Sini Kupiainen 1006562
Yulia Neradovskaya 1105421

Accurate Peripheral IV Antimicrobial Medication: Developing a Knowledge Test for Nurses

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Abstract

Author(s)	Sini Kupiainen Yulia Neradovskaya
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The purpose of this final project was to produce a knowledge test for nurses about the accuracy of peripheral intravenous antibiotic medication.

This final project is a part of a project called "TOLA". It is a study and a developmental project concerning intravenous antibiotic treatment. The aim of the TOLA project is to plan, to implement and to assess an intervention on Medical Admission Unit in HUCH where there are numerous patients in need of intravenous antimicrobial treatment.

The data collection was performed in the fall 2013 and the beginning of the year 2014, using databases CINAHL, Medline and ERIC. The keywords used were: "accurate IV medication", "technique", "accuracy", "intravenous", "safety", "antibiotics". The limitation for search was English language and publication year within the gap of 10 years, 2003-2013. 14 articles were chosen as relevant by the content. The authors carried out the content analysis of the chosen articles, and the findings have served as the theoretical evidence the knowledge questionnaire is based on.

Intravenous antibiotic medication is commonly used in nursing practice, and only the registered nurses are eligible to administer it. Intravenous route is associated with numerous errors and possible adverse reactions. According to Seki and Yamazaki (2006), medications errors have become a worldwide concern, and as Agyemang and While (2010) state, their prevention - a health priority. Intravenous antibiotic medication administration requires theoretical knowledge on medication and its pharmacology, as well as the practical skills to perform the procedure in a safe and accurate manner.

The aim of the questionnaire is to identify the inadequacies in the knowledge of nurses to be restored in order to improve patient safety. This knowledge questionnaire contains 49 statements. The statements are to be marked as true/ false/ I do not know to measure the knowledge, not the opinions, of the participants.

Keywords	Knowledge test, Intravenous antimicrobial medication, Accuracy

Tiivistelmä

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Tämän opinnäytetyön tarkoituksena oli tehdä tietotesti sairaanhoitajille perifeerisen suonensisäisen antimikrobihoidon oikeellisuudesta.

Opinnäytetyö on osa "TOLA"- kehittämishanketta. Hankkeen tarkoituksena on suunnitella, toteuttaa ja arvioida yhdenmukainen toimintamalli perifeerisen laskimonsisäisen antimikrobihoidon lääkkeenannon toteutuksen oikeellisuudesta. Hanke toteutetaan HUS:n Medisiinisessa tuloyksikössä, jossa lukuisat potilaat tarvitsevat antimikrobihoitoa.

Aineisto kerättiin opinnäytetyöhön syksyn 2013 ja alkuvuoden 2014 aikana. Tietokannat, joista aineistoa opinnäytetyöhän kerättiin ovat: CINAHL, Medline ja ERIC. Avainsanat tietokantoihin olivat: “accurate IV medication”, “technique”, “accuracy”, “intravenous”, “safety”, “antibiotics”. Hakukriteerinä toimivat englannin kieli ja julkaisu 2003–2013 vuosien aikana. 14 artikkelia todettiin relevantiksi, jotka toimivat tietotestin teoreettisena perustana.

Suonensisäistä antimikrobihoitoa käytetään hoitotyössä paljon ja sen saa suorittaa vain sairaanhoitaja. Suonensisäistä lääkehoitoa suorittaessa tapahtuu paljon virheitä ja potilas altistuu sivuvaikutuksille. Seki ja Yamazaki (2006) mukaan lääkevirheistä on tullut maailmanlaajuinen huolenaihe. Myös Agyemang ja While (2010) painottavat, että lääkevirheiden ehkäisy on terveystavoite. Suonensisäistä lääkehoitoa suorittaessa, sairaanhoitajan täytyy tietää lääkkeistä ja niiden farmakologiasta. Lääkehoidon tulee olla turvallinen ja täsmällinen.

Tietotestin tarkoituksena on lisätä potilasturvallisuutta tunnistamalla sairaanhoitajien puutteellinen tieto suonensisäisessä lääkehoidossa. Tietotesti sisältää 49 väittämää. Väittämiin vastataan valitsemalla joko tosi, epätosi, tai en tiedä. Näin pystytään mittaamaan kyselyyn osallistujien tietämys suonensisäisestä lääkehoidosta, niin etteivät heidän omat mielipiteensä vaikuta tuloksiin.

Keywords	Knowledge test, Intravenous antimicrobial medication, Accuracy

Contents

1 Introduction

Berman and Snyder (2012: 894) state that intravenous (IV) drug administration is a common procedure in nursing practice. This route is appropriate to use when a rapid effect is desired. Moreover, certain medications are to be administered via IV route for being irritating to tissues, or in case enteral route is not an option. Furthermore, the intravenous route guaranteed the “one hundred percent bioavailability”, as it is not being affected by malabsorption or being inactivated by intestines. (Dychter et al. 2012: 84-9; Berman & Snyder 2012: 894.)

However, only the registered nurses are eligible to administer medications intravenously for safety reasons. This route is associated with numerous errors and possible adverse reactions due to the medication being delivered directly into the bloodstream. Therefore it cannot be withdrawn and takes its effect immediately. Moreover, if the solution or delivery devices are contaminated, pathogenic microorganisms have a direct access to body tissues via bloodstream. Subsequently, this nursing intervention requires not only the theoretical knowledge about medications and its pharmacology, but also practical skills to perform the procedure in a safe and accurate way. (Adams & Urban 2013: 37.)

Medication errors have become a worldwide concern (Seki & Yamazaki 2006:129) and its prevention - a health priority (Agyemang & While 2010: 380). According to Agyemang and While (2010: 380), the two most common types of medication errors happen during medication preparation, such as wrong medicine or dose, and/or medication delivery, such as wrong administration rate. The human factors, as lack of professional knowledge, tiredness and heavy workload of the staff, distractions, interruptions, and even hospital policies also have their effect on the safety of the intravenous drug therapy (Agyemang & While 2010: 381-383; NHS 2009: 6-7).

It was noted in National Health Service (NHS) guideline (2009: 9-10), that nurses’ duty beside the preparation of the medication, is to be aware of the risks of intravenous insertion and drug reactions, to be able to notice them in time and act to alleviate the harm of the medicine. Patient education in regard of possible complications is also nurse’s responsibility. (NHS 2009: 9-10.)

As it has been mentioned before, intravenous drug therapy is a common procedure in hospital settings. For the purpose of treatment severe or life-threatening infections, the intravenous route is chosen for delivery of antimicrobial medication. (Varley, Sule & Absalom 2009: 187.) Antimicrobials are antibacterial drugs used to destroy the bacteria or decrease their growth. They are a powerful branch of medicine and therefore can also be hazardous when used unprofessionally. Like any other intravenous medicines, intravenous antimicrobial therapy has to be prepared and administered in a safe way concerning both, patient and the health care professional (NHS 2009: 3-4). Antimicrobials can cause allergic reactions, anaphylaxis and adverse drug reactions (Trowbridge & Kralik 2006: 29). Subsequently, healthcare professionals and especially nurses, need to have the knowledge about a patient's previous medical history and complications. Nurses also need to have knowledge about contraindications and side-effects of the antimicrobial in use. In a case of an adverse reaction, medication interactions or anaphylaxis, nurses need to be knowledgeable enough to carry out an intervention to alleviate the negative symptoms. The priorities in intravenous therapy are patient safety, asepsis and comfort. (NHS 2009: 6-9.)

This final project is a part of a project called “TOLA”. It is a study and a developmental project concerning intravenous antimicrobial treatment. The aim of the TOLA project is to plan, to implement and to assess an intervention on Medical Admission Unit in HUCH where there are numerous patients in need of intravenous antimicrobial treatment. It will be evidence-based, in-line operational model concerning intravenous antimicrobial treatment. Intervention in this project stands for a chain of action which includes correct intravenous antimicrobial dosing and preparation and accurate medication delivery to patients following the aseptic technique. This intervention will outline the action model of the accurate implementation of IV antimicrobial treatment. Its goal is to increase patient safety, decrease the reproduction of antimicrobials resistant microbe traits and to increase the effectiveness of the infection treatments. It will be designed in a way that it is always possible to repeat in a similar manner, easy to use in daily nursing life, suitable for utilization on the intervention ward, and is of similar values with HUCH Medical Admission Unit. (Rekola et al. 2013: 3-4.)

The purpose of this final project was to design a questionnaire for surveying the nurses’ knowledge on peripheral IV medication. The aim of the questionnaire is to identify the inadequacies in the knowledge to be restored in order to improve patients’ safety.

The study question of the project was: What are the principles which ensure the accuracy of peripheral IV medication?

Based on the evidence, a conclusion on what is the key concepts of the accurate peripheral IV medication are is to be drawn. Based on this data, the authors develop a knowledge test consisting of the questions addressing these concepts. This test could be applied in the recruitment process. Moreover, it might be utilized as a tool for identifying the gaps in the knowledge of the actual staff in order to design a possible educational intervention.

2 Definition of key concepts of the project

2.1 Accurate peripheral IV medication

It has been figured out by the authors of this final project that a concept of “accurate peripheral IV medication” consists of the two following parts: the concept of right medication administration and IV medication delivery competence.

2.1.1 Peripheral IV (PIV) medication administration

The term “peripheral IV medication” stands for a process of administration of a medicament to a patient via peripheral veins (Merriam-Webster & MedlinePlus Dictionary: 2013). PIV can be administered in three different ways, as bolus injection, or intermittent or continuous infusion. The choice of the delivery type depends on treatment requirements, knowledge of the medication, and patient condition. The provision of PIV is part of nursing domain. (Dychter et al. 2012.)

2.1.2 An accurate medication administration

Regardless of the route of medicament administration, a nurse must go through certain checkpoints, also known as the ten “rights” of medication. Berman and Snyder (2012: 864) have laid these “ten “rights” of medication administration” in the following way.

The first is the right medication, meaning that the given medication is consistent with the prescription. The second is the right dose, i.e. a nurse must make sure that the dose ordered is appropriate for the patient, and also pay special attention to the drug calculations and double-check them. The third rule, right time, states that medications are to be given with the right frequency and in the time ordered, in accordance with the hospital policy. The fourth one encourages a nurse to assure that the delivery route is safe as well as appropriate. The fifth rule reminds to make sure that the medication is given to the right client, meaning that the patients' identification is to be checked with each administration of a medication. The sixth one explains that a nurse should clarify the information about a drug for the client, including the indication and possible side effects of a medication, i.e. provide the right patient education. The seventh rule is to make the right documentation right after the medication is given. The eighth rule claims that patients have a right to refuse any medication, although it is nurses' duty to ensure that the patient is aware of potential consequences etc. The next one is the right assessment rule. It stresses that some medications require specific assessments prior to administration, and it goes without saying that all the medication deliveries require the assessment afterwards, which is directly linked to the last "right" of medication - right evaluation, i.e. the conduction of the appropriate follow-up to detect whether the desired effect has been achieved or not, and whether the patient has experienced any side effects or not. (Berman & Snyder 2012: 864.)

2.2 The intravenous antimicrobials

According to Varley, Sule and Absalom (2009: 184), antimicrobial are defined as pharmacological agents which are used to either diminish bacterial growth or eliminate the bacterial cells. Different antimicrobials can be used individually or in a combination to assure the desired outcome. There are various routes for administering antimicrobials, such as topical, oral, and intravenous. Intramuscular route is not commonly used. Mild and topical infections can be treated with topical antimicrobial medication preparation. Oral route is more common as it is easy to use, although the intravenous antimicrobial treatment is to be employed in case the infection is endangering the life of a patient, or the oral route is not accessible. Via IV route, the medication is able to access the blood circulation straight away, subsequently the desired effect is reached out rapidly. Additionally, the bioavailability of antimicrobial medication is higher when introduced intravenously. (Varley, Sule & Absalom: 2009.)

2.3 Knowledge test

In this project the term “knowledge test” is often substituted with the term “knowledge questionnaire” which the authors have come across in the literature. A knowledge test could be defined as a survey executed via a questionnaire, which addresses the level of one’s knowledge on a certain subject. Further in the chapter “Methodology”, the authors of this final project elaborate on the knowledge questionnaire designing as the methodology.

3 Purpose and the study question

The purpose of this final project was to design a questionnaire for surveying the nurses’ knowledge on peripheral IV medication.
The aim of the questionnaire is to identify the inadequacies in the knowledge to be restored in order to improve patients’ safety.
The study question of the project was: What are the principles which ensure the accuracy of peripheral IV medication?

4 Methodology

4.1 Knowledge test, i.e. knowledge questionnaire

Knowledge test, i.e. a questionnaire, is a “printed self-report form designed to elicit information that can be obtained through written or verbal responses of the subject” (Burns & Grove: 551). Also, Whittaker and Williamson (2011: 88) state that the terms “survey” and “questionnaire” are also commonly used interchangeably. However, a survey is “a method for collecting data to describe, compare, or explain knowledge, attitudes, and behavior” presented as a number of questions addressed to a group of subjects (Fain 2009: 127.), whereas “questionnaires are one of the methods used within surveys.” (Whittaker and Williamson 2011: 88.) As Maltby et al. (2010: 108) explain, a questionnaire is a measure of scale, usually provides a series of questions/statements, where a respondent is required to provide some written answer about a particular area, or to choose from multiple given options. Balnaves and Caputi (2001: 76) define a survey as a method of data collection from people about e.g. education, beliefs and behavior. Surveys are to be used when the subject which one wants to study could not be directly observed (Balnaves & Caputi 2001: 75).

This research method enables the studying of large groups of participants using standardized quantitative approach. When administered in clinical settings, such a tool would not only point out areas where education of health care providers is in need of improvement, but also serve as reflection on clinical teaching. (Wolf, Beitz & Peters: 2009.) In situations when there is no valid and specific enough questionnaire in access, as LoBiondo-Wood and Haber (2006: 329) state, researches might need to design an item of their own.

4.2 Developing a knowledge questionnaire

The methodology used in this final project is the development of a knowledge questionnaire. The developing of a questionnaire is a complex process and often prolonged in time. According to LoBiondo-Wood and Haber (2006: 329), this process involves the following phases. First, the concepts which are supposed to be measured, are defined. The second step is to clarify the target population and to formulate the items, statements and/or questions. Next, the statements' and/or questions' content validity is to be assessed. The last phase includes pretesting and pilot-testing in order to estimate the validity and reliability of the tool. (LoBiondo-Wood and Haber 2006: 329.)

When aiming to design a well-structured questionnaire, it is important to focus on inquiring only the information that needs to be obtained. Questions should be "short, clear and unambiguous", in order to avoid any misunderstandings. (Maltby et al. 2010: 111.) A researcher also should keep in mind that the same question formulated in two different ways can entail different results (Balnaves & Caputi 81: 2001). Moreover, for the purpose to maintain inquiring the knowledge specific to the concepts, as well as reliable, one question should include only one entity (Fain 2007: 128-129). In his book, Fain (2007: 128-129), suggests to make one informative question instead of a few smaller but similar questions.

Balnaves and Caputi (2001: 82) exemplify the checklist for the wording questions as it had been laid by DeVaus (1985: 83). By the checklist, the questions that are double-barreled, leading, negative, ambiguous, containing prestige bias, or artificially creating options should be avoided. Also the language is supposed to be simple, frame of reference clear, and the words have the same meaning for everyone. Unnecessarily detailed

or objectionable questions are to be avoided as well, although it needs to be reassured that the respondent has necessarily knowledge. (Balnaves & Caputi 2001: 82.) Furthermore, the authors continue by stating that the success of a questionnaire also inevitably depends on its administration; layout, length of questionnaire, types of questions to be inquired, the actual implementation, answers' quality check, response rates and the ethical issues are to be considered.

4.3 Data collection method

In this final project the authors' purpose is to create an item measuring the competence of nursing staff on the accurate intravenous administration of medications. To take the first step, the definition of the concept to be measured, a researcher needs to perform an extensive review of literature and the existing tests addressing similar concepts. This means that the authors are developing a knowledge questionnaire using the method of a qualitative literature review.

Parahoo (1997: 89) defines literature review a process which consists of 'scanning and critical reading of the selected literature' in order to assess its relevance to the current project and how it could be possibly utilized. Primary to that a literature search is to be carried out. Literature search stands for locating and identifying the most recent and relevant materials. (Parahoo 1997: 88.)

As the sources of literature, the authors of this final project selected both the sources of theoretical information, as studying books and manuals, and the sources of research information. The collection of research information, namely scientific articles, was performed as tentative database search using databases such as Educational Resources Information Center (ERIC), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Medline. The keywords that were used are "accurate IV medication", "technique", "accuracy", "intravenous", "safety", "antibiotics". The limitation set was English language as well as publication year within the gap of 10 years, 2003 - 2013. As the result, there were 698 hits on the actual topic of this project, although after reviewing the articles' titles and abstracts, the authors have selected 25 articles. Moreover, there had been performed a search using "knowledge test" and "nursing" as key words in order to locate similar projects. (Appendix 1)

Further, the authors have carried out the content analysis of the selected sources. As Elo and Kyngäs (2007) site after Krippendorff (1980), Downe-Wamboldt (1992) and Sandelowski (1995), content analysis as research method is a systematic and objective way of describing and phenomena. As Elo and Kyngäs (2007) state further, the aim of this method is "to attain a condensed and broad description of the phenomenon", and subsequently to draw up concepts and categories describing the phenomenon.

Between the two approaches to the method of content analysis, the authors of this final project have chosen the inductive one. In inductive approach "the categories are derived from the data" (Elo & Kyngäs 2007). As the content of the literature was diligently and thoroughly analyzed, the information obtained was drawn into categories. These categories are regarded to as the concepts assuring the accuracy of intravenous antimicrobial medication administration. These findings have served as the theoretical basis for developing a questionnaire.

5 Findings

Performing the literature review, authors of this final project sought the answers for the study question: What insures the accuracy of the peripheral IV antimicrobial medications. As Agyemang and While quote after Williams (2007) in their work, "having some knowledge of the issues surrounding the occurrence of medication errors is of importance for health professionals to practice safely."

The literature that had been found in most of the cases focuses on either the peripheral IV medication in nursing practice, or on the antimicrobial medication in nursing practice. Therefore our results had been divided into the following subcategories, where the first discusses what makes the peripheral intravenous medication error-free, and the second one reviews the aspects to be considered in order to perform the accurate antimicrobial medication. The findings that the authors have made, have served as the theoretical evidence the knowledge questionnaire is based on.

5.1 Intravenous medication in nursing practice

The intravenous treatment is commenced once medication prescription is made by a physician. Appropriately trained registered nurses are responsible for the preparation

and delivery of the intravenous medication. (Downie, Mackenzie & Williams 2010: 64; NHS 2009: 269.) The procedure of peripheral intravenous delivery includes cannulation, preparation of an infusion, administration of the prepared medication, care and observation of both, the patient's general condition and the actual cannulation site, and removal of the cannula (Nicole et al. 2012: 109-124).

In their book, Berman and Snyder (2012: 864) emphasize the importance of ten "rights" of medication administration. Also a three-time checkup before medication delivery is said to be important. According to these authors, following these guidelines minimizes the risks for medication errors in procedures as the peripheral intravenous medication.

Initially it had been presumed by the authors of this final project, that the review of the literature would back up the suggestions given in the theoretical literature, namely that the ten "rights" of medication determine its accuracy. However, once the content of the research literature has been analyzed, it was revealed that this is somewhat more complex. Further the authors present their findings which have been put into the following clusters: right drug, right dose, right time, right route, right patient, right patient education, right documentation, patient's right to refuse, right assessment, right evaluation and follow-up, right equipment, right medication preparation, infection prophylaxis, right antimicrobial use, right cannulation site, working conditions, training and experience, guidelines and policies.

5.1.1 Right drug

As it has been mentioned before, preparation of any medication should follow the ten "rights" of medication administration. Registered nurse, following doctors´ prescription, makes sure that the prescribed medication is right for the patient, and that there is no contraindications for this medication. (Berman & Snyder 2012: 864.) Agyemang and While (2010) emphasize that it must be checked prior to administration of the medication whether the patient has an allergy or not. Furthermore, these authors state that nurses are supposed to know whether the medication needs to be administered or a dose should withheld. Nurses are to use their clinical judgment and act accordingly, in regard of a patient's condition (for instance, digoxin is not supposed to be administered if a patient is bradycardic, or insulin should not be given to a patient who is hypoglycemic).

In order to make the medication accurate, the dosage, method, route and times of administration are to be considered. Agyemang and While (2010) identify amongst others the following medication errors: omission error (the failure to administer the prescribed medication dose), unauthorized drug error (administering a drug that was not meant to be given), or administration of a dose containing the wrong strength. Lavery (2011) cites after Charging for Residential Accommodation Guidelines (CRAG) (2002), “select the correct medication as per the patient prescription and then follow guidance”.

Finally, Agyemang and While (2010) have found out that appearance of medication packaging and complicated product labelling may lead to errors. They state that “medication packaging and labelling that ‘looked and sounded alike’ may mislead.”

5.1.2 Right dose

Performing the dosage calculation is also part of nursing responsibilities. A nurse has to make sure that the dose have been calculated correctly, and question it if the prescribed dose seems odd. (Berman & Snyder 2012: 864)

As with any other administration routes, the peripheral IV route is associated with risk of miscalculation if the medicine dose. Ingram and Lavery (2005) quote the NMS (2004b) guidance that suggests that the complex calculations are to be carried out by two nurses, and each of the needs to do the calculations independently. The same notion is expressed by Upton (2001) quoted by Ingram and Lavery (2005): drug calculations, prescription reviews, as well as selection, dispensing, preparation and administration of medicines is to be executed by two professionals, as it decreases the risk of occurrence of erroneous calculations.

Additionally, Ingram and Lavery (2005) touch on the already mentioned CRAG (2003) which recommend the standardization of concentration of doses of commonly used injections. Also Dougherty, Kayley and Bravery (2010) in their article express an idea that standardization of doses has many benefits, for instance, reduction of time nurses get to spend on medication preparation as well as reduced medication error rate.

The focus of this project is on the antimicrobial medication. As it is stated by Adams and Urban (2013: 37), antimicrobials are usually delivered as an intermittent infusion, which

requires the correct flow rate to be set out. Quoting after Amoore and Adamson (2003), Ingram and Lavery (2005) point out that the devices used for managing the flow rate carry the additional risk. The position of the device, incorrect rate setting or devices selection entail the potential risk of delivery of wrong medication doses (Ingram & Lavery: 2005).

5.1.3 Right time

It is a well-known fact that in order to maintain the drug concentration in the blood within the therapeutic range, medications are to be taken regularly, at the right time, as prescribed. Agyemang & While (2010) define the wrong time error as “administering a dose of medication more than 60 minutes before or after the prescribed time”.

Different reasons for medication delay have been suggested by different authors. Dougherty (2010) discusses the situation where patients in certain units require multiple medications which in its turn may require calculations. If these include also IV medications, then the nurse’s time is consumed by medication preparation and actual administration. Furthermore, she mentions “meeting other patient needs while in the room” which postpones the medication delivery. Dougherty, Sque and Crouch support this notion citing after Bruce and Wong (2001) that medication delivery at the wrong time is linked to “lack of access to the patient”.

In her work, Dougherty (2010) proposes some options to avoid the delayed medication delivery as it is recommended by the National Patient Safety Agency. The first one is to list the medications where the timeliness of administration is crucial. The other one is the aforementioned usage of pre-prepared medications. This would not only save the time nurses spend on IV medication preparation, but also reduce the errors and risk which preparation of IV drugs may entail. The Nursing and Midwifery Council guidelines (2004b) quoted by Ingram and Lavery (2005), emphasizes the necessity for the medications prepared in clinical area to be administered instantly.

5.1.4 Right route

When picking a delivery route, nurse must ensure that the route is appropriate for the actual medication as well as safe for the patient. (Berman & Snyder 2012: 864). Moreover, it must be checked that the medication is intended for the route, as Agyemang and While (2010) argue, that medication errors also occur when a medication is given in a different form via different route than the prescribed one. In regard of the intravenous route, Ingram and Lavery (2005) state, that the nurse who employs this route is to be competent and skillful as well as possess clinical judgment and expertise in PVC insertion and postinsertion maintenance in order practice safely and affect positive patient outcomes (Dychter et al. 2012) .

5.1.5 Right patient

Several authors have brought up in their work the fact that failure to check patient's identity prior to drug administration, is a very common error. In addition to misidentification, it can be referred to as an identification error if a patient does not have an identification wristband or the band is not correct. (Agyemang & While: 2010; Dougherty, Sque & Crouch (2011) after Gladstone (1995).)

This error is said to be emerged from nurses' feeling of 'knowing the patient'. Schulmeister (2008: 496) quoted by Dougherty, Sque and Crouch (2011), suggests that identification failure occurs if nurses 'believe they know their patients, particularly those who receive frequent outpatient treatments or have been hospitalized for a long period of time'.

In 2007, WHO has stated that patient misidentification continues to lead to medication errors and amongst others to wrong person procedures, and suggested some strategies to eliminate the problem. The main ideas of the guidelines is to emphasize that it is the health care professionals bear the responsibility on identifying the patients and matching the correct care with correct patients. As well as the actual nurses are to be trained to verify the identity according to local standards, the patients should receive the education concerning the importance of correct identification "in a positive fashion that also respects concerns for privacy" and encouraged to participate in the identification process. According to these guidelines, there in a health care system should exist a standardized approach or pattern of patient identification, as use if at least two identifiers, neither of which is patient's room number. Moreover, the clear protocols to question the treatment

or laboratory results which are not consistent with patient history, are to be provided. (WHO: 2007.)

5.1.6 Right patient education

Prior to the preparation for the intravenous cannulation and medication administration, nurse should establish the contact with the patient. Educating patients about the procedure and informing about the medication, expectation and possible side effects (Berman & Snyder 2012: 864) of the medication, increases cooperation and gains consent (Nicole et al. 2012: 109). In addition, Lavery (2011) suggests to consult with each patient in regard of the procedure, for example, inquire their preferences about the IV site, as it might further assist in gaining patient consent.

In their article, Ingram and Lavery (2007) second this notion. According to them, “information giving and verbal consent are paramount to promote patient understanding and cooperation”.

Citing the Resuscitation Council (2008), Kayley (2008) stresses that in case patient receives the IV therapy, s/he should be educated about the early signs and symptoms of adverse reactions to medication and encouraged to promptly seek for help if those occur.

5.1.7 Right documentation

In order for nurses to perform an accurate intravenous antimicrobial medication administration, all the steps from the labeling of the infusion bags to patients´ response to the medication, should be reflected in the patient documentation (Berman & Snyder 2012: 864; Nicole et al. 2012: 111-115). Lavery (2011) also advises documenting the patient consent in the patient record.

Nevertheless, certain errors in regard of patient documentation are highlighted in the literature. Some authors discuss the quality of prescriptions as a factor which contributes to medication errors. “Illegible handwriting, misplaced decimal points, misunderstood abbreviations and misreading and misinterpreting prescriptions” (Deans (2005) quoted by Agyemang & While (2010), use of wrong abbreviations (Pape (2001) quoted by Dougherty, Sque & Crouch (2011)) “incomplete prescriptions and medication charts” (Fry

& Dacey (2007) quoted by Agyemang & While (2010)) jeopardize the accuracy of medication.

Kayley (2008) mentions in her work the NMC's (2008b) guidelines on the medication prescription for the IV therapy. According to it, the drug chart should reflect on the following data: patient's name and date of birth, the name of the drug, dose, diluent, flushing solution, time and frequency of administration, and review or completion date. (Kayley: 2008).

Bravery et al. (2006) discuss the inadequacy in documentation of the insertion of peripheral venous cannula (PVC). The authors cite Cramer (2000) and propose that the reason for inconsistent documentation is the recent shift of responsibility, as different types of professionals are nowadays allowed to insert PVC. It has been implied that the ultimate responsibility should rest with the individual who inserts the cannula, whereas lately it has been "somewhat neglected by all staff concerned". Moreover, the removal time should be reflected in the patient notes, and the advice to keep the dressing in place for the 24 hours given. (Ingram & Lavery: 2007.)

Furthermore, the accurate documentation assists in managing the complications of treatment. For instance Bravery et al. (2006) cite after Jackson (2003) that accurate monitoring and documentation of the condition of cannula site has contributed to the development of the Visual Infusion Phlebitis (VIP) score which was based on the identified numeric phlebitis scores. "A cannula should be replaced at the first indication of infusion phlebitis, i.e. a VIP score of 2 or more." (Bravery et al.: 2006.)

5.1.8 Right to refuse

Providing patient education is essential for gaining patient consent for treatment and cooperation (Ingram & Lavery: 2007). However, in spite of provided information, an adult patient is allowed to refuse medications prescribed for him/her (Berman & Snyder 2012: 864). Nevertheless, intravenous medication delivery is employed in case patient refuses to take oral medication. Therefore, a nurse must be aware of patient's right for self-determination and to be capable of negotiating another treatment modalities. (Ingram & Lavery 2005).

5.1.9 Right assessment

When undergoing the peripheral IV therapy, a patient is to be monitored throughout the entire process. In their article, Ingram and Lavery (2007) hold an elaborate discussing in regard of patient assessment and monitoring. As it has already been mentioned before, full patient evaluation is to be undertaken prior to the medication administration. This should include the review of patient medical records and physical examination. NHS Lothian (2007) adapted by these authors recommends to assess the blood vessels and nerves on the limb that is intended to be cannulated. Patient current medication is to be reviewed as well, as "for example, anticoagulants will increase risk of bleeding or bruising". Psychological status is to be taken in account as well. Whereas the vasodilation of the patient who is relaxed is easier, patient who is confused "may affect safety of insertion and ongoing device safety". (Ingram & Lavery: 2007.)

Citing Lothian - University Hospitals Division (LUHD: 2002b), Ingram and Lavery (2007) encourage to assess the correctness of the inserted cannula, to inquire the patient if there is any pain, swelling or redness as signs of complications, and also to supervise the patient 20-30 minutes after the medication has been administered. Furthermore, Ingram and Lavery (2005) state that nurse is the one to monitor the patient and patient's prescription to make sure that the treatment is to be continued.

5.1.10 Right evaluation

Evaluation is one of the essential rights from the ten "rights" of medication administration. It is nurses' responsibility to monitor the patient's response to the medication. It has been noted that patient is to be assessed by the nurses in order to evaluate whether the desired effect has been achieved and whether the patient experienced any side effects or adverse reactions to the treatment. (Berman & Snyder 2012: 864; Downie, Mackenzie & Williams 2010: 293.)

In her article, Lavery (2011) supports this notion. She quotes the RCN (2010) statement that every nurse that delivers the IV therapy is in charge of monitoring and evaluation of its effectiveness as well as documenting the findings, including patient "response, adverse events and interventions".

Potential adverse reactions to occur when antimicrobial medication is being administered are anaphylaxis, acute and/or minor allergic reactions. Albeit the intravenous antimicrobial medication is common intervention in nursing practice, risk of the anaphylactic reaction should always be taken in consideration. (Jevon et al. 2012: 223-226; Downie, Mackenzie & Williams 2010: 293.)

5.1.11 Correct use of equipment

Several sources emphasize that proper use of equipment during the procedure of the intravenous medication delivery contributes to the accuracy of it. The correct medication preparation, cannulation technique and caring of the cannula, the aseptic technique and the use of personal protection equipment (PPE) are discussed further.

Recently the insertion as well as care after the PVC has become the part of the nursing domain, Bravery et al. (2006) cite after Trim (2005) and Snelling and Duffy (2002). Several authors discuss the importance of choosing the most suitable equipment for this procedure.

It is the nurse duty to consider which size of the cannula to choose. The choice of gauge is affected by the purpose of the cannula and the length of treatment. (Ingram & Lavery: 2007 after Hadaway & Millam: 2005.) The RCN (2003) recommend the use of the “smallest gauge that will be accommodated by the vein”; the 22 gauge cannulas are to be used for blood transfusions and the 20 gauge cannula is suitable for the large volumes of fluids (Bravery et al.: 2006 after Dougherty & Lister: 2004), whereas the use of the larger gauge as 16-18 is not recommended unless clinically indicated as it increases risk of infection (Ingram & Lavery: 2007 after Tagalakis et al.: 2002).

The application of the local anesthetic is also suggested, one hour prior to the procedure for the drug to take its effect (Berman & Snyder 2012: 1490). Local anesthetics do not only maintain patient’s comfort during the cannulation, but also as Ingram and Lavery (2007) rationalize it, are to be used for individuals with needle phobia, since fear might cause the blood vessels to constrict.

Before the actual insertion of the cannula, the intended cannulation site is to be wiped with topical disinfectant and allowed to dry up (Berman & Snyder 2012: 1490). More

detailed, the aseptic issues are discuss further, however in this project the authors have not focused on the actual insertion technique.

Once the cannula is in situ, it is suggested to apply clean, dry and partially transparent dressing, in order for the cannula site to be easy to view. In order to reassure the accurate placement of the cannula and its patency as well as to remove the blood from the lumen, the application of flush directly after insertion is recommended. (Bravery et al. 2006; Berman & Snyder 2012: 1490.)

Several authors argue about the timing when the PVC has to be removed. The local guidelines of HUS suggest removal and application of the new cannula after 48-72 hours, unless there are signs of complications present. However, Ingram and Lavery (2007) justified in their work that the cannula may be allowed to remain at place up to 96 hours in case its patency is daily reassured with use of flush, and unless there are signs of complications present. They also emphasize that the polyurethane is the material of choice, as it causes less friction, hence entails less risk of mechanical phlebitis. However, as it has been mentioned, the guidelines vary. In their article, Bravery et al. (2006) suggest the removal of the cannula every 72-96 hours, and termination of use if it is no longer required. Brown and Rowland (2013) have come to a conclusion that "implementing clinically indicated replacements (i.e. in case complications occurred) of IV could decrease hospital cost and improve patient satisfaction".

Clearly, all devices should be removed if there are any signs of complications. Coolness, pain and blanching indicate that tip of the cannula is being placed outside the blood vessel, i.e. the infiltration or extravasation has occurred. Redness and swelling indicate phlebitis. The medication class of focus of this project, the antimicrobials are known to be particularly irritant for the tissues, therefore is it vital that the nurse that delivers IV antimicrobial medication is aware of the signs of complications. (Ingram & Lavery: 2007; Nicole et al. 2012: 110.)

Establishing the access to the bloodstream and delivery of IV medication connote the risk of spillage of either blood, or medication, or both. Therefore, Ingram and Lavery (2007) advise the use of PPE, such as gloves and aprons, and if necessary masks and goggles. Moreover the authors encourage to follow the local guidelines in case of medication spillage.

As the focus of this final project is on the antimicrobial medication, it is clearly vital to keep in mind that the patients in need for antimicrobial treatment are infected by bacteria. The importance of use of PPE and adhering the rules of aseptics in order to protect from contamination both the patients and the nurses themselves, are highlighted by Nicole et al. (2012: 109). Ingram and Lavery (2007) also state that nurses must wash their hands and wear PPE when removing the cannula in order to decrease the risk of blood contamination.

Furthermore, Lavery (2011) mentions that certain medications as for example benzylpenicillin possess the risk of skin desensitization, thus the use of the PPE as gloves is advocated. She also cites after RCN (2010) that PPE as apron and gloves are to be used during preparation and administration of IV medication, and additionally, if the procedure implies the risk of spillage of bodily fluids, the use of masks, goggles and caps is also advocated.

Lavery (2011) emphasize the importance of the proper checkup of the equipment. She cites after Finlay (2006) that a nurse is to assure that the outer packaging and the actual fluid bag are intact, that the expiration date has not been exceeded, and in the similar manner check the intactness and the date on the infusion set, as well as its appropriateness for the intended procedure (Nicole et al. 2012: 109-111).

The antimicrobial medications are usually delivered as an intermittent infusion (Adams & Urban 2013: 37). Agyemang and While (2010) have found out that the use of infusion devices has decreased the rates of infusion duration and administration rate errors. Clinical Excellence Commision (2013) states in their guidelines for PIVC that antimicrobial medications are irritant for the vein, therefore flushing of the cannula after the infusion is required. Moreover, use of flush prior to the procedure reassures the placement of the cannula and its patency, and rules out possible interactions with previously administered medications. It is also highlighted that the dressing need to remain dry, clean and attached, as well of the cannula site needs to be cleaned from blood and secretions with alcohol swab, in order to decrease the risk of infection. (Clinical Excellence Commission: 2013; Nicole et al. 2012: 120-121.)

5.1.12 Accurate medication preparation

Many intravenous antimicrobial medications are to be reconstituted from the powder with diluent in a way it is laid in manufacturer's instructions and local policies. When preparing the medication, a nurse has to adhere to these instructions. (Downie et al. 2010: 292) According to Koskinen et al. (2012: 89), the prepared antimicrobial infusion medication should be administered immediately, in order to avoid any possible microbiologic changes that may happen as the result of poor aseptic technique or unclean environment during the medication preparation. Additionally, some antimicrobial medications are sensitive to temperature changes, and others might get damages by sunlight, as for example Cefuroxime and Metronidazole. (Koskinen et al. 2012: 89.)

According to Koskinen et al. (2012: 86-90), in order to perform the accurate antimicrobial medication administration and to avoid life-threatening situations, nurses need to prepare infusion using aseptic technique, to dispose expired and contaminated medication. Besides, it needs to be reassured that neither diluent, not already reconstituted medication contain particles, are crystallized or have no color changes; the fluids are to be visibly clear (Nicole et al. 2012: 109-111).

In relation to the medication reconstitution, some authors emphasize the risk associated with it. Lavery (2011) reminds the use of the PPE in case of potential "drug splashing onto skin or surrounding areas", or "aerosol spray as a result of pressure in the vial". In order to avoid the aerosol spray, Finlay (2006) as quoted by Lavery (2011) suggests venting the vial. The same authors advise to use the 45-degrees angle when inserting the needle into the vial, to reduce the risk of coring the rubber bung. Moreover, when a drug is reconstituted from the powder there is also a risk of incomplete powder dissolving (Lavery: 2011). As Ingram and Lavery (2005) state in their work, in order to perform accurate drug reconstitution, a nurse should be knowledgeable about the "compatibility, interactions, storage, stability and equipment".

5.1.13 Infection prophylaxis

The PVC do not only establish the vascular access required for the treatment, but also put the patients at risk of potential local and systemic infectious complications (Ahlquist et al.: 2006). Therefore, all the nurses who are involved in peripheral IV drug therapy, should act towards prevention of infection and its spread. Proper hand washing as well as adherence to aseptic techniques when handling IV system, can reduce the infection.

(Ingram & Lavey: 2005.) The HUS (2013) guidelines suggest the use of hand disinfectant before and after handling the cannula, as well as the use of topical disinfectants for swiping the injection port valve of the cannula, the tubing and the valve of the infusion bag, prior to puncturing it with the infusion set needle.

Furthermore, Ingram and Lavery (2005) provide several suggestions for infection risk reduction. According to these authors, proper storing of the equipment and disposing products that have exceeded the expiry date assist in diminishing of the infection risk. It is also within nursing domain to identify the patients who are in greater risk of infection, as for example younger and older population, immunosuppressed, malnutried, or undergoing multiple invasive procedures, and for this reason or another, have lower skin integrity. (Ingram & Lavery: 2005 after Dougherty: 2002.) Finally, these authors highlight that "it is essential that nurses seek ways to reduce the risk of infection for patients, while taking precautions to protect themselves".

5.1.14 Antimicrobials

There are certain issues associated with the administration of antimicrobial medication. Needless to mention that as antimicrobials are anti-infectious agent, the patients who receive this treatment belong to the risk group (Ingram & Lavery: 2005) as they pose the source of infection. As it has been mentioned before, the preparation of antimicrobial medication as well as administration requires special attention. Moreover, Dougherty, Sque and Crouch (2011) have researched that antimicrobials are one of the medication classes that is associated with greater error rate. They cite after Hoefel et al. (2008) who have identified during observation that "143 administrations of Vancomycin that 81% were administered incorrectly".

Furthermore, Kayley (2008) discusses the administration of antimicrobial medication in the community. Whereas the UK legislation does not require administration of the first doses in hospital environment, the guidelines from the USA and Australia support the notion that the first doses of antimicrobial therapy are to be administered in a supervised setting due to the potential risk of allergic or anaphylactic reactions (Kayley: 2008).

5.1.15 Correct site of cannulation

In several sources the choice of the cannula site is discussed. In order to maintain comfort and safety throughout the cannulation procedure, it is nurse's responsibility to carefully choose an insertion site. Preferably the insertion site should be on the non-dominant arm, the cannula size, as it has been mentioned, should be suitable for both the infusion type and patient's vein size and condition. Cannulation is also easier for the nurse and the patient if the hand of insertion site is warm, the veins are perfused and bouncy. (Nicole et al. 2012: 109-111.) Bravery et al. (2006) suggest to use the veins of the upper extremities, the dorsal or ventral surfaces. They advise to avoid the routine use of the lower extremities in adults. The antecubital fossa is not recommended for use because of the increased risk of cannula displacing and further complications due to that (Ingram & Lavery: 2007).

Furthermore, Ingram and Lavery (2007) advise the nurses to pay attention to the following factors. The veins of the older population are more brittle (Milliam: 2003); and in case of rheumatoid arthritis the application of the tourniquet may cause pain (Black & Hughes: 1997). Such conditions of the cannulated limb, as fracture, being stroke-affected, or edema of the lymph nodes, complicate the procedure and obscure the assessment. Local conditions of the skin as eczema or a wound, heighten the risk of infection. (Ingram & Lavery: 2007.)

5.1.16 Safe working conditions

Agyemang and While (2010) summed up the several literature reviews and found out that amongst others, the working conditions such as type of nursing shifts (three-shift job), stress and tiredness, as well as distractions and interruptions, contribute to occurrence of medication errors. In their work, Seki and Yamazaki (2006) support this notion affirming that in majority of cases, the drug-related errors usually derive from organizational flaws, or if put otherwise, they suggest that rarely errors come from a single person, but from a failure in the entire care process.

As it has been mentioned, Agyemang and While (2010) found out that stress from a heavy workload is a common factor which leads to medication error. The second common cause is fatigue from lack of sleep. As Seki and Yamazaki (2006) cite after Krueger (1994) and O'Shea (1999), the long working hours and extended surgical times lead to inadequate rest, and the shift-work creates disturbances in biological rhythms. These

factors in their turn, lead to “fatigue, lower mood and motivation, reduced morale and decreased ability to perform tasks and pay attention”. Contrary wise, the research of Seki and Yamazaki (2006) demonstrated that enough sleep and consequently decreased level of tiredness, facilitated the detection of near-miss errors.

The near-missed errors in medication delivery are often induced by urgent orders and/or often changes in them. This forces nurses to work under time pressure. Seki and Yamazaki (2006) state that in this kind of situations, in order to deal with urgent orders, the unwritten rules that differ from the basic medication delivery policies, are often applied. These authors argue that less experienced nurses might not be aware of these unwritten rules, and unless senior nurses to ask for advice are present during the shift, the situation results in near-miss errors.

Furthermore, as the most frequent organizational factors which lead to medication error, Agyemang and While (2010) have pronounced distractions and interruptions. These authors cite after Taxis and Barber (2003) that distractions occur when working on several time at the same time; interruptions from patients as well as answering phone calls were identified as problematic, too (Agyemang & While (2010) after Fry & Dacey (2007)). As Seki and Yamazaki (2006) state, it is the error-provoking conditions that stand behind the unsafe acts.

Speaking of the prevention measures, Seki and Yamazaki (2006) refer to the human cross-check as the key tool in accident prevention. They continue reporting that in Japan many prevention measures have been suggested, however many of them rather focus on “the medical tasks performed by health care workers, such as cross checks, and working conditions are ignored”.

Dougherty, Sque and Crouch (2011) identified the similar organizational factors, as distraction and fatigue and exhaustion. However, as they quote after Armitage and Knapman (2003) an important notion that “respondents may imply distraction as a key factor in error as it may prove an important mitigating factor in the event of any disciplinary proceedings”.

5.1.17 Human factor: knowledge, training, experience

In their book Jevon et al. (2010: 234-235) summarizes that the delivery of IV medications is identified with numerous adverse reactions, and regardless the most of them could possibly be foreseen and avoided, a nurse should be trained to respond to the potential complications, and furthermore be able to reflect on these events to improve patient safety. They state that “nurses must use the same evidence based approach to care when using such devices to ensure effective care and therapy.”

Lavery (2011) discusses, that in regard of the IV medication, a nurse must possess the knowledge of its principals, such as “reconstituting, including aseptic technique, compatibility, stability, storage, labelling, interactions, dosage, calculations and the use of appropriate equipment” as well as to be trained to respond to anaphylactic reaction. Kayley (2008) also supports the notion that the nurses must participate in basic life support training which also includes the management of anaphylaxis. Ingram and Lavery (2005) narrate that NHS Education for Scotland (NES) (2004) lays the focus of educational programmes on the clinical skills, venipuncture, cannulation and peripheral IV medication. Quoting after the RCN (2003), the same authors emphasize that nurses must accomplish “an approved competency based training programme relating to their field of practice and be familiar with associated medicines and policies”. The similar notion is expressed by Ingram and Lavery (2005), the nurses are to possess the knowledge and training adequate to their area of practice.

Ingram and Lavery (2005) also mention the importance of the appropriate knowledge of medications. Agyemang and While (2010) stress in their article, that lack of knowledge on the medication preparation and administration leads to errors. They state that nurses should be aware of the therapeutic implications of drugs, their contraindications and side effects, etc. The necessity of the training on the correct usage of the drug delivery equipments is also emphasized by these authors.

The calculation skills and the errors which derive from its inadequacy, are mentioned in both publications, Lavery’s (2011) as well as Agyemang and While’s (2010). In their article, Agyemang and While (2010) also discuss the double-checking. They quote after Kruse et al (1992) that the mediations that were double checked had fewer error. However, it has been noticed that sometimes the steps of double-checking get violated and hence errors - missed. This can be caused by the following factors: acquiescence to the authority, if the senior nurse inquires the junior one to double-check; responsibility dimi-

nution, as one nurse expects the other to be more precise when doing the double-checking; auto-processing, when one nurse recites the medication details or calculations to the second checker; and lack of time."

In regard of the difference in the experience of nurses, Agyemang and While (2010) conclude in the ir article that the nurses who are new to the working place are more likely to make errors, whereas the more experienced ones, according to Seki and Yamazaki (2005) are more likely to detect the errors or prevent them. Therefore they suggest that having the junior nurses working alongside with the senior ones might assist in reduction of the medication error rates.

Nevertheless, the years of nursing experience might have the negative effect on the nursing practice. In their article, Dougherty, Sque and Crouch (2011) have identified that some nurses "base their decision making on the use of heuristics such as overconfidence, anchoring, hindsight bias and pattern recognition". Overconfidence states for the trait of overestimating of one's own righteousness, which leads to the nurses being overly confident about their actions. Anchoring is the situation when an individual continues to hold on to the initially made decision, in spite of the incoming evidence that contradicts it. Hindsight bias is a phenomenon in which the event from the past seem to be more predictable than it seemed while it was occurring. Finally the pattern recognition stands for the "process of making a judgement on the basis of a few critical pieces of information, which trigger plans similar to those that worked in the past (Dougherty, Sque & Crouch: 2011 after Manias et al.: 2004.)

Needless to say, that in nursing profession being competent and updating one's knowledge throughout the working career is essential, as well as being able to apply the knowledge to practice. However, as Dougherty, Sque and Crouch (2011) highlight it, error-triggering behaviour is not only matter of lack of training, but also matter or nurses' attitudes. (Dougherty, Sque and Crouch: 2011; Lavery: 2011.)

5.1.18 Adherence to guidelines and policies

"Although medication preparation and administration policies and procedures exist on the wards, many errors occur as a result of nurses not following these policies and procedures", Agyemang and While (2010) cite after Armitage and Knapham (2003). In their

article, Dougherty, Sque and Crouch (2011) support this notion. They state that the error can be avoided by adherence to the safety guidelines.

Alqvist et al. (2006) concluded in their article that applying the guidelines to practice lead to considerable improvements in prevention of thrombophlebitis, as well as PVC-related documentation. The similar finding had been made by Lavery (2010), that standardization of practice, and furthermore reassurance that “practice and procedures are consistent” leads to improvements in care, as for example reduction of infection risk.

In regard of the policies, the NMC (2004b; 2008) guidelines which emphasize the necessity of the double-checking are being mentioned. Ingram and Lavery (2005) state that for the purpose of accurate medication, two nurses are required to carry out complex calculations. Agyemang and While (2010) second this notion affirming that double-checking of the dosages of intravenous medications results in reduction of risk of error.
As Ingram and Lavery (2005) conclude in their work, “peripheral IV therapy theory should relate to local and/or national guidance or procedures”, and their purpose is to be of support in nursing practice.

5.2 Antibiotic medication in nursing practice

Antimicrobials, or antibiotics, or anti-infectives, are the drugs used to manage infections. These drugs can be classified in different ways, e.g. according to the type of microbe they affect, or by mechanism of action. Classification by susceptible organism includes antibacterial drugs, antiviral drugs, antifungal drugs, etc. Regarding the mechanism of action, the antimicrobials could be divided into the ones which inhibit bacterial cell wall synthesis, protein synthesis, nucleic acid synthesis, viral enzymes, etc. In addition to that, antimicrobials are further classifier as bacteriostatic and bactericidal, depending on their action. In regard of antimicrobial medication, there are certain facts that are necessary to know for nurses who implement the antimicrobial therapy, as they signify the hazardousness of this medication class. (Aschenbrenner & Venable 2009: 746.)

Key principle of effectiveness of antimicrobial therapy is selective toxicity. Selective toxicity is achieved because the drug’s action is specific to the pathogen’s cell structure of biochemical processes. Therefore these medications are able to harm the bacteria without injuring the host cells. However, not all of the antimicrobials have absolute selective

toxicity, thus they affect the host cells' biochemical processes as well. Managing infection in humans has become safe and effective due to understanding of the phenomenon of selective toxicity. (Aschenbrenner & Venable 2009: 746.)

Another phenomenon related to antimicrobial medication, is antimicrobial resistance. It refers to the microbe's ability to resist the action of the drug and embodies a major problem. Due to this, pharmaceutical companies fall into a need to constantly search for new ways to eradicate microbes in spite of the large variety of already existing antimicrobial drugs. As the resistant bacteria is most likely to be come across in hospital settings, it is within nursing domain to act against the spreading of these bacteria. It is essential for the nurse to undertake basic precautions as hand wash between contacts with patients, use aseptic technique for all procedures, adhere to isolation procedures, clearly document improvement or worsening of symptoms of infection, and obtain specimens appropriately. (Aschenbrenner & Venable 2009: 746.)

5.3 Intravenous antimicrobial therapy in nursing practice

As it has been mentioned, intravenous drug therapy is a common practice in hospital settings. Usually the patients that are in need of intravenous drug and/or fluid therapy, are severely ill and/or susceptible to infections. Therefore, it is highly important that patients are able to get professional care and are held under infection control. (Lavery 2010: 6.) Antimicrobials are one major entity of intravenous drug therapy. It was noted in NHS (2009: 3), that only registered nurses are allowed to deliver intravenous antimicrobial drug therapy to patients. In order to maintain a safe and aseptic practice the professionals are to be trained and competent (Lavery 2010: 6). Registered nurses are competent to fulfill this specific procedure as they possess the required knowledge and skills. In order to reduce possible infection spread and growth, it is nurses' professional responsibility to keep their theoretical knowledge and practical updated throughout their careers. (NHS 2009: 4.) When nursing students graduate and become registered nurses, they are expected to possess sufficient knowledge and clinical skills similarly to experienced nurses (Hemingway, Stephenson & Allmark 2011: 291).

In their book, Aschenbrenner and Venable (2009: 752) emphasize that when working with patients that receive antimicrobial therapy, the nurse's task is not only to undertake the aforementioned basic precautions, but also to assess the individual patient carefully. Some special considerations in regard of dealing with the antimicrobial medication, such

as the aseptic issues, the need for careful drug reconstitution and precise dosing, have been already discussed. The following aspects, as patient's health status, age and gender, and cultural background are to be assessed with particular accuracy. Moreover, the assessment of the general condition as well as the cannulation site and patient monitoring, are to be carried out with special attention.

5.3.1 Health status

Whereas the immunocompetent patients may receive either bactericidal or bacteriostatic drugs, because their immune system can function with adequate response from phagocytic cells, immunocompromised patients should receive drugs that are quickly bactericidal. Moreover patient should be assessed for previous history of allergic reactions, or other side effects. Also each patient who receives the antimicrobial therapy, is to be inquired about this/her previous experiences with this kind of medication. (Aschenbrenner & Venable 2009: 752.)

5.3.2 Life span and gender

Infants and elderly are the populations most prone to drug toxicity. In the infant, the liver and kidneys are not yet mature enough, thus metabolizing and excreting the drug is complicated, which results in accumulation. The same process in the elderly is related to the age of their liver and kidneys, entailing risk for toxicity. It is the nurse's role to make sure that the patient's age has been taken in consideration, before administering an antimicrobial agent. It is also known that most of antimicrobials also able to cross the placenta and are being teratogenic for the fetus. Moreover, antimicrobial agents are often able to enter breast milk, resulting in injury of the nursing child. (Aschenbrenner & Venable 2009: 752.)

5.3.3 The delivery route

The route via which the antimicrobial is administered, depends on the severity of the infection. It is well-known that the highest serum drug concentration is achieved when

the antimicrobial is given via IV route. Although as it has been mentioned, the intravenous antimicrobial delivery may cause some severe adverse reactions. In addition to the aforementioned hypersensitivities, there is such an adverse effect as an infusion reaction. Infusion reaction can occur immediately during the administration time, or occur with a delay. By nature, they are divided into allergic (anaphylactic) and non-allergic (anaphylactoid). However, their clinical manifestations are the same, and require quick and accurate assessment and perceptive management to avoid more severe complications, including fatality. (Vogel: 2010; Aschenbrenner & Venable 2009: 752.)

5.3.4 Cultural and inherited traits

Some groups of patients coming from the African American population have a predisposition to glucose-6-phosphate deficiency, which causes red blood cells to break down when exposed to certain drugs. Subsequently, these patients should not receive certain antimicrobials, which may induce red blood cell lysis. (Aschenbrenner & Venable 2009: 752.)

5.3.5 Monitoring

The serum levels are to be monitored for drugs that have potential severe adverse effects. The goal is to keep the drug concentration within the therapeutic margin in order to achieve the therapeutic level, meaning to eradicate the infection. Moreover patient should be monitored using the complete blood counts, as some antimicrobials are known to cause anemia. Children and older adults are to be monitored for liver and kidney functioning. (Aschenbrenner & Venable 2009: 752.)

5.3.6 Local tissue conditions

Antimicrobial must be able to reach the area of infection in sufficient concentrations to be effective; thus the local conditions at the infection site are important to the success of pharmacotherapy. Injury, inflammation, hematomas, or pus formation can cause tissues to have poor circulation. (Adams & Urban 2013: 835.)

6 Discussion

6.1 Discussion of the results

In this final project the authors have looked into such a common procedure in nursing practice (Berman & Snyder 2012: 894) as peripheral intravenous medication, with focus on the PIV antimicrobial medication. The purpose of the final project has been fulfilled as the knowledge questionnaire for surveying nurses' knowledge has been designed.

In order to design this questionnaire, the authors have done the review of the theoretical and research literature. Searching for the relevant literature, the authors sought and found the answer to the study question: What are the principles which ensure the accuracy of peripheral IV medication? The authors looked for the key concepts that reassure the accuracy of the intravenous antimicrobial medication, as this final project is the part of the bigger project called TOLA which concerns the delivery of the antimicrobial medication. This knowledge was required in order to build theoretical evidence for the questionnaire. It has been found out what makes the procedure of the peripheral IV antimicrobial medication accurate and when and where the common errors occur. It has been revealed that not only the basic ten "rights" of medication ensure the accuracy of the intravenous antimicrobial medication, but also the correctness of the use of equipment, the error-free antimicrobial medication management, the safe working conditions, and adherence to the medication policies, are crucial.

The key concepts have been classified into clusters and addressed in the questionnaire. The clusters are as follows: right medication, right dose, right time, right route, right patient, right patient education, right documentation, right to refuse, right assessment, right evaluation, correct use of equipment, right medication preparation, right infection prophylaxis, correct antimicrobial medication, safe working conditions, and adherence to policies. The questions in the knowledge questionnaire have also been categorized in the same way. The idea behind it was to keep the questionnaire simple and fail for the potential participants, as the logic of placing the questionnaire statements has been kept up.

This knowledge questionnaire has been designed for nurses. When used in clinical settings, this knowledge test would reveal the areas where the education of the nurses is in need of improvement, and also serve as reflection on clinical teaching (Wolf, Beitz & Peters: 2009). This particular questionnaire would survey nurses' knowledge on the PIV

antimicrobial medication, when used, for instance, on the infection ward the TOLA project group has been working is collaboration with. As this knowledge test is a survey tool, the background section addressing the demographical data has been added. The purpose of it is to link the possible inadequacies in the knowledge to, for example, the kind of education a participant possesses, little working experience, recent transfer from different field, or even rule out the participants who have not been granted the IV license. However, the knowledge test the authors of this project have created has not however been validated. Therefore, in order to prove its validity and reliability further pilot-testing has to be conducted.

In addition, the authors of this project have carried out the database search using the key words “knowledge test” and “nursing” to investigate whether the similar works have been already implemented. The aim of this search was also to find out the possible implications of knowledge tests in nursing practice. In the majority of the articles that have been found, knowledge tests are used for surveying the knowledge of health care professionals or health care students, on some certain issues. Although, one article by Higgins et al. (2013) suggest the use of knowledge tests as a part of hiring process, as it might assist in identifying and selecting the nurses with “full-spectrum knowledge in their field”.

6.2 Validity and reliability

Lobiondo-Wood and Haber (2010) define the term validity as “determination of whether a measurement instrument actually measures what is purposed to measure”. According to Parahoo (2006) “validity refers to the degree or extent to which a questionnaire, interview or observation schedule and other methods of data collection studies or measures the phenomenon under investigation”.

6.2.1 Validity of the findings: Literature review

In this final project, the findings are based on a qualitative literature review. Parahoo (2006: 145) emphasizes that the validity of the findings is based on different variables,

such as reliability and professionalism of the databases, relevance of the previous studies and furthermore, summary of the findings. The validity of qualitative research is based on the objectivity of the authors and their interpretation (Holloway & Wheeler 2010: 299). In this project subjectivity of the authors is diminished as the project has been done by two authors and has been supervised by two experienced nurse researchers. Subsequently, this final project does not contain the authors' own ideas or preferences. (Holloway & Wheeler 2010: 301.) In order to find valid and reliable data, the authors used databases such as ERIC, CINAHL and MedLine, which are referred to as trustworthy in nursing science. The keywords for the database search were selected intending to find the literature that answers the study question. The selected articles were published within the gap of 2003-2013. English language was set as another search limitation. The authors also looked up the theoretical information amongst the nursing studying books and the variety of national guidelines. The authors considered these sources of information and limitations to give the most contemporarily and reliable knowledge on the accuracy of intravenous antimicrobial medication.

6.2.2 Validity of the results: Knowledge questionnaire

The outcome of this final project is the knowledge questionnaire which address the findings of the literature review. In his book, Parahoo (2006: 300) indicates two questions to assess the validity of a questionnaire. First one is, "Does the questionnaire answer the research question?" and the second one is, "Do the questions adequately represent the different attributes of the concept or the different aspects of the issues being studied?" In this project, its authors' product is based on these two questions. The questions are presented in the way that the entire questionnaire answers the study question. Also the questions refer to the actual topic, i.e. the accuracy of intravenous antimicrobial medication delivery. The authors used dichotomous (True/False) statements (Research Method Knowledge Base: 2006) in order to add up to the the validity of the potential results of the instrument, as the own opinions of participants will not be included. (Parahoo 2006: 300-304.) Parahoo (2006: 303) also states in his book, "the reliability of the questionnaires depends largely on question wording and questionnaire structure", the questions have been structured in a comprehensible way, using the nursing vocabulary. Nevertheless, the validity of this questionnaire is reduced as it has not been pilot tested. Therefore, the quality of the questionnaire cannot be guaranteed. It is not possible to foresee whether its questions would be understood in the same way by all participants, is the

formatting correct, or is the length of the questionnaire appropriate. Pilot testing would have indicated the strengths and the weaknesses of the produced knowledge questionnaire. (Parahoo 2006: 309.)

6.3 Ethical considerations

The ethical principles of research conduct were taken in consideration during this project work. The authors kept in mind the principles of responsible conduct of research as it laid by the Finnish Advisory Board on Research Integrity (TENK 2012), and falsification, fabrication, and plagiarism have been avoided. Moreover, the ethical principles suggested by Holzemer (2010: 176) as honesty, objectivity, integrity, carefulness, openness, respect for intellectual property, legality and non-discrimination were adhered to.

In addition to the general principles of ethical research conduct, Parahoo (1997: 276) indicates certain ethical aspects to be taken in consideration when working with questionnaires. The author points out the necessity of respecting of the respondents' anonymity, privacy and confidentiality. In practice, it means that the questionnaires must not be coder or numbered and must be administered alone and in private space. Additionally, the approval of the ethical committee is expected to be obtained before the questionnaires are being administered. Also the informed consent of respondents is to be obtained. (Parahoo 1997: 277.) In practice it means that clear instructions are to be attached to questionnaire, stating that participation in the study is volunteer.

The questionnaire that the authors of this project have produced, is aiming to test the nurses' knowledge on the peripheral intravenous antimicrobial administration. Parahoo (1997: 278) reminds to the researchers that "knowledge questions can be threatening to health professionals as the data may fall into the hands of their employers".

7 References

Adams, M. and Urban, C. (2013) *Pharmacology: connections to nursing practice. Second edition*. New Jersey: Pearson education.

Agyemang, R. and While, A. (2010) Medication errors: types, causes and impact on nursing practice. *British Journal of Nursing*. 19(6): 380-385.

Ahlqvist, M., Bogren, A., Hagman, S., Nazar, I., Nilsson, K., Nordin, K., Valfridsson, B., Söderlund, M. and Nordström, G. (2006) Handling of peripheral intravenous cannulae: effects of evidence-based clinical guidelines. *Journal of Clinical Nursing* 15. 1354–136.

Aschenbrenner, D. and Venable, S. (2009) *Drug therapy in nursing. 3rd ed.* Philadelphia PA: Lippincott Williams & Wilkins.

Balnaves, M. and Caputi, P. (2001) *Introduction to Quantitative research methods. An investigative approach.* London: Sage Publications Ltd.

Berman, A. and Snyder, S. (2012) *Kozier & Erb's fundamentals of nursing: concepts, process, and nursing.* Upper Saddle River, N. J.: Pearson.

Bravery, K., Dougherty, L., Gabriel, J., Kayley, J., Malster, M. and Scales, K. (2006) Audit of peripheral venous cannulae by members of an IV therapy forum. *British Journal of Nursing* 15(22): 1244-1249.

Brown, D. and Rowland, K. (2013) Optimal timing for peripheral IV replacement? *The journal of family practice.* 62 (4).

Burns, N. and Grove, S. (2007) *Understanding Nursing Research, 4th edition. Building an evidence-based practice.* Philadelphia, PA: Elsevier Inc.

Clinical Excellence Commission (2013) *Peripheral Intravenous Cannula (PIVC) Insertion and Post Insertion.* Ministry of Health. North South Wales (NSW) Government.

Dougherty, L. (2008) IV therapy: recognizing the differences between infiltration and extravasation. *British Journal of Nursing* 17(14): 896-90.

Dychter, S., Gold, D. Carson, D. and Haller, M. (2012) Intravenous Therapy: A Review Of Complications and Economic Considerations of Peripheral Access. *Journal Of Infusion Nursing.* 35(2). 84-91

Dougherty, L., Kaley, J. and Bravery, K. (2010) Optimizing safe and effective IV practice. *British Journal of Nursing* 19(19): 4.

Dougherty, L., Sque, M. and Crouch, R. (2011) Decision-making processes used by nurses during intravenous drug preparation and administration. *Journal of Advanced Nursing*. 1302-1311.

Downie, G., Mackenzie, J. and Williams, A. (2010) *Pharmacology and medicines management for nurses.* New York: Churchill Livingstone. 3rd edition.

Elo, S. and Kyngäs, H. (2008) The qualitative content analysis process. *Journal of Advanced Nursing* 62(1), 107-115.

Fain, J. (2009) *Reading, understanding and applying nursing research. Third edition*. Philadelphia: F.A.Davis Company.

Hemingway, S., Stephenson, J. and Allmark. H. (2011) Student experiences of medicines management training and education. *British Journal of Nursing.* 20(5): 291-298.

Higgins, J., Kuthy, J., Sadler, F., Gonzalez, R. and Biddle, D. (2013) Hiring right, every time. *Nursing Management* 44(9): 51-53.

Holloway, I. and Wheeler, S. (2010) *Qualitative Research in Nursing and Healthcare*. UK: John Wiley & Sons Ltd.

HUS Infektiosairauksien klinikka. (2013) *Perifeerinen verisuonikanyyli.* Helsingin ja Uudenmaan sairaanhoitopiiri.

Ingram, P. and Lavery, I. (2005) Peripheral intravenous therapy: key risks and implications for practice. Nursing Standard. 19(46): 55-64.

Ingram, P. and Lavery, I. (2007) Peripheral intravenous cannulation: safe insertion and removal technique. *Nursing Standard*. 22(1): 44-48.

Institute for Safe Medication Practices (2008) Lack of standard dosing methods contributes to IV infusion errors. *Alberta RN* 64 (4): 10-1.

Jevon, P., Payne, E., Higgins, D. and Endacott, R. (2010) *Medicines management. A guide for nurses.* Ames, Iowa: Wiley-Blackwell.

Kayley, J. (2008) Effective practice in community iv therapy. *British Journal of Community Nursing* 13(7): 323-328.

Keeling, P., Scales, K., Keeling, K. and Borthwick, M. (2010) Towards IV drug standardization in critical care. *British Journal of Nursing* 19(19) 30-33.

Koskinen, T., Puirava, A., Salimäki, J., Puirava, P. and Ojala, R. (2012) *Lääkehoitoa ammattilaisille.* Sanoma Pro Helsinki. 1.-2 painos.

Lavery, I. (2010) Infection control in IV therapy: a review of the chain of infection. *British Journal of Nursing.* 19(19): 6-14.

Lavery, I.(2011) Intravenous therapy: preparation and administration of IV medicines. *British Journal of Nursing* 20(4): 22-34.

LoBiondo-Wood, G. and Haber, J. (2010) *Nursing research: Methods and critical appraisal for evidence-based practice.* St. Louis, Mo.: Mosby Elsevier.

Nicol, M., Bavin, C., Cronin, P., Rawlings-Anderson, K., Cole, E. and Hunter, J. (2012) *Clinical skills for caring. Essential Nursing Skills*. Edinburgh: Elsevier.

Parahoo, K. (1997) *Nursing research. Principles, process and issues.* London: Macmillan Press Ltd.

Parahoo, K. (2006) *Nursing research. Principles, process and issues*. London: Macmillan Press Ltd.

Policy for Administration of Intravenous Antibiotic Therapy to Adults in the Community and community Hospital. (2009) *Community Services Manager. National Health Service (NHS) United Kingdom* 348(1): 1-24.

Research Method Knowledge Base (2006) *Types of questions.* <http://www.socialresearchmethods.net/kb/questype.php> Read on 18.9.2014.

Seki, Y. and Yamazaki, Y. (2006) Effects of working conditions on intravenous medication errors in a Japanese hospital. *Journal of Nursing Management* 14: 128–139.

Trowbridge, K. and Kralik, D. (2006) Evidence for intravenous antibiotic therapy in the community. *Australian Nursing Journal* 13(9): 28-30.

Varley, A. J., Sule, J. and Absalom, R. (2009) Principles of antibiotic therapy. Continuing Education in Anaesthesia, critical care and pain*. Oxford University Press on behalf of the British Journal of Anaesthesia.* 9(6): 184-187.

Vogel, W. (2010) Infusion reactions: diagnosis, assessment, and management. *Clinical journal of oncology nursing* 14(2).

Whittaker, A. and Williamson, G. (2011) *Succeeding in research project plans and literature reviews for nursing students.* Exeter: Learning Matters Ltd.

Wolf, Z.R., Beitz, J.M. and Peters, M.A. (2009) Teaching baccalaureate nursing students in clinical settings: development and testing of the clinical teaching knowledge test. *Journal of Professional Nursing*. 25(3): 130-144.

8 Appendices

8.1 Description of the tentative data base searches and presentation of the references

Table 1. Database search results

Date	Keywords	Results
30.9	Medline: “knowledge test” + nurs? + 2003-2013	879; duplicated 694; relevant: 12
	CINAHL: “knowledge test” + nurs? + 2003-2013 + English language (Note: Exact duplicates removed from the results)	71 hits; duplicated: 39 hits; relevant: 7
30.9	CINAHL full text: “accurate iv-medication” + nurs? + 2003-2013	17; relevant 2
30.9	CINAHL: peripheral + iv + medication + 2003-2013	91; relevant 7
30.9	CINAHL: “peripheral iv medication” + technique + full text + 2003-2013	127; relevant 3
30.9	CINAHL: iv medication + accuracy + full text + 2003-2013	9; relevant 0

30.9	CINAHL: “accurate iv medication” + nurs? + full text + 2003-2013	197; relevant 10
4.11	CINAHL: intravenous + antibiotics + full text + 2003-2013	233; relevant 2
4.11	CINAHL: intravenous + antibiotics + safety full text + 2003-2013	2; relevant 1
10.1	ERIC/ProQuest: TI(“knowledge test”) + “nurs*” + scholarly articles + deduplicated	22; relevant 6

8.2 Article selection process

Database CINAHL
2003–2013 + English language

Table 2. Article selection process

Keywords	“IV medication” + nursing	“intravenous antibiotics”
Total hits	214	235
Relevant by the title	22	3
Relevant by the abstract	16	1
Relevant by content (answering the study question)	13	1

8.3 Accurate Peripheral IV Antimicrobial Medication:

Knowledge Test for Nurses *(Correct asnwers)*

Read the following statements and mark as True/False/I do not know.

NN	Statements	True	False	I do not know	Answer
5.1.1 Right drug					
1.	Any nurse is allowed to administer the prescribed IV medication.		X		Only registered nurse, following doctors´ prescription, is allowed to administer medication.
2.	Nurse is allowed to with-hold a medication.	X			Using clinical judgment, nurse is obliged to decide whether a dose of medication should be given or withheld in case of some contraindications in patient condition.
5.1.2 Right dose					
3.	Nurse is to administer a drug dose as it is stated in prescription.		X		A nurse has to question the prescribed dose if it seems odd.
4.	Complex drug calculations should be carried out by two nurses independently.	X			Complex calculations are to be carried out by two nurses, and each of the needs to do the calculations independently.
5.	Standardization of medication doses is meant to reduce the risk of medications errors.	X			Standardization of concentration of infusion is recommended and it has many benefits; reduction of medication preparation time

					but also reduces the medication errors.
6.	The intravenous antimicrobial medications are always delivered as intermittent infusion.		X		IV antimicrobials are usually but not always delivered as an intermittent infusion.
5.1.3 Right time					
7.	The medication prepared in clinical setting has to be administered instantly.	X			Medications prepared in clinical area has to be administered instantly.
8.	The two-hour deviation from the prescribed time for the antimicrobial medication delivery is allowed.		X		Wrong time error is administering a dose of medication more than 60 minutes before or after the prescribed time.
5.1.4 Right route					
9.	It is nurses´ responsibility to make sure that the prescribed medication is suitable for the chosen route.	X			It must be checked that the medication is intended for the route. Medication errors also occur when a medication is given a different form via different route than prescribed one.
5.1.5 Right patient					
10.	The combination of patient room number and bed number can be used as patient's identification number.		X		In health care system, should exist a standardized approach or pattern of patient identification, as use if at least two identifiers, neither of which is patient's room number, or bed number.
5.1.6 Right patient education					

11.	Patient education is meant to increase the co-operation, but does not gain patient consent.		X		Educating patients about the procedure and informing about the medication, expectation and possible side effects of the medication, increases cooperation and gains consent.
12.	It is nurse's obligation to educate the patients about the signs and symptoms of adverse reactions of the administered medications.	X			Patient who receives the IV therapy, should be educated about the early signs and symptoms of adverse reactions to medication and encouraged to promptly seek for help if those occur.
5.1.7	Right documentation				
13.	Accurate documentation also decreases the risk or medication errors and potential complications of treatment.	X			The accurate documentation assists in managing the complications of treatment.
14.	The documentation in regard of insertion of PVC could be done by any health professional taking care of the patient who receives the IV medication.		X		The ultimate responsibility for the PVC-related documentation should rest with the individual who inserts the cannula.
5.1.8 Right to refuse					
15.	Patient is not allowed to refuse the medication if s/he receives the full information about the necessity of it to treat the life-threatening infection.		X		In spite of provided patient education, an adult patient is allowed to refuse medications prescribed for him/her.
5.1.8	Right assessment				

16.	The patient who receives IV medication does not need to be evaluated prior to the medication administration, unless otherwise is specified in his/her record.		X		Full patient evaluation is to be undertaken prior to the medication administration. This should include the review of patient medical records and physical examination.
17.	Pain, swelling or redness are common side effects when administering the IV antimicrobial medication.		X		Pain, swelling or redness are signs of complications, as phlebitis or infiltration.
5.1.9	Right evaluation				
18.	Patient who is receiving the intravenous antimicrobial medication needs to be monitored throughout the entire procedure.	X			Potential adverse reactions to occur when antimicrobial medication is being administered, are anaphylaxis, acute and/or minor allergic reactions. Albeit the intravenous antimicrobial medication is common intervention in nursing practice, risk of the anaphylactic reaction should always be taken in consideration.
19.	In order to improve patient safety, patient's response to the treatment, as well as adverse reactions and interventions, are to be documented.	X			Every nurse that delivers the IV therapy is in charge of monitoring and evaluation of its effectiveness as well as documenting the findings, including patient "response, adverse events and interventions".
5.1.10	Correct use of equipment				

20.	Personal protective equipment (PPE) is meant to protect the nurse from blood or hazardous medication spillage.		X		The use of PPE and adhering the rules of aseptics are important in order to protect from contamination both, the patient and the nurse her/himself.
21.	Local guidelines state that PVC can remain in situ up to 96 hours, unless the replacement is clinically indicated.				The local guidelines of HUS suggest removal and application of the new cannula after 48-72 hours, unless there are signs of complications present.
22.	Flushing of the cannula is meant to identify the potential dislocation of PVC.		X		All antimicrobial medications are irritant for the vein, therefore flushing of the cannula after the infusion is required. Use of flush prior to the procedure reassures the placement of the cannula and its patency, and rules out possible interactions with previously administered medications.
23.	Cannula should be removed if patients' skin is sore at the insertion site.	X			Removal and application of new cannula if there are signs of complications present.
24.	Dressing of the cannula should be changed every day.		X		There is no need to remove the dressing, as long as it remains dry, clean and attached.
25.	Broken outer package and tiny leakage is an indication not to use the equipment.	X			Nurse needs to assure that the outer packaging and the actual fluid bag are intact.
5.1.12 Accurate medication preparation					

26.	The reconstituted antimicrobials are susceptible to microbiological changes as well as are sensitive to temperature changes and sunlight.	X			The reconstituted medication should be administered immediately, in order to avoid any possible microbiologic changes that may happen as the result of poor aseptic technique or unclean environment during the medication preparation. Additionally, some antimicrobial medications are sensitive to temperature changes, and others might get damages by sunlight, as for example Cefuroxime and Metronidazole
27.	Medication prepared from powder is usable if the powder has dissolved to as small particles to be able to get through the cannula.		X		It needs to be reassured that neither diluent, not already reconstituted medication contain particles, are crystallized or have no color changes; the fluids are to be visibly clear.
28.	Nurse's responsibility is to know about the medication compatibility, interactions, storage, stability and equipment.	X			Nurse should be knowledgeable about the compatibility, interactions, storage, stability and equipment.
5.1.13 Infection prophylaxis					
29.	Establishing the vascular access entails the increase of risk of either local or systemic infection complications.	X			Vascular access required for the treatment, but also put the patients at risk of potential local and systemic infectious complications.
30.	If cannulation equipment has remained sterile, there		X		Use of the topical disinfectants for swiping the injection port

	is no need to disinfect the injection port valves or valves of infusion bag before puncturing it with a sterile needle.				valve of the cannula, the tubing and the valve of the infusion bag, is suggested prior to puncturing it with the infusion set needle.
31.	It is not possible to identify patients at higher risk of an infection.		X		It is within nursing domain to identify the patients who are in greater risk of infection, as for example younger and older population, immunosuppressed, malnutried, or undergoing multiple invasive procedures, and for this reason or another, having lower skin integrity.
32.	It is suggested to use hand disinfectant before and after handling a PVC.	X			The HUS (2013) guidelines suggest the use of hand disinfectant before and after handling the cannula.
5.1.14 Antimicrobials					
33.	Patients who are receiving antimicrobial medication pose the source of infection.	X			Antimicrobials are anti-infectious agent, the patients who receive this treatment belong to the risk group as they pose the source of infection.
34.	IV antimicrobial medication can only be given in hospital settings.		X		The administration of antimicrobial medication could be done in community. Whereas the UK legislation does not require administration of the first doses in hospital environment, the guidelines from the USA and Australia support the notion that the first doses of antimicrobial therapy

					are to be administered in a supervised setting due to the potential risk of allergic or anaphylactic reactions.
5.1.15 Correct site of cannulation					
35.	Cannula should be inserted to the most convenient from nurse's perspective vein, regardless the patients´ will.		X		In order to maintain comfort and safety throughout the cannulation procedure, it is nurse's responsibility to carefully choose an insertion site. Lavery (2011) suggests to consult with each patient in regard of the procedure, e.g. inquire their preferences about the IV site.
36.	Insertion site and size of the needle depends on the type of infusion it is intended for.	X			The cannula size should be suitable for both the infusion type and patient's vein size and condition.
37.	Lower extremities are as good option for cannulation in adult patient, as arms.		X		It is advisable to avoid the routine use of the lower extremities in adults.
5.1.16 Safe working environment					
38.	The biological rhythm disturbances caused by three-shift work, lead to decreased ability to perform tasks and concentrate.	X			The shift-work creates disturbances in biological rhythms, which in its turn leads to "fatigue, lower mood and motivation, reduced morale and decreased ability to perform tasks and pay attention".
5.1.17 Human factors: knowledge, training, experience					

39.	The knowledge of how to store a medication is as important as aseptic technique when considering a safe medication delivery.	X			Nurse must possess the knowledge of its principals, such as “reconstituting, including aseptic technique, compatibility, stability, storage, labelling, interactions, dosage, calculations and the use of appropriate equipment” as well as to be trained to respond to anaphylactic reaction.
40.	Hierarchy and acquiescence to the authority can compromise the rules of double-checking while preparing and administering medication.	X			It has been noticed that sometimes the steps of double-checking get violated and hence errors - missed. This can be caused by the following factors: acquiescence to the authority, if the senior nurse inquires the junior one to double-check.
41.	More experienced nurses are not prone to error-provoking behavior.		X		Years of nursing experience might have the negative effect on the nursing practice. In their article, Dougherty, Sque and Crouch (2011) have identified that some nurses “base their decision making on the use of heuristics such as overconfidence, anchoring, hindsight bias and pattern recognition”.
42.	Updating the knowledge only makes difference if a nurse is able to apply the knowledge to practice.	X			In nursing profession being competent and updating one’s knowledge throughout the working career is essential, as well

					as being able to apply the knowledge to practice.
5.1.18 Adherence to guidelines and policies					
43.	Medication errors often occur as the result of non-adherence to the local guidelines and policies.	X			“Although medication preparation and administration policies and procedures exist on the wards, many errors occur as a result of nurses not following these policies and procedures”, Agyemang and While (2010) cite after Armitage and Knapham (2003).
5.2 Antimicrobial medication in nursing practice					
44.	Immunosuppressed patients may receive both bacteriostatic and bactericidal drugs.		X		Immune system of immunosuppressed individuals cannot function by production and adequate response from phagocytic cells, therefore they should receive bactericidal medication only.
45.	Before administering antimicrobial medication, patient should be inquired about previous experiences with antimicrobial treatment.	X			Also each patient who receives the antimicrobial therapy, is to be inquired about this/her previous experiences with this kind of medication.
46.	It is necessary to inform a patient what kind of medication is given and its possible effects and side-effects.	X			Some side effects are normal as nausea, diarrhea, or headache. However rash, itching, hives, swelling and shortness of breath are signs of possible fatal anaphylaxis.

47.	There is no difference in action of antimicrobial on humans coming from different ethnic backgrounds.		X		Some groups of patients coming from the African American population have a predisposition to glucose-6-phosphate deficiency, which causes red blood cells to break down when exposed to certain drugs. Subsequently, these patients should not receive certain antimicrobials, which may induce red blood cell lysis.
48.	Dosages of antimicrobial medication should be prescribed taking in consideration patient's age.	X			Infants and elderly are the populations most prone to drug toxicity. In the infant, the liver and kidneys are not yet mature enough, thus metabolizing and excreting the drug is complicated, which results in accumulation. The same process in the elderly is related to the age of their liver and kidneys, entailing risk for toxicity. It is the nurse's role to make sure that the patient's age has been taken in consideration, before administering an antimicrobial agent.
49.	It is not necessary to inquire a female patient if she is possibly pregnant or nursing an infant.		X		It is known that most of antimicrobials also able to cross the placenta and are being teratogenic for the fetus. Moreover, antimicrobial agents are often able to enter breast milk, resulting in injury of the nursing child.

8.4 Accurate Peripheral IV Antimicrobial Medication:

Knowledge Test for Nurses *(The version intended for administration)*

I. Background information	
1. Gender	Female □ Male □
2. Age	Under 20 □ 20-30 □ 30-40 □ Over 50 □
3. Education	Registered nurse □ Practical nurse □ Nurse graduated before 1993 □ Nurse student □ If other, specify _____
4. Working experience as a nurse	Less than 1 year □ 1 - 5 years □ 5 - 10 years □ 10 - 15 years □ 15 - 20 years □ More than 20 years □
5. Experience of work at the current place	Less than 1 year □ 1 - 5 years □ 5 - 10 years □ 10 - 15 years □ 15 - 20 years □ More than 20 years □

6. IV license	Yes □ No □ When granted (dd/mm/yyyy) ___/___/_____
7. How often do you administer intravenous medication?	Every day □ Every week □ Every month □ Less than, specify _____
8. Do you feel competent administering intravenous medication?	Yes □ No □ I do not know □
9. Would you like to receive further training in intravenous medication administration?	Yes □ No □ I do not know □

II. Knowledge test			
Statements	True	False	I do not know
Right drug			
1. Any nurse is allowed to administer the prescribed IV medication.			
2. A nurse is allowed to withhold a medication.			
Right dose			
3. Nurse is to administer a drug dose as it is stated in prescription.			
4. Complex drug calculations should be carried out by two nurses independently.			
5. Standardization of medication doses is meant to reduce the risk of medications errors.			
6. The intravenous antimicrobial medications are always delivered as intermittent infusion.			
Right time			
7. The medication prepared in clinical setting has to be administered instantly.			
8. The two-hour deviation from the prescribed time for the antimicrobial medication delivery is allowed.			
Right route			
9. It is nurses´ responsibility to make sure that the prescribed medication is suitable for the chosen route.			
Right patient			
10. The combination of patient room number and bed number can be used as a mean of patient identification number.			

Right patient education			
11. Patient education is meant to increase the co-operation but does not gain patient consent.			
12. It is nurse's obligation to educate the patients about the signs and symptoms of adverse reactions of the administered medications.			
Right documentation			
13. Accurate documentation also decreases the risk or medication errors and potential complications of treatment.			
14. The documentation in regard of insertion PVC could be done by any health professional taking care of the patient who receives the IV medication.			
Right to refuse			
15. A patient is allowed to refuse the medication if s/he receives the full information about the necessity of it to treat the life-threatening infection.			
Right assessment			
16. The patient who receives IV medication does not need to be evaluated prior to the medication administration unless otherwise is specified in his/her record.			
17. Pain, swelling or redness are common side effects when administering the IV antimicrobial medication.			
Right evaluation			
18. Patient who is receiving the intravenous antimicrobial medication needs to be evaluated throughout the entire procedure.			
19. In order to improve patient safety, patient's response to the treatment as well as adverse reactions and interventions, are to be documented.			
Correct use of equipment			

20. Personal protective equipment (PPE) is meant to protect the nurse from blood or hazardous medication spillage.			
21. Local guideline states that PVC can remain in situ up to 96 hours, unless the replacement is clinically indicated.			
22. Flushing of the cannula is meant to identify the potential dislocation of PVC.			
23. Cannula should be removed if patients' skin is sore at the insertion site.			
24. Dressing of the cannula should be changed every day.			
25. Broken outer package and a leakage is an indication not to use the equipment.			
Accurate medication preparation			
26. The reconstituted antimicrobials are susceptible to microbiological changes, as well as are sensitive to temperature changes and sunlight.			
27. Medication prepared from powder is usable if the powder has dissolved to as small particles to be able to get through the cannula.			
28. Nurse's responsibility is to know about the medication compatibility, interactions, storage, stability and equipment.			
Infection prophylaxis			
29. Establishing the vascular access entails the increase of risk of either local or systemic infection complications.			
30. If cannulation equipment has remained sterile, there is no need to disinfect the injection port valves or valves of infusion bag before puncturing with a sterile needle.			
31. It is not possible to identify patients at higher risk of an infection.			
32. It is suggested to use hand disinfectant before and after handling a PVC.			

Antimicrobials			
33. Patients who are receiving antimicrobial medication pose a source of infection.			
34. The IV antimicrobial medications can only be given in hospital settings.			
Correct site of cannulation			
35. Cannula should be inserted into the most convenient from nurse's perspective vein, regardless the patient's will.			
36. Insertion site and size of the needle depends on the infusion it is intended for.			
37. Lower extremities are equally as good option for cannulation as patient's lower extremities.			
Safe working environment			
38. The biological rhythm disturbances caused by three-shift work lead to decreased ability to perform tasks and concentrate.			
Human factors: knowledge, training, experience			
39. The knowledge of how to store a medication is as important as aseptic technique when considering the safe medication delivery.			
40. Hierarchy and acquiescence to the authority can compromise the rules of double-checking while preparing and administering medication.			
41. More experienced nurses are not prone to error-provoking behavior.			
42. Updating the knowledge only makes difference if a nurse is able to apply the knowledge to practice.			

Adherence to guidelines and policies			
43. Medication errors often occur as the result of non-adherence to the local guidelines and policies.			
Antimicrobial medication in nursing practice			
44. Immunosuppressant patients may receive both bacteriostatic and bactericidal drugs.			
45. Before administering antimicrobial medication, patient should be inquired about previous experiences with antimicrobial treatment.			
46. It is necessary to inform a patient what kind of medication is given and its possible effects and side effects.			
47. There is no difference in action of antimicrobial medication on humans coming from different ethnic backgrounds.			
48. Dosages of antimicrobials should be prescribed taking in consideration the age of a patient.			
49. It is not necessary to inquire a female if she is possibly pregnant or nursing an infant.			