

ORIGINAL RESEARCH

Nurses' perceptions of verification of medication competence

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ABSTRACT

Objective: Medication administration is a common clinical procedure of nurses. However, medication errors are a significant cause of morbidity and mortality in hospitalized patients. Previous studies have shown that nurses lack theoretical knowledge and drug calculation skills. This challenges nurses to update their skills regularly and hospitals to organise a systematic verification process of medication competence. The Finnish Ministry of Social Affairs and Health defined in 2006 how nurses' medication competence should be verified. Hence, Finnish nurses' perceptions of the verification process of medication competence was considered a significant topic to be studied.

Methods: The study has a qualitative descriptive design and the data were analysed using inductive content analysis.

Results: Two main categories and nine generic categories were generated from collected data. Five of the generic categories contain nurses' perceptions of how they accept the verification process as part of their work. Four of the generic categories contain nurses' perceptions of barriers to successful implementation of the verification process.

Conclusions: Nurses considered the verification process of medication competence important to developing medication safety and practices. Nurses considered that the verification process maintains and improves their medication competence. E-learning is a sound method of implementing the process but nurses suggest additional lectures and workshops, *e.g.* on drug calculations. Nurses appreciate the mandatory nature of the verification process as long as they perceive the verified competence meaningful to their professional role as nurses.

Key Words: Medication safety, Medication competence, Nurses, E-learning, Inductive content analysis

1. INTRODUCTION

Internationally acknowledged ethical guidelines and laws require nurses to provide high standard and safe care.^[1-3] Patient safety is characterized by efforts to reduce risk, and to address and reduce incidents and accidents that may negatively impact healthcare consumers.^[4] The ambiguities and variability of the terms and definitions related to medication safety make the phenomenon complicated to define;^[5] even haphazard.^[6]

Medication errors are a significant cause of morbidity and mortality in hospitalized patients.^[7-10] In literature medication errors are defined as errors in prescribing, dispensing or administering medication that result in the patient failing to receive the correct drug or the indicated or proper drug dosage.^[11-14] Medication errors include issues both on individual and organizational level.^[5, 15] A systematic review revealed that probability of making at least one error in iv medication administration was 73%.^[16] This creates an im-

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perative to reduce medication errors to deliver safe care to patients.^[5]

1.1 Medication competence and e-learning

Medication administration is a common clinical procedure of nurses.^[17] Medication administration involves intellectual activity in addition to the physical act of medication preparation or administration.^[5] All registered nurses in Finland (henceforth, nurses) are trained to be responsible for performing intravenous (IV) therapy which includes administration of medicine both by infusion and injection.^[18] It is a particularly difficult and precarious skill as it involves many risks.^[15,19]

In literature medication competence is defined as a complex combination of knowledge, skills, performance, values and attitudes.^[20,21] Medication competence of nurses appears to vary depending on how often they administer medication in their daily work.^[22-24] Whether or not nurses need to administer drugs in their daily work, they are required to maintain their medication competence.^[25-27] In this study the focus is on knowledge, skills and performance as they are assessed in the verification process. The values and attitudes of nurses are not significant in the verification process.

Previous studies have shown that nurses have a lack of theoretical knowledge^[28-30] and drug calculation skills.^[31] This challenges nurses to update their skills regularly in order to be able to perform safe medication administration.^[32-35] Nurses need to wield both their theoretical and practical skills when implementing and making decisions about medication.^[9,20,36,37] Given the growing complexity of medication competence, the need for coherent processes to verify nurses' medication competence (henceforth, verification process of medication competence), is increasing in order to ensure medication safety.^[5,15,26,38]

The Finnish Ministry of Social Affairs and Health^[25] published a handbook for safe pharmacotherapy which, among other things, defines how the verification process of medication competence is to be implemented. The general guidelines and principles for verification of medication competence are the same for all public and private social and health care units. The responsibility for the organization of medication competence is vested in the management of the social and health care units.^[25] Finnish health care organizations are encouraged to develop electronic learning (e-learning) environments.^[25] Health care organizations in this study follow the national guidelines for organizing the process of medication competence (see Figure 1). This study focuses on nurses' perceptions of the verification process of medication competence.

Electronic learning (e-learning) has been described as "integrating information technology into the learning/teaching process, using materials" delivered by the Internet.^[39] E-learning is easily accessible to all the nurses because participation does not depend upon time and place.^[39,40] That is, nurses can also log into the e-learning environment outside their workplace.^[25,41] This is an advantage since nurses seldom have time to study within normal working hours. E-learning is a time-effective and cost-effective method for teaching.^[15] Altogether, information and communication technologies in education do not guarantee in-depth, high-quality or effective learning,^[15,42] but allow for diverse learning progression and multiple ways of knowing are stimulated.^[39] E-learning can also be used to engage the students in active exploration.^[39] As demonstrated in previous studies, nurses consider e-learning a sound way to improve their competence.^[41,43] The use of online courses appears to improve nurses' skills. Computer skills and self-regulated learning skills, however, are important for e-learning.^[15,42,44]

1.2 The verification process of medication competence in the organizations of this study

All the nurses of this study, regardless of the department, are required to perform the verification process of medication competence to receive a local medication license. The local medication license is granted by the head of department and it is valid for five years, but only in the department where granted. If a nurse changes working department she needs to retake the practical skills test if there is variation between the medication administration practices of the departments. Theoretical verification is valid in all departments; usually also on the national level.^[25]

The e-learning used by the participants of this study consists of a theoretical material and an online exam. The material consists of basic information on medication, aseptic, frequently-used drugs, intravenous therapy and drug calculations. The online exam contains 40 multiple-choice questions and three drug calculations. The exam measures the knowledge and abilities necessary for nurses to safely administer medication and intravenous therapy. To pass the exam nurses need to answer 75% of the multiple-choice questions correctly and complete 100% of the drug calculations accurately. Use of the study material and a calculator are permitted while taking the exam.^[25]

To achieve the local medication license used in the hospitals in this study, nurses need to complete both the theoretical exam and a practical skills test. The practical skills test involves a required demonstration of basic procedures in drug therapy for designated nurses or clinical pharmacists. The medication license is valid for five years, *i.e.* both the the-

oretical exam and the practical skills test must be retaken every five years.^[25]

Verification of medication competence is relatively new in Finland and, hence, there are no studies to be found concerning the exact topic. That is to say, this study will provide new and pertinent knowledge on the phenomenon. It is important to study nurses' perceptions of the verification process

of medication competence.^[37] E-learning appears to be an effective method for in-service training.^[40] European institutions seek methods and tools that would best contribute to ensuring safe and high-quality care.^[7,21,45,46] Even though, this study was conducted in Finland, medication competence can be considered universal in nursing. Hence, the results of this study can be utilized internationally.

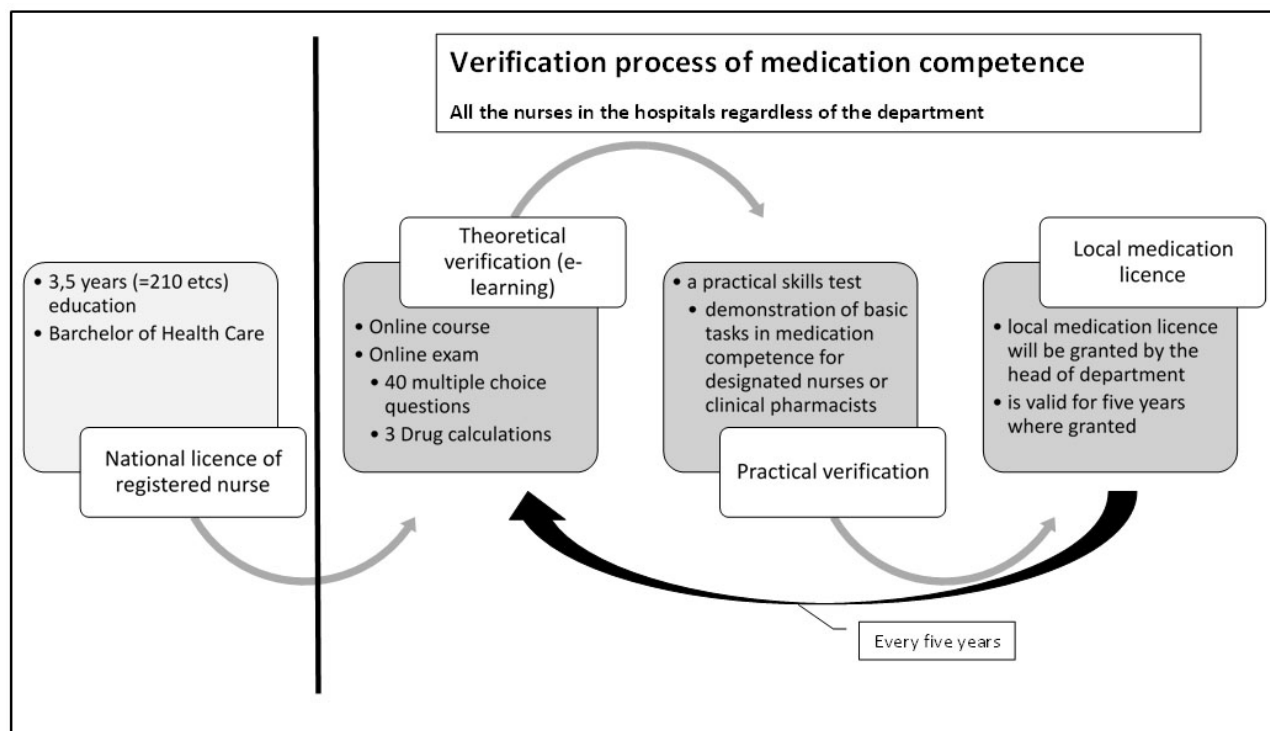


Figure 1. Verification process of medication competence

1.3 Aim of study

The aims of this study are to discover nurses' perceptions of the verification process of medication competence and to understand their perceptions of e-learning as the method for the verification process of medication competence.

Research questions are: What are nurses' perceptions of the verification process of medication competence?

- (1) What are the advantages of the verification process that make the verification process accepted as part of nurses' work?
- (2) What are the barriers to successful implementation of the verification process?

2. METHODS

A qualitative descriptive design was selected to describe the nurses' perceptions of the verification process of medication competence. The qualitative design was used to produce

a rich description and in-depth understanding of the phenomenon of interest.

2.1 Participants

The target population consisted of nurses from a university hospital and two district hospitals in a single Finnish health district. All the hospitals selected use exactly the same verification process of medication competence and were therefore chosen to participate in this study. The study utilizes a total sampling method ($N = 2202$). The contact information of the nurses were obtained from hospital staff registers.

2.2 Data collection

The focus of this study is on qualitative data gathered as a part of a larger study carried out in spring 2011. The instrument developed for this study is based on an instrument generated by Veräjänkorva.^[47] The instrument was designed using Webropol Online Survey and Analysis software,^[48] hence, all the data gathered were in electronic form. A panel

of experts (N = 4) assessed the content and construct validity of the instrument and it was pre-tested by 21 nurses. The survey was sent to work email of the nurses (N = 2202). A reminder message was sent, as well. The nurses were given a two week response time. A total of 692 responses were received, producing a response rate of 31.4%. A total of 342 nurses gave 672 responses to open-ended questions, 10971 words in total. The mean age of the participants were 42.2 years, 92.4% of them were females and 71.3% of them perform iv therapy at least weekly.

The open-ended questions were as follows:

- (1) What advantages do you associate with the verification process of medication competence?
- (2) What has to be enhanced in the verification process of medication competence?
- (3) Do you have any additional comments about the online course/exam for the verification process of medication competence?

2.3 Analyses

Open-ended questions were analysed using inductive content analysis and with the help of the QRS Nvivo program. The inductive approach enables researchers to identify key themes in the area of interest by reducing the data into categories. First, the data was read repeatedly to sense patterns in the data. Single words or phrases were units in this study. Responses were divided into two classes: 1) responses with positive perceptions (n = 337) and 2) responses with negatively oriented perceptions (n = 343). The same participant could provide both classes of answers. Eleven (11) answers, e.g. "I really don't know" were interpreted as non-relevant.

Open coding was performed using the QRS Nvivo program. Headings (called Nodes in Nvivo) were organized into subcategories. Subcategories were classified into generic categories which were named according to the content. At the end of the analysis, generic categories were grouped into two main categories. The data was analysed and simplified into categories that reliably reflect the study subject and that cover the entire data set. Authentic citations were used to demonstrate links between the raw data and the analysis results.^[49-51]

The response, "Medication safety will improve; professional nursing skills will be maintained/will develop" was classified as response with positive perception. The terms "medication safety", "improve", "professional nursing skills", "maintain", and "develop" were considered units. Examples of authentic citations (the original data) are presented along with the corresponding generic categories in results. The final result of this abstraction process is presented in Table 1.

2.4 Ethical considerations

The aim of the study is in the interest of nursing science and practice. There has been very little research on the subject and so this study gives new research-based information on the topic. This research was permitted by the head matron of the health care district. The study did not involve the use of any patient information, therefore permission from the Ethics Committee was not required. Participation in the study was voluntary, and refusal to participate incurred no penalty or prejudice. Participants could not be identified from the data collected. A cover letter containing information on the purpose and aim of the study was provided to each participant. Provision of answers for the study questionnaires was considered informed consent.^[50]

3. RESULTS

The result of the content analysis are presented next. The two main categories are used as headings. The main categories contain one or more generic categories. An authentic citation is presented from each generic category in order to connect the results to the original data. Furthermore, the subcategories of each generic category are also described in the results. The main results of the content analysis are gathered into Table 1.

3.1 Acceptance of the verification process as part of nurses' work

Responses with positive perceptions were abstracted into five generic categories.

The first generic category, Improved medication safety, included only one subcategory: "safety." Nurses considered the verification process important for safety. Authentic citation: "*Absolutely a good thing to ensure safe medication*".

The second generic category included seven sub categories. The category was named Improved professional nursing skills and knowledge. Nurses considered that the verification process would maintain and improve their professional skills in medication. They considered that their knowledge would be updated. They perceived that the verification process would ensure that nurses were equally competent in medication. Authentic citation: "*professional nursing skills will be maintained/will develop*".

The third generic category was named Applicable e-learning material. It included four subcategories. Drug calculations and the theoretical exam were considered effective for learning and maintaining knowledge of drug therapy. The online course was considered an applicable learning method, and the material was thought to be clear and rich in its content. Authentic citation: "*The material was clear and rich in its*

content”.

The nurses appreciated that their theoretical knowledge would be regularly verified. The fourth generic category was named Systematic verification process. Nurses appreciated the systematically implemented verification process. The fourth generic category included four sub categories. Authentic citation: “Ensured that nurses really know what they should”.

The fifth generic category was named Relevance to practical nursing work and included two subcategories. Nurses perceived that the verification process, especially the practical skills test, is relevant to practical nursing work. Authentic citation: “Practical skills tests ensure that one knows how to work aseptically and how to use the correct administration methods”.

Table 1. The main results of the content analysis - Nurses’ perception of verification process of medication competence, acceptance the process as part of work and barriers to the successful implementation

First classification	Sub-category	Generic category	Main category
Responses with positive perceptions	Safety	Improved medication safety	Acceptance of the verification process as part of nurses’ work
	professional skill	Improved professional nursing skills and knowledge	
	basic know-how		
	special know-how		
	updating knowledge		
	drug calculations	Applicable e-learning material	
	material		
	theoretical exam		
	online course	Systematic verification process	
	verification		
equality			
mandatory regularity			
practice	Relevance to practical nursing work		
practical skills testing			
Responses with negatively oriented perceptions	Skill	Uncertainty about benefits to professional nursing skills and knowledge	Barriers to the successful implementation of the verification process
	professional skill		
	know-how		
	basic know-how		
	special know-how	Insufficiency of e-learning as an in service training method	
	knowledge		
	education/training		
	calculations	Authoritarian verification process	
	lecture		
	material		
test			
on paper	Questioning of mandatory verification for all nurses		
online course			
compulsion			
regularity	Authoritarian verification process		
similarity			
time			
have time	Questioning of mandatory verification for all nurses		
practice			
practical skills test	Questioning of mandatory verification for all nurses		
requirements			

3.2 Barriers to the successful implementation of the verification process

Responses with negatively oriented perceptions were abstracted into four generic categories.

Uncertainty about benefits to professional nursing skills and

knowledge was the sixth generic category. It included six subcategories. Nurses considered five year interval between verification processes too long to be effective at maintaining medication competence, particularly if medication administration is not required for daily work. Some nurses were

of the opinion that they needed to learn content which they didn't consider beneficial for their work. Authentic citation: *"Each unit requires a different kind of knowledge, so why is the course content not more targeted to related patient material"*.

The seventh generic category was named Insufficiency of e-learning as an in-service training method. It included seven subcategories. Nurses would need training and lectures in addition to the online course. Some nurses considered that the material was difficult, and that the drug calculations should be more practical. Some nurses considered it to be surprising that the use of study materials during the theoretical exam was allowed. Nurses considered that the study materials should also be easier to print. The time limit for the theoretical exam caused stress for some nurses. Authentic citation: *"Lectures on everything that the IV exam and practical skills tests include. One doesn't learn as much in online courses as in lectures, and facts are much easier to memorize when a lecture is given on them"*.

The eight generic category was named Authoritarian verification process. It included five subcategories. Some nurses proposed lectures instead of the compulsory theoretical exam. They considered that the practical skills test should be executed similarly. Nurses perceived that employers should allow time, during work hours, to study the online course content. They considered that they were unable to study at home. Authentic citation: *"No compulsory drug calculations but opportunity to go to trainings and more medication education"*.

The ninth generic category was named Questioning of mandatory verification for all nurses. It included three subcategories. Some nurses considered that verification should only be compulsory for nurses who require drug therapy knowledge and skills for their daily work. Some participants believed that the content should vary depending on where a nurse works. Some nurses also questioned the need for repeating verification every five years. Authentic citation: *"IV exam should be specialty-specific. Then the theoretical exam would test real knowledge on nursing practices, and not only facts studied from the book which will be forgotten right after the theoretical exam"*.

4. DISCUSSION

According to the nurses, the verification process of medication competence improves medication safety. None of the nurses mentioned medication safety as a barrier to the successful implementation of the verification process. Medication administration, and especially IV therapy, is often complex and involves many risks, so all efforts to improve

safety are important.^[5,16,19]

According to the results of this study the verification process maintains and improves their medication competence, and both skills and knowledge are updated in the process. The regularly implemented verification of medication competence is an excellent opportunity to ensure that nurses' knowledge and skills are current and evidence-based. Increasing quality requirements and more complex methods in medication challenge the field of health care to develop methods to verify nurses' medication competence.^[34,36] Increasing requirements also challenge nurses as individuals. Nurses need to update their skills and knowledge regularly.^[20,33,34] Based on nurses' perceptions, the verification process is a sound and effective way to meet these challenges. The process and especially the practical skills test were considered to improve the real skills needed in everyday work. So according to the results of this study, the verification process of medication competence suites as a tool for ensuring high quality and safe care.^[21,45,46]

One barrier to successful implementation of the verification process appeared to be uncertainty about benefits to nursing skills and competence in medication. The verification process does not guarantee medication competence, according to some nurses. Those who do not need to implement drug therapy in their daily work considered the verification process factitious and even unnecessary. These perceptions were especially characteristic of nurses who do not need to implement IV therapy in their daily work, e.g. nurses in psychiatric fields and nurses who care for the mentally disabled. According to some nurses, verification should be targeted to nurses' own specialties. Earlier studies indicate that nurses' medication competence depends on how often they implement drug therapy in practice.^[22,24] Since medication administration is a basic task of nursing^[17] and nurses are responsible for maintaining their medication competence^[20,36,37] the verification process can be considered obligatory for all.

A systematic and well organized verification process was appreciated as it ensures uniform competence and equal requirements. Nurses acknowledged that the compulsory nature, the similarity in the relevant guidelines, and the requirement for regular renewal of the local medication license were some of the advantages of the verification process. On the other hand, some nurses were of the opinion that the compulsory nature of the process does not increase motivation to improve their knowledge and skills. Instead of exams, they suggested frequently organized lectures. Modern education seems to be based on self-regulated learning skills, meaning that students take responsibility for their own learning.^[15,40,42,44]

E-learning was considered a sound method for learning and

the content of the online course was considered applicable. Some nurses were also eager to practice drug calculations on the online course. Nurses regarded the online exam as meaningful. One barrier to successful implementation of the verification process appeared to be insufficiency of e-learning as an in-service learning method. Nurses suggested that there should also be lectures on medication and practical workshops for reviewing drug calculations. According to previous studies, e-learning is a sound method for in-service training^[40,41] but combination of e-learning and traditional learning approaches, *e.g.* lectures and practical workshops, might significantly increase successful implementation.^[42]

Limitations

The study was conducted in Finland. Therefore the findings may not be representative of the field of nurses' medication competence and medication safety. At the time of the study, the verification process and its necessity provoked strong emotions and resistance among the nurses. On the other hand, the process was highly supported primarily where drug therapy is part of daily work. The nurses' strong emotions might have influenced their answers and response rate. Even though the response rate was relatively low, the open-ended questions were answered by 342 participants. A relatively wide range of qualitative responses increased the trustworthiness of this study. According to the non-response analysis, there was no significant bias among the participants. It can be concluded that the participants represent all specialty fields. Use of the QRS Nvivo program supported systematic inductive analysis of the large data set. Despite its limitations, the current findings can be used as foundation for further studies and implementation of verification of nurses' medication competence.

5. CONCLUSIONS

In the recent years medication safety has risen as an important target of development in the field of health care. Medication errors and reasons leading to the errors have been studied earlier. Also nurses' medication competence has been a focus of nursing studies. However, systematically organized verification of medication competence has not been studied earlier. That's why the results of this study bring new knowledge to the field of health care.

According to the nurses participating in this study medica-

tion safety can be improved by organizing regularly repeated verification of medication competence. Verification of competence is accepted as an important part of nurses' work and e-learning as a method is regarded suitable for the verification process. Based on the results of this study, verification of competence is most successful if traditional lectures and practical workshops are organized in addition to e-learning. Verification of medication competence, especially through e-learning, is a cost-effective method which according to the results of this study can be used to improve nurses' theoretical and practical medication competence.

Nurses appreciate the mandatory nature of the verification process as long as they perceive the verified competence meaningful to their professional role as nurses. The verification process can be improved by tackling the barriers that arose in this study. Since the nurses expressed that there needs to be a variety of learning methods in the verification process, further studies need to be conducted to find out which are the suitable and effective learning methods to be added to the process to ensure that optimal learning results are achieved. In addition, new means need to be found to increase practicing nurses' understanding of the importance of comprehensive medication competence. Whether or not nurses administer medication in their daily work, their medication competence needs to be up to date.

From the point of view of employers it is important that all employed nurses master the basic skills of their profession. This enables mobility of work force, *e.g.* in the case of a crisis situation all the employed nurses can fully contribute to patient care. It is the task of nursing management to ensure that the authoritarian nature of the verification process will not grow to become too big a barrier to successful implementation of the process. The direct impacts of verification of medication competence to medication safety need to be studied in the future since this study only provides knowledge on the perceptions of nurses.

Regardless of the fact that this study was conducted in Finland, the results indicate that the systematic verification of medication competence can be recommended to be started internationally since the foundations of medication safety and medication competence can be considered universal.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

- [1] International Council of Nurses. The ICN Code of Ethics for Nurses. Geneva, Switzerland: ICN – International Council of Nurses; 2012.
- [2] Nursing and Midwifery Council. The Code: Standards of conduct,

performance and ethics for nurses and midwives [Internet]. London, (UK): NMC; 2008. Available from: <http://www.nmc-uk.org/article.aspx>

- [3] Ministry of Social Affairs and Health. Health Care Act No. 1326/2010

- [Internet]. Helsinki (Finland): Ministry of Social Affairs and Health; 2010. Available from: <https://www.finlex.fi/en/laki/kaanokset/2010/en20101326>
- [4] National Library of Medicine. Medical Subject Headings [Internet]. 2015. Available from: <http://www.nlm.nih.gov/mesh/MBrowser.html>
- [5] Brady AM, Malone AM, Fleming S. A literature review of the individual and systems factors that contribute to medication errors in nursing practice. *J Nurs Manag.* 2009 Sep; 17(6): 679-97. PMID:19694912 <http://dx.doi.org/10.1111/j.1365-2834.2009.00995.x>
- [6] Yu KH, Nation RL, Dooley MJ. Multiplicity of medication safety terms, definitions and functional meanings: When is enough enough? *Quality & Safety in Health Care.* 2005 Oct; 14(5): 358-63. PMID:16195570 <http://dx.doi.org/10.1136/qshc.2005.014159>
- [7] European Commission. Patient safety and quality of healthcare. Special Eurobarometer 327. Eurobarometer, Special; 2010.
- [8] Kohn LT, Corrigan JM, Donaldson MS. *To Err Is Human: Building a Safer Health System.* National Academies Press; 2000.
- [9] Härkänen M. Medication-related Adverse Outcomes and Contributing Factors among Hospital Patients [Doctoral thesis]. Faculty of Health Sciences, University of Eastern Finland; 2014.
- [10] Barker KN, Flynn EA, Pepper GA, et al. Medication errors observed in 36 health care facilities. *Arch Intern Med.* 2002 Sep 9; 162(16): 1897-903. PMID:12196090 <http://dx.doi.org/10.1001/archinte.162.16.1897>
- [11] Lassetter JH, Warnick ML. Medical errors, drug-related problems, and medication errors: A literature review on quality of care and cost issues. *J Nurs Care Qual.* 2003; 18(3): 175-81. PMID:12856901 <http://dx.doi.org/10.1097/00001786-200307000-00003>
- [12] Mayo AM, Duncan D. Nurse perceptions of medication errors: What we need to know for patient safety. *J Nurs Care Qual.* 2004 Jul-Sep; 19(3): 209-17. PMID:15326990 <http://dx.doi.org/10.1097/00001786-200407000-00007>
- [13] Runciman W, Hibbert P, Thomson R, et al. Towards an international classification for patient safety: Key concepts and terms. *International Journal for Quality in Health Care.* 2009 Feb; 21(1): 18-26. PMID:19147597 <http://dx.doi.org/10.1093/intqhc/mzn057>
- [14] Ackroyd-Stolarz S, Hartnell N, Mackinnon NJ. Demystifying medication safety: Making sense of the terminology. *Research In Social & Administrative Pharmacy.* 2006 Jun; 2(2): 280-9. PMID:17138513 <http://dx.doi.org/10.1016/j.sapharm.2006.01.001>
- [15] Dennison RD. A medication safety education program to reduce the risk of harm caused by medication errors. *J Contin Educ Nurs.* 2007 Jul-Aug; 38(4): 176-84. PMID:17708117 <http://dx.doi.org/10.3928/00220124-20070701-04>
- [16] McDowell SE, Mt-Isa S, Ashby D, et al. Where errors occur in the preparation and administration of intravenous medicines: A systematic review and bayesian analysis. *Quality & Safety in Health Care.* 2010 Aug; 19(4): 341-5. PMID:20065297 <http://dx.doi.org/10.1136/qshc.2008.029785>
- [17] McBride-Henry K, Foureur M. Medication administration errors: Understanding the issues. *Australian Journal of Advanced Nursing.* 2006 Mar-May; 23(3): 33-41. PMID:16568877
- [18] Finnish Ministry of Education. From polytechnic school to health care. Graduating students' professional competence, essential studies and minimum credits. Publications of the Ministry of Education; 24; 2006.
- [19] Taxis K, Barber N. Causes of intravenous medication errors: An ethnographic study. *Quality & Safety in Health Care.* 2003 Oct; 12(5): 343-7. PMID:14532365 <http://dx.doi.org/10.1136/qshc.12.5.343>
- [20] Sulosaari V, Suhonen R, Leino-Kilpi H. An integrative review of the literature on registered nurses' medication competence. *J Clin Nurs.* 2011 Feb; 20(3-4): 464-78. PMID:20738454 <http://dx.doi.org/10.1111/j.1365-2702.2010.03228.x>
- [21] Cowan DT, Norman I, Coopamah VP. Competence in nursing practice: A controversial concept—a focused review of literature. *Nurse Educ Today.* 2005 Jul; 25(5): 355-62. PMID:15904996 <http://dx.doi.org/10.1016/j.nedt.2005.03.002>
- [22] Khomeiran RT, Yekta ZP, Kiger AM, et al. Professional competence: Factors described by nurses as influencing their development. *Int Nurs Rev.* 2006 Mar; 53(1): 66-72. PMID:16430763 <http://dx.doi.org/10.1111/j.1466-7657.2006.00432.x>
- [23] Dyjur L, Rankin J, Lane A. Maths for medications: An analytical exemplar of the social organization of nurses' knowledge. *Nursing Philosophy.* 2011 Jul; 12(3): 200-13. PMID:21668619 <http://dx.doi.org/10.1111/j.1466-769X.2011.00493.x>
- [24] Sneek S, Isola A, Saarnio R. Nurses' assessment of their competence in intravenous infusion and drug therapy and their views on the confirmation of their competence. *Hoitotiede.* 2013; 25(4): 253-65.
- [25] Ministry of Social Affairs and Health. Safe pharmacotherapy. National guide for pharmacotherapy in social and health care. An abbreviated version. Publications of the Ministry of Social Affairs and Health. 2009: 10; 2009.
- [26] Hicks RW, Becker SC. An overview of intravenous-related medication administration errors as reported to MEDMARX, a national medication error-reporting program. *Journal of Infusion Nursing.* 2006 Jan-Feb; 29(1): 20-7. PMID:16428997 <http://dx.doi.org/10.1097/00129804-200601000-00005>
- [27] Ministry of Social Affairs and Health. Health Care Professionals Act No. 559/1994 [Internet]. Helsinki (Finland): Ministry of Social Affairs and Health; 1994. Available from: <https://www.finlex.fi/en/laki/kaanokset/1994/en19940559>
- [28] Latter S, Rycroft-Malone J, Yerrell P, et al. Nurses' educational preparation for a medication education role: Findings from a national survey. *Nurse Educ Today.* 2001 Feb; 21(2): 143-54. PMID:11170801 <http://dx.doi.org/10.1054/nedt.2000.0528>
- [29] Bullock S, Manias E. The educational preparation of undergraduate nursing students in pharmacology: A survey of lecturers' perceptions and experiences. *J Adv Nurs.* 2002; 40: 7-16. PMID:12230523 <http://dx.doi.org/10.1046/j.1365-2648.2002.02335.x>
- [30] Morrison-Griffiths S, Snowden MA, Pirmohamed M. Pre-registration nurse education in pharmacology: Is it adequate for the roles that nurses are expected to fulfil?. *Nurse Educ Today.* 2002 Aug; 22(6): 447-56. [http://dx.doi.org/10.1016/S0260-6917\(02\)90756-2](http://dx.doi.org/10.1016/S0260-6917(02)90756-2)
- [31] Wright K. Student nurses need more than maths to improve their drug calculating skills. *Nurse Educ Today.* 2007 May; 27(4): 278-85. PMID:16876919 <http://dx.doi.org/10.1016/j.nedt.2006.05.007>
- [32] Schelbred AB, Nord R. Nurses' experiences of drug administration errors. *J Adv Nurs.* 2007 Nov; 60(3): 317-24. PMID:17908127 <http://dx.doi.org/10.1111/j.1365-2648.2007.04437.x>
- [33] Meretoja R, Koponen L. A systematic model to compare nurses' optimal and actual competencies in the clinical setting. *J Adv Nurs.* 2012 Feb; 68(2): 414-22. PMID:21722169 <http://dx.doi.org/10.1111/j.1365-2648.2011.05754.x>
- [34] Smith SA. Nurse competence: A concept analysis. *Pediatric Obesity.* 2012 Oct; 23(3): 172-82. <http://dx.doi.org/10.1111/j.2047-3095.2012.01225.x>

- [35] Keers RN, Williams SD, Cooke J, et al. Causes of medication administration errors in hospitals: A systematic review of quantitative and qualitative evidence. *Drug Safety*. 2013 Nov; 36(11): 1045-67. PMID:23975331 <http://dx.doi.org/10.1007/s40264-013-0090-2>
- [36] Walsh M, Bailey PH, Koren I. Objective structured clinical evaluation of clinical competence: An integrative review. *J Adv Nurs*. 2009 Aug; 65(8): 1584-95. PMID:19493134 <http://dx.doi.org/10.1111/j.1365-2648.2009.05054.x>
- [37] Folkmann L, Rankin J. Nurses' medication work: What do nurses know? *J Clin Nurs*. 2010 Nov; 19(21-22): 3218-26. PMID:21040023 <http://dx.doi.org/10.1111/j.1365-2702.2010.03249.x>
- [38] Kendall-Gallagher D, Blegen MA. Competence and certification of registered nurses and safety of patients in intensive care units. *American Journal of Critical Care*. 2009; 18(2): 106-13. PMID:19255100 <http://dx.doi.org/10.4037/ajcc2009487>
- [39] Glen S. E-learning in nursing education: Lessons learnt? *Nurse Educ Today*. 2005; 25(6): 415-7. PMID:16054949 <http://dx.doi.org/10.1016/j.nedt.2005.07.001>
- [40] Juan A, Huertas A, Steegmann C, et al. Mathematical e-learning: State of the art and experiences at the open university of catalonia. *International Journal of Mathematical Education in Science and Technology*. 2008; 39(4): 455-71. <http://dx.doi.org/10.1080/00207390701867497>
- [41] Blake H. Staff perceptions of e-learning for teaching delivery in healthcare. *Learn Health Soc Care*. 2009; 8(3): 223-34. <http://dx.doi.org/10.1111/j.1473-6861.2009.00213.x>
- [42] Atack L. Becoming a web-based learner: Registered nurses' experiences. *J Adv Nurs*. 2003 Nov; 44(3): 289-97. PMID:14641399 <http://dx.doi.org/10.1046/j.1365-2648.2003.02804.x>
- [43] Gresty K, Skirton H, Evenden A. Addressing the issue of e-learning and online genetics for health professionals. *Nurs Health Sci*. 2007 Mar; 9(1): 14-22. PMID:17300540 <http://dx.doi.org/10.1111/j.1442-2018.2007.00296.x>
- [44] Sung YH, Kwon IG, Ryu E. Blended learning on medication administration for new nurses: Integration of e-learning and face-to-face instruction in the classroom. *Nurse Educ Today*. 2008 Nov; 28(8): 943-52. PMID:18599162 <http://dx.doi.org/10.1016/j.nedt.2008.05.007>
- [45] Watson R, Stimpson A, Topping A, et al. Clinical competence assessment in nursing: A systematic review of the literature. *J Adv Nurs*. 2002 Sep; 39(5): 421-31. PMID:12175351 <http://dx.doi.org/10.1046/j.1365-2648.2002.02307.x>
- [46] Stievano A, Jurado MG, Rocco G, et al. A new information exchange system for nursing professionals to enhance patient safety across europe. *Journal of Nursing Scholarship*. 2009; 41(4): 391-8. PMID:19941585 <http://dx.doi.org/10.1111/j.1547-5069.2009.01307.x>
- [47] Veräjänkorka O. Nurses' Medication Skills. Developing a Test and Educational Models [Sairaanhoitajien lääkehoitotaidot: lääkehoitotaitojen arviointimittarin ja täydennyskoulutusmallin kehittäminen] [Doctoral dissertation]. Turku: University of Turku; 2003. PMID:14597247
- [48] Webropol. Webropol 2.0: Online survey and analysis software [Internet]. 2013. Available from: <http://w3.webropol.com/int/>
- [49] Hoskins CN, Mariano C. *Research in Nursing and Health: Understanding and Using Quantitative and Qualitative Methods*, 2nd Edition. Springer Publishing Company; 2004.
- [50] Polit DF, Beck CT. *Essentials of Nursing Research: Appraising Evidence for Nursing Practice*. Wolters Kluwer Health; 2013.
- [51] Elo S, Kyngas H. The qualitative content analysis process. *J Adv Nurs*. 2008 Apr; 62(1): 107-15. PMID:18352969 <http://dx.doi.org/10.1111/j.1365-2648.2007.04569.x>