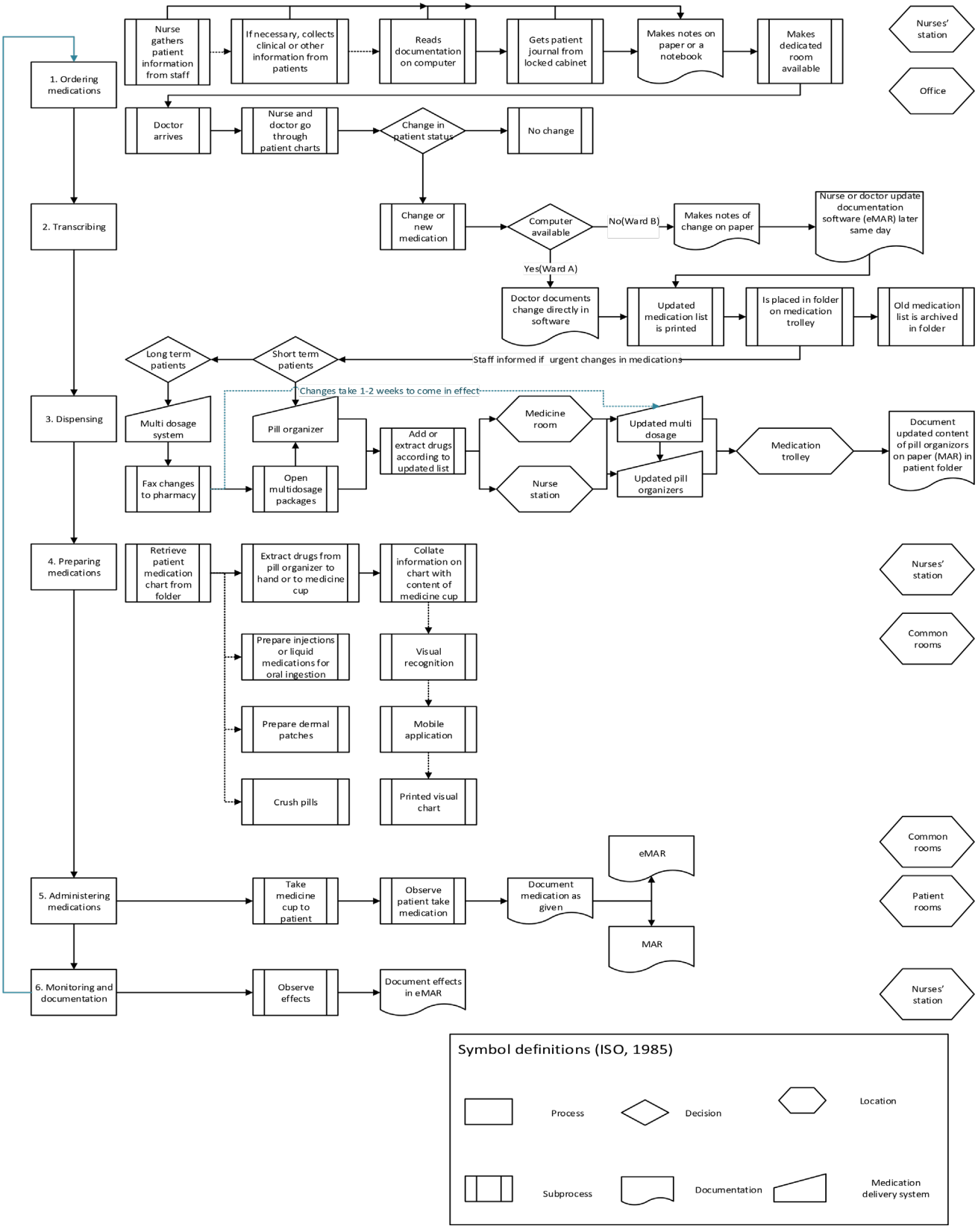

Figure 1: Flowchart of the medication process in Ward A and Ward B

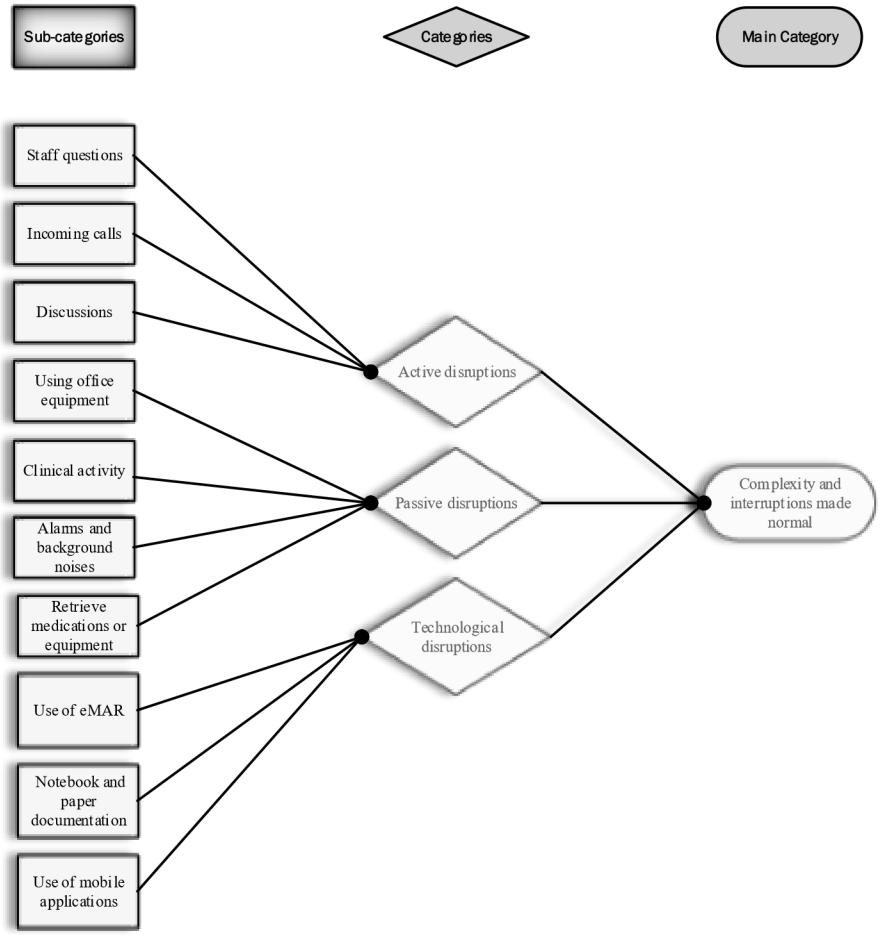

Figure 2: Overview of sub-categories, categories and main category