STADIA
HELSINGIN AMMATTIKORKEAKOULU

Oops! Another Medication Error.

A Literature Review of Contributing Factors and Methods to Prevent Medication Errors

Degree Programme in Nursing
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Final Thesis
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Katja Alanko
Lilli Nyholm

HELSINGIN AMMATTIKORKEAKOULU STADIA
HELSINKI POLYTECHNIC
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Author/Authors

Katja Alanko and Lilli Nyholm

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ABSTRACT

The purpose of this bachelor's thesis was to chart scientific research articles to present contributing factors to medication errors done by nurses in a hospital setting, and introduce methods to prevent medication errors. Additionally, international and Finnish research was combined and findings were reflected in relation to the Finnish health care system.

Literature review was conducted out of 23 scientific articles. Data was searched systematically from CINAHL, MEDIC and MEDLINE databases, and also manually. Literature was analysed and the findings combined using inductive content analysis.

Findings revealed that both organisational and individual factors contributed to medication errors. High workload, communication breakdowns, unsuitable working environment, distractions and interruptions, and similar medication products were identified as organisational factors. Individual factors included nurses' inability to follow protocol, inadequate knowledge of medications and personal qualities of the nurse. Developing and improving the physical environment, error reporting, and medication management protocols were emphasised as methods to prevent medication errors. Investing to the staff's competence and well-being was also identified as a prevention method.

The number of Finnish articles was small, and therefore the applicability of the findings to Finland is difficult to assess. However, the findings seem to fit to the Finnish health care system relatively well. Further research is needed to identify those factors that contribute to medication errors in Finland. This is a necessity for the development of methods to prevent medication errors that fit in to the Finnish health care system.

Keywords

medication error, medication management, literature review

HELSINGIN AMMATTIKORKEAKOULU STADIA
Sosiaali- ja terveysala

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Tekijä/Tekijät

Katja Alanko ja Lilli Nyholm

Työn nimi

Oho! Taas yksi lääkevirhe. Kirjallisuuskatsaus lääkevirheisiin vaikuttavista tekijöistä ja niiden ehkäisymenetelmistä

Työn laji	Aika	Sivumäärä
Opinnäytetyö	Syksy 2007	24 + 3 liitettä

TIIVISTELMÄ

Tämän opinnäytetyön tarkoituksena oli kartoittaa tekijöitä, jotka vaikuttavat sairaanhoitajien sairaalassa tekemiin lääkevirheisiin, sekä esittää näiden ehkäisymenetelmiä. Pyrkimyksenä oli sisällyttää opinnäytetyöhön suomalaisia sekä ulkomaalaisia tutkimuksia ja pohtia tuloksia suhteessa suomalaiseen terveydenhuoltojärjestelmään.

Kirjallisuuskatsaukseen valittiin 23 tieteellistä julkaisua. Aineisto kerättiin systemaattisesti CINAHL, MEDIC ja MEDLINE tietokannoista sekä manuaalisesti. Aineisto analysoitiin ja tulokset koottiin käyttäen induktiivista sisällön analyysia.

Tuloksista kävi ilmi, että lääkevirheisiin myötävaikuttavat organisatoriset ja yksilölliset tekijät. Organisatorisiksi tekijöiksi lukeutuivat suuri työmäärä, kommunikaatio-ongelmat, työympäristön heikkoudet, häiriöt ja keskeytykset sekä lääketuotteiden samankaltaisuus. Sairaanhoitajan kyvyttömyys noudattaa ohjeita, riittämätön lääketietous sekä tietyt henkilökohtaiset ominaisuudet olivat yksilöllisiä tekijöitä, jotka vaikuttivat lääkevirheiden syntyyn. Esitettyjä ehkäisykeinoja olivat parannukset fyysisessä ympäristössä sekä lääkevirheiden raportoinnin ja lääkehoidon ohjeiden kehittäminen. Näiden lisäksi henkilökunnan pätevyyteen ja hyvinvointiin panostaminen nousivat esille yhtenä ehkäisymenetelmänä.

Koska suomalaisia tutkimuksia oli mukana vain muutama, on tuloksia sovellettava Suomeen harkiten. Esitetyt lääkevirheisiin vaikuttavat tekijät ja ehkäisymenetelmät kuitenkin sopinevat suomalaiseen terveydenhuoltojärjestelmään suurimmalta osin. Tulevaisuudessa tutkimusten olisikin syytä keskittyä tekijöihin jotka myötavaikuttavat juuri Suomessa tapahtuviin lääkevirheisiin. Tämä on edellytyksenä, että pystyttäisiin kehittämään Suomen terveydenhuoltoon soveltuvia lääkevirheiden ehkäisymenetelmiä.

Avainsanat

lääkevirhe, lääkehoito, kirjallisuuskatsaus

CONTENTS

1 INTRODUCTION

Safe medication management is ground for proper patient care and an important part of nurses' profession. While people are more and more treated with medications, health care professionals, and especially nurses who often administer medications, are carrying a greater responsibility than ever. Each nurse that has the right to practice medication management has also the duty and responsibility to do it safely. To implement successful medication therapy, one should know the manual skills, but also hold information about the patient, and have knowledge about the action mechanisms and adverse reactions of the medications. The nurse should also know the documentation and report protocol of the health care setting one is practising in. (Veräjänkorva - Huupponen - Huupponen - Kaukkila - Torniainen 2006: 32-37; 43)

Nursing literature acknowledges the importance of safe medication management and expresses concern about the large number of medication errors conducted in the hospitals worldwide. Exact statistics about the prevalence of medication errors is difficult to obtain and the incident rate varies from study to study. Osborne, Blais, and Hayes (1999), for example, reports a relative low error rate of 2, 2% while Pape (2001) presents a far higher incidence rate (38%).

The number of medication errors taking place in Finland is also hard to estimate. The Finnish Poison Information Centre receives an average of 200 telephone inquiries per year related to medication errors that have occurred in health care settings (Kuisma - Hoppu 2006). However, this hardly indicates the actual number of errors, as health care professionals have no obligations to contact the centre. These inquiries are rather done spontaneously.

Medication errors have several and varying consequences. Errors committed increase patient morbidity and mortality, result in prolonged hospital stays, and increase economical demands (Mihailidis - Krones - Boger 2006). The Institute of Medication (2000) reports that in the USA over 7000 deaths occur annually due to medication errors, and approximately every two out of 100 patients admitted to hospital experience a preventable adverse drug event. These errors diminish the patients' trust and

satisfaction to the health care system (The Institute of Medication 2000), and can be psychologically traumatic to the nurse involved (Osborne et al. 1999).

Medication errors occur along the medication process and are committed by different health care professionals. Errors in the prescribing phase are usually done by the physician, while nurses more often make mistakes during administration (Lassetter - Warnick 2003). Many researches recognise prescribing and administration phases as those most prone to errors (Brown 2001; Davidhizar - Lonser 2003; Lassetter - Warnick 2003). Similar results can be obtained from Kuisma and Hoppu's (2006) study. They conclude that wrong drug, followed by incorrect dose, are the most common causes for medication errors (for which the Poison Information Centre in Finland is contacted).

As future registered nurses with the responsibility of medication management on our shoulders, we decided to conduct a literature review about medication management, and the errors taking place in it as our final thesis. We acknowledge that the topic has been widely researched during the last years, and several literature reviews have been produced about it. However, most of these studies are done in the USA and UK but there seems to be lack of Finnish ones. Therefore, our plan is to combine Finnish and international research related to medication errors, and analyse the findings in relation to the Finnish health care system. In our paper we will concentrate on nurses' role in medication management.

Based on this background information, the purpose of the literature review is to chart scientific research articles to present contributing factors to medication errors done by nurses in a hospital setting, and introduce methods to prevent medication errors.

2 MEDICATION MANAGEMENT

Medication management, or pharmacotherapy, is seen as a health care activity that is carried out by a health care professional with training in medication management. The process of medication management consists of several phases. The phases include prescribing, receiving the prescription, dispensing, preparing, and administering the medication, as well as monitoring its effect. Medication management also involves documenting the process, and counselling and educating the patient. Nurses carry out

medication management in all phases except the prescribing phase. (Ministry of Social Affairs and Health 2006) In our literature review we perceive medication management to be any activity between the nurse, the patient, and the medication.

The US National Coordinating Council for Medication Error Reporting and Prevention defines medication error as any preventable medication-related event occurring as a result of actions by a health care professional that may cause or lead to patient harm while the patient is in the care of the health care provider (Brown 2001; Pape 2001; Davidhizar – Lonser 2003; Copping 2005). Medication errors include adverse drug events (ADEs) and potential adverse drug events. An ADE is a medication error that causes patient harm or injury. A potential ADE has a significant potential to harm a patient. (Brown 2001) A medication error is regarded as potential ADE whether or not the patient receives the medication or the dose causes harm to the patient. Nonpreventable ADEs, such as adverse drug reactions, can also be perceived as medication errors. (Brown 2001; Fortescue et al. 2003) However, in this review nonpreventable ADEs are excluded because they are beyond the health care professional's control.

3 LEGISLATION AND EXISTING PRACTICES IN FINLAND

3.1 Legislation

The Finnish legislation sets standards for patients' rights and professionals' obligations, and the guidelines from the Ministry of Social Affairs and Health rules how and by whom medication management should be carried out in Finland. However, guidelines set by the Ministry of Social Affairs and Health are only recommendations on how medication management should be implemented in hospitals and other clinical settings. Each work unit is responsible for planning and implementing medication management, as well as monitoring and reporting errors in it (Ministry of Social Affairs and Health 2006).

According to the 785/1992 Act on the Status and Rights of Patients, patient has the right to good quality health care and medical care within resources available at a particular time. Patients must be informed of different treatment options and their effect, as well

as all other factors related to their care. Patient's autonomy must be respected at all times.

559/1994 the Act on Health Care Professionals describes the general responsibilities of health care professional, which includes registered nurses, as follows:

> "The aim of the professional activities of health care professionals is to promote and maintain health, to prevent illness, to cure those who are ill and to alleviate their suffering. In their professional activities health care professionals must employ generally accepted, empirically justified methods, in accordance with their training, which should be continually supplemented. Each health care professional must weight the benefits of their professional activity to the patient, and its possible hazards."

These acts can be seen as baseline for safe medication management. Because medication errors are always possible threats for patient safety, and may alter patient's health, they are seen as misconduct of professional actions. Anyone neglecting the obligations described in the acts, performing tasks for which their training and professional skills and knowledge are inadequate, or acting otherwise incorrectly, can be faced with disciplinary actions from the National Authority for Medicolegal Affairs (559/1994 Act on Health Care Professionals).

The Ministry of Social Affairs and Health describes in Safe Pharmacotherapy (2006) nurses' medication responsibilities in more detail. A registered nurse in Finland is a licensed health care professional with the skills and rights to order medications to the unit, prepare them for administration, and administer them natural ways, subcutaneously, intradermally and intramuscularly. With additional training, a registered nurse can get a license to administer intravenous fluids and medications, implement blood transfusions, participate in medication therapy given to the epidural space, and administer vaccinations. The Ministry emphasises each nurse's responsibility over the actions they take when providing or participating in medication management.

The legislation and guidelines from the society, protocols of different organizations, and the Ethical Guidelines of Nursing by Finnish Nurses Association should direct the nurse's behaviour and professional action.

3.2 Medication management skills of Finnish nurses

Finnish nurses' medication skills are generally good. Their knowledge about ethics, anatomy, and physiology are on average better than skills on pharmacy, pharmacology, legislation, and mathematics. However, it seems that nurses do not sufficiently recognise the factors in medication management that compromise patient safety. Neither do nurses consider their actions in medication management to present a threat to patients. Near misses that can cause medication errors are reported unsystematically and randomly. (Veräjänkorva 2003)

4 RESEARCH QUESTIONS

The study questions to be answered are:

> What are the contributing factors to medication errors done by nurses in a hospital setting?
>
> How can medication errors be prevented in a hospital setting?

5 DATA COLLECTION AND ANALYSIS

5.1 Data search

Systematic literature review is a scientific research method in which existing information is identified and gathered, quality of the information is assessed, and the results are combined comprehensively. Systematic literature review involves the research plan; definition of research questions; work with the primary sources (search, selection, evaluation of the quality, and analysis); and presentation of the results. (Kääriäinen - Lahtinen 2006) Systematic review follows a strict scientific design to minimize the chance of systematic bias, and allows reproducibility of the review (LoBiondo-Wood - Haber 2006: 87).

The aim of a systematic literature review is to produce best available objective evidence of a certain topic. With the produced data, evidence based practice protocols can be developed. It also offers health care professionals best available evidence to make reliable clinical judgements when caring for their patients. (LoBiondo-Wood – Haber 2006: 87-88). We chose systematic literature review as a method to gather and process data to meet the purpose of our study, and answer the study questions.

The literature was searched from internet databases and manually from nursing journals. Only articles that filled the selection criteria were included in to the review. The selection criteria included:

1. The study is an empirical research.
2. The study is published either in Finnish or English.
3. The study is published between the years 2000 and 2007.
4. The study has relevance to nursing field.
5. The study has relevance to the topic of the review.

Databases used for data collection were CINAHL, MEDLINE and MEDIC. A systematic search was completed from each of the databases. Keywords medication errors, lääkevir, and lääkintävir were used.

Literature search from CINAHL took place on the 19th of February 2007 by using the keyword medication errors. By mapping the term to subject heading 430 articles were found. After going through all the findings, 98 articles were approved by their title. Based on the abstracts, 34 studies remained. Out of these, ten articles were discarded because full text could not be found neither in electronic nor in paper format. Having read the remaining 24 articles in full text, 16 were chosen to be included in the review.

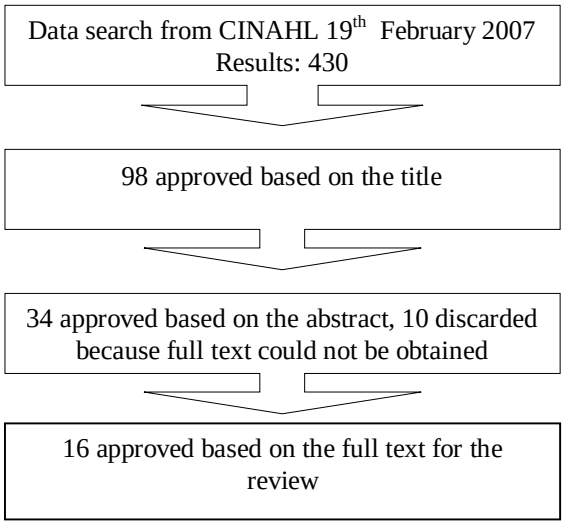

FIGURE 1. Data search from CINAHL.

The literature search from MEDLINE was completed 27th February 2007. A keyword medication errors was used, and the term was mapped to subject heading. Limits were set to include subject headings related to nursing. This produced 151 results. Based on the title 26 articles were approved. After reading the abstracts, 14 articles were rejected. For two studies the full text could not be obtained, and they had to be cast aside. Ten articles were read in full text and three were chosen for the literature review.

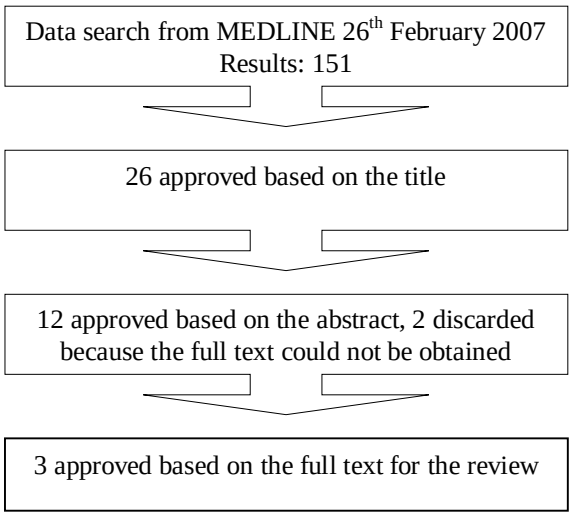

FIGURE 2. Data search from MEDLINE.

MEDIC database search was performed 19th of February 2007. Using search word lääkevir*, lääkintävir*, medication error*, 24 results were found. Based on the title 12

articles were approved. After reading the abstracts two articles remained. One of the remaining studies, being a doctoral dissertation, was too extensive for this project, and had to be dropped. Thus, one article remained for the review.

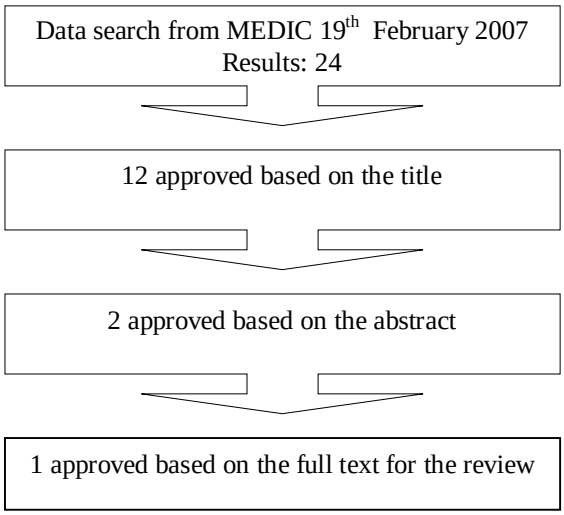

FIGURE 3. Data search from MEDIC.

The database searches produced 20 journal articles. In addition to the computerised database searches, literature was also searched manually. This resulted in five research articles. After reading these, three remained for the literature review. Thus, 23 articles were used in the literature review. Table 1 illustrates the different journals from which the studies were obtained.

TABLE 1. The articles approved for analysis.

Name of the journal	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
Archives of Disease in Childhood	1				1				
Ergonomics							1		
International Journal for Quality in Health Care						1			
JONA's Health Care Law, Ethics, and Regulation				1					
Journal of Advanced Nursing							1		
Journal of Clinical Nursing				1					
Journal of Continuing Education in Nursing						1			
Journal of Emergency Nursing				1					
Journal of Nursing Administration			1				1		
Journal of Nursing Care Quality	1				1				
Journal of Nursing Management							1		
MEDSURG Nursing				1		1			
Nevada RNformation			1						
Pediatrics				1					
Quality & Safety in Health Care				1		1	1		
Suomen Lääkärilehti			1			1			
Total	**2**	**0**	**3**	**6**	**2**	**5**	**5**	**0**	**23**

5.2 Data analysis

The articles were independently read by both authors, as recommended by Kääriäinen and Lahtinen (2006), and also tentatively analysed. After this, 23 suitable articles for the review were chosen in consensus, and analysed using inductive content analysis. Summaries of the articles can be seen in Appendix 1.

Content analysis is a systematic and objective way to process documents. The aim of content analysis is to produce concepts or categories which provide a condensed and general description of the phenomena in question. Content analysis can be either inductive or deductive. Inductive content analysis, which was used for this paper, aims to simplify, categorise, and conceptualise data. The data is examined in order to find answers to the study questions. The findings are categorised into sub categories according to their similarities and differences. These thematic entities are further combined into main categories. This is called conceptualisation. (Kyngäs - Vanhanen 1999)

The findings of the articles were grouped according to the study questions - what are the contributing factors to medication errors, and how errors can be prevented - and divided into subcategories and main categories (see Appendices 2 and 3).

6 FINDINGS

6.1 Contributing factors to medication errors

The reviewed literature indicate that medication errors occur due to nurses' actions but also because of many organisational factors. Ross, Wallace and Paton (2000) state that most errors arise from systematic organisational failures, and not as a result of individual nurse's negligence. Also Mustajoki (2005), Fogarty and McKeon (2006) and McKeon, Fogarty and Hegney (2006) recognise that both organisational and individual variables affect to the occurrence of errors.

6.1.1 Organisational factors contributing to errors

Several factors contribute to nurses' workload which in turn is associated with higher incidence of violations in medication management (McKeon et al. 2006). Both Smith and Crawford (2003), and Potylycki et al. (2006) recognise inadequate staffing levels and excess hours worked to influence nurses' ability to perform medication management. Additionally, intensity of work, time pressure, hurried situations, and job stress appear to increase nurses' workload (Huber 2002; Simpson - Lynch - Grant - Alroomi 2004; Mustajoki 2005; Stetina - Groves - Pafford 2005; Potylycki et al. 2006; Seki - Yamazaki 2006).

Administrative and managerial weaknesses, physical environment, and communication breakdowns are factors in the working environment that contribute to medication errors. Some researchers point out managerial flaws, such as insufficient information, missing instructions, staffs' inadequate orientation to the tasks, and lack of supervision of student and agency nurses (Taxis - Barber 2003; Mustajoki 2005) as causes for deviations. Other environmental factors include high noise level, poor team work, and multiple medication administration times (Schaubhut - Jones 2000; Pape et al. 2005).

Communication breakdowns between nurses and other professionals are one of the most frequently mentioned elements influencing error occurrence (Schaubhut - Jones 2000; Benner et al 2002; Huber 2002; Smith - Crawford 2003; Taxis - Barber 2003; Mayo - Duncan 2004; Simpson et al. 2004; Pape et al. 2005; Seki - Yamazaki 2006). Examples include inadequate communication among nurses, between nurses and pharmacists, and nurses and physicians (Schaubhut - Jones 2000; Taxis - Barber 2003). Misinterpreting physicians' orders, either written or verbal, seems to be fairly common reason for mistakes in medication management (Schaubhut - Jones 2000; Benner et al. 2002; Taxis - Barber 2003; Mayo - Duncan 2004; Seki- Yamazaki 2006).

TABLE 2. Organisational factors contributing to medication errors.

Categories of contributing factors	Number of mentions in the data
higher workload	14
communication breakdowns	12
working environment	10
distractions and interruptions	7
medication products	5

Many authors identify distractions and interruptions as contributing factors to medications errors (Schaubhut - Jones 2000; Huber 2002). Causes leading to distractions include restless working environment, carrying out several tasks at the same time, other personnel, external conversation, nurse carrying out conversation, and loud noises (Taxis - Barber 2003; Mustajoki 2005; Pape et al. 2005).

According to Mayo and Duncan (2004) medications with similar names and damaged packages compromise safe medication management. Also similar looking medications and medications in multidose formulas are risky (Schmidt - Bottoni 2003). Changing medication products and brand names are, according to Mustajoki's (2005) research, challenges in the Finnish health care system.

6.1.2 Individual factors contributing to errors

Health care settings often employ different types of specialised protocols, such as the six rights (right patient, right medication, right dose, right route, right time and right

documentation) for safe medication administration. However, several authors report nurses' inability to follow these protocols (Benner et al. 2002; Huber 2002; Taxis - Barber 2003; Stetina et al. 2005; McKeon et al. 2006; Seki - Yamazaki 2006). The studies do not specify whether the deviations from set practices are intentional or not, except for Taxis and Barber (2003) who recognise deliberate violation of guidelines.

Simpson et al. (2004) and Seki and Yamazaki (2006) identify poor documentation of administered medications - also a departure from protocol - as a contributing factor to medication errors. Benner et al. (2002), Mayo and Duncan (2004), and Pape et al. (2005) all count inability to identify the patient as a cause for medication error. Also inadequate knowledge about the patient (Huber 2002), such as his/her drug allergies (Pape et al. 2005; Stetina et al. 2005), contribute to deviations.

TABLE 3. Individual factors contributing to medication errors.

Categories of contributing factors	Number of mentions in the data
inability to follow protocol	15
inadequate knowledge of medications	14
personal factors	8

According to Grandell-Niemi, Hupli, Leino-Kilpi and Puukka (2003) Finnish nurses' medication knowledge is inadequate and may lead to adverse drug events. Similar results are reported from the USA (Benner et al. 2002; Huber 2002; Stetina et al. 2005), Japan (Seki - Yamazaki 2006), and Australia (McKeon et al. 2006). Also nurses' dosage calculation skills leave room for improvement (Benner et al. 2002; Mayo - Duncan 2004; Simpson et al. 2004). Technology has brought new challenges to nurses, which they are according to some studies unable to meet. Complex design and obscure equipment manuals (Taxis - Barber 2003), as well as difficulties in operating infusion devices (Mayo - Duncan 2004) and using computerized charting (Schaubhut - Jones 2000) are current problem areas for nurses.

Nurses' level of stress and tiredness positively affect the occurrence of medication errors (Mayo - Duncan 2004; Fogarty - McKeon 2006; Seki - Yamazaki 2006). Lack of focus and less work experience are other personal factors associated with adverse drug events (Pape et al. 2005; Seki - Yamazaki 2006). Only Fogarty and McKeon (2006) address nurses' low morale as contributing factor.

6.2 Methods to prevent medication errors

6.2.1 Improvements in the physical environment

Huber (2002) along with Pape (2003) introduce checklists and reminders as a way to focus on the appropriate medication administration procedure. Pape (2003) and Pape et al. (2005) also emphasise the use of visible signage and symbols as a method to reduce distractions.

TABLE 4. Prevention method: Improvements in the physical environment.

Categories of prevention methods	Number of mentions in the data
use of assistive systems and devices	11
physical environment	9

Many authors highlight the use of technology as a prevention strategy (Schaubhut - Jones 2000; Huber 2002; Fortescue et al. 2003; Lisby - Nielsen - Mainz 2005). Fortescue et al. (2003) suggest the use of computerized physician order entry (CPOE) together with clinical decision support system. Lisby et al. (2005) also recognise advantage gained from CPOE and recommend utilising bar code medication administration.

According to the studies, the best physical environment for medication management is free from distractions (Huber 2002; Pape 2003). Pape (2003) highlights the value of different distraction elimination techniques, and suggests educating staff about the importance of not distracting a colleague who is in the middle of medication management. Schaubhut and Jones (2000) give a practical suggestion of placing medication dispensing stations to quiet areas. Other aspects of developing the physical environment include improvements in the storage of medications (Marck et al. 2006), increased availability of patient information (Huber 2002), and improvements in the transcriptions of medication orders (Marck et al. 2005).

6.2.2 Focusing on human resources

Some studies suggest that specialised staff should be used instead of nurses to carry out medication management in hospitals (Benner et al. 2002; Fortescue et al. 2003; Simpson et al. 2004). Fortescue et al. (2003) and Simpson et al. (2004) recommend closer collaboration between the nursing unit and the pharmacy.

Using and improving teamwork is recognised by several authors as a significant factor in medication error prevention (Huber 2002; Pape 2003; Pape et al. 2005). Trust between professionals enhances communication and promotes teamwork according to Mustajoki (2005). Fortescue et al. (2003) present improved communication between professionals as a way to prevent errors. Marck et al. (2006) specify that new medications, protocols, equipment, and developments in treatment practices are areas in which communication should be emphasise.

Several authors present staff education as crucial factor in medication error prevention (Huber 2002; Mattila - Isola 2002; Pape 2003; Schmidt - Bottoni 2003; Simpson et al. 2004; Marck et al. 2006; McKeon et al. 2006). Education should include information about pharmacology as well as safe and proper medication administration skills (Schmidt - Bottoni 2003; Marck et al. 2006). Mattila and Isola (2002) point out that the different techniques of medication administration should be taught within basic nursing education. According to them, nurses should not only hold adequate knowledge of medications and their effects but also have the ability to act in unforeseeable situations.

TABLE 5. Prevention method: Focusing on human resources.

Categories of prevention methods	**Number of mentions in the data**
professional competence and growth	13
workload	8
improved communication and teamwork	7
use of specialised staff	3

Fogarty and McKeon (2006) conclude that if nurses' workloads are reasonable, they are less likely to conduct medication errors. Thus, to relieve time pressures, nurse's amount of work and his/her abilities to carry out the tasks should be considered (Seki -

Yamazaki 2006). When staffing levels are adequate (McKeon et al. 2006), nurses are less likely to participate in unsafe practices. Also, controlling the amount of overtime nurses work, play role in reducing their workload (Smith - Crawford 2003).

Fogarty and McKeon (2006) bring up the importance of managerial support in promoting safe medication management. They also emphasise nurses' involvement in decision making and opportunities for professional development.

6.2.3 Importance of and improvements in safety issues

Studies suggest development of hospital-wide, and nationally, even internationally, agreed protocols to guide safe medication practice (Ross et al. 2000; Huber 2002; Pape 2003; Cousins - Sabatier - Begue - Schmitt - Hoppe-Tichy 2005; Lisby et al. 2005; Pape et al. 2005; Marck et al. 2006). Pape (2003) and Lisby et al. (2005) underline the importance of evidence based guidelines while Huber (2002) suggests that error prone and high hazard medications should have own procedures. Visibility and accessibility of existing protocols is emphasised by Marck et al. (2006). The use of current procedures should be audited regularly and feedback provided to health care professionals on the areas in which their actions are not in accordance with the protocol (Cousins et al. 2005).

Mattila and Isola (2002) call for unified medication permission protocols and special instructions regarding nursing students' and agency nurses' involvement in medication management. Nurses' dosage calculation skills should be annually tested (Grandell-Niemi et al. 2003) and medication permissions regularly renewed (Mattila - Isola 2002) to ensure safe medication practices.

A recurrent theme throughout the literature is medication error reporting. It is believed that a great number of violations remain unreported. Huber (2002) indicates that 33% of detected errors result into a written incidence reports, while Mayo and Duncan (2004) report a slightly higher incidence (45, 6%). Main reasons for not reporting errors include fear of managerial response and possible repercussions (Schmidt - Bottoni 2003; Mayo - Duncan 2004; Potylycki et al. 2006). Additionally, the number of reports is lower than the real occurrence because many nurses do not view errors that do not

reach the patient or cause harm to the patient as adverse drug events. Therefore, nurses should be told what constitutes a medication error, when and to whom to report it. (Mayo - Duncan 2004)

TABLE 6. Prevention method: Importance of and improvements in safety issues.

Categories of prevention methods	Number of mentions in the data
medication management protocols	10
error reporting	7
medication tests and permissions	5

All incident reports, even the ones of near-misses, offer essential information about causes of errors, and provide opportunities for changes in the organisation to reduce future medication errors (Ross et al. 2000). As long as majority of errors remain unreported, health care settings will lack precise means to improve their medication management. Hence, the atmosphere at work places should be positive towards medication error reporting, and nurses should not need to be afraid to admit the errors they have committed. Changing the culture from punitive to one that promotes learning and encourages reporting is highlighted. (Huber 2002; Schmidt - Bottoni 2003) Also Mustajoki (2005) acknowledges the importance of incident reporting.

Fogarty and McKeon, (2006), Marck et al. (2006), and McKeon et al. (2006) see positive organisational climate as a method to prevent medication errors. As Fogarty and McKeon conclude, “when the climate is positive, nurses are less likely to feel stressed, less likely to violate procedures and therefore less likely to make errors”.

7 DISCUSSION

7.1 Reliability, validity and ethical considerations

Since this paper was not about conducting empirical research, we were forced to rely on previous studies about the topic. Therefore, the ethical considerations included careful inspection of the reliability and validity of the process and chosen literature.

The database searches were conducted only from reliable internet databases. CINAHL, MEDLINE and MEDIC are all reference databases from health care field, which ensure that all references had undergone at least some degree of surveillance (Elomaa - Mikkola 2004: 45). Information specialist's expertise was utilised to ensure the correctness of the search process. Only original researches with apparent and trustworthy research methods were included into the review. The validity and reliability are, however, compromised by the data search limitations. As all of the studies could not be obtained in full text, some important researches might have been left out.

All chosen literature was read and tentatively analysed by both of us and the results were charted similarly (Appendix 1), which decreased the potential for subjective bias. The process of combining the data from review articles was done systematically and illustrated step by step. The literature review is extensive, with over 20 original researches. This led to a massive amount of identified contributing factors as well as prevention methods which were, at times, difficult to structure as many of them overlapped with each other. Especially distinguishing organisational factors from individual was difficult.

Since neither one of us is a native English speaker, the risk of mistranslating has to be recognised. The various terms and concepts used by different authors were confusing at times. Also literature acknowledge the variety of terminology regarding medication management (Yu - Nation - Dooley 2005).

All the articles included in the review were of researches conducted in hospital settings. In general, sample groups consisted of nurses. Few researches included other health care personnel to their sample groups, but even in these studies nurses were the majority of participants. Therefore, we view that the results validly present the situation of the nurses working in a hospital setting.

The literature present the health care situation in nine different countries. However, we do not perceive this to diminish the validity of the findings, since all of these countries operate according to a Western health care model.

It has to be acknowledged that the process of choosing and analysing the data was inevitably affected by our personal judgement. However, all the steps in the review

process are described in detail which enables the repetition of the data collection and analysis.

7.2 Review of the results

The aim of our literature review was to find out the contributing factors to medication errors and methods to prevent them. We aspired to explore this from the point of view of nurses working in the hospital setting. Furthermore, our purpose was to present the findings in relation to the Finnish health care system.

The findings were in general as anticipated. Nurses' personal qualities were rarely identified as causes for errors, but emphasis was on organisational factors, which are often beyond nurses' control. Surprisingly only Finnish literature suggested regular testing of nurses' dosage calculation skills as a method to prevent errors, even though many authors identified nurses' poor mathematical skills as contributing factor to errors.

The inability to follow set protocols was one of the main causes for errors. However, it can be speculated whether this is because nurses are not able to follow rules, or there are not specifically defined protocols to comply. According to our experiences from the clinical area, many health care units lack written protocols for medication management.

It was surprising how so many articles emphasised the importance of error reporting, while, at least in Finland, very little attention seems to be put on it in the clinical area. However, the reasons for the neglect in reporting were not surprising, and are most probably valid in Finland as well. Since many authors point out the importance of error reporting, we were pleased to find out that the Ministry of Social Affairs and Health has together with VTT Technical Research Centre of Finland started a HaiPro II-project (http://haipro.vtt.fi), which aims to implement a reporting system for hazard situations, including those regarding medications, in the health care organisations. The ultimate aim of the project is to develop a nationwide reporting practice. By now a reporting tool has been constructed, and it is accessible for the over 30 participating health care units that are involved in the project's pilot phase.

At the end only three Finnish studies were included into the review which makes the applicability of the findings to Finland difficult to assess. Additionally, the Finnish studies focused mainly on nurses' dosage calculation skills and medication permission protocols in hospitals. Even if these researches' purpose was not to present factors that contribute to errors or methods to prevent them from occurring, the themes emerged among the findings.

In our opinion, many of the contributing factors to errors presented in this paper fairly well describe the situation of the Finnish health care system. Nurses' workloads are high, the working environment is not always peaceful or free from distractions, and nurses' medication knowledge might not always be adequate. Majority of the suggested prevention methods presumably fit into the Finnish system too. However, it has to be recognised that the studies were from nine different countries, whose health care practices inevitable differ from each other and from the Finnish system. This makes it unfeasible to implement some of the suggestions as such. For example, some authors disclosed improved communication between pharmacists and nurses as a method to prevent medication errors. This suggestion is highly applicable, for example, to the United Kingdom where nurses and the pharmacy staff already work closely together. In Finland, based on our experience, pharmacists are hardly ever present at the wards, and there is little cooperation between the two.

As can be concluded from the literature medication errors continue to pose a threat to safe patient care. Therefore we feel that more empirical research focusing on the causes of medication errors especially in Finnish hospitals is needed. Once the causes for errors are detected, it will be possible to further assess the aptitude of the solutions for safer medication management presented in this paper for the Finnish system.

The findings of this review could be helpful when planning further research concerning contributing factors to medication errors. The various contributing factors presented in this paper offer future researchers several starting points from which to approach the occurrence and causes of medication errors. Hopefully, this would increase the diversity of Finnish research, which by now has mainly concentrated on nurses' mathematical and pharmacological skills.

7.3 Conclusions

Major factors contributing to errors are identified as the excess workload of nurses'; noisy environment with distractions; ineffective communication; and weaknesses in the working methods, and protocols of the work place. Improvements and changes on the organisational level reduce the impact of all these factors. Workloads lessen with adequate staffing, distractions are avoided by reorganising the physical environment and educating the staff, and communication improved by investing to an open and trusting atmosphere at the workplace. Development of unified protocols and work procedures, and introducing these to the staff that carry out medication management, offer professionals clear, evidence based rules to follow.

The individual factors that affect to the occurrence of errors include nurse's inability to follow protocols, lack of knowledge about medications, and personal qualities of the nurse. Problems deriving from these factors are also prevented with strong leadership and management principles. Staff education is the main method to improve staffs' compliance with the set protocols, as well as to increase their knowledge about medications.

Medication error reporting, and the lack of it, is a key factor in the development of safer medication practices. Error reports are not just important for the sake of patient safety but vital for the organisation, so that causes of errors can be better identified and measures taken to prevent further errors.

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Articles used for the literature review

Author, title, journal	Purpose of the study	Sample	Data collection and analysis	Main results
Benner, P. – Sheets, V. – Uris, P. – Malloch, K. – Schwed, K. – Jamison, D. 2002: Individual, Practice, and System Causes of Errors in Nursing: A Taxonomy. Journal of Nursing Administration 32(10). 509-523.	To develop a taxonomy of nursing errors and determine the feasibility of the taxonomy for educational purposes. To describe the types of actions taken by state Board of Nursing for the errors.	21 completed disciplinary case files from State Boards of Nursing in USA.	Disciplinary case files were collected from 9 State Boards of Nursing and analysed for causes of errors and actions taken by the State Board.	Categories for nursing errors include: lack of attentiveness; lack of agency/fiduciary concern; inappropriate judgement; lack of intervention on the patient's behalf; medication errors; lack of prevention; missed or mistaken MD/health care providers orders; documentation errors.
Cousins, D. H. - Sabatier, B. - Begue, D. - Schmitt, C. - Hoppe-Tichy, T. 2005: Medication errors in intravenous drug preparation and administration: a multicentre audit in the UK, Germany and France. Quality & Safety in Health Care 14 (3). 190-195.	To compare the effect of the design and implementation of systems for the preparation and administration of i.v. therapy in hospitals in three European countries. To gain a better understanding of the risks of i.v. therapy and about methods to manage the risks.	Six hospital departments in UK, Germany and France. 824 prepared and 798 administered medication doses.	Observation of preparation and administration of IV drugs. The data was entered into computer software spreadsheet applications.	Most errors in labelling, use of diluent, rate of administration, and aseptic techniques. There is a requirement to develop better national and possibly even international procedures.
Fogarty, G. J. - McKeon, C. M. 2006: Patient safety during medication administration: The influence of organizational and individual variables on unsafe work practices and medication errors**.** Ergonomics 49 (5-6). 444-56.	To measure organisational climate and to test links between climate and unsafe medication administration behaviours. To examine the role of stress and morale in medication errors.	176 nurses working in 11 public sector hospitals in Australia.	Data was collected with questionnaires and analysed using descriptive statistics.	Importance of monitoring the state of whole health care system. Weaknesses at organisational level affect staffs' psychological well-being and stressed staff may take part in unsafe medication practices.
Fortescue, E. B. - Kaushal, R. - Landrigan, C. P. - McKenna, K. J. - Clapp, M. D. - Federico, F. - Goldmann, D. A. - Bates, D. W. 2003: Prioritizing Strategies for Preventing Medication Errors and Adverse Drug Events in Pediatric	To classify the major types of medication errors in peadiatric inpatients and to determine which methods most effectively prevent the errors.	1020 patients in two medical centers. 10 778 medication orders were reviewed to tract errors.	Review of medication order sheets, medication administration records and charts of all patients on study wards during study period.	Error types: dosing and transcription errors, wrong route of administration. Prevention methods: use of computerised physician order entry with clinical decision support systems, use of clinical pharmacist, improved

Inpatients. Pediatrics 111(4). 722-9.				communication among physicians, nurses and pharmacists.
Gandell-Niemi, H. - Hupli, M. - Leino-Kilpi, H. - Puukka P. 2003: Medication calculation skills of nurses in Finland. Journal of Clinical Nursing 12(4). 519-28	To describe the medication calculation skills of nurses in Finland.	546 nurses from one Finnish university hospital.	A questionnaire with medication calculation test. Data analysis was based on descriptive statistics.	The importance of checking and maintaining nurses´ medication calculation skills. There is a need to develop a medication calculation test for quality assurance.
Huber D. 2002: Nevada nurses participate in medication errors survey. Nevada RNformation 11 (3). 18-9.	To reveal Nevada nurses experiences and perceptions of medication errors.	825 nurses (71.3% of participants), pharmacists, physicians and other hospital staff from 25 hospitals in Nevada and Utah.	A questionnaire was distributed to the staff. Results were analysed using descriptive statistics.	Describes the type and nature of medication errors and causes for violations. System factors important in prevention of errors.
Lisby, M. - Nielsen, L. P. - Mainz, J. 2005: Errors in the medication process: frequency, type, and potential clinical consequences. International Journal for Quality in Health Care 17(1). 15-22.	To investigate the frequency, type, and consequences of medication errors.	Hospital patients (N=64), nurses dispensing and administering medications, physicians prescribing drugs and secretaries transcribing drugs into the medical record in a university hospital in Denmark.	Direct observation, unannounced control visits to the wards and review of charts. The data was analysed using SPSS 11.0.	Lists medication error types and frequencies. Improvements are needed in most stages of medication process. Prevention methods: use of automated technology and simple changes in existing procedures.
Marck, P. B. - Kwan, J. A. - Preville, B. - Reynes, M. - Morgan-Eckley, W. - Versluys, R. - Chivers, L. - O'Brien, B. - Van der Zalm, J. - Swankhuizen, M. - Majumdar, S. R. 2006: Building safer systems by ecological design: using restoration science to develop a medication safety intervention. Quality & Safety in Health Care 15 (2). 92-7.	To determine if restoration science can be adapted to medication safety issues. To find out how, by using restoration science, safer places for giving care can be created.	26 registered and practical nurses from teaching and referral hospital in Canada.	Mediation safety issues inventory was distributed to the staff. Analysis with descriptive statistics.	Staff education and the physical environment for medication administration were identified as problem areas. The research resulted in healthier reporting culture, introduction of regular discussions of near misses, development of educational strategies, redesigned delivery and storage processes and renovated environment at the ward in question.
Mattila, M. - Isola, A. 2002: Sairaanhoitaja lääkehoidon ja verensiirron toteuttajana -	To chart protocols regarding health care professionals' rights to carry out medication	57 nurse managers from 19 hospital districts in Finland.	A questionnaire with open-ended and structured questions was distributed to ward managers.	Different administration methods should be taught already in basic education. Pharmaceutical

lupakäytäntö. Suomen Lääkärilehti 57(39). 3884- 3887.	management and blood transfusions in different hospital districts.		Analyses using SPSS program.	knowledge more important than mastering different techniques. Presents areas for development.
Mayo, Ann M. - Duncan, Denise 2004: Nurse perceptions of medication errors: What we need to know for patient safety. Journal of Nursing Care Quality 19 (3):.209-217.	To examine nurses´ perceptions over medication errors. To investigate what nurses believe constitutes a medication error, what is reportable, and what barriers to reporting exist.	5000 registered nurses from 16 acute care hospitals in USA.	A self-report survey was distributed to the participants. Data was analysed using descriptive statistics.	Lists causes of medication errors and prevalence of error reporting. Identifies need for clarification over the concept of medication error, barriers to reporting and gives recommendations for practice development.
McKeon, C. M. - Fogarty, G. J. - Hegney, D. G. 2006: Organizational factors: impact on administration violations in rural nursing**.** Journal of Advanced Nursing 55(1). 115-23.	To investigate the influence of organisational factors on procedual violations during administration of medication.	627 nurses working in Australia.	A questionnaire was distributed to participants. Thematic content analysis was used.	High level of knowledge results to lower level of errors while high work loads and expectations from other staff results to higher level of errors. Holistic management approach important in practice development.
Mustajoki, P. 2005: Hoitoon liittyvät virheet ja niiden ehkäisy: Peijaksen sairaalan projekti. Suomen Lääkärilehti 60(23). 2623-2625.	Charts the medical errors and deviations occurring in the wards.	210 deviations in 10 hospital units in a Finnish hospital	Review of incident reports. Specified analytical method (analyysilomake) was used.	61,4% of all deviations were medication errors. Lists factors contributing to medication errors. Emphasises the importance of incident reporting.
Pape, T. M. 2003: Applying airline safety practices to medication administration. MEDSURG Nursing 12(2). 77-94.	To measure the effect of the interventions for decreasing nurses' distractions during medication administration.	24 medication cycles performed by three groups (one control and two intervention) in acute care hospital in USA.	Data was collected with the Medication Administration Distraction Observation Sheet. Data was entered into SPSS 10.0.	Standard protocols for medication administration should be established and environmental factors decreased to ensure safe medication management.
Pape, T. M. - Guerra, D. M. - Muzquiz, M. - Bryant, J. B. - Ingram, M. - Schranner, B. - Alcala, A. - Sharp, J - Bishop, D. - Carreno, E. - Welker, J. 2005: Innovative Approaches to Reducing Nurses' Distractions During Medication Administration. Journal of	To find out innovative methods that reduces nurses' distractions and promotes their focus while administrating medication.	78 nurses in a hospital in USA.	Nurses were observed during medication administration. Data was entered into SPSS 11.5.	Lists reasons for medication errors. Brings up the importance of following standard protocols for medication delivery and the value of signage, protocol steps check lists and teamwork in distraction reduction.

Continuing Education in Nursing 36 (3). 108-116.				
Potylycki, M. J. - Kimmel, S. R. - Ritter, M. - Capuano, T. - Gross, L. - Riegel-Gross K. - Panik, A. 2006: Nonpunitive Medication Error Reporting: 3-Year Findings From One Hospital's Primum Non Nocere Initiative. Journal of Nursing Administration 36(7-8). 370-6.	To identify underlying practices and attitudes on medication error occurrences and reporting practices.	1309 members of nursing staff.	A survey was distributed to nursing staff. Statistical analysis was performed using SPSS and MetStat.	Medication errors result from job stress, inadequate staffing and excess hours worked. Errors are not consistently reported and primary barrier for not reporting is staffs´ perception that reporting carries a risk of disciplinary action.
Ross, L. M. - Wallace, J. - Paton, J. Y. 2000; Medication errors in a paediatric teaching hospital in the UK: Five years operational experience. Archives of Disease in Childhood 83(6). 492-7.	To determine the incidence and type of medication errors. To test whether any error prevention programmes influence error occurrence.	Review of 195 medication error reports from a hospital in UK.	Retrospective review of documented medication errors. Data was summarised using standard descriptive methods.	Presents types of and causes for medication errors. Most errors are caused by organisational failures and there is a need for hospital wide standardisations. Organisation should step away from punitive culture regarding error reporting.
Schaubhut, R. M. - Jones, C. 2000: A System Approach to Medication Error Reduction. Journal of Nursing Care Quality 14(3). 13-27.	To implement an interdisciplinary process for the reduction of medication errors	6234 patient days were reviewed (10 patient / ward/ month) in a hospital in USA..	Review of medication charts. Data was analysed for accuracy of right patient, medication, dose, route, and time.	Error reporting increased and documentation errors decreased during the project. Also, higher awareness of medication error prevention and reporting among staff due to the project.
Schmidt, C. E. - Bottoni, T. 2003: Improving medication safety and patient care in the emergency department. Journal of Emergency Nursing 29(1). 12-16.	Which human and system factors contribute to medication errors.	58 emergency department staff members (23 nurses) in a hospital in USA.	A written questionnaire was distributed to participants and analysed for barriers to reporting errors. Medications used at the ward were analysed using Pyxis method.	Lists potential causes for errors and barriers to reporting. Importance put on staff training over safe and proper medication administration. Counselling sessions a good alternative for a punitive event in a case of deviation.
Seki, Y. - Yamazaki, Y. 2006: Effects of working conditions on intravenous medication	To explore which working conditions influence the occurrence of medical near- miss	90 nurses working in four different wards in a hospital in Japan.	A self-reporting questionnaire was used to gather data. Bivariable and multivariate	Workload and lack of experience causative factors to errors. Lack of fatigue and work experience

errors in a Japanese hospital. Journal of Nursing Management 14(2). 128-39.	errors related to iv medications.		logistic regression analyses were used to process the data.	increase error prevention. Working conditions should be improved for safer medication practices.
Simpson, J. H. - Lynch, R. - Grant, J. - Alroomi, L. 2004: Reducing medication errors in the neonatal intensive care unit. Archives of Disease in Childhood 89(6). 480-82.	To describe the medication errors occurring within a neonatal intensive care unit, and assess the impact of a combined risk management/ clinical pharmacist led education programme on the errors.	105 reported medication errors	Prospective review of medication error reports. Statistical methods were used to analyse the data.	Interventions to improve staff education and awareness of errors are effective in reducing errors. Also, close liaison with ward based clinical pharmacist is another prevention method.
Smith J. - Crawford L. 2003: Medication errors and difficulty in first patient assignments of newly licensed nurses. JONA's Healthcare Law, Ethics, and Regulation 5(3). 65-7.	To find out in which degree new nurses are involved in medical errors and challenges they face in their first client assignments.	1000 registered nurses and 1000 licensed practical nurses.	Survey questionnaires were used for data collection. Data was analysed using desriptive statistics.	Presents contributive factors for errors. Nurse managers should be aware of the vulnerability of new nurses and monitor their length of work days and amount of overtime worked.
Stetina, P. - Groves, M. - Pafford, L. 2005: Managing Medication Errors - a qualitative study. MEDSURG Nursing 14 (3). 174-178.	To explore the management of medication errors and how medication errors affect nurses' day to day practice. To examine the ways that nurses define medication errors and make decisions regarding the reporting of medication errors.	6 nurses working in a hospital in USA.	Participants were interviewed and data was analysed using interpretive methodology.	Nurses perceptions over what constitutes an error varied and they perceive that context counts regarding medication administration. Nurses generally had increased reliance on the system.
Taxis, K. - Barber, N. 2003: Causes of intravenous medication errors: an ethnographic study. Quality & Safety in Health Care 12(5). 343-7	To investigate causes of errors in IV drug preparation and administration.	130 nurses from ten wards in two hospitals in the UK.	Nurses were observed during medication preparation and administration. The data was coded based on Reason's four stage model of human error theory and the framework of categories by Vincent et. al.. Errors were analysed to identify the main active failures and the factors contributing to the errors.	Presents types of and causes for errors. Concludes that individual acts are rarely to blame for medication errors but they are usually caused by a range of organisational and managerial issues.

Contributing factor	Subcategory
"...contributed to the error... time pressure..."	time pressure
"....contributed to the error... excessive workload..."	workload
"... higher workload... associated with a higher incidence of violations..."	workload
"... poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... ruuhkatilanne..."	hurry
"... medication error occurs as a result of… job stress... "	job stress
"...medication error occurs as a result of… inadequate staffing... "	inadequate staffing
"... medication error occurs as a result of…excess hours worked... "	excess hours worked
"... the amount of work one nurse can... perform... "	workload
"... when busyness was felt... "	hurry
"... intensity of work in the unit… "	intensivity of work
"...amount of overtime worked... contributed to errors… "	overtime
"... inadequate staffing contributed to errors… "	staff levels
"... long working hours as a factor influencing errors..."	long working hours
"... practice for medication administration were increasingly difficult given the increased patient acuity and workload of the nurse..."	workload
"... distractions... contributing to errors... "	distractions
"...interruptions... contributing to errors..."	interruptions
"... poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... rauhaton työympäristö..."	distraction
"... nurses reported numerous distractions..."	distractions
"... medication errors often occur because of…distractions... "	distractions
"... medication errors often occur because of…interruptions... "	interruptions
"... distractions when carrying out several tasks at the same time... "	distractions
"... medication errors occur because of high noise level... "	high noise level
"...poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... toimintaprosessin heikkous... "	weaknesses in the organisational procedures
"... unsuitable working environment... " (regarding technology)	working environment
"... poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... puutteellinen perehdytys..."	inadequate orientation
"... lack of supervision of student nurse/ agency nurse... "	lack of supervision
"... medication errors often occur because of…poor teamwork..."	poor team work
"...poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä...puutteellinen informaatio..."	inadequate information
"... poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... puuttuva ohje... "	missing instruction
"… most errors are not a result of individual negligence but arise from systematic organisational failures… "	systematic organisational factors

"... multiple administration times... "	multiple administration times
"… misconstrued the physician's verbal order on the phone… "	misinterpreting physician's orders
"… MD handwriting is difficult to read or illegible… "	misinterpreting physician's orders
""… communication breakdowns… "	ineffective communication
"… medication errors often occur because of… ineffective communication… "	ineffective communication
"… there was lack of communication between pharmacy and the nursing units…"	ineffective communication
"… lack of awareness...regarding the importance and necessity to write clear, concise, and legible orders… "	misinterpreting physician's orders
" … misinterpreting doctor's handwritten orders…"	misinterpreting physician's orders
"… poor communication between staff… "	inadequate communication
"… lack of adequate communication as a factor contributing to errors… "	inadequate communication
"… communication problems between… nurses… nurses and pharmacists… "	inadequate communication
"… causes included… poor role models…"	poor role models
"… communication problems between doctors and nurses included ambiguous hand written prescriptions… "	misinterpreting physician's orders
"... multiple doses, especially when similar in appearance... "	similar looking medications
"...errors occur when there is a confusion between 2 drugs with similar names..."	medications with similar names
"... medication labels/packaging are of poor quality or damaged... "	labels/medication package damaged
"... multidose formulation... increase the risk… overdosing… "	multidose formulation
"... kehittämistarpeina... vaihtuvat kauppamerkit ja uudet lääkkeet... "	changing medications/different brand names
"...not fulfil practice responsibility to read the medication label, match it with the order sheet, and double check the 6 "rights" for safe administration of medications..."	not following protocol
"...contributed to the error... deviation from established procedures..."	not following protocol
"... less-than-ideal compliance with legal and best-practice guidelines... "	not following protocol
"... giving bolus doses too quickly... "	not following protocol
".. the philosophy of not using the five rights consistently... "	not following protocol
"... causes included a lack of perceived risk..."	lack of perceived risk
"... type of error was the deliberate violations of guidelines... "	not following protocol
"... poor documentation of administration..."	poor documentation
"... failing to record that medications had been given... "	failure to document
"... wrong medications delivered due to misidentifying the patient... "	failure to identify the patient
".. nurse fails to check the patient's name band... "	failure to identify the patient
"... mistakes can easily happen if the nurse does not check the patient's ID band... "	failure to identify the patient
"... errors were made duo to failure to check doses,	lack of patient knowledge

allergies, drugs, and interactions... ”	
“... administers medications without knowing the patient’s medication allergies... ”	lack of patient knowledge
“…contributed to the error... patient knowledge… “	lack of patient knowledge
“...not recognise that... had miscalculated...”	miscalculations
“… serious errors included... miscalculations… ”	miscalculations
“... nurse miscalculates the dose... “	miscalculations
“... knowledge/competence issue... not know the toxic and immediate effect... " (of the drug)	inadequate medication knowledge
“... the pharmacological skills of the nurses seemed to be inadequate according to this study... “	inadequate pharmacological skills
“... contributed to the error... medication knowledge... “	inadequate medication knowledge
“… higher level of knowledge… associated with lower levels of violations”	inadequate medication knowledge
“... preparing the wrong solvent/diluent...“	inadequate medication knowledge
“... giving bolus doses too quickly... ”	inadequate medication knowledge
“... errors were made due to failure to check doses, allergies, drugs, and interactions... ”	inadequate medication knowledge
“... nurse sets up or adjusts and infusion device incorrectly… nurses are confused by the different types and functions of infusion devices... ”	failure to use medication administration devices
“... lack of knowledge of preparation or administration procedures…in handling technology... ”	inability to use technology
“... computerized charting was difficult...”	difficulty using technology
“… ambiguous manufacturer leaflets… “ (regarding technology)	ambiguous manufacturer instructions
“... contribute to violations... when individuals are suffering from stress... “	stress
“... contribute to violations... when individuals are... low on morale...”	low morale
“...causes include…nurses are tired and exhausted..."	tiredness/unwell
“... poikkeamien analyysissä arvioitiin tapahtumiin olleen seuraavia syitä... inhimillinen erehdys... ”	human error
“... medication errors often occur because of…lack of focus... ”	lack of focus
“... contributed to the error... simple mistakes... “	simple mistakes
“... when arousal level is low... ”	tiredness
“... when years of experience of the nurses at current ward were shorter... ”	lack of experience

FIGURE 4. Contributing factors to medication errros 1.

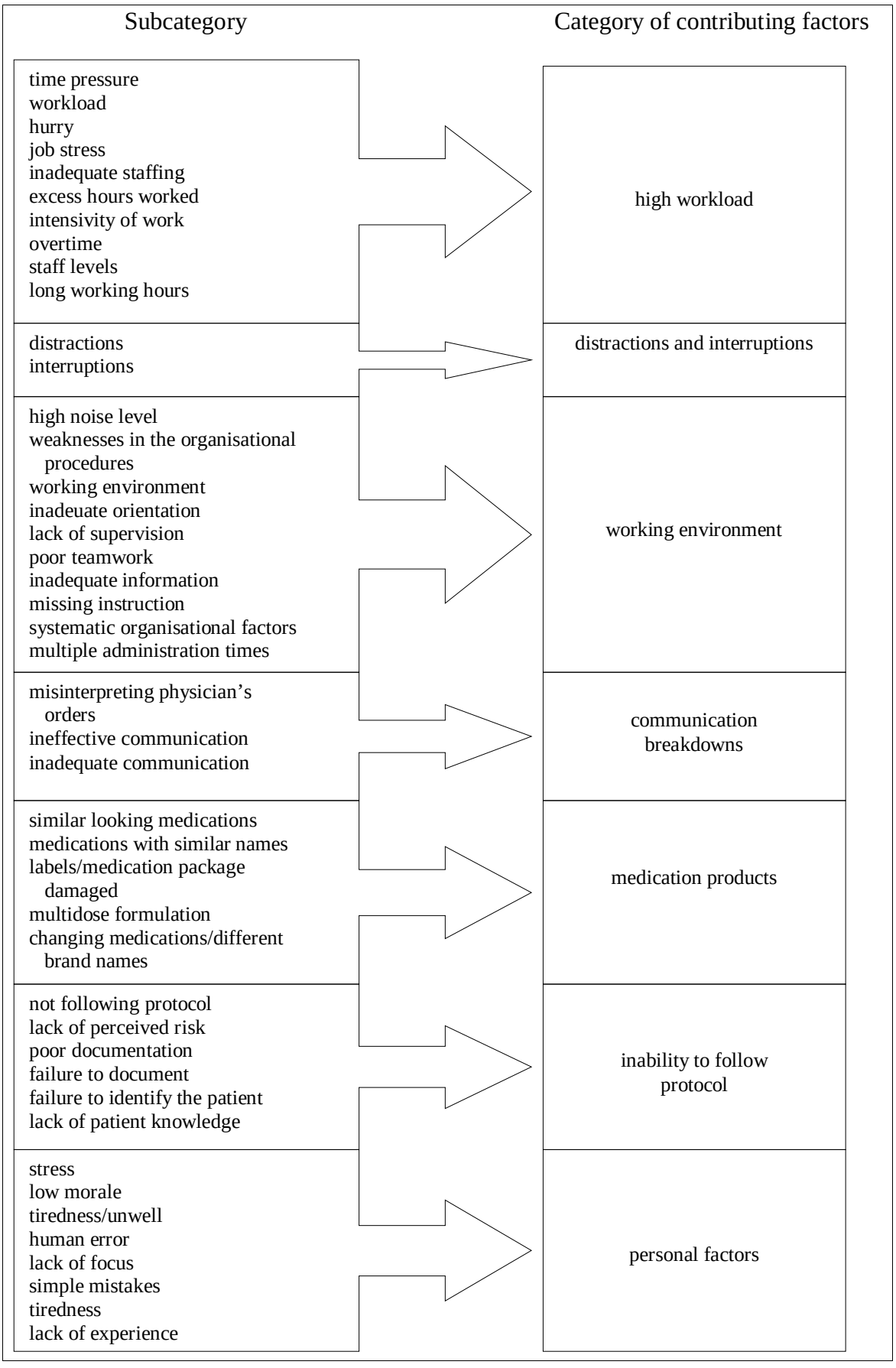


FIGURE 5. Contributing factors to medication errors 2.

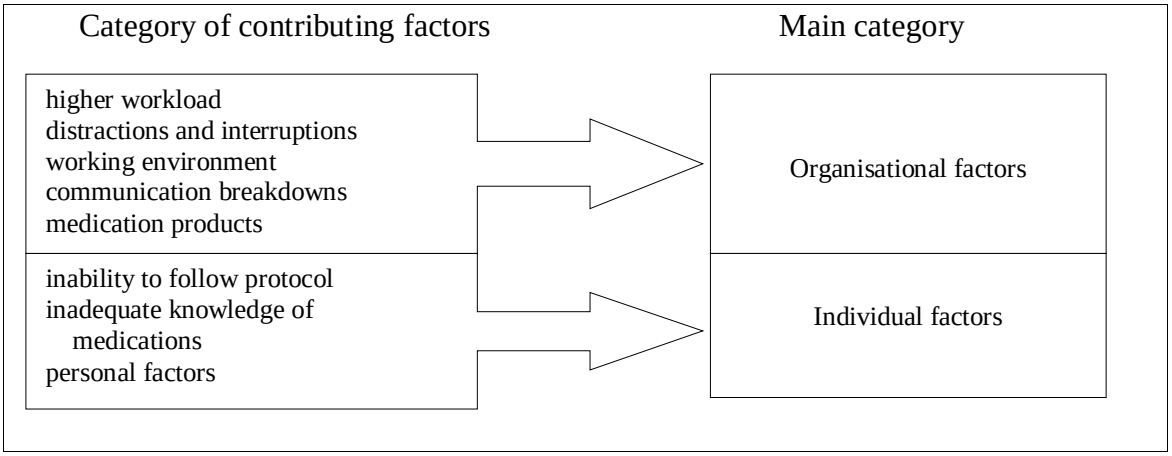


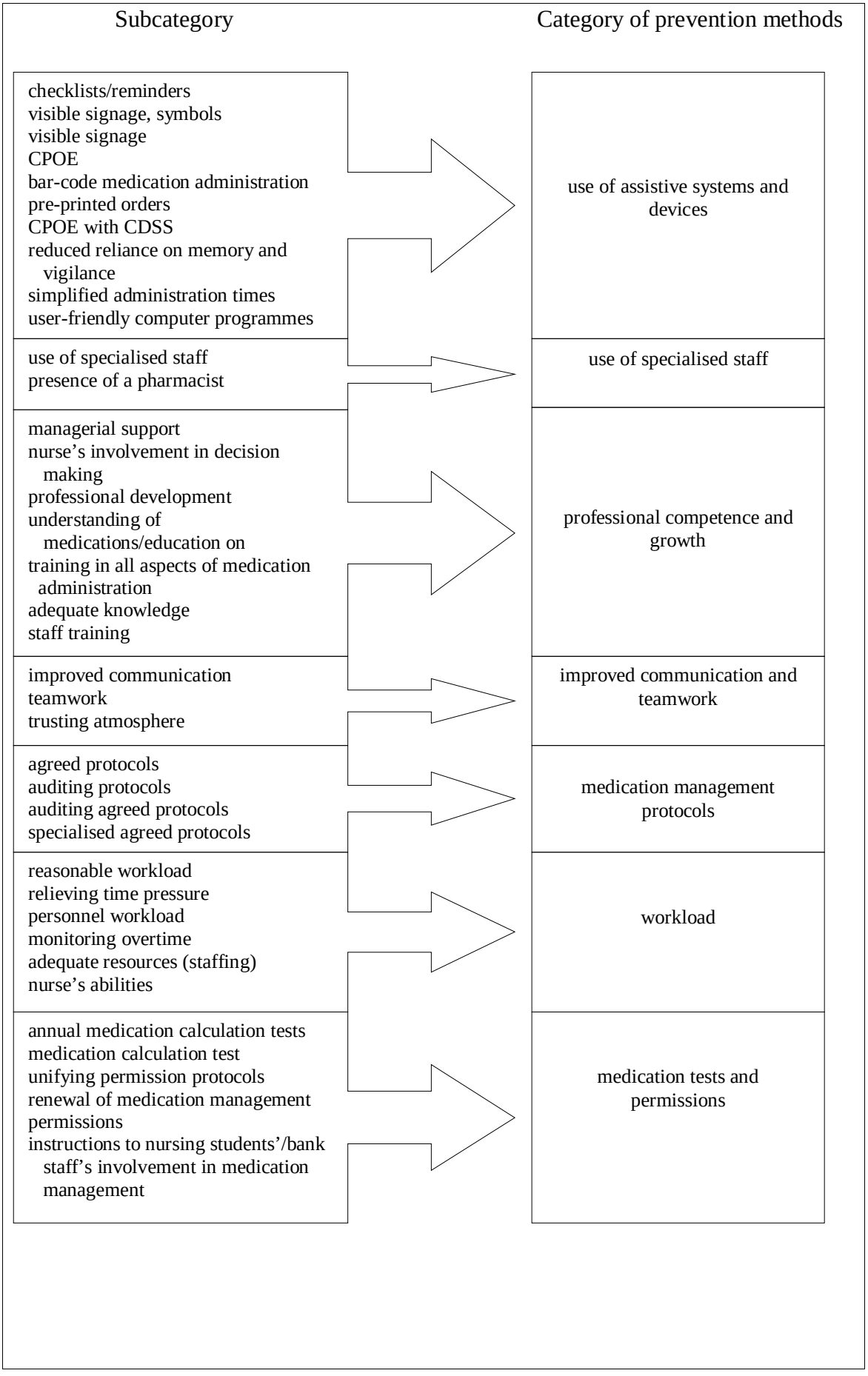
FIGURE 6. Contributing factors to medication errors 3.

Prevention method	Subcategory
".. dedicated medication administration personnel to be used instead of nursing staff... "	use of specialised staff
"... the presence of clinical pharmacist to monitor ordering... transcribing and administering... "	presence of a pharmacist to monitor ordering, transcribing and administering
"... close liaison with a ward based clinical pharmacist is an effective way of reducing errors..."	use of specialised staff
"... checklists and reminders are built into work processes... help track progress... "	checklists/reminders
"... distractions can be…reduced…by use of a visible symbol... "	visible signage, symbols
"... using checklists as reminders to focus on the appropriate medication administration procedure…"	checklist/reminders
"... effective signage …should be used... "	visible signage
"... several of the identified errors... could be avoided by... computerised order entry... "	CPOE
"... several of the identified errors... could be avoided by... bar code medication administration..."	bar code medication administration
"... pre-printed orders... in reducing adverse drug events... "	pre-printed orders
"... CPOE with CDSS... have prevented..."	CPOE with CDSS (clinical decision support system)
"... reduced reliance on the nurse's memory and vigilance… "	reduced reliance on memory and vigilance
"... administration times were standardized and simplified... "	simplified administration times
"… programmers reorganised the charting documents to provide clarity…"	user-friendly computer programmes
"... improved communication between physicians, pharmacists and nurses... in potential error prevention... "	improved communication
"... improving... communications can also reduce errors... "	improved communication
"... improved communication about new medications, policies, equipment, and developments in patients' treatment orders... "	improved communication
"... develop better national (possibly international) procedures for safe intravenous practice... "	agreed protocols
"... evidence-based clinical guidelines for safe medication practice... "	agreed protocols
"... user friendly policies and procedures... improving the visibility and accessibility of clear procedures for medication administration... "	agreed protocols
"... the key to preventing medication errors lies within adopting protocols... "	adopting protocols
"... protocols used should be specific... "	agreed protocols
"… standard protocols for medication administration should be established based on evidence-based guidelines… "	agreed protocols
"... standard protocols should be used... "	agreed protocols
"... importance of hospital wide standardisation... "	agreed protocols

"... to audit the implementation of these procedures regularly and to provide feedback to practitioners on those areas of practice that are out of compliance with the procedure... "	auditing agreed protocols
"... protocols for error-prone or high hazard medications... in reducing adverse drug events... "	specialised agreed protocols
"... commitment to a just culture to promote error reporting... "	just culture for error reporting
"... identifying what is a medication error, when to report it, and to whom... "	documentation of errors
"... havaittujen virheiden ja poikkeamien ilmoittaminen... "	documentation of errors
"... publications on medication errors identify opportunities for systematic changes to reduce the risk of future errors... "	importance of error reporting
"... when nurses receive supportive leadership... less likely to participate in unsafe behaviour... "	managerial support
"... when... nurses are involved in decision making... less likely to participate in unsafe behaviour... "	nurses involved in decision making
"... when... nurses are able to participate in professional development... less likely to participate in unsafe behaviour... "	professional development for nurses
"... improving team functioning... can also reduce errors... "	teamwork
"... luottamuksellinen ilmapiiri... "	trusting atmosphere
"... use educational interventions and teamwork... "	teamwork
"... value of teamwork to decrease distractions... "	teamwork
"... staff training... to reduce the physical effects of errors... "	staff training
"... adequate staff knowledge... were positive... "	staff training
"... understanding of medications... regular staff medication safety education... "	understanding of medications/education on
"... erilaiset lääkehoitoon liittyvät tekniikat tulisi opettaa peruskoulutuksen yhteydessä... tieto lääkkeistä ja niiden vaikutuksista ja kyky toimia ennalta odottamattomissa tilanteissa... "	training in all aspects of medication administration
"... interventions may take the form of training programmes... "	staff training
"... higher level of knowledge... acts as a buffer against unsafe practice... "	adequate knowledge
"... educating staff members to the importance of not distracting nurses during medication management... "	staff training
"... use educational interventions and teamwork... "	staff training
"... classes were scheduled...to review safe and proper medication administration... "	staff training
"... to improve staff education and awareness of errors are effective in reducing… errors... "	staff training
"... when... workloads are reasonable... nurses are less likely to participate in unsafe behaviour... "	reasonable workload
"... identification of conditions that induce time pressures..."	relieving time pressure
"... to consider work responsibilities… and personnel distribution carefully in view of the number of patients... "	personnel workload
"... consider…amount of work one nurse can	workload

precisely perform... ”	
“... need to monitor the amount of overtime worked... ”	monitoring overtime
“... buffers against errors... adequate resourcing... ”	adequate resources (staff)
“... it is vitally important to perform testing annually, to improve nurses’ medication calculation ability… checking and maintaining one’s medication calculation skills... “	annual medication calculation tests
“... a need of developing medication calculation test which… useful tool in quality assurance...”	medication calculation test
“... kehittämistarpeina... lupakäytännön yhtenäisyys... “	unifying permission protocols
“... kehittämistarpeina... lupien uusiminen määräajoin... “	renewal of medication management permissions
“... kehittämistarpeina... opiskelijoiden osallistuminen lääkehoitoon, tilapäistyöntekjöiden lääkkeenantoluvat...”	instructions to nursing students'/bank staff's involvement to medication management
“... consider…the ability of each nurse...”	individual nurse's abilities
“... eliminating the distractions can be a good improvement strategy... “	eliminating distractions
“... educating staff members to the importance of not distracting nurses during medication management... ”	eliminating distractions
“... discourage unnecessary conversation...”	eliminating distractions/interruptions
“… using distraction reducing techniques to improve medication safety…”	eliminating distractions
“... the medication dispensing stations were moved....to less active, quiet areas or rooms... ”	quiet dispensing areas
“... when the organisational climate is positive... nurses are less likely to participate in unsafe behaviour when administering medications... “	positive organisational climate
“... organizational attitudes... were positive…”	positive organisational climate
“... interventions may take the form of... systems redesign... ”	organisational factors
“... regular monitoring of organizational climate...”	monitoring organisational climate
“... highest ranked priorities for strengthening patient safety... improving the storage of medications... “	improving storage of medications
“... availability of important patient information should also be evaluated... “	availability of patient information
“... availability of clear, accurate information... to reduce the physical effects of errors... “	availability of information
“... improving the accuracy and completeness of transcribing medication orders... “	improving transcription of medication orders

FIGURE 7. Methods to prevent medication errors 1.


Subcategory
Category of prevention methods
checklists/reminders
visible signage, symbols
visible signage
CPOE
bar-code medication administration
pre-printed orders
CPOE with CDSS
reduced reliance on memory and vigilance
simplified administration times
user-friendly computer programmes
use of assistive systems and devices
use of specialised staff
presence of a pharmacist
use of specialised staff
managerial support
nurse's involvement in decision making
professional development
understanding of medications/education on
training in all aspects of medication administration
adequate knowledge
staff training
professional competence and growth
improved communication
teamwork
trusting atmosphere
improved communication and teamwork
agreed protocols
auditing protocols
auditing agreed protocols
specialised agreed protocols
medication management protocols
reasonable workload
relieving time pressure
personnel workload
monitoring overtime
adequate resources (staffing)
nurse's abilities
workload
annual medication calculation tests
medication calculation test
unifying permission protocols
renewal of medication management permissions
instructions to nursing students'/bank staff's involvement in medication management
medication tests and permissions

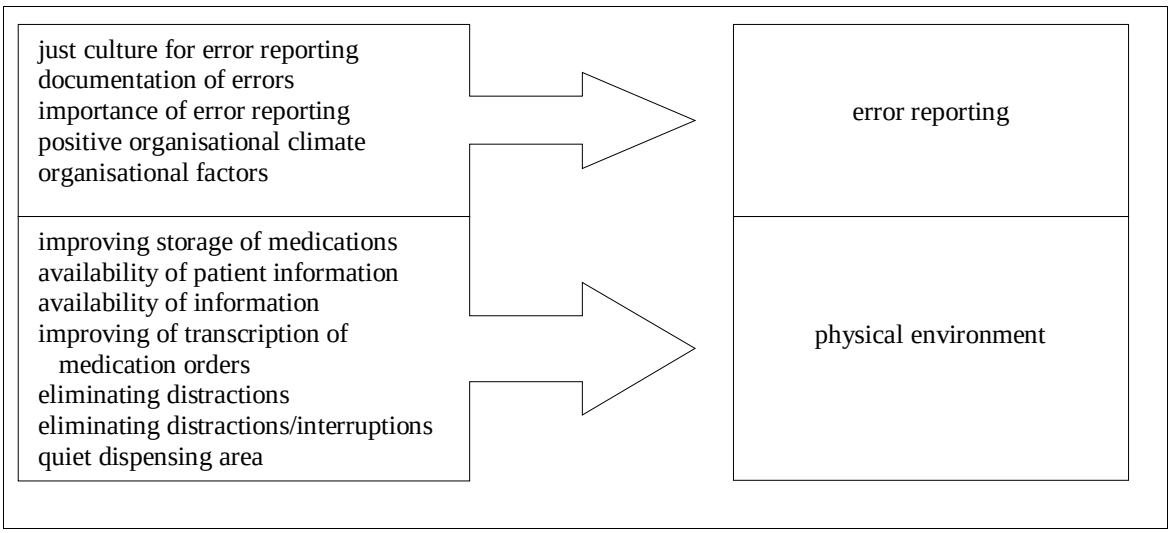


FIGURE 8. Methods to prevent medication errors 2.

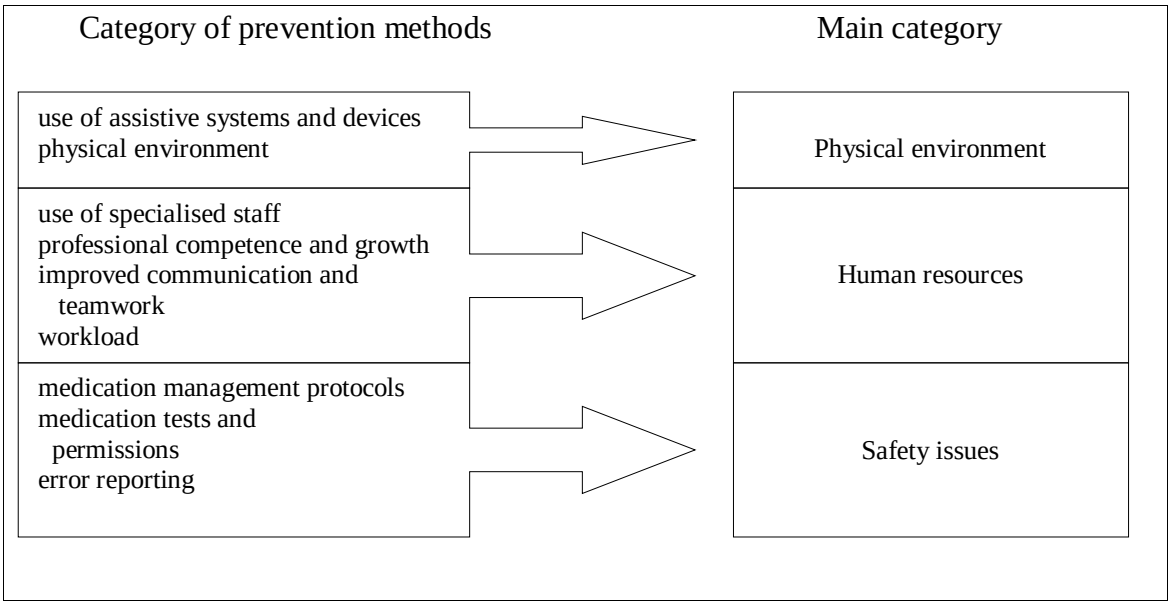


FIGURE 9. Methods to prevent medication errors 3.