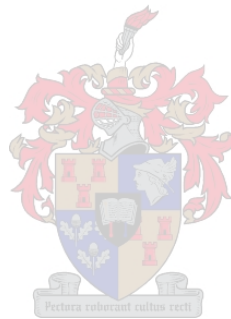


# Fluid balance monitoring in critically ill patients

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Thesis presented in partial fulfilment  
of the requirements for the degree of Master of Nursing  
in the Faculty of Medicine and Health Sciences  
at Stellenbosch University

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Supervisor: Janet Bell

## **Declaration**

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Date: December 2012

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## **Dedication**

To Nathalie and Andreas

## Abstract

**Motivation.** Homeostasis is a dynamic and balanced process that must be maintained in order to for health to be sustained (Scales & Pilsworth, 2008:50-57). In critically illness, homeostasis is disrupted and along with inadequate tissue perfusion potentially leads to multiple organ failure (Elliot, Aitken & Chaboyer, 2007:437). The fluid balance of a patient is essential for preserving homeostasis and to maintain optimal tissue perfusion, thus monitoring fluid balance plays an important role in the managing a critically ill patient. Current literature and best nursing practice emphasise the importance of accurate and correct fluid balance monitoring in critically ill patients including recording fluid intake and output on a purpose designed fluid balance sheet.

Research has shown that the patient's outcome after critical illness is influenced by the fluid balance management including fluid balance monitoring (Vincent, Sakr, Sprung, Ranieri, Reinhart, Gerlach, Moreno, Carlet, Le Gall & Payen, 2006:344-353), while several studies have questioned accuracy of fluid balance calculation in various acute care settings (Johnson & Monkhouse, 2009:291; Smith, Fraser, Plowright, Dennington, Seymour, Oliver & MacLellan, 2008:28-29).

In an informal audit performed in a local critical care unit, seven out of ten fluid balances were incorrectly calculated. Clinical experience of nurses' inattention to fluid balance monitoring, together with the informal audit data, reveals that fluid balance monitoring is generally not performed correctly or accurately by nurses working in critical care units. The aim of the study was to describe the perspectives and practices of registered nurses in critical care units with regard to fluid balance monitoring.

**Methods.** A quantitative approach in the form of an audit was applied to establish the current practice of fluid balance monitoring. A survey was conducted among registered nurses to gain insight into their perspectives and knowledge of fluid balance monitoring. The sample for the audit was drawn from fluid balance records, which met the study inclusion criteria. The survey was conducted with a sample of participants from registered nurses in critical care units from a particular hospital group, in compliance with the inclusion criteria. The researcher collected the data using a purpose designed audit tool and questionnaire.

**Results.** The audit revealed that 90 % of the sampled fluid balance records were inaccurate (tolerated deviation 0-10ml) and 79% were inaccurate if a deviation of 50ml would be tolerated. Furthermore the inaccuracy in calculation was larger in patients who received diuretics. The questionnaire data revealed that registered nurses considered fluid balance monitoring as an important part of patient nursing care and were aware that inaccuracy can pose a risk to the patient. The nurses feel responsible for performing fluid balance monitoring. In addition the nurses gave recommendations for the practice.

**Discussion.** The results of this study are similar to other studies done internationally. The nurses are aware of the importance of the fluid balance, and recognise the inaccuracies. With our limited resources, both financial and in terms of nursing staff, the solutions have to be very basic and practical.

**Key words:** fluid balance, critical care, accuracy and auditing, best practice

## Opsomming

**Motivering.** Homeostase is 'n dinamiese en gebalanseerde proses wat onderhou moet word vir gesondheid om handhaaf te word (Scales & Pilsworth, 2008:50-57). Onder toestande van kritieke siekte, word homeostase onderbreek en kan dit saam met onvoldoende weefselperfusie moontlik tot veelvuldige orgaanmislukking lei (Elliot, Aitken & Chaboyer, 2007:437). Die vloeistofbalans van 'n pasiënt is van die uiterste belang vir die preserving van homeostase en om optimale weefselperfusie te onderhou, en dus speel die monitering van vloeistofbalans 'n belangrike rol in die bestuur van die pasiënt wat kritiek siek is. Die huidige literatuur en beste verpleegkundige praktyk beklemtoon die belangrikheid van akkurate en korrekte vloeistofbalansmonitering in pasiënte wat kritiek siek is, insluitend die aantekening van vloeistofinname en -afskeiding op 'n vorm wat vir die doel pasgemaak is.

Navorsing het getoon dat die pasiënt se uitkoms ná kritiese siekte deur vloeistofbalansbestuur, insluitend vloeistofbalansmonitering, beïnvloed word (Vincent, Sakr, Sprung, Ranieri, Reinhart, Gerlach, Moreno, Carlet, Le Gall & Payen, 2006:344-353), terwyl verskeie studies die akkuraatheid van die vloeistofbalansberekening in 'n verskeidenheid kritiekesorgeenhede bevraagteken het (Johnson & Monkhouse, 2009:291; Smith, Fraser, Plowright, Dennington, Seymour, Oliver & MacLellan, 2008:28-29).

In 'n informele oudit wat in 'n plaaslike kritiekesorgeenheid uitgevoer is, is daar gevind dat sewe uit tien vloeistofbalanse verkeerdelik bereken is. Kliniese ervaring van verpleërs se agtelosigheid met betrekking tot vloeistofbalansmonitering, tesame met die data vanuit die informele oudit, wys dat vloeistofbalansmonitering oor die algemeen nie korrek of akkuraat deur verpleërs in die kritiekesorgeenheid uitgevoer word nie. Die doelwit van hierdie studie was om die perspektiewe en praktyke van geregistreerde verpleërs in kritiekesorgeenhede met betrekking tot vloeistofbalansmonitering te beskryf.

**Metodes.** 'n Kwantitatiewe benadering in die vorm van 'n oudit is gebruik om die huidige praktyk van vloeistofbalansmonitering te bepaal. 'n Opname is onder

geregisteerde verpleërs gedoen om insig te bekom oor hulle perspektiewe oor en kennis van vloeistofbalansmonitering.

Die steekproef vir die oudit is geneem uit vloeistofbalansrekords wat aan die studiekriteria voldoen het. Die opname is gedoen onder 'n steekproef van geregisteerde verpleërs in 'n kritiekesorgeenheid van 'n spesifieke hospitaalgroep, in ooreenstemming met die insluitingskriteria. Die navorser het die data met 'n pasgemaakte ouditinstrument en vraelys versamel.

**Resultate.** Die oudit het gewys dat 90% van die vloeistofbalansrekords in die steekproef onakkuraat was (toleransie verskil 0-50ml) en 79% was onakkuraat as een verskil van 50 ml was tolereer. Verder was die onakkuraatheid in die berekenings groter in pasiënte wat urineermiddels ontvang het. Die data vanaf die vraelys het gewys dat geregisteerde verpleërs vloeistofbalansmonitering as 'n belangrike deel van die verpleging van 'n pasiënt beskou en daarvan bewus is dat onakkuraatheid 'n risiko vir die pasiënt kan inhou. Die verpleërs voel daarvoor verantwoordelik om die vloeistofbalansmonitering uit te voer. Hulle het ook aanbevelings vir die praktyk gemaak.

**Bespreking.** Die resultate van hierdie studie is baie soortgelyk aan dié van ander internasionale studies. Die verpleërs is bewus van die belangrikheid van die vloeistofbalans en is bewus van die onakkuraatheid. Met ons beperkte hulpbronne, beide finansiële en in terme van verpleegpersoneel, is dit noodsaaklik dat die oplossings baie basies en prakties is.

**Sleutelwoorde:** vloeistofbalans, kritieke sorg, akkuraatheid en ouditering, beste praktyk



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## **Chapter 1: Introduction**

### **1.1 Introduction**

Fluid balance plays an important role in the management of a critically ill patient. The accurate assessment of the fluid balance data that is collected during physical assessment as well as during monitoring activities and recordkeeping, form an essential part of the baseline patient information that guides medical and nursing interventions aimed at achieving physiological stability in a patient.

### **1.2 Rationale**

The effective management of critically ill patients requires accurate assessment of their fluid balance status. This assessment includes appropriate monitoring of fluid intake and output, as well as the accurate calculation and correct recording of this data. In an informal audit of fluid balance records in a local critical care unit, seven out of ten of these fluid balance calculations were incorrect. Inaccurate monitoring and recording of the fluid balance can have far-reaching consequences with respect to on-going patient assessment and clinical management (Elliot, Aitken & Chaboyer, 2007:440,445-446). It therefore is essential that a critical care nurse implements appropriate fluid balance monitoring, accurate calculation and correct recording to deliver safe, quality patient care. For this reason it is necessary to determine the current clinical practices relating to fluid balance monitoring and to discover why critical care nurses do not seem to prioritise this component of patient monitoring in critical care.

### **1.3 Background literature**

Fluid balance implies a harmony of the fluids in the body. In healthy people, maintaining fluid homeostasis is a dynamic and balanced process (Scales & Pilsworth, 2008:50). Fluid balance is controlled through meticulous coordination of the hormonal and renal systems (Elliot et al., 2007:369-372). Maintaining harmony in the body fluids is essential



for human beings, and requires that the volume of intake should be similar to the volume of output. A loss of fluids will cause dehydration and hypotension, while an increase will cause a fluid overload and pulmonary oedema. Any disturbances in the fluid balance can lead to complications for the patient (Mooney, 2007:12-16).

Monitoring a patient's fluid balance is of great importance in understanding the patient's clinical status. In the critically ill patient, normal fluid balance control mechanisms are disrupted, leading to altered homeostasis and further patient risk. Fluid balance plays a role in preserving homeostasis and is crucial to maintaining optimal tissue perfusion. Inadequate tissue perfusion can lead to multi-organ failure (Elliot et al., 2007:437) and patient death. Thus, accurate fluid balance monitoring plays an essential role in patient management. When the fluid balance monitoring is inaccurate, incorrect conclusions regarding fluid balance status may be drawn (Elliot et al., 2007:440, 445-446). Inaccurate fluid balance status assessment will delay nursing or medical interventions that are necessary, with resultant negative physiological consequences, such as hypotension (Stevens, 2008:12).

One component of fluid balance monitoring is the measurement and recording of fluid intake and output over a 24-hour period. Usual critical care nursing practice requires that fluid intake and output be recorded hourly on a purpose-designed fluid balance sheet. Fluid intake consists of oral fluid, intravenous fluid and medication fluid, whilst output comprises urine, vomit, stools, bleeding and drainage (Scales & Pilsworth, 2008:53).

To avoid the consequences of fluid imbalance in the critically ill patient, accurate documentation of intake and output is essential. Several studies have questioned the accuracy with which fluid therapy is monitored and fluid balance is calculated. Johnson and Monkhouse (2009:291) noted that poor management of the replacement of fluids and electrolytes is due to inaccuracies in monitoring and recording. Reid, Robb, Stone, Bowen, Baker, Irving and Waller (2004:36-40) paid attention to the reasons for inaccuracy in fluid balance assessment, reporting these to be: a deficit in knowledge, a heavy workload and a lack of personal responsibility. A significant shortage of nurses in

South Africa, and in the critical care environment as described by Scribante and Bhagwanjee (2007:1315), increases an already heavy workload for nurses, which may impact on accurate fluid balance monitoring in the South African critical care setting.

Solutions to improve the accuracy of fluid balance monitoring and recording have been mentioned by Reid et al. (2004:36-40), who suggest that fluid balance-focussed training, information notes at the patient bedside, a “user friendly” fluid balance sheet and the requirement of the signature of the responsible nurse be included in usual nursing practice. Smith, Fraser, Plowright, Dennington, Seymour, Oliver and MacLellan (2008:28-29) advise simplifying the recording charts to reduce the workload of the nurses. Further research by this team showed that regular auditing of fluid balance monitoring practices improves nursing practice with regard to fluid balance monitoring (Smith et al., 2008:28-29). The outcome of these changes could lead to better patient care and consequently support best practice in nursing.

The concepts underpinning best practice and evidence-based practice in nursing were used as a framework for this study. Both of these concepts connect research with practice to enhance patient care of excellent quality (Pearson, 2005:207-215). Best practice originates mainly from experience of the practice, and evidence-based practice develops from a research-based strategy, including a thorough literature review. For this study, the concepts of best practice and evidence-based practice (Philipsen, 2004:51) are combined. An important aspect of best practice in nursing is the accurate recording of activities and interventions. Scales and Pilsworth (2008:57) provide guidance for best practice in fluid balance; this includes assessment of the patient, informing the doctor or shift leader about deterioration in the patient’s health status, handover of the fluid balance to the next shift, as well as accurate calculation and recording. Recordkeeping is an important component of the scope of practice of professional nurses, as described in the regulations relating to the scope of practice of persons who are registered or enrolled under the Nursing Act of 1978. This regulation requires that nurses take responsibility for their actions and practices (SANC, South African Nursing Council, 2006; Searle, 2000:261-262).

#### **1.4 Problem statement**

The literature and best nursing practice emphasise the requirement of accurate and correct fluid balance monitoring in critically ill patients. The researcher's clinical practice experience, together with the data from the informal audit, identified that fluid balance monitoring was generally not done correctly by nurses working in critical care units.

#### **1.5 Research question**

The following question therefore arose:

What are the current practices of registered nurses in critical care units with regard to fluid balance monitoring?

#### **1.6 Aim of the study**

The aim of the study was to describe the perspectives and practices of registered nurses working in critical care units with regard to fluid balance monitoring.

#### **1.7 Objectives**

The objectives of this study were the following:

- To identify and describe the current clinical practices related to fluid balance monitoring and recording in critical care units.
- To describe the perspectives and knowledge of nurses in critical care units with regard to fluid balance monitoring and recording.

#### **1.8 Operational definitions**

- Evidence-based practice is the use of knowledge obtained through research with the purpose of making recommendations for patient care (Elliot et al., 2007:58).

- Best practice is defined as practice based on evidence, but focused on how it works best in the clinical setting (Philipsen, 2004:51). In this study, the concepts “best practice” and “best nursing practice” are used interchangeably.
- A registered nurse is a person who is registered with the South African Nursing Council (SANC) as a nurse in terms of the Nursing Act. In this study, the registered nurse are those working in the critical care environment, with or without an additional qualification in critical care nursing (SANC Regulation 2598, 2006). Another term used for a registered nurse is that of professional nurse.
- A critical care unit is a highly specialised unit in which patients are admitted with life-threatening conditions in need of close observation and intensive care by highly skilled nurses. It is also known as an intensive care unit; in this study it is called the critical care environment.
- A high care unit is a unit equipped with monitoring devices to observe patients more closely than in a normal ward.
- A private sector hospital group is a company with several hospitals that are privately owned, in contrast to the state hospitals.
- Clinical practice is the nursing that happens at the patient’s bedside, in contrast to educational practice.
- In healthy persons, fluid balance is when the amount of intake is equal to the amount of output. Fluid intake is the amount of fluid that comes into the body orally or by intravenous infusion. Fluid output is the amount of fluid that leaves the body by means of urine, sweat, respiration and stools (Scales & Pilsworth, 2008:53).

- Monitoring includes the assessment, recording and calculation of a particular component in patient management; in this study the particular component is fluid balance variables (Reid, 2004:36).
- Daily chart is the observation sheet used in the critical care environment of the hospital group on which the following daily recordings are made on the patient individually: vital signs, fluid balance, patient's characteristics, doctor's orders, laboratory results and nursing notes.

## **1.9 Study context**

The study was conducted in the adult critical care environment of a private sector hospital group in Cape Town.

## **1.10 Conceptual framework**

LoBiondo-Wood and Haber (2010:57) define a conceptual framework as a guide to how the different concepts in research are structured. De Vos, Strijdom, Fouché and Delport (2008:34-35) write that the conceptual framework organises the researcher's thoughts at the beginning of the research to develop relevant questions and to find answers to these questions.

In this conceptual framework, the patient is located at the centre. This view originates from Henderson's nursing theory (George, 2002:87), in terms of which the outcome of the patient improves through excellence in patient-centred nursing. Virginia Henderson offered that nursing has a:

unique function to assist the individual, sick or well, in the performance of those activities contributing to health or its recovery (or to peaceful death) that the patient would perform unaided if the patient had the necessary strength, will or knowledge, and

to do so in such a way as to help the patient to gain independence as rapidly as possible (George, 2002:87).

Figure 1.1 provides a diagrammatic representation of the conceptual framework.

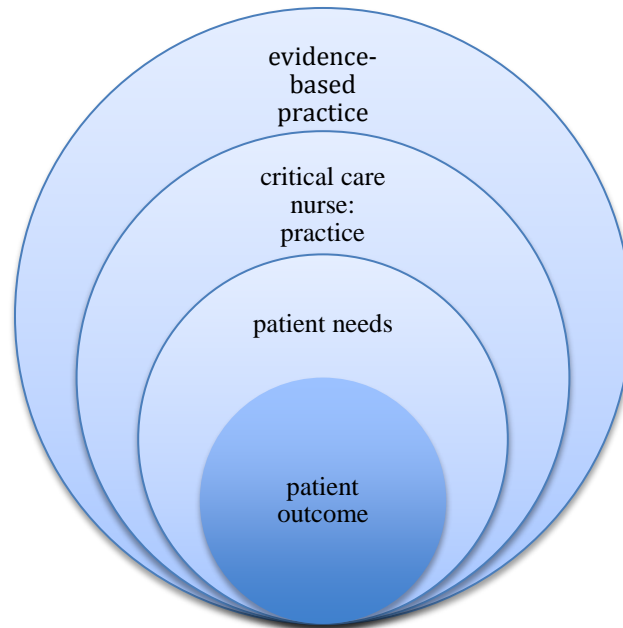


Figure 1.1 Conceptual framework

Developing towards best nursing practice begins with understanding what outcome is desired and appropriate for the patient. The possible patient outcome determines the patient's needs. The critical care nurse responds to the patient's needs with the appropriate nursing practice informed by research evidence. Evidence-based nursing is an accepted concept in achieving excellence in nursing (Pearson, 2005:207). The meaning of evidence-based practice is the use of knowledge obtained through research, with the purpose of making recommendations for patient care (Elliot et al., 2007:58).

Evidence-based practice, according to LoBiondo-Wood and Haber (2010), develops from a meticulous review of the currently available literature, combined with clinical experience (best practice). Thus the conceptual framework for this study recognises that the current nursing practices of critical care nurses should be informed by evidence-based

practice, as well as by any described and recognised best practices that can improve patient care and the quality of nursing.

This study makes use of the Johanna Briggs model, as it connects evidence, practice and theory in nursing (Pearson, 2005:207). Current evidence and theory are appraised through a thorough literature review, which is discussed in Chapter 2. Current nursing practice in the form of the practices and perspectives of nurses in relation to fluid balance monitoring are gathered by means of the audit tool and the questionnaire. Data analysis and discussion allow for the current practice to be understood and situated within the known evidence and theory of fluid balance nursing practices, enabling recommendations to be made to improve fluid balance monitoring in critically ill patients.

## **1.11 Research methodology**

### **1.11.1 Introduction**

A quantitative approach was utilised for this study. Within this approach, an exploratory, descriptive design provided the broader framework for the study. Quantitative data regarding the current clinical practices relating to how components of fluid balance were monitored and recorded, and were collected utilising an audit tool to assess all relevant fluid balance records. This data was supplemented by means of a survey tool to determine the perspectives and knowledge of critical care nurses regarding best practice in fluid balance monitoring in the clinical environment.

The population for this study was critical care patient records, which were used for the audit, and registered nurses working in critical care in purposively identified hospitals within a hospital group, who were used for the survey. Purposive sampling was used to identify the participant hospital group due to time constraints related to the academic requirements.

The specific methodology relating to the audit of the patient records and the survey tool are described separately below.

### **1.11.2 Part 1: audit of fluid balance records**

The current clinical practices implemented in fluid balance monitoring and recording were determined utilising an audit tool to gather quantitative data from the relevant fluid balance records.

#### **1.11.2.1 Population and sampling**

The population comprised the fluid balance records of patients admitted to critical care units in a private sector hospital group in Cape Town. Fluid balance records were audited in the critical care environments of three hospitals of the hospital group. These three hospitals were chosen because their patient profiles were similar in terms of the multidisciplinary nature of their critical care environment. All the nursing documentation and nursing policies were uniform across the units.

The researcher approached each hospital's critical care units as a single critical care environment entity.

The study sample was drawn from patient records according to the predetermined inclusion criteria and a random sampling technique as described in Chapter 3.

#### **1.11.2.2 Data collection**

The audit tool was developed from the literature and clinical experience. An expert in auditing assisted in the development of this tool, and the tool was scrutinised by a statistician. The audit tool allowed for data to be collected with respect to the implementation of fluid intake and output prescriptions, the recording of fluid balance data in critical care observation records, as well as deviations in calculation with regard



to the recording of fluid intake, fluid output and total fluid balance (Addendum A). After ethical approval had been obtained (Addendum D), a pilot study, comprising 10% of the recommended total sample size, was performed to test the audit tool. The data from the pilot study was excluded from the data for the main study.

### **1.11.3 Part 2: survey tool**

The perspectives and knowledge of critical care nurses with respect to fluid balance monitoring practices were determined utilising a survey tool in the form of a questionnaire (Addendum B).

#### **1.11.3.1 Population and sampling**

The population for this survey was critical care nurses working in the adult critical care environments of three hospitals of the private sector hospital group from the fluid balance records (used in Part 1) had been obtained. The inclusion criterion for the possible participants was that they had to be registered nurses with or without additional qualifications in critical care nursing. Registered nurses retain ultimate responsibility and accountability for the patients allocated to their care in a critical care unit. This remains the case when care activities (such as fluid balance monitoring practices) are delegated to other categories of nurses. As the design of this study was descriptive in nature, a sample size of 62 nurses allowed confidence intervals of 7.5%; to adjust for non-response rates, the sample size was inflated by 15%. Thus, a total sample of 71 participants was required.

#### **1.11.3.2 Data collection**

The questionnaire was developed with reference to the available research and literature describing best practices related to all relevant aspects of fluid balance monitoring and recording. Section A of the questionnaire concerned the participants' knowledge of the concepts of fluid balance. Section B comprised statements requiring responses on a four-point Likert scale regarding the participants' perspectives of fluid balance monitoring.

Section C offered three open-ended questions to allow the participants to describe their practices further. To ensure that the questionnaire was unambiguous and appropriate, it was pre-tested in a pilot study in a critical care unit in a hospital similar to the participating hospitals. The pilot study was not included in the main study. An appropriate time and method for distributing the questionnaire were determined by the researcher in collaboration with each unit manager to ensure that patient care activities were not affected. The questionnaires were combined with an informed consent form (Addendum C). The consent forms were collected prior to the nurses completing the questionnaire so that the participants' completed questionnaires remained anonymous. The researcher visited the hospitals regularly during the data collection period to ensure that every participating nurse had the opportunity to complete and return the questionnaire.

#### **1.11.4 Reliability and validity of the study**

The audit tool and the questionnaire were evaluated by critical care nursing experts to determine their content and face validity. An expert was drawn from each of the following critical care environments: clinical practice, quality assurance and education. All the experts had a minimum academic qualification of a Master's degree to ensure experience in the processes and requirements of research. All the experts were active participants in their particular environment and together offered a complete assessment of the content and face validity of the tool. The audit tool and the questionnaire were tested in a pilot study to ensure the accuracy and relevance of the measurements. The study was exploratory and descriptive and no intervention was used, thus internal validity was not at risk. Through the use of different hospitals belonging to the same hospital group, the analysed samples supported the external validity and this added to the generalisability of the study (De Vos et al., 2005:154-157, 160-163). The researcher collected all the data herself to ensure consistency in the data collection technique.

### **1.11.5 Data analysis in the study**

A qualified statistician was consulted and recommended MS Excel to be used to capture the data, and STATISTICA version 10 (StatSoft Inc., 2011) (data analysis software system, [www.statsoft.com](http://www.statsoft.com)) to analyse the data. The data is presented as histograms. Medians or means were used as the measures of central location for ordinal and continuous responses and standard deviation and quartiles as indicators of spread. Depending on the data, the relationship between two continuous or ordinal variables was studied by a Mann-Whitney U test for correlation. A p-value of  $p < 0.05$  represented statistical significance in the hypothesis testing, and 95% confidence intervals were used to describe the estimation of unknown parameters.

### **1.12 Ethical considerations**

The proposal was submitted to the Human Research Ethics Committee at the Faculty of Health Science at Stellenbosch University for approval (Addendum D). A waiver of consent was approved to allow access to patient records for the fluid balance audit (Addendum E). This was a low-risk study and no risk or harm to the participants was anticipated.

A reference number was used on the audit tool to allow the researcher to track the study documentation during data analysis, but this could not identify the patient record or hospital in any manner. No copies were made of the patient records. No patient name was recorded on the audit form. Only patient records meeting the inclusion criteria of the study were accessed.

The nurses working in critical care units participated voluntarily and they could withdraw at any time as there was no obligation to participate. All the participants in the study received information on the study and a consent form in English to sign (Addendum C). The informed consent form was attached as an introduction to the questionnaire. The

consent forms were collected separately to the questionnaire so that the participants' completed questionnaires remained anonymous. All hospital documentation was in English, thus it was accepted that all the participants were competent in at least the English language as a communication tool. The consent form was kept separate for confidentiality and privacy and did not appear in the data collection. The names of the participants were treated confidentially and were withheld from any documentation. The study data was only accessible to the investigator and her supervisor. All data was only used for this study. The data was kept secure in a locked cabinet in the researcher's office during the study, and will be kept in the supervisor's office for a period of five years after data analysis had been completed. The researcher was available telephonically for any queries regarding the research study generally, or regarding the data collection specifically.

### **1.13 Chapter layout**

Chapter 1: Introduction

Chapter 2: Literature review

Chapter 3: Methodology

Chapter 4: Data analysis and discussion

Chapter 5: Conclusions and recommendations

### **1.14 Conclusion**

The aim of the study, the rationale, the research question and the objectives of the study were discussed in this chapter. The research describes the perspectives and practices of registered nurses working in critical care units.

In the next chapter the reviewed literature is discussed.

## **Chapter 2: Literature review**

### **2.1 Introduction**

A literature review provides an overview of what is at present known about a particular topic of research. The purpose of undertaking a literature review is to determine previously unstudied areas, and how a unique research project can be developed to expand knowledge and to contribute to the development of the practice (Burns & Grove, 2007:135-136).

The purpose of this research was to describe the perspectives and practices of registered nurses working in critical care units with regard to fluid balance monitoring. Thus the literature review was guided by the available international literature, which captures knowledge about fluid balance monitoring in critically ill patients. Obtaining this information is important to avoid copying an existing study, to become aware of research done on this subject, as well as to be aware of the findings and methodology of related studies (Mouton, 2001:86-87).

To obtain a structured overview of this topic, the discussion will take place according to the following subsections:

- An overview of critical care nursing
- Fluid balance physiology and monitoring
- Fluid balance in critically ill patients
- Accuracy and auditing

To search for studies that had already been done on the research topic and related concepts, a search strategy was deployed. The strategy to collect information for this literature review commenced by identifying relevant keywords. The following keywords concerning the research topic were derived from the research question in Chapter 1:

- Critical care
- Fluid balance

- Accuracy and auditing
- Best practice in nursing
- Evidence-based practice

Using these keywords, a search was performed of the following databases: PubMed, CINAHL® and Cochrane. The electronic sources were searched by entering the above-mentioned keywords and the Boolean operators (AND, OR, NOT). On the basis of the results of these searches, 35 articles were included as a result of their relevance to the research topic. To obtain contemporary articles, articles published before the year 2000 were excluded, with the exception of three containing information related to the history of nursing. Textbooks that are of particular relevance were also included.

## **2.2 An overview of critical care nursing**

A critical care unit is a specific area in the hospital where patients with life-threatening illnesses or disorders are monitored and treated (Elliot et al., 2007:3).

The patients in an intensive care unit experience life-threatening conditions and are in need of highly specialised nursing care that is implemented by critical care nurses. Critical care nurses are expected to understand the clinical patient health situation and respond with adequate decision making to further improve the quality of patient care and increase the safety of the patient (Elliot et al., 2007:5-11).

Critical care nursing is defined by the World Federation of Critical Care Nurses (WFCCN) as nursing critically ill patients with life-threatening conditions in a highly specialised unit, providing care to restore health or to offer palliative care (WFCCN, 2007:n.p.). Thus, the profile of a critical care nurse is that of a nurse with strong skills in decision making, comprehensive knowledge and the ability to cope in a highly technical environment (De Beer, Brysiewicz & Benghu, 2011:6-10).

The following section will describe how critical care nursing developed internationally and in South Africa.

### **2.2.1 International development of critical care**

There have always been critically ill patients, but critical care units only emerged in 1950. An awareness of the need for separate units for critically ill patients emerged in 1850, when Florence Nightingale saw the need for a specific area in which to treat patients after surgery. She noticed higher survival rates among very sick patients when the patients were in units where the nurses were more capable of caring for them. She monitored and documented the care she provided to her patients and applied her acquired knowledge to improve the standards of nursing (Society of Critical Care Medicine, s.a.).

Methods of managing patients during World War 2 (1939–1945) and during the polio outbreak (1947) were forerunners of the designation of specialised areas for critically ill patients. During World War 2, wounded soldiers were treated in shock rooms. The soldiers presented mostly in hypovolemic shock due to the considerable blood loss from the injuries they had sustained. Such shock is a life-threatening condition, as blood flow is insufficient to maintain tissue perfusion (Elliot et al., 2007:445). Monitoring these wounded soldiers more closely, ideally in separate units, and providing adequate fluid resuscitation, especially transfusions of whole blood, was essential for their survival.

During the polio outbreak in 1947, negative pressure ventilation was introduced. Negative pressure ventilation was performed with the “Iron Lung”, a chamber into which the patient’s body was placed, with the head outside of the chamber. The internal chamber pressure could be manipulated and, when the pressure in the chamber was lower than the pressure in the lungs, the patient would be able to breathe in through the nose. The endotracheal tube was invented in Copenhagen, Denmark, and allowed for positive-pressure mechanical ventilation of patients. Positive-pressure ventilation differs from negative-pressure ventilation in that the ventilator pushes air into the patient’s lungs (Corrado, Confalonieri, Marchese, Mollica, Villella, Gorini & Della Porta, 2002:193).

Caring for patients diagnosed with polio was complex, and the need for a special area in the hospital where this complex nursing care could be carried out more efficiently by specifically skilled nurses became evident. Critical care emerged from the treatment of polio patients at this time and has continued to develop (Sale, 1990:1; Society of Critical Care Medicine, n.p.). As ventilation technology progressed, more specialised nursing skill and closer monitoring of these patients were required.

Hilbermann (1975:160) noted that the intensive care units evolved because critically ill patients are observed more readily in a special unit. Also, skilled staff can react early to a patient's condition and potentially limit any deterioration in the patient's condition.

### **2.2.2 Critical care nursing in South Africa**

In South Africa, nursing began with the arrival of Jan van Riebeeck, a surgeon, in 1652. He needed a hospital for his sailors. From that time on general nursing, or hospital nursing, was shaped by several wars, colonialism and the apartheid regime (Searle, 2000:10).

By the end of the 19<sup>th</sup> century, Sister Henrietta Stockdale had established the first training school for nurses, most of whom were nuns. In 1908, Cecilia Makiwane passed the exam and became the first professional nurse in South Africa (Breier, Wildschut & Mqgolozana, 2009:15-16). In 1944, the South African Nursing Council (SANC) was given the same authority as the SA Medical Council, with nursing attaining professional status. This was a significant turning point in the history of South African nursing. The Nursing Act (Act 45 of 1944) was passed (Searle, Human & Mogotlane, 2009:29-30) to provide a legal framework for the profession. The South African Nursing Council (SANC) was given legal, ethical and professional responsibilities in regulating, amongst many other aspects, the postgraduate qualifications for nurses (De Beer et al., 2011:6-10).

Parallel to the development of critical care internationally, the first special wards for ventilated patients were established in South Africa, in Cape Town and Durban, with the



first multidisciplinary intensive care unit was established in the Addington Hospital in Durban in 1970 (Scribante, Schmollgruber & Nel, 2004:112).

As critical care began to develop as a clinical discipline, a multi-professional and multidisciplinary society was established in 1978 to promote the interests of critical care in South Africa. The Critical Care Society of Southern Africa today represents a large multidisciplinary society of doctors, nurses and other health-care professionals. The Society is also represented in the World Federation of Societies of Intensive and Critical Care, as well as in the World Federation of Critical Care Nurses (Scribante, Schmollgruber & Nel, 2004:112).

The development of this specialised area of care resulted in the need for nursing personnel who were trained specifically to understand and meet the health needs of critically ill patients (De Beer et al., 2011:6-10). A critical care programme was offered as a post-registration qualification for registered nurses under regulation No. R. 212 (19 February 1993, as amended). After completion of this course, the registered nurse is registered with SANC with an additional qualification in medical and surgical nursing science (De Beer et al., 2011:6-10).

The practice of registered nurses in South Africa is regulated by the scope of practice (SANC, 2006). The role and function of the critical care nurse is governed by the same regulation.

Scribante, Muller and Lipman (1995:437-441) adapted the scope of practice for the registered nurse into a scope of practice for the critical care nurse, in which each item is explained with reference to the critical care nurse. In the table below, the acts and procedures relevant to fluid balance monitoring are listed. On the left are the relevant acts and the procedures a registered nurse may perform. Next to this on the right are the interpretations of the abovementioned responsibilities of a registered nurse, which Scribante et al. (1995:437-441) interpreted for application to critical care nursing. Scribante et al. (1995) consider this interpretation as a guide to improve the quality of

patient care. The scope of practice of registered nurses (SANC, 2006) determines that monitoring and assessing a patient's fluid balance is the responsibility of any registered nurse working in the critical care environment (SANC, 2006).

Table 2.1 Scope of practice for the critical care nurse

Scope of practice (SANC, 2006)	Adapted version (Scribante et al. 1995)
(a) <i>The diagnosis of a health need and the prescribing, provision and execution of a nursing regimen to meet the needs of a patient or a group of patients or where necessary, by referral to a registered person.</i>	The critical care nurse is responsible for the patient and should react to any sudden change in the critical care environment; this change can occur quickly and unexpectedly.
(b) <i>The execution of a programme of treatment or medication prescribed by a registered person for a patient.</i>	Similar for critical care nurse.
(c) <i>The treatment and care of and the administration of medicine to a patient, including the monitoring of the vital signs and of his [/her] reaction to disease conditions, trauma, stress, anxiety, medication and treatment.</i>	The critical care nurse is expected to have great knowledge about patient treatments. Crucial is an accurate and competent recording of the vital signs and a prompt response to changes.
(d) <i>The supervision over and maintenance of fluid,</i>	Similar for critical care nurse, although more thorough knowledge is necessary in the critical

<i>electrolytes and acid base of patients.</i>	care environment.
<i>(e) The facilitation of the maintenance of bodily regulatory mechanisms and functions in a patient.</i>	The bodily regulatory mechanisms are the mechanism mostly affected in the critical care environment and therefore fundamentally important.
<i>(f) The facilitation of the maintenance of nutrition of the patient.</i>	The critical care nurse ought to have sufficient knowledge about the feeding, either oral or parenteral, and should have understanding of the risks involved.
<i>(g) The supervision over and maintenance of elimination by a patient.</i>	The critical care nurse needs to be skilled and well informed about the fluid status of the patient. It is essential to record the fluid balance accurately. The nurse needs to respond to fluid status and electrolyte imbalances.

As can clearly be seen above, the scope of practice of registered nurses includes the monitoring of the fluid balance as a responsibility of any registered nurse (SANC, 2006).

## **2.3 Fluid balance**

### **2.3.1 Physiology of fluid balance**

Fluid balance implies a harmony in the fluids in the body. In healthy persons, the amount of intake should be similar to the amount of output. The maintenance of homeostasis in fluids is a dynamic and balanced process. In an average adult male, the total amount of water in the body is 45 litres; 30 litres are in the cells (intracellular), 12 litres are between the cells (interstitial), and three litres are in the blood vessels (intravascular). The

exchange between the intra- and extracellular compartments occurs through a semipermeable cell membrane, which allows water and small molecules to pass through (Scales & Pilsworth, 2008:51).

Fluid moves freely between the intracellular and extracellular compartments, maintaining homeostasis. The processes by which the fluid moves are diffusion and osmosis. Diffusion is the passive transfer of molecules and electrolytes through a permeable membrane and depends on the concentration gradient, with the intention being to reach an equivalent concentration on the other side of the membrane. Osmosis is a special form of diffusion and is the transfer of water through a semipermeable membrane (Culleiton & Simko, 2011:31).

Fluid balance is controlled through the meticulous coordination of hormones and by the renal system (Elliot et al., 2007:371). When considering the hormonal system there are three hormones that play a role in fluid balance, namely:

- Antidiuretic hormone (ADH or vasopressin), which is produced in the hypothalamus and stored in the pituitary gland. ADH, when released, is responsible for the return of fluid from the kidneys into the bloodstream.
- Atrial natriuretic peptide (ANP), which responds to cardiac filling and stimulates the elimination of water and sodium by the kidneys.
- Aldosterone, which is produced in the adrenal gland of the kidneys. Aldosterone re-absorbs sodium and will exchange sodium for potassium.

The hormonal system works closely with the renal system. The renal system is essential for the homeostasis of fluids and electrolytes, the regulation of the acid-base balance, the regulation of blood pressure and the production of hormones. Renal fluid regulation is a process of filtration, re-absorption and secretion. The kidneys maintain the electrolyte concentration in the blood.

Electrolytes are important to regulate fluid balance, and cardiac and neurological activities. The following electrolytes can be found intracellularly, interstitially and

intravascularly: sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), bicarbonate (HCO<sub>3</sub><sup>-</sup>), calcium (Ca<sup>2+</sup>) and magnesium (Mg<sup>2+</sup>).

Of the electrolytes dissolved in the body water, sodium in particular plays an essential role in osmotic pressure. Osmotic pressure, or osmolality, is normally 300 mOsm/kg. Osmolality is defined as a measurement of the amount of parts per kilogram, dissolved in a fluid (Silverthorne, 2004:153). The body attempts to equalise the concentration of water and sodium by means of water and sodium passing the (semi-) permeable membrane (Elliot et al., 2007:371). A higher value of osmolality means a higher concentration of particles, indicating dehydration, and a lower value of osmolality indicates oedema (Medical Dictionary, 2011:n.p.).

Maintaining harmony in the body fluids is essential for human beings. A fluid loss will cause dehydration, and a fluid gain will cause an overload of fluid. Disturbances in the fluid balance can lead to serious complications for the patient (Mooney, 2007:12-16).

### **2.3.2 Fluid balance disorders**

Dehydration is a shortage of fluid in the body, either intra- or extracellularly.

Dehydration occurs when there is either a diminished fluid intake or an increased output of fluid, such as through vomiting, diarrhoea, fever or sweat. Signs and symptoms of dehydration are thirst, low blood pressure, an increased pulse rate and a reduced urine production. Severe fluid loss can result in hypovolemic shock (Elliot et al., 2007:445-446). Hypovolemic shock occurs when the circulating volume of fluid in the blood vessels is significantly decreased, resulting in poor tissue perfusion. There are many different causes of this type of shock, and treatment depends on the cause of the shock. Treatment might be fluid resuscitation, supportive medication, surgical intervention and/or other technical assistance (Elliot et al., 2007:445).

Fluid overload is an excess of fluids in the body. Fluid overload occurs when there is an increased intake of fluid or a diminished output of fluid. This is caused by specific

disorders such as cardiac failure, liver failure or kidney disease or in critically ill patients. It manifests in body tissue oedema or pulmonary oedema. Patients show signs of swollen extremities or shortness of breath (Scales & Pilsworth, 2008:53). Pulmonary oedema appears when the blood pressure in the lung capillaries is more than 30 mmHg. Under this pressure, the fluid moves from the intravascular compartment into the alveoli and affects effective gas exchange. Symptoms of pulmonary oedema are shortness of breath, pink sputum, anxiety and low oxygen saturation (Elliot et al., 2007:560-561). Patients can be acutely critically ill and might need urgent admission to the intensive care unit (Stevens, 2008:20-21).

To avoid fluid balance disturbances, it is essential to monitor the fluid balance in critically ill patients with great care.

### **2.3.3 Monitoring of fluid balance**

The word monitoring is derived from the Latin word “monere”, and means “warn”. Monitoring therefore means to observe and check (South African Concise Oxford Dictionary, 2002:750).

Monitoring technology in the critical care environment has developed over the last 40 years. Critically ill patients are monitored continuously through the considered adjustment of the alarm limits. The monitor will alert the nurse when any changes occur in the condition of the patient (Thomas, 2011:9).

Monitoring of the fluid balance is the assessment, recording and calculation of the fluid intake and the fluid output (Reid et al., 2004:36). Intake is the amount that comes into the body orally or by intravenous infusion. Fluid output is the amount of fluid that leaves the body by means of urine, sweat, respiration and stools (Scales & Pilsworth, 2008:53). Fluid intake may vary between 1 500 and 2 500 ml/day, and urine output should be at least 0,5 ml/kg bodyweight/hour, depending on the intake. When the output is less than

0,5 ml/kg bodyweight/hour, it should be mentioned to the doctor or shift leader (Scales & Pilsworth, 2008:57).

Scales and Pilsworth (2008:55) emphasise the importance of fluid balance charts. These charts allow the recording of all measurable ingested and excreted fluids. The heading “intake” must include all medication and fluids taken orally, medication and fluids given intravenously, and all fluids administered via any other tube. The heading “output” must include all urine, drainage, vomit, measurable stools (colostomy bag) and nasogastric tube secretions. It is important to recognise the invisible excretion of fluid via bowel activity, respiration, fever and perspiration, as this can add up to 600 to 900 ml/day, which is usually not included on a fluid balance chart (Scales & Pilsworth, 2008:53). It may not always be possible to measure the fluid balance exactly, for instance in the case of large, unmeasurable amounts of diarrhoea (Stevens, 2008:13).

The accuracy of fluid balance recording is the responsibility of the registered nurse. The nurse should recognise and react to irregularities and disturbances in the fluid balance. In addition to the charts, the patient’s clinical status and blood chemistry values should also be watched closely (Scales & Pilsworth, 2008:56).

The patient’s clinical condition is recorded by examination of the patient: skin, tongue and face, blood pressure, pulse rate, temperature, breathing rate and urine production. A further indicator of fluid imbalance is to determine if the patient is thirsty. The clinical picture, combined with an electrolyte and full blood cell count laboratory test, might offer additional information on the patient’s fluid status (Mooney, 2007:12-16).

Assessing the fluid balance is an important part of the total monitoring of the patient, as control mechanisms are easily disrupted in critically ill patients, leading to great risks for the patient. The accurate assessment and interpretation of fluid balance therefore is important for effective patient management, in combination with the patient’s health history, physical appearance and vital signs (such as urine production, blood pressure and pulse rate).

It is noted by Vincent et al. (2006:344) that accurate fluid balance monitoring results in a better outcome for the patient, while a positive fluid balance may predict higher mortality in critically ill patients.

#### **2.3.4 Fluid balance monitoring in critically ill patients**

In critically ill patients, a change in the fluid balance can cause deterioration and possibly have a negative impact on the clinical outcome of the patient. Thus, the fluid balance is monitored and recorded continuously for all critical care patients (Culleiton & Simko, 2011:30).

This section will focus on the assessment of the fluid balance in critically ill patients, including urine production and laboratory results, dehydration and fluid overload, as well as patient outcome.

An early warning sign of fluid imbalance is the production of urine. The minimum expected volume is calculated as 0,5 ml/kg bodyweight/hour (Scales & Pilsworth, 2008:55). When a urine volume of less than 0,5 ml/kg bodyweight/hour is recorded, the nurse should respond to this data. In addition, it is important to consider the patient's holistic clinical picture, including the observation of the patient's appearance, skin, face, tongue and thirst, where possible. These details can add useful information related to the fluid status of the patient (Scales & Pilsworth, 2008:54).

Assessment of the fluid status includes the monitoring of other important vital signs, namely blood pressure, pulse rate, heart rhythm, breathing rate, central venous pressure and body weight (Elliot et al., 2007:442). Low blood pressure results in decreased organ perfusion and can lead to organ failure, which will have a severe impact on the outcome for the patient. According to Stevens (2008), even when the acute shock situation is managed and the patient appears to be in a stable condition, hypoperfusion in the tissue could continue and may cause more damage to the organs, resulting in organ failure



(Stevens, 2008:12). Elliot et al. (2007) note clearly that fluid balance plays an essential role in nursing management in critically ill patients, as preserving homeostasis is crucial to maintain optimal tissue perfusion. Tissue perfusion is linked to stable haemodynamic systems and sufficient oxygenation. Inadequate tissue perfusion can cause multi-organ failure (Elliot et al., 2007:436).

Laboratory results have to be included in the fluid balance monitoring, especially for electrolytes, urea, creatinine, haemoglobin and lactate. Information on the medical history of the patient can give reasons for the underlying cause of the illness and of the imbalance in the fluid balance (Stevens, 2008:12).

According to Scales and Pilsworth (2008:54), a patient presenting with a fluid overload usually has a previous medical history of cardiac, liver or kidney failure. Clinical indications for fluid overload are bodyweight gain, high blood pressure, tachycardia, swollen neck veins, shortness of breath, increased breathing rate, cyanosis, raised pulmonary arterial pressure, raised pulmonary capillary wedge pressure, peripheral oedema and increased body weight. Pulmonary oedema can occur in severe fluid overload; this is a critical condition and the patient might need the assistance of a ventilator (Elliot et al., 2007:436).

Dehydration in critically ill patients will manifest as weight loss, low blood pressure, increased pulse rate, arrhythmia, thirst, dry skin, decreased urine output (urinary catheter required), generalised weakness, low central venous pressure and drowsiness (Elliot et al., 2007:446). Dehydration can vary from light dehydration to an acute shock condition, for which immediate action is required while the patient is in a life-threatening situation (Stevens, 2008:12).

The importance of accurate monitoring and assessment of the fluid balance with regard to the outcome of the patient has been shown in several studies. In a multicentre observational study in 198 intensive care units in Europe, Vincent et al. (2006) showed that a positive fluid balance is a predictor of higher mortality in septic patients. Vincent et

al. (2006:344) stated that a positive fluid balance in their study was a prognostic tool for patient outcome.

In a recent article by Culleiton and Simko (2010:30), fluid balance monitoring is described as an important and challenging component in the care of critically ill patients what the authors referring to as the “critical care shuffle”. The shuffle relates to the complex fluid and electrolyte movements in critically ill patients, in whom a history of existing diseases and unpredicted reactions to chosen therapies complicates fluid status. Consequently, it is reasonable to consider that fluid balance monitoring in critically ill patients can have an impact on the patient’s outcome. According to Culleiton and Simko (2010:30), critical care nurses should be able to recognise and react to fluid balance irregularities.

A retrospective study by Alsous, Khamiees, DeGirolamo, Amoateng-Adjepong and Manthous (2000:1749) stated that a negative fluid balance is a powerful prognostic indicator for reduced mortality in critical care patients. This retrospective chart review in a twelve-bed medical intensive care unit investigated the medical records of 36 patients over 21 months. The authors concluded that 24-hour fluid balance volume totals could indicate the efficiency of the treatment in patients with septic shock in the first few days after admission.

The value of fluid balance monitoring, as a marker for a better outcome for the critically ill patient, has been shown in the above-mentioned studies. These studies emphasise the importance of accurate fluid balance monitoring in nursing practice to deliver care based on best practice. However, the performance of accurate monitoring of the fluid balance can be challenging and will be discussed in the next section.

### **2.3.5 Challenges in fluid balance monitoring accuracy**

Currently, nursing in South Africa faces a shortage of registered nurses. This has direct consequences for the critical care environment (Scribante et al., 2004:111). An article

published by Scribante and Bhagwanjee (2007:1315) further showed that there was an alarming, significant deficit of registered nurses in South Africa, especially nurses with intensive care unit training. This shortage has an enormous impact on the nursing workload in critical care.

Gillespie, Kyriacos and Mayers (2006:50) conducted a survey looking at the number of critical care nurses in the critical care nursing workforce in the Western Cape. The study concluded that there was a significant shortage of registered nurses working in the critical care environment. Gillespie et al. describe the situation as a crisis. The survey also determined that only 24.7% of registered nurses working in the Western Cape critical care units hold an additional qualification in critical care nursing.

Expertise is required to monitor the patient, and to react appropriately. The World Federation of Critical Care Nurses (WFCCN) has developed practice guidelines with regard to the critical care nursing workforce and education for nurses. An increase in complications is seen in a setting with a shortage of trained nurses. These complications include infections, pressure sores, falls or patient deaths. To provide a safe environment for the patient, the nursing staff should be trained sufficiently and, according to the WFCCN, only registered nurses should care for the complicated, critically ill patient (Williams, Schmollgruber & Alberto, 2006:398).

Appropriately trained nursing personnel are required to ensure the accurate monitoring of fluid balance. A study in England noted that the main cause of inaccurate fluid balance monitoring was a shortage in qualified nursing staff (Lobo, Dube, Neal, Allison & Rowlands, 2002:156). Although the technical aids used in fluid balance monitoring devices are fitted with alarms and security features, it is still extremely important to have a critical care nurse actively participating in the care of the patient (Williams et al., 2006:395).

According to the adapted scope of practice offered by Scribante et al. (1995:437), one of the functions that critical care nurses fulfil is that of accurate and thorough fluid balance

monitoring of the critically ill patient. Critical care nurses are trained to perform patient assessment and monitoring, and to implement nursing care in a highly complex environment. To support good quality of care, regularly audits of care records are essential. This will be discussed in the next subsection.

## **2.4 Accuracy and auditing**

### **2.4.1 Accuracy in recording and documentation**

Accurate recording and documentation of the patient's fluid balance is within the scope of practice of a registered nurse (SANC, 2006; Searle, 2000:123). Nurses should be aware of their responsibility and acknowledge this to be as important as performing a medication prescription (Scales & Pilsworth, 2008:56).

Accuracy in the documentation is required, but also accuracy in the administration of the prescribed medication and fluids to assure safe patient care. A useful adjunct in accurate fluid administration is volumetric pumps. The use of volumetric pumps is common practice in the critical care units in the hospitals in the Western Cape. A volumetric pump delivers a controlled amount of fluid or medication over a certain timespan. The pump consists of a portable pump with a specially designed infusion set and has a backup battery and an acoustic warning device. The advantage is that it measures hourly fluid input and avoids the administration of uncontrolled volumes (Braun Products). The measured fluid volumes can be recorded accurately on the fluid balance documentation sheet.

In addition, nurses can improve the accuracy of monitoring fluid output by using a device with a precise volume capacity to determine the amount of urine produced per hour. A "urimeter" is a urine measurement device that is connected to the indwelling urinary catheter, permitting a direct flow of urine into the collection bag. A scale with millilitre specification allows the nursing staff to measure urine output hourly, and these volumes can then be recorded accurately on the fluid balance documentation sheet.

Less has been published regarding the development of a well-designed fluid balance chart. A fluid balance chart should be designed for each intensive care unit individually (Bennet, 2010:1-4), and should be reviewed regularly to assess the practical and accurate use of the chart. According to Bennet (2010:1-4), the fluid balance is often inaccurate, despite the fact that the monitoring of fluid balance is not very difficult.

The Nursing and Midwifery Council (NMC) in the United Kingdom published guidelines on recordkeeping for nurses and midwives. They stated that the recordkeeping should be legible, clear, relevant and understandable, signed and dated, and that only appropriate abbreviations should be used. Confidentiality should to be respected and the records should be managed with care and according to the policies of the institution. Quality assurance can be performed by auditing the documentation (NMC, 2009:2). Since these guidelines are relevant to any practice environment, South African nurses should also apply them.

Hinds and Watson (2008:111, 293-294) have suggested that daily weighing of the patient gives additional information on the fluid balance. Bodyweight was measured and compared to fluid balance in a recent study by Perren, Markmann, Merlani, Marone and Merlani in Switzerland (2011:802). They reviewed fluid balances from 147 intensive care patients and compared the fluid balance to the daily bodyweight measurement. The authors found incorrect fluid balance calculations in 33% of the investigated fluid balances. They expressed their concern about the accuracy of fluid balances, and suggested using more accurate measurements, such as bodyweight.

Subsequently, other researchers have also agreed that calculated fluid balances should not be used for clinical decision making, but rather that bodyweight should be the most important parameter for clinical decision making, suggesting that it should be measured daily (Gonzales & Vincent, 2011:766-767).

### 2.4.2 Auditing

An audit performs a systematic evaluation of clinical practices and, besides the legal obligation to document all actions in nursing care according to the National Institute for Clinical Excellence (NICE) (Pink, 2002:1), this process of auditing patient records will also enhance the quality of patient care.

A number of studies have been performed that evaluate the management of fluid balance in intensive care units by means of audits. Johnson and Monckhouse (2009:291) estimated the fluid and electrolyte replacement in postoperative patients by analysing the documentation of 32 patients and came to an alarming conclusion. Their study found a discrepancy between the fluids ordered and the fluids recorded as administered.

Another study in which an audit was performed on the management of patients with aneurismal subarachnoid haemorrhage showed incomplete fluid balance records, which can have a negative effect on the outcome of these patients. The failure was mainly due to the absence of urine output data, as the patients had no urinary catheter to measure hourly urine production (Whiteley, Lai, Simpson, Nosib, Parris, Wood & Salman, 2009:E10).

A study by Smith, Fraser, Plowright, Dennington, Seymour, Oliver and MacLennan (2008:28-29) gave a positive rating to the regular auditing of vital signs. They performed yearly audits from 2000 until 2006, excluding 2005, and investigated the accuracy in documentation over the years. As part of their study they offered training sessions to nursing staff. By auditing vital signs, including fluid balance, they concluded that the accuracy of the documentation improved with training on and awareness of audits. However, their study showed that an increase in the required documentation increased the workload, which resulted in less time for calculation of the fluid balances. Therefore they concluded that the endeavour should be to achieve comprehensive recording charts.

The automatic calculation of hourly fluids could be a solution to the shortcomings in the current systems of fluid balance charts. There are promising features on the market, for example United Medical offers a software module called “Digistat” R. The module captures the patient’s data and the company promises a reduction in human errors and an improvement in the outcome for the patient (Digistat® Fluid Balance, s.a.). Until these automatic systems are integrated into the daily routine, the role of the nurse remains of major importance for best practice in fluid balance management.

The literature therefore describes a need for accuracy and expresses the requirement for quality assurance of this accuracy by means of audits being performed. This demands guidance for best practice, partly discussed below and also discussed in Chapter 1.

## **2.5 Best practice and fluid balance**

With regard to applying best practice principles to fluid balance assessment in the critically ill patient, Scales and Pilsworth (2008:56) have emphasised the need for nurses to comprehend fluid balances in patients. They state that the nurse is the primary person responsible for the monitoring of the fluid balance. To improve the knowledge of nurses in this regard, they offered online questionnaires called “learning zones” where nurses could test their understanding of fluid balance physiology. These researchers believe that fluid balance practice can be enhanced if recommendations are made on it.

Reid et al. (2004:36) showed ways in which practice development occurs with particular reference to fluid balance. The main problem was a shortage of nursing staff, a deficit in knowledge and a heavy workload. The researchers designed a survey, a quiz and an audit, which had the following outcomes: nobody felt responsible for the accurate documentation of the fluid balance, insufficient information was given in reports or to colleagues, and there was inadequate training of the nursing staff. The research team suggested training, a notification at the patient’s bedside, simplifying the fluid balance chart, and a space for the nurse to sign that the documentation was her responsibility.

Scales and Pilsworth (2008:57) provide the following guidance for best practice in fluid balance:

- A clear, comprehensive assessment of the patient
- The use of fluid measurement containers
- The use of urine dipstick tests
- Observing and informing the shift leader or doctor of:
  - ✓ urine production less than 0.5 ml/kg bodyweight/hour,
  - ✓ tachycardia,
  - ✓ hypovolaemia
  - ✓ low blood pressure
- The handover of the fluid balance to the next shift
- The accurate calculation and auditing of the fluid chart

The registered nurse has to perform according to current best practice and therefore should adhere to guidelines and protocols put into practice in the critical care environment (Elliot et al., 2007:187).

## **2.6 Conclusion**

In this chapter the available literature with regard to fluid balance was discussed. The development of nursing worldwide and in South Africa was described and the scope of practice for nurses, in particular for the critical care nurse, was set out. The physiology and monitoring of fluid balance were discussed, as were the importance of auditing and accuracy to reach quality assurance in patient care, and to achieve best practice in nursing. According to the literature, auditing nursing practices will contribute to best practice. The fluid balance is an important part of the documentation and an incorrect fluid balance can be a risk for the patient. Evidence-based research will help to implement more effective ways of managing the nursing process by means of guidelines. The next chapter will discuss the methodology used in the study.



## **Chapter 3: Research design and methodology**

### **3.1 Introduction**

After the review of the literature on fluid balance monitoring in the previous chapter, this chapter provides a discussion of the methods applied in conducting the research. The chapter provides an in-depth discussion of the research design and approach, as well as of the data collection and analysis processes implemented in the study.

### **3.2 Research design**

According to Polit and Beck (2006:509), the research design is the complete strategy implemented to address the research question, including all details needed to strengthen the integrity of the study. In order to describe and explore the practices and perspectives of registered nurses with regard to fluid balance monitoring, a quantitative approach encompassing a descriptive, exploratory and non-experimental design was chosen. A detailed discussion of and arguments for why these items were chosen are found in the following subsections.

#### **3.2.1 Quantitative approach**

A quantitative approach was used for the purpose of this study on “fluid balance monitoring in critically ill patients”. A quantitative approach enables the systematic investigation of precise data (Burns & Grove, 2007:18). Quantitative research is commonly done in nursing research (Burns & Grove, 2007:24).

The study followed the steps of the quantitative research process as described by Burns and Grove (2007:32), in terms of which a research question, the aim and the objectives of the study were identified. The collected data should answer the research question, with the goal being to achieve the aim of the study.

The research question, as stated in Chapter 1, is: “What are the current practices of registered nurses in critical care units with regard to fluid balance monitoring?” To answer this, the researcher implemented an audit of the 24-hour fluid balance calculations performed during patient monitoring to establish the correctness of the data in numerical form, and at the same time captured precise data relating to the perspectives of the registered nurses on fluid balance monitoring. In terms of the objectives: “To identify and describe the current clinical practices related to fluid balance monitoring and recording in critical care units” and “to describe the perspectives and knowledge of nurses in critical care units with regard to fluid balance monitoring and recording”, the data obtained from the audit and the questionnaire answered the research question and fulfilled the objectives.

A quantitative approach was used for this study to obtain insight into the practices and perspectives of registered nurses with regard to fluid balance monitoring in critically ill patients, which was the purpose of the study. The audit of fluid balances and the questionnaire relating to the perspectives of registered nurses supplied the researcher with the appropriate data. The data is presented in histograms and these were compatible with the quantitative data.

### **3.2.2 Descriptive design**

In a descriptive design, a situation is studied and the researcher will outline what was observed (Babbie, 2007:89). A descriptive design is a useful tool to obtain particulars of a situation and will lead to the forming of a concept or the recognising of possibilities for improvement (Burns & Grove, 2007:240). Descriptive studies inquire what, where, when and how (Babbie, 2007:89-90) about a particular situation.

The researcher decided to distribute questionnaires in which registered nurses could express their opinions. The questionnaires collected information about what the nurses considered important in their monitoring of fluid balance, where and when they implemented fluid balance monitoring, and what the problem areas were that they had

experienced and how the fluid balance monitoring could be improved. No treatment or intervention was applied in this study, thus the descriptive design was a suitable one.

### **3.2.3 Non-experimental design**

In non-experimental research the subjects are not exposed to a treatment or an intervention (Polit & Beck, 2006:52-53). Furthermore, the aim of descriptive, non-experimental research is to detect, discuss and record features of a specific setting (Polit & Beck, 2006:189).

With consideration of the aim of the study, the researcher determined that it was not appropriate to implement an intervention. No treatment was administered and therefore there was no influence on the variables, resulting in a non-experimental design (LoBiondo-Wood & Haber, 2010:196). The field of fluid balance monitoring in critically ill patients was explored on the basis of the available scientific literature. The researcher identified certain aspects of fluid balance monitoring that were of value in developing the data collection tools.

### **3.2.4 Exploratory design**

The motivation to use an exploratory approach was to obtain more information about the subject or situation and to discover problem areas (Babbie, 2007:88). LoBiondo-Wood and Haber define exploratory design as the collection of data to assess contemporary circumstances (2010:578) and to find information about the subjects of the study (2010:198-199). According to Burns and Grove (2009:359), the use of exploratory studies enhances the comprehension of a certain area.

In this study, the current practices of nurses with regard to fluid balance monitoring were explored by means of questionnaires in which the nurses were asked about their practices and their opinions on this aspect. One section of the questionnaire gave the registered nurses an opportunity to point out problem areas in fluid balance monitoring, and allowed

them to make recommendations. On this basis, the exploratory approach gave the researcher the chance to discover where problems originate in fluid balance monitoring and what improvements could be possible.

The decision to use a descriptive, exploratory and non-experimental quantitative design in this study therefore was well considered.

### **3.3 Data collection**

#### **3.3.1 Introduction**

Data collection is the meticulous assembling of facts related to the research. The purpose of data collection is to gather information about a certain issue, investigate this information and pass it on to others with the aim of improving a situation (Burns & Grove, 2007:41). The data should be without bias or personal emotions and has to be consistent so that other researchers would be able to replicate similar research (LoBiondo-Wood & Haber, 2010:269).

The study combined an audit and a survey questionnaire in order to collect data appropriate to the research question and the objectives of the study. The quantitative data regarding the clinical practices of fluid balance monitoring was collected utilising an audit tool to assess the relevant fluid balance records. The data obtained from the audit was supplemented by means of a survey tool in the form of a questionnaire to determine the perspectives of critical care nurses regarding the practice of fluid balance monitoring in the clinical environment. The data collection processes will be described in two parts, with part 1 being the document audit and part 2 the questionnaire.

The information on the data collection contains the following subsections:

- Context of the study
- Target population and sampling in part 1 and 2
- Data collection instruments for part 1 and 2

- Pilot study

### **3.3.2 Context of the study**

The data was collected in critical care units of three purposively selected private hospitals, hereafter called the hospital group, in Cape Town.

### **3.3.3 Target population and sampling**

#### **3.3.3.1 Target population**

The population is a group of subjects with shared particulars. All the subjects that meet the inclusion criteria stipulated in the study proposal form the population (Burns & Grove, 2007:40).

Using purposive sampling, the researcher chose a single hospital group with five established hospitals in the Cape Metropole district for specific reasons (Burns & Grove, 2007:344). Of the five hospitals available for inclusion, only three hospitals of the hospital group were selected to participate in the research because of: time limitations in terms of the requirements to complete the MCur programme, the accessibility of the facilities in terms of travelling, and the fact that their patient profiles were similar in terms of the multidisciplinary nature of their critical care environment. All the nursing documentation and nursing policies were uniform across the critical care units in these hospitals.

The two other hospitals from the hospital group were excluded. The first hospital was excluded because it transfers critically ill patients as soon as possible to hospital B (Table 3.1). The second hospital (D) was utilised for the pilot study and therefore was excluded from the main study. Permission to access the hospitals was obtained according to the hospital group's policy and is discussed later in this chapter.

As mentioned earlier, the study combined an audit and a survey questionnaire. The population for the audit, part 1, was all critical care patient fluid balance and related records, while the population for part 2 comprised all registered nurses working in critical care in the purposively identified hospitals.

The quantitative data regarding the clinical practices of fluid balance monitoring was collected utilising an audit tool to assess the relevant fluid balance records. The population for the audit was compiled from the fluid balance records of patients admitted to critical care units in the hospital group in the Cape Metropole district. The critical care fluid balance patient records included in the audit were the following documents: daily chart, medication prescription form, non-medication prescription form, fluid balance-related forms, other doctor order forms and the laboratory result forms of the three hospitals.

The data that was obtained was supplemented by means of a survey tool in the form of a questionnaire to determine the perspectives and knowledge of the critical care nurses regarding best practice in fluid balance monitoring in the clinical environment. The population for the questionnaire was compiled from registered nurses working in the adult critical care environment of the three selected hospitals.

According to Burns and Grove (2007:40), a part of the population is the sample. The sampling for the audit and the survey is discussed in the subsections below.

### **3.3.3.2 Sampling for part 1: the audit**

For a subject of the population to be assigned to the study sample it has to comply with the sample inclusion criteria (Burns & Grove, 2007:325).

All three of the hospitals included in the study have two critical care units. Two of the three hospitals handle the admissions procedures separately for each critical care unit. One hospital combines the admissions to the two critical care units. For the purpose of

this research, the researcher combined the critical care units in each separate hospital to have a single critical care environment per hospital.

Table 3.1 Overview of the characteristics of the selected hospitals

Hospital	Number of beds	Admissions: July 2011 to December 2011	Number of records sampled
A	16 + 10 = 26	509 + 511 = 1 020	34
B	28	691 + 336 = 1 027	34
C	16 + 22 = 38	591 + 431 = 1 022	35
D	12	300	Pilot study

The study sample was drawn from fluid balance records according to the following inclusion criteria:

- Nursing records of admissions to critical care from 1 July 2011 to 31 December 2011, using the records describing current clinical practices.
- Nursing records of the first 48 hours of a patient's stay in the critical care unit, when available. This period of admission was chosen as it is the time during which the patient tends to be haemo-dynamically unstable, often requiring significant fluid resuscitation and thus complex fluid balance monitoring.
- Adult admission (patients over the age of 18: a person over the age of 18 is an adult person (Children's Act 38 of 1996, 2011:12). Children were excluded because the fluid balance of a child requires a child-appropriate approach.
- Patients had to be classified as "intensive care": activity one (1) or two (2) on the patient classification (NET 21-77346) (Addendum K). This form was filled in by the attending doctor to determine the financial charges to the patient and was not a nursing task. No written policy regarding this form was available at the selected and included hospitals.

A simple random sampling technique was implemented in the audit. Simply random sampling is probability sampling in which all subjects in the population have an equal chance of being included in the study sample. In this study, each complete patient record was subjected to the sampling technique as described below. The random sampling technique was implemented as follows:

- All the admission numbers of patients meeting the inclusion criteria were identified through the hospital information system and admission record book of the critical care unit.
- A list was drawn from the hospital information system of the relevant patient admission numbers.
- The patient record file connected with every third patient admission number was drawn until the required sample was achieved.

Since this is a descriptive study, a formal power calculation was not performed. The sample size was calculated to ensure adequate precision in population estimates using 95% confidence intervals. A sample size of 80 fluid balance records resulted in 6% precision in the 95% confidence interval width, and assumed a 10% error rate in the calculation of the fluid balance. This was well within the accepted precision of between 5% and 10%. In Table 3.1 a sample size of 103 was selected and divided specifically among the various units under the guidance of the statistician.

### **3.3.3.3 Sampling for part 2: the survey**

A sample was drawn from registered nurses in the critical care environment in the selected hospitals, with the inclusion criterion being that each person had to be a registered nurse with or without an additional qualification in critical care nursing science. Registered nurses have the ultimate responsibility and accountability for the patients allocated to their care in a critical care unit. This remains the case even when the care activities (such as fluid balance monitoring practices) are delegated to other categories of nurses (Searle, 2000:261-262).



All nurses meeting the inclusion criteria could participate when they were engaged in work in the hospital during the data collection. The shift cycle of registered nurses was approximately two weeks. In any one cycle, most of the registered nurses who meet the inclusion criteria will be working either the dayshift or the nightshift.

As the design of this study was descriptive in nature, a sample size of 62 nurses allowed confidence intervals for proportions with 7.5%. To adjust for the non-response rate, the sample size was inflated by 15%. Thus, in consultation with the statistician, a total of 71 registered nurses was decided upon.

### **3.3.4 Data collection instruments and process**

#### **3.3.4.1 Part 1: audit instrument**

The current clinical practices implemented in fluid balance monitoring were determined utilising an audit tool to gather quantitative data from the relevant fluid balance monitoring data. An audit systematically investigates the record keeping with the intention to assess and improve the quality of nursing care (Björvell, Thorell-Ekstrand & Wredling, 2000:8).

Firstly, an audit tool was developed from the available literature on fluid balance monitoring, and from the clinical experiences of the researcher and the study supervisor. An expert in auditing at one of the participating hospitals assisted in the development of this tool. A statistician also scrutinised the tool. Two experts in critical care nursing examined the audit tool thoroughly. The experts have experience in patient care, education and quality management in critical care nursing. The feedback obtained from the experts was applied in the audit tool to improve the validity and relevance of the audit tool. The audit tool allowed for quantitative data to be collected with respect to the implementation of fluid intake and output prescriptions, the recording of fluid balance

data on critical care observations records, as well as deviations in the calculations with regard to the recording of fluid intake, fluid output and total fluid balance (Addendum A).

No adaptations were made to the audit tool following the pilot study (see 3.3.5).

The population and sampling method have been described in this chapter. A study sample was drawn from the fluid balances recorded in the patient records.

Patient records are stored in a storage room. The researcher and the fieldworker worked together to confirm the correct calculation and recording of data. According to the sample inclusion criteria, the patient records matching the randomly selected patient identification number were drawn by the researcher and requested from the audit department, which provided the patient records to the researcher. The patient record files were used to locate the following documents: daily chart, medication prescription form, non-medication prescription form, fluid balance-related forms, other doctor order forms and the laboratory result forms, hereafter referred to as the “patient records”. These records were audited on location in the storage room of the audit department, as no records were removed from these venues in each hospital. The information from the patient records was copied by the researcher into the source document (Addendum A). A fieldworker confirmed the correctness of the captured data immediately. When both the researcher and the fieldworker had the same end result on the calculator, the calculated fluid balance information was accepted as correct. A printed record of each calculation was kept by the researcher and the fieldworker. Only one patient record was used at a time and the record was returned to its allocated storage location after the information had been copied.

Subsequent to the data capture in the source document, the data was carefully and accurately recorded in an Excel© spreadsheet by the researcher and analysed by the statistician.

### 3.3.4.2 Part 2: survey instrument

Survey questionnaires are an appropriate tool to obtain opinions from a population (Babbie, 2007:244). A questionnaire is an instrument in which the participants write down their knowledge in a document that has been designed for the purpose (Burns & Grove, 2007:382). Questionnaires are a commonly used research tool (De Vos et al., 2005:166). The questionnaire allowed the researcher to include a substantial number of registered nurses in a short time, which is why the researcher chose questionnaires for the data collection. Questionnaires can be used in descriptive studies to collect information from the participants with regard to the research topic (Burns & Grove, 2007:382). Utilising a survey questionnaire, the researcher could determine the practices and perspectives of critical care nurses with respect to fluid balance monitoring practices.

The questionnaire was developed from the available published research and literature describing best practices related to all relevant aspects of fluid balance monitoring.

Since all hospital documentation was in English, it was accepted that the participants were able to communicate in the English language and the questionnaire therefore was designed in English (Addendum B).

The questionnaire comprised four sections:

- Introduction to the research and collection of demographic data
- Section A: fluid balance knowledge
- Section B: statements to be responded to on a four-point Likert scale
- Section C: three open-ended questions

The introduction provided the participants with the necessary information to complete the questionnaire. At the same time, demographic data was requested from the participants regarding their qualifications and years of experience. The demographic data was collected because it describes the characteristics of the participants and thus, according to Burns and Grove (2007:127), this data describes the sample.

Section A examined the participants' knowledge with regard to fluid balance monitoring in nine multiple-choice questions with only one possible answer to each question. These questions were developed from the available current literature. The questions were discussed with critical care nurses with expertise in critical care nurse education. The content of the questions is important, because it provides insight into the nurses' current knowledge.

Section B comprised eleven statements requiring responses on a four-point Likert scale to determine the perspectives of the nurses on fluid balance monitoring. Statements were supplied and the respondent could select one answer and comment on the chosen answer in the provided space. The Likert scale responses were given a certain value, resulting in an outcome (Burns & Grove, 2007:388). The Likert scale survey tool is a method to obtain the perspectives of the participants.

Section C consisted of three open-ended questions to allow the participants to describe their practices further. They were asked what their perspectives are with regard to fluid balance monitoring, and they could contribute information on how improve fluid balance monitoring. The researcher considered this information important to the study in that it providing an opportunity for the participants to express their thoughts.

Before the questionnaire was finalised, two experts in critical care nursing examined the document and their recommendations were utilised to improve the quality of the questionnaire. To ensure that the questionnaire was unambiguous and appropriate, it was pre-tested in a pilot study (see 3.3.5) in a critical care unit of a hospital similar to the participating hospitals. Permission to access the facility was requested and granted.

Once finalised, the questionnaires were distributed in the selected hospitals. An appropriate time for and method of questionnaire distribution was determined by the researcher in collaboration with each unit manager to ensure that patient activities were not affected. The questionnaires were hand delivered by the researcher to the

participating critical care units. The researcher visited the units to clarify the study and the questionnaire. All participants received information on the study and a consent form in English to sign (Addendum C). The consent forms were collected separately to the questionnaires and were stored in an opaque, sealed box separate from the completed questionnaires so that the participants' completed questionnaires remained anonymous. The participants were asked to place their consent form in the supplied envelope, seal the envelope and place it in the opaque, sealed box specified "for informed consent only". After completion of the questionnaire, the participants were asked to place their questionnaire in the supplied envelope, seal the envelope and place it in another opaque, sealed box, designated "for questionnaire only". The researcher collected the completed questionnaires on the same day. The researcher visited the hospitals regularly during the data-collection period to ensure that every participating nurse had the opportunity to return the questionnaire, and had a chance to make further enquiries. Over a three-week period, the researcher collected the sealed boxes on a daily basis, and one final collection was done after another two weeks.

The data collection was accomplished exclusively by the researcher, with assistance from the unit managers.

### **3.3.5 Pilot study**

A pilot study was conducted once ethical approval and permission to access the hospital were obtained. Performing a pilot study is of great help to enhance the outcome of the research by pre-testing the data collection instruments (De Vos et al., 2005:210). A pilot study on the fluid balance audit and the survey questionnaire was conducted on a sample of 10% of the fluid balance records to represent the population.

The pilot study was conducted in the critical care unit in a selected hospital of the hospital group from 19 February to 26 February 2012. The critical care unit was similar to the units in the study, ensuring that the tool was tested in an environment similar to

that of the study sample. This hospital and the data obtained were not included in the final study.

The survey questionnaire was distributed to seven registered nurses working in the critical care unit. The nurses gave verbal consent to participate and were asked to complete the questionnaire. The pilot study was also performed to test the audit tool using 10 fluid balance records. All the obtained data was excluded from the main study data.

Any recommendations made by the respondents about problem areas in the questionnaire and the audit tool were corrected, resulting in a solid research instrument that would promote the success of the study. Only one minor change was made, with the word “dyspnoea” being used instead of “shortness of breath”. No changes were made to the audit tool.

### **3.4 Reliability and validity**

To provide research that enhances evidence-based practice, the instruments used must be useful. The reliability and validity of the instruments are of significant concern in nursing research. Reliability and validity give soundness to the study and reduce the degree of bias (LoBiondo-Wood & Haber, 2010:286).

#### **3.4.1 Reliability**

Reliability is related to a solid and accurate method of measuring (De Vos et al., 2005:160-163). Burns and Grove define reliability as having stability in the measurement (2007:364). The measurement technique therefore has to be consistent throughout the whole process. To ensure consistency the researcher collected all the data herself. This means that the same data collection instruments were used in all hospitals by the same person. Furthermore, a fieldworker acted as a quality control person and was available to

check the collected data, and the same person was used throughout the data collection process.

In addition to the above, the audit tool and the questionnaire were tested beforehand in a pilot study (see 3.3.5) to ensure accuracy and whether the measurement instruments were relevant for the research. The necessary changes were made in the audit and the questionnaire to ensure that the instruments were understandable. This was done according to the responses of the participants in the pilot study.

Furthermore, the data collection instruments were checked by a statistician from Stellenbosch University and were pronounced to be appropriate and adequate for data collection and analysis purposes (Burns & Grove, 2007:364-365).

### **3.4.2 Validity**

Validity estimates if the measurements are appropriate for the study (De Vos et al., 2005:160-163). In this study, the face validity, content validity and external validity were the criteria with which validity was measured. Internal validity was not at risk, as the study was exploratory and descriptive and no intervention was used (Babbie, 2007:230).

To determine content and face validity, the audit tool and the questionnaire were evaluated by critical care nursing experts (De Vos et al., 2005:160-161). An expert was drawn from each of the following critical care environments: clinical practice, quality assurance, and education. All the experts had a minimum academic qualification of a master's degree, thus ensuring experience in the process and requirements of research. Each of the experts was an active participant in their particular environment and together they offered a complete assessment of the content and face validity of the instruments. Their recommendations were adopted in the data collection instruments. The following recommendations were made: the questions that were not appropriate to ask registered nurses were taken out and one question needed clarification. This question was question

A9 (see Addendum B), where the form in which the question was asked was confusing; once it had been corrected the question was easier to understand.

External validity is defined as the degree to which the results of the study can be used in a more widespread study (Polit & Beck, 2006:201, 500). By making use of three different hospitals, although in the same hospital group, the analysed data supported the external validity, and this added to the potential to generalise the study (De Vos et al., 2005:154-157).

### **3.5 Ethical considerations**

Ethics is defined as a concept concerned with moral codes of behaviour (LoBiondo-Wood & Haber, 2010:247). The following ethical principles concerning research were considered and are explained further on (Burns & Grove, 2007:201-228):

- Respect for persons (right to self-determination, voluntarily participation)
- Beneficence (right to protection from harm)
- Justice (right to anonymity and confidentiality)

The Human Research Ethics Committee of the Faculty of Health Science at Stellenbosch University approved the proposal (Addendum D). Furthermore, a letter of permission was required to enter the hospitals in terms of the policy of the hospital group and was approved by the hospital group (Addendum F). A waiver of consent was requested to allow access to patient records for the fluid balance audit (Addendum E).

#### **3.5.1 Respect for persons**

Respect for persons includes the right for participants to make their own decisions (Pera & Van Tonder, 2005:149). This principle was applied through the consideration that the registered nurses working in the critical care units participated voluntarily and could withdraw at any time, as there was no obligation to participate.



### **3.5.2 Right to protection from harm**

The purpose of this principle is to prevent harm and encourage benefit (Pera & Van Tonder, 2005:33). This was a low-risk study and no risk or harm to the participants was anticipated. However, the researcher did provide a contact telephone number should any participant require additional information or wish to report any other concern about their participation in this study.

### **3.5.3 Right to anonymity and confidentiality**

Anonymity and confidentiality are linked. Anonymity means that there is no possibility to discover what information was provided by the participant, and confidentiality means that no personal information relating to the participant is disclosed (Pera & Van Tonder, 2005:154). In this study, these principles were applied and respected in the following ways. A reference number on the audit was used to allow the researcher to track the study documentation during data analysis without being able to identify the patient or hospital in any manner. No hospital or patient record was identified in the document audit and no copies were made of the documents. Patient names or numbers were also not recorded on the audit form. Only patient records meeting the inclusion criteria of the study were accessed.

All the participants in the study received information on the study and a consent form in English to sign (Addendum C). All hospital documentation was in English, thus it was accepted that all the participants would be competent in at least the English language as a communication tool. The consent form was kept separate for confidentiality and privacy and was not included in the data collection. The names of the participants were treated confidentially and were withheld from any documentation. The study data was only accessible to the investigator and her supervisor. All data was used exclusively for this

study. The data was kept secure in a locked cabinet in the researcher's office during the study, and was stored in the supervisor's office after data analysis had been completed, where it will be kept for a period of five years. The distribution of the questionnaire was planned with the unit manager of the particular unit to ensure that data collection had no impact on patient care activities. The researcher was available telephonically for any queries regarding the research study generally, or the data collection specifically. No remuneration was given to the participants.

Furthermore, the hospitals in the hospital group were not specified individually in the data and the names of the hospitals or the hospital group were not mentioned.

### **3.6 Limitations of the study**

A limitation of this study was the choice of three hospitals belonging to a private sector hospital group. The hospital group has certain policies and does not provide a comprehensive picture of critical care fluid balance monitoring practices in South Africa to allow broad generalisation of the study.

Furthermore, a qualitative approach with focus group interviews would have produced more depth in the topic. The time constraints faced by the researcher and the time limitations of the participants who work in a critical care environment, where workloads are not easy to foresee, guided the researcher in deciding to use questionnaires.

### **3.7 Data analysis processes**

Data analysis is defined as arranging, minimising and delivering significance to the collected data (Burns & Grove, 2007:41).

### **3.7.1 Part 1: audit**

For the audit, quantitative data was captured on a source document (Addendum A) in each hospital environment. The audit source documents were given an identification number, and the data was carefully and accurately recorded in the Excel© spreadsheet. The source document was designed on the basis of the available literature on fluid balance monitoring, the clinical experience of the researcher and the supervisor, and constructive feedback from experts in nursing and auditing. The source document was tested in a pilot study. The raw data sheets were submitted to the statistician for data processing to provide the researcher with descriptive statistics to enable analysis of the collected data.

### **3.7.2 Part 2: survey**

Each questionnaire was given an identification number and the data was recorded on an Excel© spreadsheet. For the survey, the different sections were grouped and are discussed below.

- Introduction: Demographic data
- Section A: Knowledge of nurses with regard to fluid balance monitoring
- Section B: Likert scale questions to identify the nurses' perspectives
- Section C: Open-ended question to describe the nurses' perspectives

#### **3.7.2.1 Introduction**

The introduction contained demographic data on age, gender, qualification, years of experience and permanent employment, which was grouped together and also checked to verify that the participants met the requirements of the inclusion criteria.

### **3.7.2.2 Section A**

Section A contained nine multiple-choice questions to identify the knowledge of the nurses with regard to fluid balance monitoring. The participants were asked to give only one answer to each question. The answers were numbered 1, 2, 3 and 4, and only one answer was correct for each question. The statistician provided the researcher with histograms of the data. A Mann-Whitney U test was also performed to establish a correlation.

### **3.7.2.3 Section B**

Section B comprised 11 questions to which answers were given on a Likert scale to identify the perspectives of the registered nurses. The participants were asked to give one answer and to provide a brief comment. This data was provided in an Excel© spreadsheet by the statistician.

### **3.7.2.4 Section C**

Section C enabled the nurses to provide their perspectives of fluid balance monitoring in three open-ended questions. The researcher read the open-ended questions several times and keywords were captured. A summary of the answers from this section is provided in the data analysis in the next chapter.

The audit, as well as the introduction and Sections A and B of the survey, were analysed with the support of the statistician; this is described in the following subsection.

## **3.7.3 Data analysis**

A qualified statistician was consulted and recommended MS Excel to be used to capture the data, and the data analysis software STATISTICA version 10 (StatSoft Inc., 2011) was used to analyse the data. The data is presented as histograms. Medians or means

were used as the measures of central location for ordinal and continuous responses, and standard deviation and quartiles were used as indicators of spread. Depending on the data, Pearson or Spearman correlation was implemented for the analysis. Relationships between two nominal values were investigated by contingency tables and likelihood ratio chi square tests. Relationships between continuous variables and nominal variables were investigated with t-tests or ANOVA, depending on the data obtained. A p-value of  $p < 0.05$  represented statistical significance in the hypothesis testing, and 95% confidence intervals were used to describe the estimate of unknown parameters.

The data from Section C was captured as a summary of the perspectives of the nurses with regard to fluid balance monitoring. The researcher first read the answers carefully and tried to identify certain keywords. The answers were then put into groups, arranged according to the keywords. An overview of the results is given in Chapter 4.

### **3.7.4 Interpretation**

Using the abovementioned results, the researcher identified and described the current clinical practices related to fluid balance monitoring in critical care units and described the perspectives and knowledge of nurses in critical care units regarding fluid balance monitoring. This will be discussed in Chapter 4.

## **3.8 Conclusion**

This chapter has given an overview of the methodology used for this research, including the population and sampling, data collection and analysis, reliability and validity and ethical considerations.

The next chapter discusses the data analysis and interpretation in depth.

## **Chapter 4: Data analysis and discussion**

### **4.1 Introduction**

According to Burns and Grove (2007:41), data analysis will reveal the findings that can be deduced on the basis of the collected data. Data analysis in quantitative studies is performed with statistical procedures in order to examine the gathered data. This chapter provides a discussion of the data analysis of the audit, followed by that of the questionnaire.

### **4.2 Data analysis**

The data collection for part 1 and part 2 of the study occurred as described in Chapter 3. The collected data was then recorded on an Excel© spreadsheet. A qualified statistician was consulted for the analysis of the data, as well as prior to data collection to organise the data collection tools to allow for more relevant analysis. The data collection tools were recorded on Excel© spreadsheet in such a way to comply with the statistician's analysis tools to allow for more relevant analysis. The quantitative data was analysed using STATISTICA version 10. The tables drawn from the descriptive statistics are presented as histograms, provided by the statistician. A histogram provides a diagrammatic representation of the number of observations and the class interval for each item. Each item from the audit tool and the questionnaire is represented as a histogram and the data is discussed.

### **4.3 Part 1: audit of fluid balance records**

The audit of the fluid balance records formed the first part of the study. The audit was performed on fluid balance records in the three selected hospitals of the hospital group, according to the inclusion criteria stated in Chapter 3. A total of 103 records (N = 103) were examined using the audit tool (Addendum A). The records were spread equally over the three hospitals, namely hospital A: 34 records, hospital B: 34 records and hospital C: 35 records (see Table 3.1.). The audits were done at each hospital by the researcher, with a fieldworker who checked the audit data as it was completed by the researcher. The data is presented and discussed in the order of appearance in the audit tool.

#### **4.3.1 Recorded vital signs and blood results**

All the patient record documents (N = 103) showed that the commonly accepted baseline vital signs in critical care were monitored, namely blood pressure, heart rate, respiratory rate, body temperature and peripheral oxygen saturation. CVP (central venous pressure) was measured in 71 patients (69%), but not measured in 32 patients (31%). In a systematic review by Marik, Barem and Vahid (2008:172-178) of 24 studies, including 803 patients, it was concluded that the CVP should not be used as a device to estimate fluid balance. However, these authors reasoned that CVP could be implemented to measure the function of the ventricles. As the observations in the histogram are mainly from patients after a coronary artery bypass, it is appropriate to measure CVP (Marik, Barem & Vahid (2008:172-178).

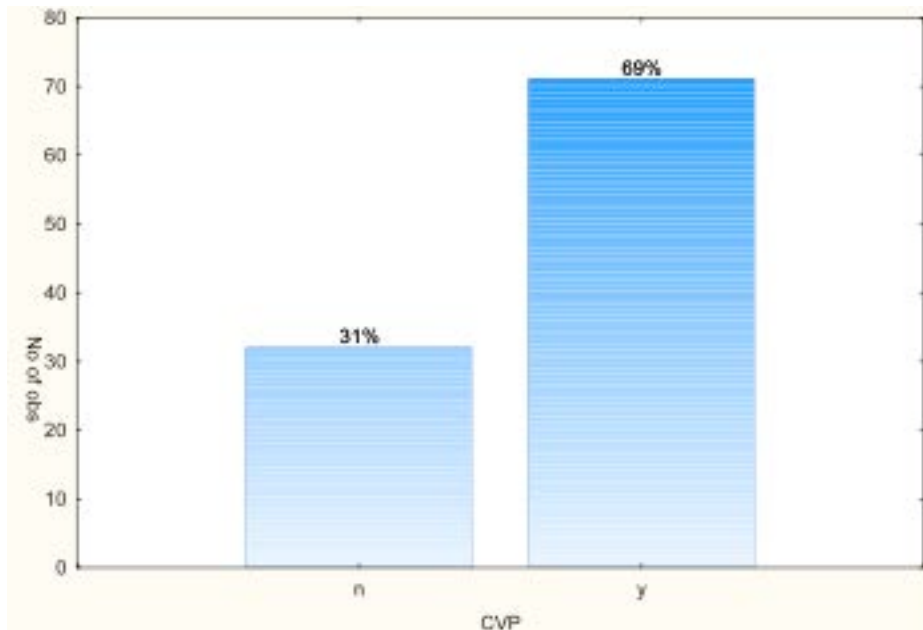


Figure 4.1 Histogram of CVP

The commonly accepted baseline laboratory results related to fluid balance monitoring, namely the serum electrolytes and urea and creatinine, were measured and recorded in all the patients (N = 103).

#### 4.3.2 Accuracy in recording of fluid balances

Accuracy in the documentation is a component assuring safe patient care, and is of particular importance in defending nursing care in medico-legal matters. Where documentation is not accurate, court cases may result in claims against the registered nurse (Verschoor, Fick, Jansen & Viljoen, 1997:45). Accurate documentation is essential in fluid balance monitoring. Missing or wrongly noted numbers can result in incorrect calculations, which can influence the patient's outcome severely.

The histograms below represent the particular aspects investigated with respect to accuracy of record keeping and documentation, namely legibility, matching prescription order to administered fluids, and the place where the prescription was written.



The following histogram provides a representation of documents in which the written records were legible. The researcher assessed whether a document could be classified as legible by looking at whether the record was on the correct document and if the record was legible. A document was determined to be legible when the researcher was able to read it.

This histogram shows that, in the audit of 103 documents, 90 documents (86%) were written in a legible manner. The writing was illegible in three documents (3%). A further six documents (6%) were legible, but written on the incorrect page. The record was found on the wrong page, however the record was still usable for fluid balance recording. In four documents (4%), no written fluid balance was allocated.

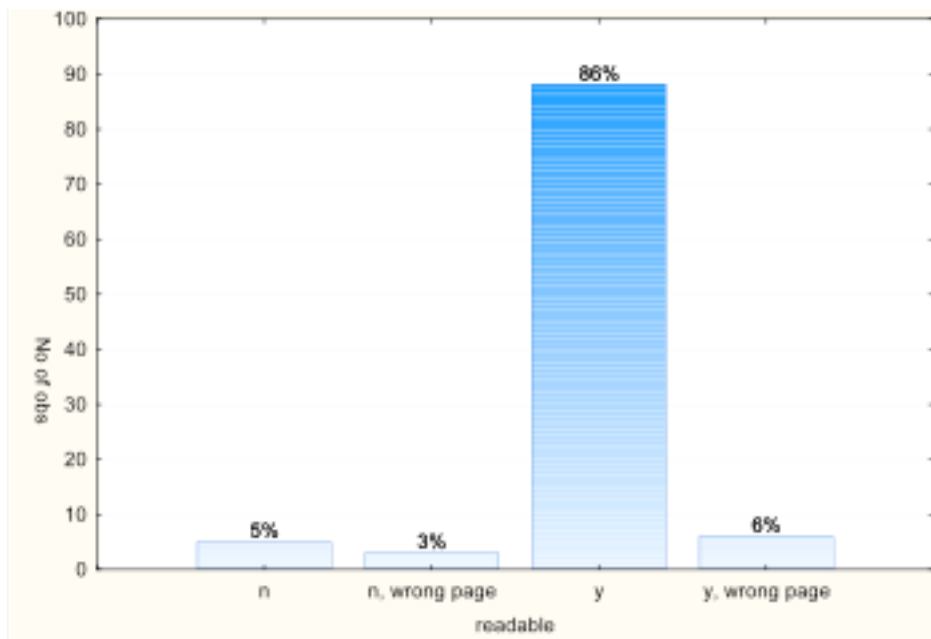


Figure 4.2 Histogram of legible balances

The audit also determined if the prescribed fluids matched the fluids administered. The histogram reflects that the fluid administration matched the prescription order from the doctor in 80 documents (78%), whereas 23 documents (22%) did not match. Prescribed fluids are classified in the same degree as a medication prescription. Twenty two (22) of the documents did not show adherence to the doctor's prescription, this can result in a medico-legal matter (Verschoor et al., 1997:45). A study done by Johnson and

Monckhouse (2009:291) found a discrepancy between fluids ordered and fluids recorded as administered.

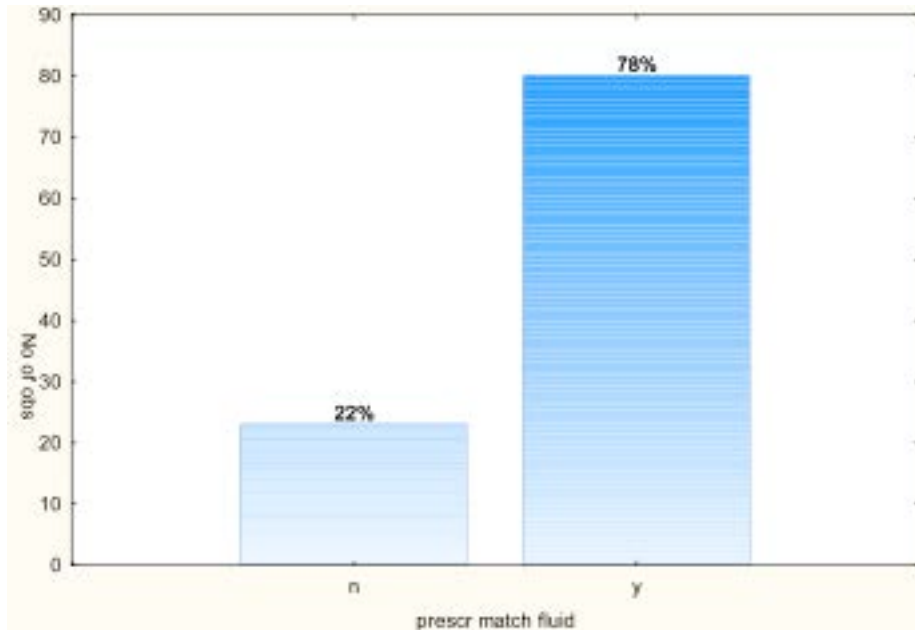


Figure 4.3 Histogram of “prescription match fluid administration”

Furthermore, the place where the prescription was written in the patient record was of interest. The following histogram shows where the doctor’s prescriptions for fluid therapy were documented. In 21 cases (20%), no prescription was found in the documentation, thus the prescription was missing. In 38 cases (37%) the prescriptions were found on the non-medication prescription (nmp) form, in one document (1%) the prescription was found on the prescription chart (N = 103), and in 12 cases it was on the specially designed form from the treating doctor (12%) (n/N = 12/103). In 31 of the cases (30%) the prescription was found on the daily chart. The daily chart is the patient observation chart, compiled from observations of vital signs, patient’s diagnosis, history, contact details and treatment plan. During the research period the hospital group made changes to the daily chart, and provided a special area on this chart where the doctor can write his prescription for the daily fluids.

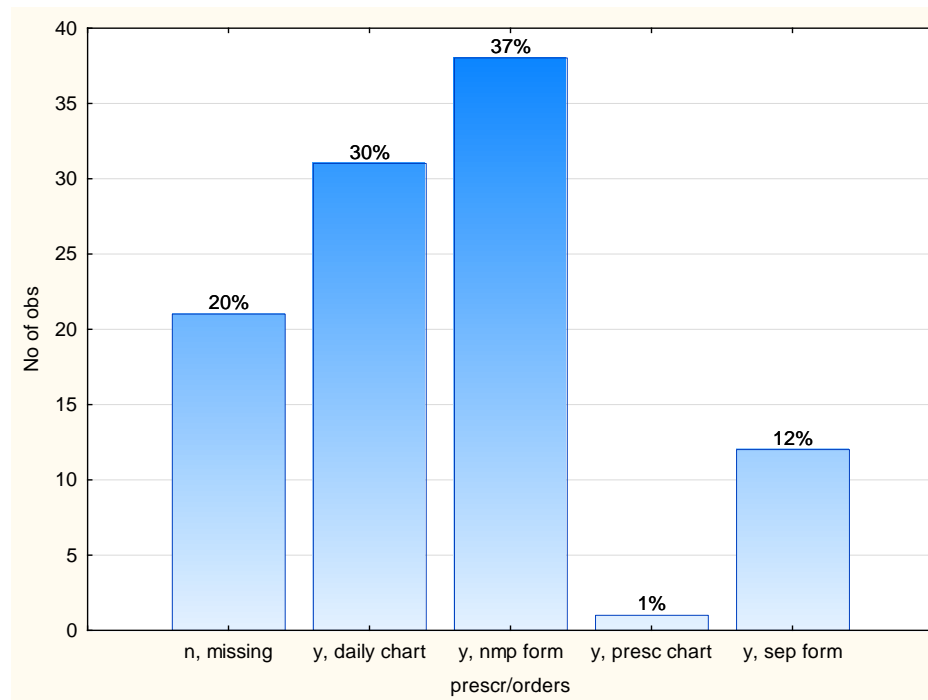


Figure 4.4 Histogram of the position of the prescription orders in the patient records

Key to the histogram

- nmp form = non-medication prescription form
- presc chart = prescription chart
- sep form = separate form

### 4.3.3 Characteristics of the patients

To provide a picture to the reader of the fluid balance aspects of the critically ill patients in the critical care environment in this research, the following can be noted:

- Four of the 103 patients (4%) had diarrhoea.
- Only eight of the included patients (8%) received blood products. The other 95 patients (92%) did not receive blood. Several studies have been performed on colloids versus crystalloids, especially in resuscitation situations (Pryke, 2004:32), and therefore not relevant to this study.
- Four patients (4%) were receiving dialysis. A very accurate output of fluids is performed during dialysis. This might have influenced the audit.

- A weight was recorded in 93 of the documents (90%), while no weight was recorded in 10 documents (10%). However, the recorded weight was not the actual weight of the patient on that day, but a value obtained by questioning the patient or the patient's family, mainly on admission. A bodyweight measured daily would be more accurate for clinical decision making than fluid balances (Gonzales & Vincent, 2011:766-767).

#### **4.3.4 Miscellaneous**

Two more items were audited, namely the Roche Combur® test and whether the patient received more than two intravenous, continuous drug infusions.

The Combur® test is a urine test used to diagnose pathological changes in the urine. The test uses a test strip that is dipped into urine. With the resultant colour changes in comparison to the normal colours it is possible to perform a urine analysis. Various test can be performed; one of the tests is specific gravity in urine. Specific gravity is a test to measure the concentration of the urine and is strongly related to fluid balance monitoring. Normal values vary from 1002 to 1030 (MedlinePlus Medical Dictionary, 2012). In 96% of the cases (n/N=99/103), a Combur® urine test was performed. In four of the observations the Combur® test was missing (4%).

The researcher was interested in determining whether the administration of more than two continuous intravenous drug infusions simultaneously influenced the accuracy of the calculation of the fluid balance (see 4.4). In 65 documents (63%) there was no evidence that the patients received more than two intravenous continuous drug infusions simultaneously. In 38 documents (37%) there was evidence that the patients received more than two continuous drug infusions simultaneously.

#### 4.3.5 Deviation in 24-hour calculated fluid balance totals

For this section, the original fluid balance calculation was compared to the control calculation of the fluid balance in the audit. The difference in calculation is referred to as the deviation in fluid balance calculation. The following histogram presents the deviation.

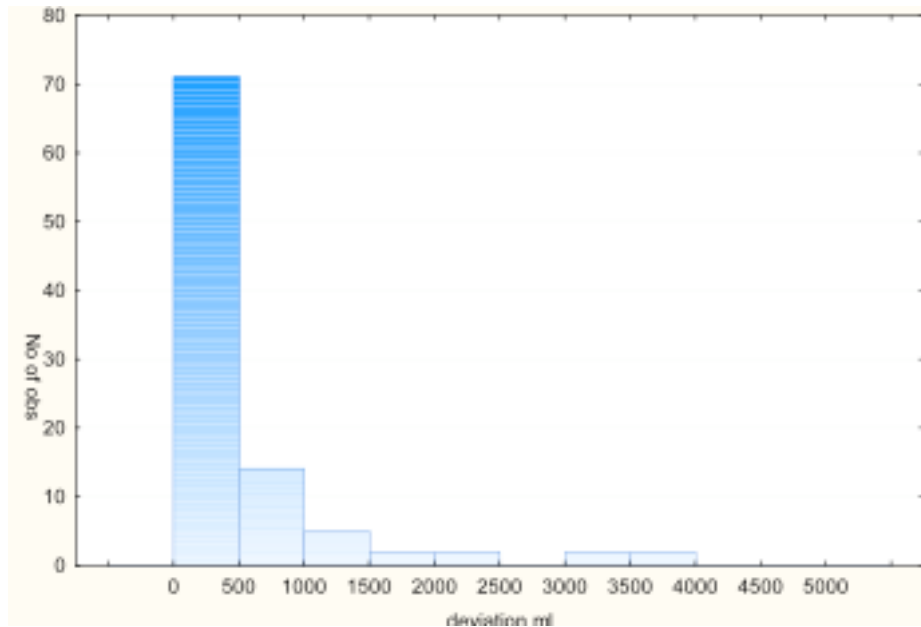


Figure 4.5 Histogram of deviation in fluid balance in millilitres

In the audit of 103 fluid balance documents, a total of 71 recorded calculated fluid balance totals (69%) were within a 500 ml deviation from the fluid balance calculated by the researcher. Fourteen recorded calculations (14%) were found to deviate between 500 ml and 1000 ml, while seven recorded calculations (7%) were found to deviate between 1000 ml and 2000 ml. Six recorded calculations (6%) were found to have a deviation of more than 2000 ml. Thus the majority of the fluid balances showed a deviation within 500 ml. Five (5) fluid balance totals (5%) were not recorded on the fluid balance documents.

In a recent study by Perren (2011:802), incorrect 24-hour fluid balance totals were noted in 33% of the investigated fluid balances. The researcher contacted Perren to determine the volume deviation tolerated in that study in order to establish a standard for this study.

Perren (2012) confirmed that the standard applied to the data in their study was that no deviation in the recorded volume versus the volume calculated by the researcher was considered acceptable. Forty-nine cases (33%) of incorrect calculation were identified in the Perren et al. (2011) study (Perren, 2012). Perren did not give an explicit reason for the inaccuracy. He stated that the errors that were identified were due to arithmetic errors, which are errors in combining numbers in counting and calculation (South African Concise Oxford Dictionary, 2002:57), but also due to incomplete documentation. When the same standard is applied to the data in the present study, the researcher determined that only ten documents (10%) were correct (tolerated deviation 0-10ml) and 21% were correct if a deviation of 50ml would be tolerated. Of great concern are the 27 documents (26%) with a deviation of more than 500 ml. This is an enormous risk for the critically ill patient. In the SOAP study it was shown that a positive fluid balance is a prognostic tool for patient outcome (Vincent et al, 2006). Vincent et al. do not state how much was regarded as a positive fluid balance, but referred to Alsous et al. (2000:1749). Alsous et al. found that patients in septic shock, with a negative balance of 500 ml in the first three days, had a higher survival rate. These studies all rely on accuracy in calculating the fluid balance.

### 4.3.6 Administration of diuretics

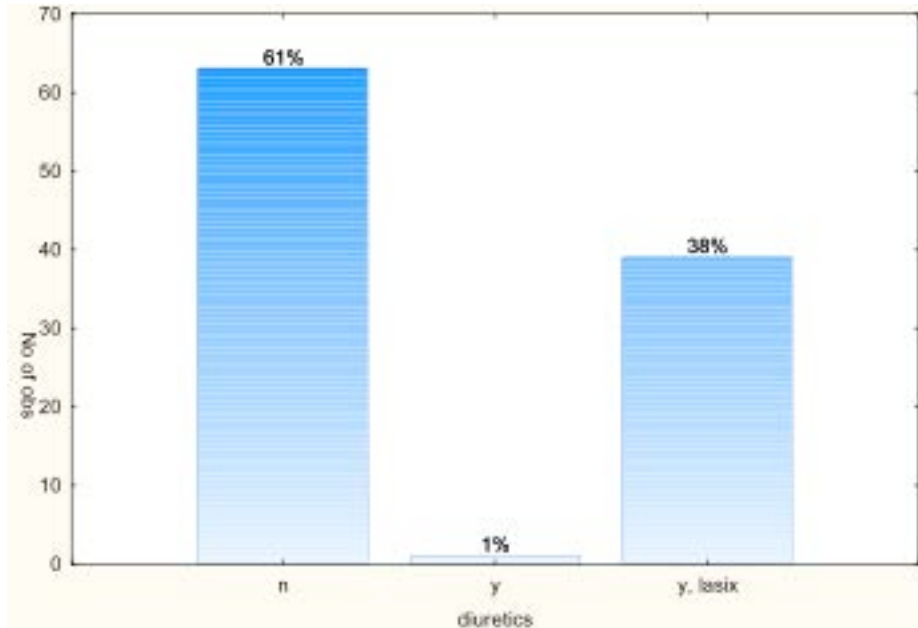


Figure 4.6 Histogram of diuretics administered

The last component in the audit was the administration of diuretics. A total of 38% (40/103) of the critically ill patients received diuretics. The other 63 patients (61%) did not receive diuretics. A recent study linked the use of diuretics, in particular furosemide, to reduced mortality (Grams, Estrella, Coresh, Brouwer & Liu, 2011:966). The administration of diuretics will be discussed in the next subsection.

## 4.4 Correlation

Although the study follows a descriptive design, the researcher chose to perform a Mann-Whitney U test to determine if there is a relationship between the above measured findings in the audit. This analysis was guided by the following hypothesis:

There is no relationship between the established deviation in fluid balance calculation totals and:

- The administration of blood products
- The measurement of CVP (central venous pressure)
- The matching doctor's prescription orders

- The administration of diuretics
- The administration of more than two continuous intravenous drug infusions

The Mann-Whitney U test is a version of the t-test, a nonparametric statistic to test group differences based on ranked scores.

The findings of the Mann-Whitney U test showed no relationship between the established deviation in fluid balance calculation totals and:

- The administration of blood products
- CVP
- The matching doctor's prescriptions orders
- The administration of more than two continuous intravenous drug infusions

Only the deviation in fluid balance calculation totals compared to diuretic use resulted in a significant difference, with a p-value of 0.013012. If  $p < 0.05$  there is significance, meaning that the groups are in fact different (Polit & Beck, 2006:503). Furthermore, if a Z-value (this value can be found in a Z-distribution table) is less than -1.96 or more than 1.96, the null hypothesis is rejected. As can be seen in Table 4.1, the p-value is 0.013012 and  $< 0.05$  and the Z-value is 2.483452, which confirms that the two groups are different.

Table 4.1 Mann-Whitney U test

Mann-Whitney U test by variable diuretics; test is significant at  $p < .05000$

Variable	Rank-sum y	Rank-sum n	U	Z	p-value	Valid N y	Valid N n
Deviation in ml	2119.500	2731.500	778.500	2.483452	0.013012	36	62



Glossary of the symbols:

- p-value      probability that data is consistent with null hypothesis
- N              number of observations
- U              test statistic in Mann-Whitney U test; is used to calculate Z
- Z              Z distribution table: if Z is less than -1.96 or greater than 1.96, the null hypothesis is rejected

(Polit & Beck, 2006:386) (Information obtained from the statistician).

This abovementioned statistical analysis is shown in the following box and whisker plot. A box and whisker plot gives information about the mean of the data and shows how widespread the data is, and is written in standard deviation. Standard deviation is variability in which the deviation differs from the mean (Massart, Smeyers-Verbeke, Capron & Schlesier, 2005:215).

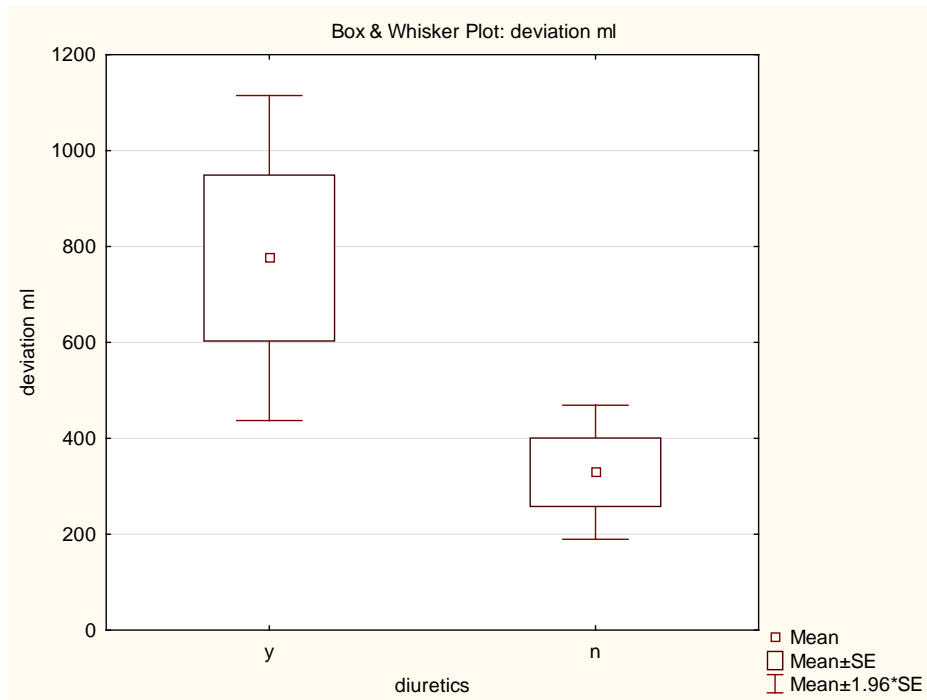


Figure 4.7      Box and whisker plot: deviation in ml

The significance in this test points to the possibility that, in cases where diuretics were administered, there was a higher chance that the fluid balance calculation was wrongly

incorrect. From the 40 observations (39%) in cases where diuretics had been administered, seven balances had a positive balance in the patient records, but a negative balance in the audit calculation. In one observation, the patient record showed a 1 807 ml positive balance, while the control audit presents -1 899 ml, resulting in a deviation of 3 706 ml. It needs to be borne in mind that behind the deviation of 3 706 ml is a critically ill patient with a difference in fluid balance state of almost four litres. A large number of the included patient records are from patients admitted for coronary artery bypass graft operation, in other words cardiac-impaired patients for whom a fluid overload is life threatening. There was no statistically significant correlation between the deviation in fluid balance calculations and the other variables investigated.

#### **4.5 Summary**

Although the research design is a descriptive one, the result of the Mann-Whitney U test gives a significant difference in the fluid balance deviation compared with the administration of diuretics. If the decision is made to administer diuretics on wrongly calculated fluid balances, this can result in risk for the patient. This correlation, in addition to the finding that only 1% of the fluid balance calculations were accurate and, of greater concern, that 27% of the sampled records reflected a difference of 500 ml and greater between the calculation in the patient record and the control calculation in the audit, indicates that the patient's outcome is reduced as a result of such practices.

The next section will discuss the findings derived from the questionnaire that was used to determine the perspectives of the registered nurses regarding fluid balance monitoring.

## 4.6 Part 2: questionnaire on perspectives of fluid balance monitoring

### 4.6.1 Introduction

The second part of the research was a questionnaire to be filled in by the registered nurses working in the critical care units of the three selected hospitals. A questionnaire, designed and developed by the researcher, was combined with feedback from nurses with expertise in research.

### 4.6.2 Sample size and response rate

Over a six-week period, questionnaires were distributed to all the available registered nurses working in the unit at the time, as described in Chapter 3. The required sample size was 72 participants. Questionnaires were handed out to 140 registered nurses. Fifty-eight (58) questionnaires were returned, and this number was accepted by the statistician as an adequate sample size, below the table with the distribution of the questionnaires.

Table 4.2 Distribution of the questionnaires

Distribution of the questionnaires	Distributed questionnaires	Completed and returned questionnaires
Hospital A	49	14
Hospital B	41	17
Hospital C	50	27
Total	140	58

### 4.6.3 Data analysis

The descriptive data from the questionnaire is divided into four subsections:

- Demographics of the participants
- Section A: Multiple choice questions relating to knowledge with regard to fluid balance monitoring (Questions A1 to A9)
- Section B: Likert scale statements concerning perspectives of registered nurses with regard to fluid balance monitoring (Questions B1 to B11)
- Section C: Open questions concerning perspectives of registered nurses with regard to fluid balance monitoring (Questions C1 to C3)

All data relating to the demographics, Section A and Section B were captured in histograms. The perspectives of the registered nurses given in Section B and Section C were analysed by the researcher. Keywords were highlighted, brief statements and citations of participants were recorded.

#### 4.6.3.1 Demographics

The demographics are the characteristics of the participants and, according to Burns and Grove (2007:127), it describes the sample. The demographic data listed below was obtained from the participants:

Age, gender, years of experience as a registered nurse, years of experience as a critical care nurse, additional qualification in critical care and permanent or agency staff

The majority of the nurses (39 out of 58; 76%) were in the age group 35 to 55 years, with a peak of 13 nurses (22%) in the age group 45 to 50 years. The mean age was 42 years. Only 14 participating nurses (24%) were available in the age group 20 to 35. This reflects the ageing population of critical care nursing staff, since fewer young nurses are working

in critical care units. According to Gillespie, Kyriacos and Mayers (2005:50), the number of nurses entering the profession is insufficient to provide for the number of nurses needed. In an article on the situation in the nursing workforce in 2005, concern was expressed about the number of nurses working in the critical care environment at that time. The number of graduating nurses is not adequate to provide the workforce needed (Gillespie et al., 2005:50), resulting in an increased workload for those still in the profession. And, as was seen in the reference in Chapter 2 to a study done by Smith et al. (2008:28-29), the consequence of this increased workload is less time for the calculation of fluid balances.

A similar problem emerged in relation to the number of years of experience of the registered nurses working in the critical care units. Scribante and Bhagwanjee (2007:1315) describe this situation in an article that shows that there is a serious deficit in the number of experienced nurses working in the critical care environment. Only registered nurses were included in the present study, therefore the picture looks better, but this does not represent the reality in critical care nursing.

The number of years of experience as a registered nurse (see figure 4.8) and the number of years of experience (see figure 4.9) in critical care are shown in the following histograms. More than half of the participating nurses were in possession of a qualification in critical care nursing. Twenty-nine participants had less than 10 years of experience (50%). The average number of years of experience was 13. The other 50% had more than 10 years of experience.

The number of years' experience in the critical care environment of the registered nurses with a qualification in critical care nursing ( $n/N = 29/58$ ) was between five and 20 years. Ten participants (17%) had less than one year of experience in the critical care environment.

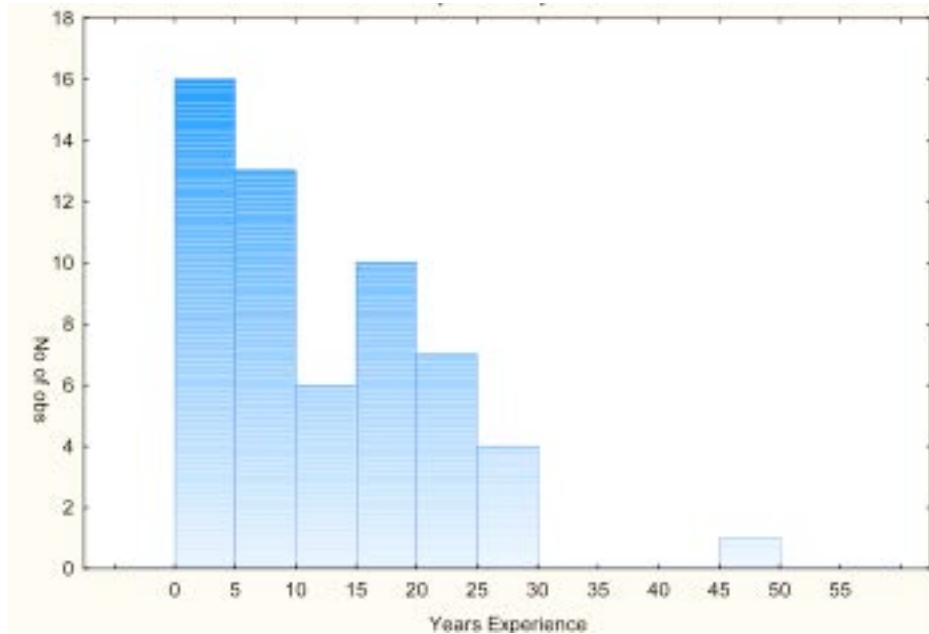


Figure 4.8 Histogram of years' experience as a registered nurse

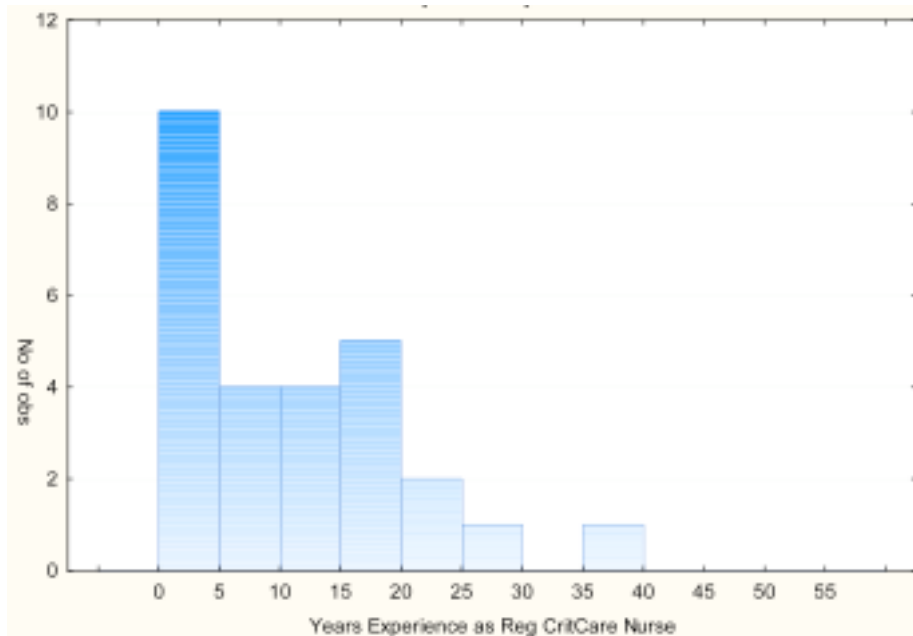


Figure 4.9 Histogram of years' experience as a critical care nurse

Seventy percent of the nurses in this study had permanent appointments. A reason for this could be that the permanent staff were more prepared to participate in the survey,

whereas the agency staff are less involved in the unit. In an audit done by Scribante and Bhagwanjee (2007), the number of agency staff compared to permanent staff was 36 percent agency staff to 65 percent permanent staff. In comparison, this study included only registered nurses, therefore there was a different percentage of permanent staff in relation to agency staff.

The demographics in the questionnaire showed an average age of the registered nurses of 42 years, and that 96% were women and only 4% were men. They had a mean of thirteen years' experience as a registered nurse. Fifty percent of the nurses had an additional qualification in critical care nursing, with an average of twelve years of experience in the critical care environment.

#### **4.6.3.2 Section A: knowledge quiz**

Of the nine questions in Section A, four were related to knowledge of the assessment of a patient's fluid balance status (A1, A4, A5, A6), another four questions were related to theoretical knowledge (A2, A3, A8, A9), and one question asked for mathematics skills (A7). The following tables give an overview of the correct answering of the questions.

Table 4.3 Knowledge of assessment

Question	Correctly answered
A1	91% (n = 50)
A4	98% (n = 56)
A5	54% (n = 30)
A6	100% (n = 58)

In a study by Mwewa and Mweemba (2010:143), who looked at the knowledge and utilisation of ICU admission criteria and guidelines, if the percentage of participants getting the answer correct was above 90%, this was seen as a high level of knowledge. In this study the percentage was the number of participants getting the answer correct. Therefore the lower percentage of 54% in question A5 needs to be explained. This questions was as follows:

Question A5: These clinical signs are most likely to occur in a patient who is hypervolemic:

- 1) Dyspnoea, tachypnoea, tachycardia
- 2) Arrhythmia, dyspnoea, desaturation
- 3) Anuria, thirst, hypertension
- 4) Hypotension, oedema, petechia

The correct answer was 1), chosen by 54% (n = 30) of the registered nurses. Answer 2) was chosen by 32% (n = 18) of the nurses. The reason why 2) was chosen by so many nurses was that it was very similar to the correct answer, 1). Answers 3) and 4) were also wrong, and were chosen by 14% (n = 10) of the nurses.

Table 4.4 Theoretical knowledge

Question	Correctly answered
A2	86% (n = 50)
A3	60% (n = 35)
A8	98% (n = 57)
A9	98% (n = 57)

Question A2 was as follows:

Adequate urine output is determined as follows:

- 1) 50 ml/kg bodyweight/hour
- 2) 0.5 ml/kg bodyweight/hour



- 3) 20 ml/kg bodyweight/min
- 4) 5 ml/kg bodyweight/hour

The right answer is 2), which was chosen by 86% of the nurses, which means that 14%, or eight, of the nurses chose the wrong answer.

Sixty percent (n = 35) of the nurses answered question A3 correctly, namely that the required amount of fluid intake per day is 1 500 to 2 000 ml. The question was: On average an adult patient requires a fluid intake (excluding solids) per day of approximately:

- 1) 500-1000 ml
- 2) 1000-1500 ml
- 3) 1500-2000 ml
- 4) 2500-3000 ml

The right answer is supported by following guidelines from RNAO (Registered Nursing Association of Ontario). They give out best practice guidelines, which are clear and easy to apply in best practice (RNAO, 2005:6-7).

Table 4.5 Mathematical skills

Question	Correct answer
A7	67% (n = 37)

Question A7 was as follows:

An audit was done to determine if 24-hour fluid balance calculations were done accurately. A patient has a 24-hour total positive fluid balance of 2 000 ml, after recalculating the total balance was 2 600 ml. This is a difference of 600 ml, more than 25% higher than the original calculation. What percentage incorrect fluid balance calculation do you consider acceptable when managing a critically ill patient:

- 1) 0-5%, in this case 0-100 ml
- 2) 5-10%, in this case 100 ml or more, less than 200 ml
- 3) 10-25%, in this case 200 ml or more, less than 500 ml

4) >25%, in this case 500 ml or more

Sixty-seven percent of the respondents (n = 37) allowed a 0 to 5% difference from an accurate calculation, which reflects a maximum of 100 ml difference. Thirteen percent (n = 7) allowed a 5 to 10% difference, and 15% (n = 8) allowed a calculation difference of more than 25%, meaning more than 500 ml difference from the correct calculation. Five percent (n = 3) of the nurses did not give an answer to this question. The reason for not answering the question could be a lack of confidence in the mathematics. When the number of non-responders is combined with the number of responders who chose a difference of greater than 25%, it gives a total of 20% of the participants. This is an alarmingly high number, and increases the risk for an inaccurate calculation during fluid balance monitoring.

#### **4.6.3.2.1 Summary**

This section tested the knowledge of the registered nurses. Knowledge in nursing is difficult to define, as it is a developing profession (Hall, 2005:34). Earlier, nurses were the helping hands of doctors. Nowadays, nursing is an independent profession, although nursing is still striving to achieve acknowledgement. Nursing knowledge comes from various fields, such as physiology and psychology. Nursing knowledge is also obtained from the practice. In addition, nurses have an intimate relationship with patients, which requires expertise in communication and relationships (Hall, 2005:34). From the nine questions asked it would appear that the participating are equipped with theoretical and practical knowledge about fluid balance monitoring. A concern is found in relation to question A7, where a mathematical question was asked. This question was answered incorrectly or not answered by 30% of the respondents.

#### 4.6.3.3 Section B: perspectives of nurses

Statements designed to be answered on a Likert scale are designed to provide information about the opinions of participants. The Likert scale is a frequently used instrument (Burns & Grove, 2007:388).

The first statement was the following:

Statement B1: There are many other patient care activities that are more important for me to attend to than recording the intake and output every hour

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses to this question are illustrated in the histogram below.

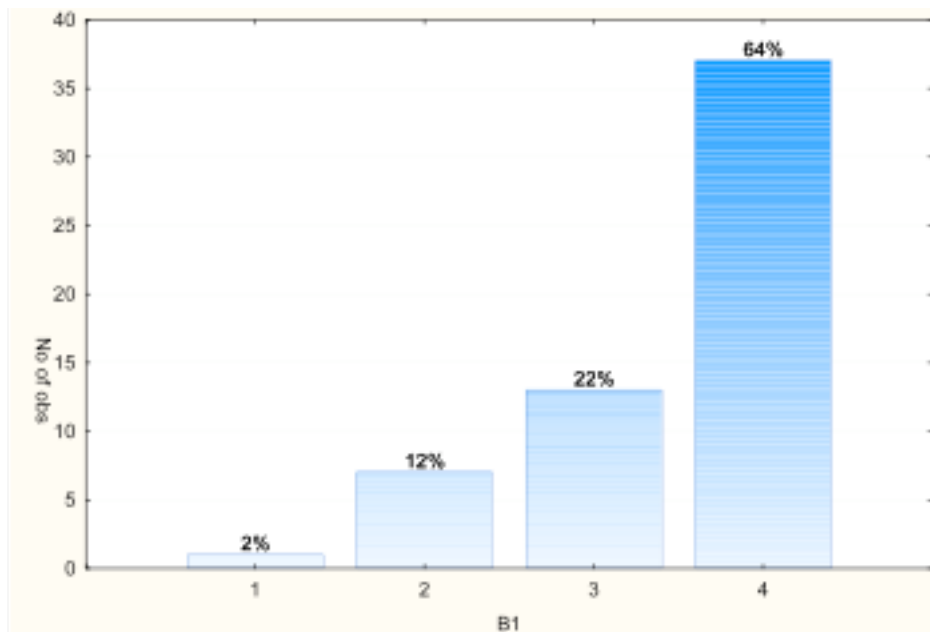


Figure 4.10 Histogram of responses to statement B1

For 86% of the participants (n = 50), recording the fluid balance plays an important role in their nursing care. One of the participants comment in response to this statement: “Intake and output is a must to an ICU patient”. According to Culleiton and Simko (2011:30-34), critical care nurses should be able to recognise and react to fluid balance irregularities. Fourteen percent of the participants (n = 8) did not think the fluid balance was important, but did not comment why they thought it was not important.

The second statement was as follows:

Statement B2: There are too many people who fill in one patient’s fluid balance chart:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses to the statement are illustrated in the histogram below.

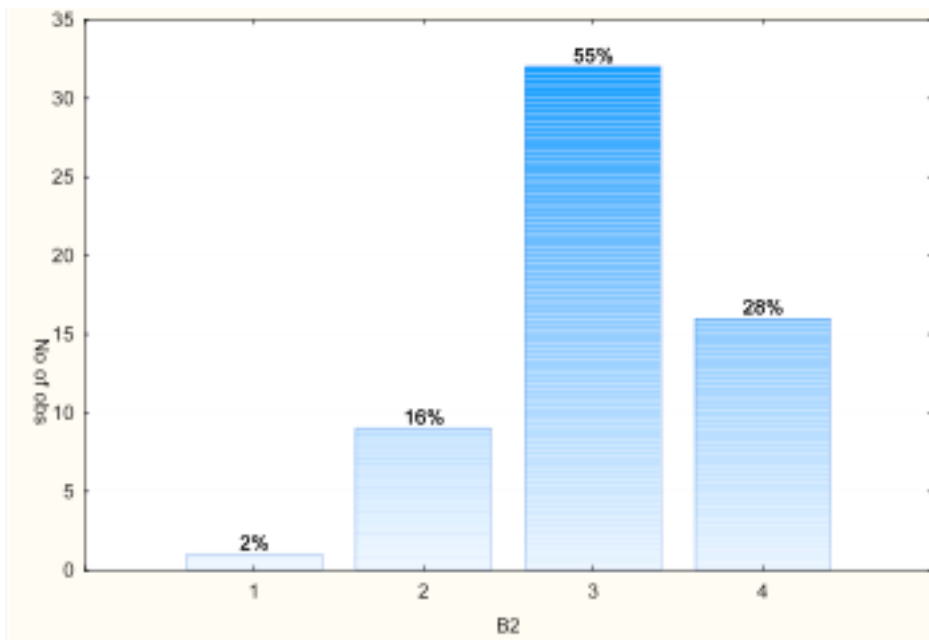


Figure 4.11 Histogram of responses to statement B2

Eighteen percent of the respondents (n = 10) agreed with the abovementioned statement. The remaining group of 82% (n = 48) disagreed and responded that only the allocated nurse was responsible for filling in the fluid balance. Another study found that nobody felt responsibility for the accurate documentation and suggested that the allocated person should sign for the accurate recording of the data (Reid et al., 2004:36). When 18% of the participants' opinions is that too many people are filling in the fluid balance chart, there is a window of opportunity to make improvements. Signing for the accurate recording of the fluid balance provides an explicit statement of responsibility.

The next statement was the following:

Statement B3: As a registered nurse I am responsible for more than one patient, and it is difficult to supervise all the fluid balance activities:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses to this statement are shown in the histogram below.

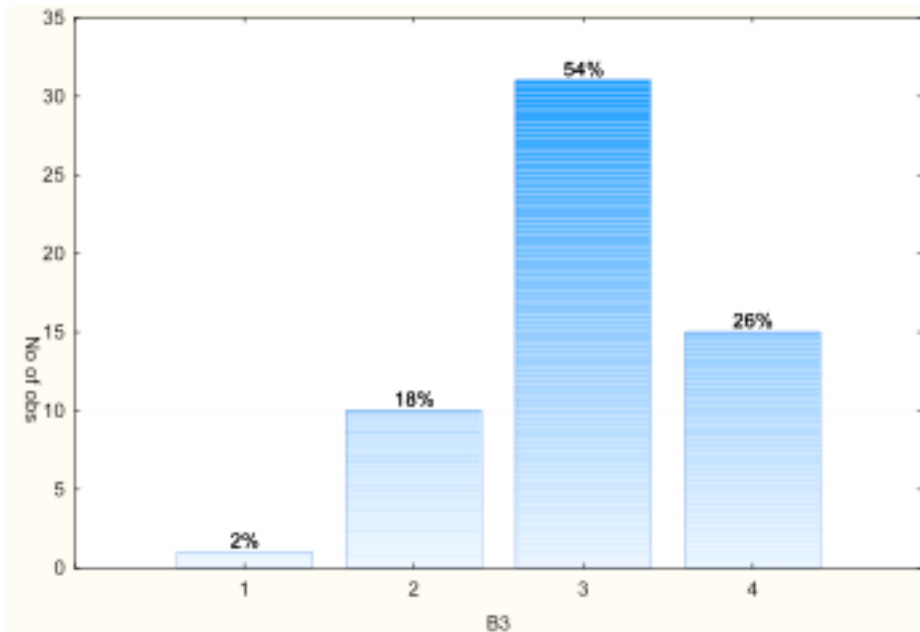


Figure 4.12 Histogram of responses to statement B3

Eighty percent of the nurses ( $n = 46$ ) believed it was manageable to supervise the fluid balance activities: “be committed and organised”. On the contrary, 20% ( $n = 12$ ) agreed with the statement. “Sometimes the unit is busy or you have two really sick patients allocated to one person”, wrote one of the participants. A study in England indicated that the main cause of inaccurate fluid balance monitoring was a shortage of nursing staff (Lobo et al., 2002:156). There is a shortage of registered nurses in South Africa, and this has an enormous impact on the workload in critical care units (Scribante & Bhagwanjee, 2007:1315).

The next statement was as follows:

Statement B4: I am satisfied with the design of the fluid chart sheet. It is straightforward to complete:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The results of the responses to this statement are given in the figure below.

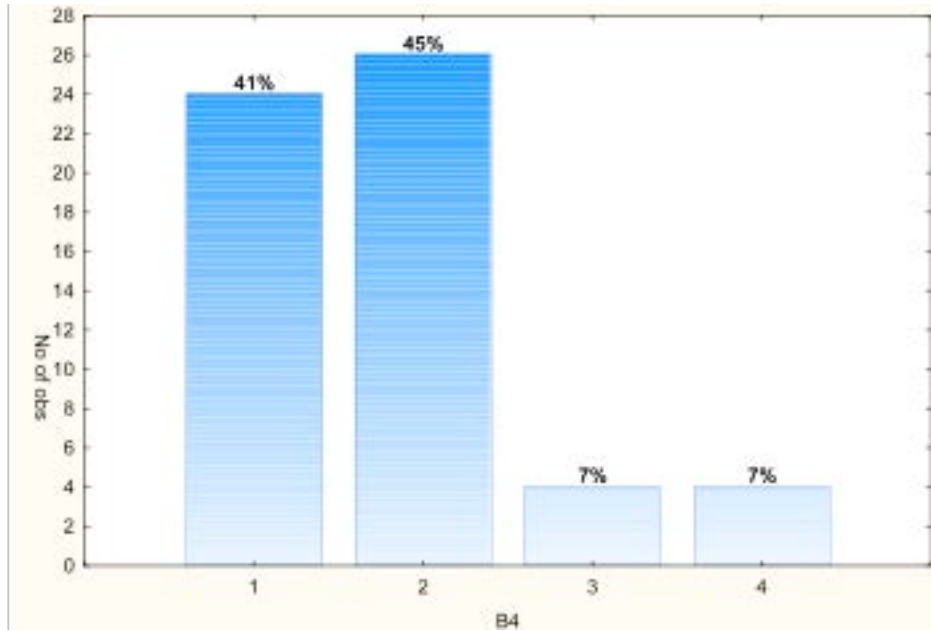


Figure 4.13 Histogram of responses to statement B4

Overall, 86% of the nurses ( $n = 50$ ) agreed that the fluid balance chart in their unit was well designed. Comments on the fluid balance chart related to a lack of space for the irrigation of wounds and the daily weight of cardiac patients, but otherwise the opinion was that the layout was good that it was user friendly.

The fifth statement was as follows:

Statement B5: The space to write the fluid numbers on the chart is:

- 1) Too small
- 2) Adequate
- 3) Too big

The responses to this statement are recorded in the histogram below.

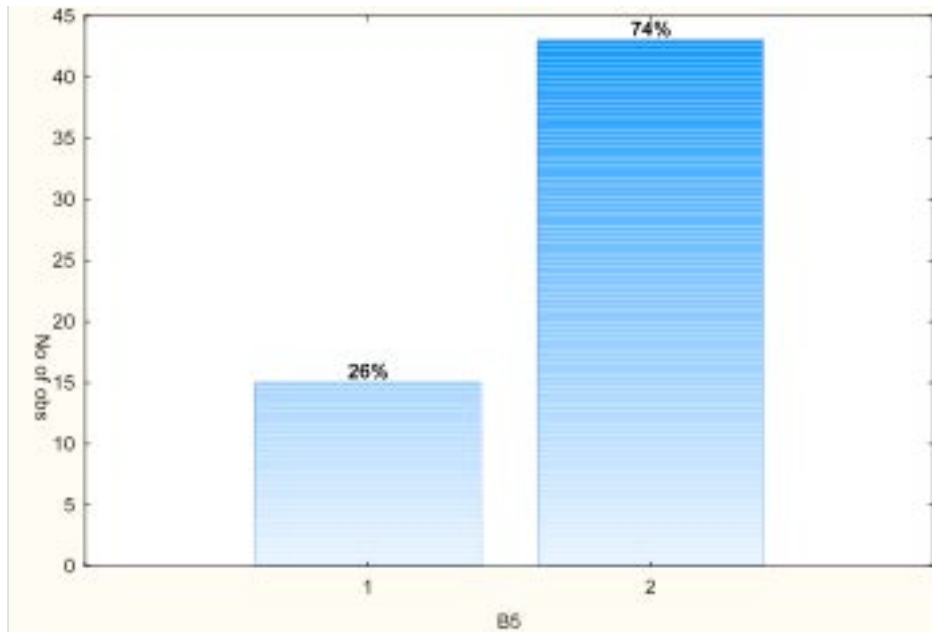


Figure 4.14 Histogram of responses to statement B5

Seventy-four percent of the nurses ( $n = 43$ ) expressed satisfaction with the space to write the numbers, while 26% ( $n = 15$ ) felt the space was too small.

According to the information from statements B4 and B5, the fluid balance chart should be designed for each intensive care unit individually and should be assessed and updated regularly, according to Bennet (2010:1-4).

The next statement, the sixth, was the following:

Statement B6: The final 24-hour fluid balance is correctly calculated all the time:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses to this statement are summarised in the figure below.



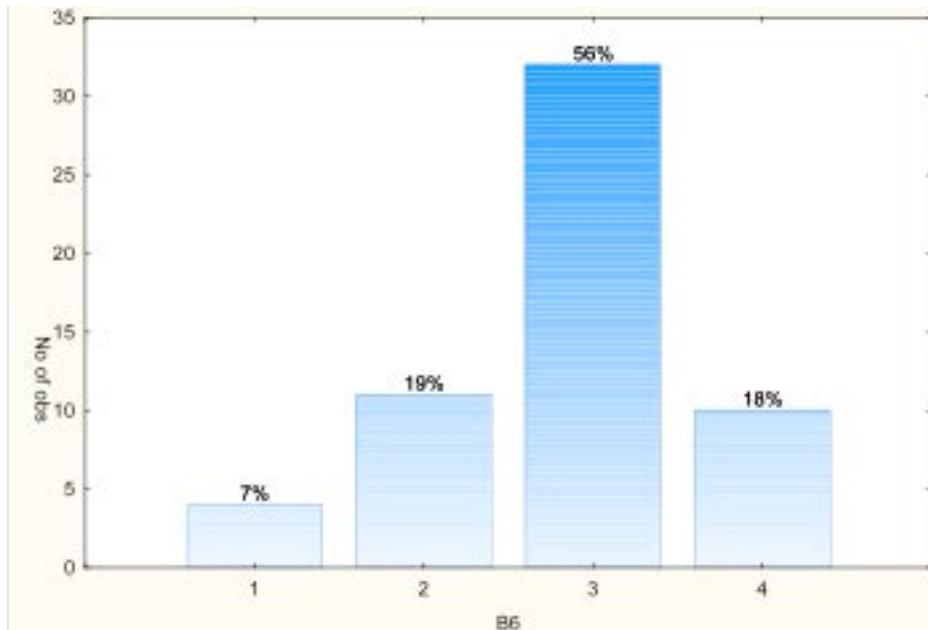


Figure 4.15 Histogram of responses to statement B6

The opinion of 74% of the nurses (n = 42) was that the fluid balance was not always correct, while 26% (n = 17) believed that the fluid balance was always correct. There clearly is an enormous gap in perception, as 17 of the 58 participants believed the fluid balance was mostly correct, while the audit showed only a 1% correct calculation. Creating awareness of regular audits and training sessions can improve the accuracy (Smith et al., 2008:28-29).

The seventh statement was as follows:

Statement B7: If I could decide, I would choose to calculate the final (totals) 24-hour fluid balance at:

- 1) 12:00, midday
- 2) 06:00, morning
- 3) 18:00, evening
- 4) 10:00, midmorning

The responses to this are summarised in the histogram below.

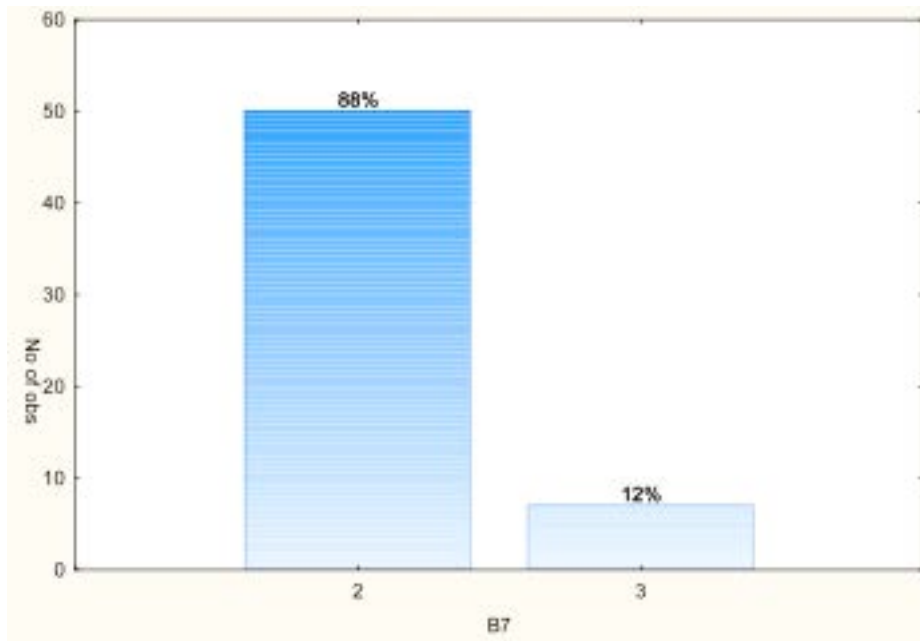


Figure 4.16 Histogram of responses to statement B7

Only two options were chosen, namely 06:00 or 18:00, with the main reason being given that the doctor can utilise an up-to-date fluid balance and can prescribe the new orders for the current day.

The next statement was: Statement B8: Fluid balance assessment is important to guide nursing care in critically ill patients:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses are shown in the figure below.

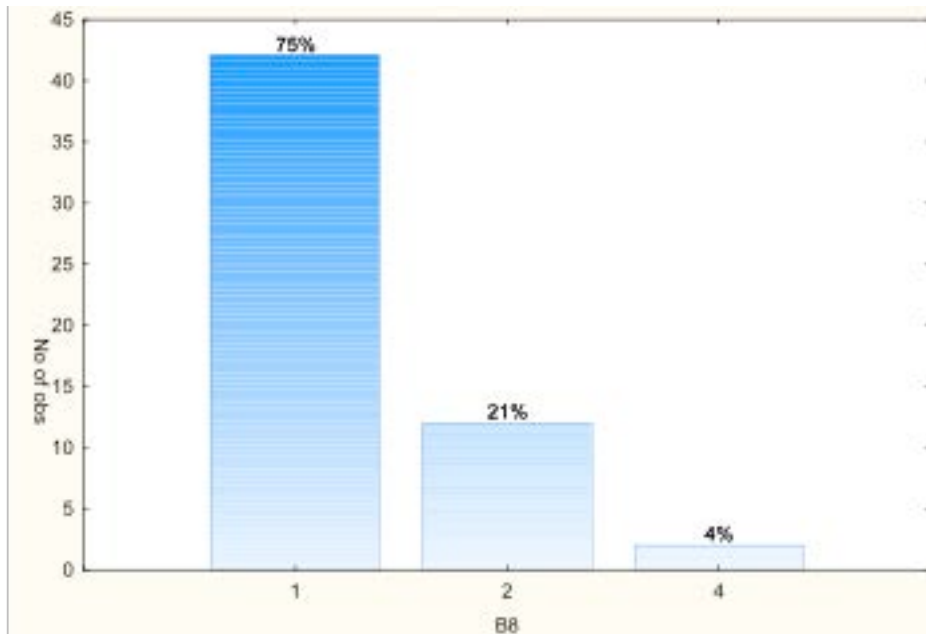


Figure 4.17 Histogram of responses to statement B8

Nearly all the nurses, namely 54 out of the 58 (96%) agreed with this statement. One of the participants mentioned: “Fluid balance in collaboration with clinical evaluation of the patient’s fluid status, oedema, hypotension, hypertension, urine output, capillary filling and other signs of perfusion determines the plan for holistic care of the patient.” As Elliot et al. (2007:437) have pointed out, fluid balance plays an essential role in nursing management, as preserving homeostasis is crucial to maintaining optimal tissue perfusion. Four (4%) of the participants did not agree, and did not comment on their opinion.

The next statement was Statement B9: Inaccurate fluid balance calculation can be a risk for the critically ill patient:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses to this are summarised in Figure 4.18.

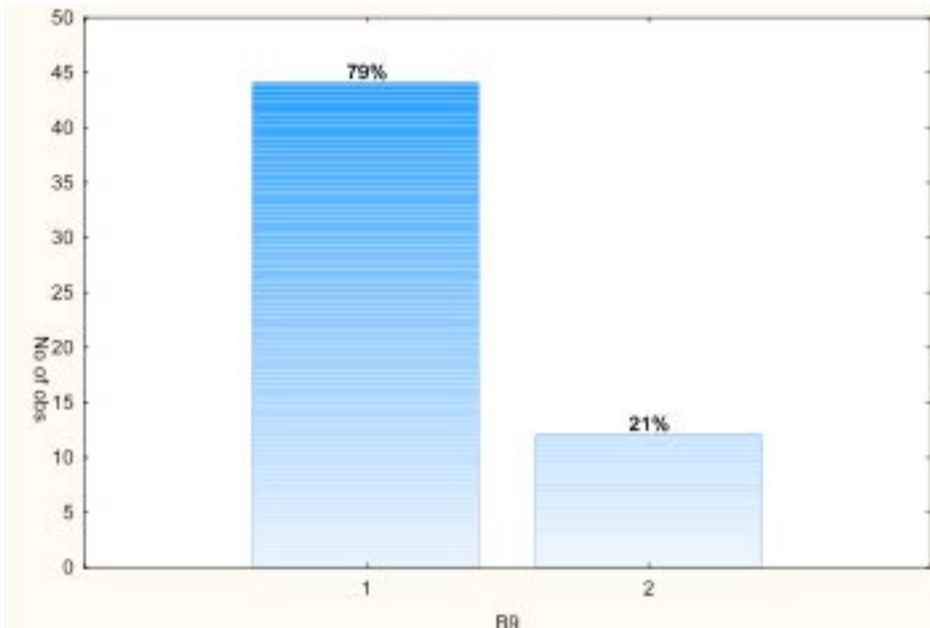


Figure 4.18 Histogram of responses to statement B9

All the nurses agreed with this statement, while 79% (n = 46) strongly agreed. One participant said: “It may influence the outcome of the patient.” The importance of fluid balance monitoring has been shown in several studies with regard to the outcome of the critically ill patient (Alsous et al., 2000:1749; Vincent et al., 2006). None of the nurses selected answer 3) or 4).

The tenth statement was as follows:

Statement B10: Fluid balance information is recorded in too many different places on critical care observation and patient records:

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

The responses are given in the figure below.

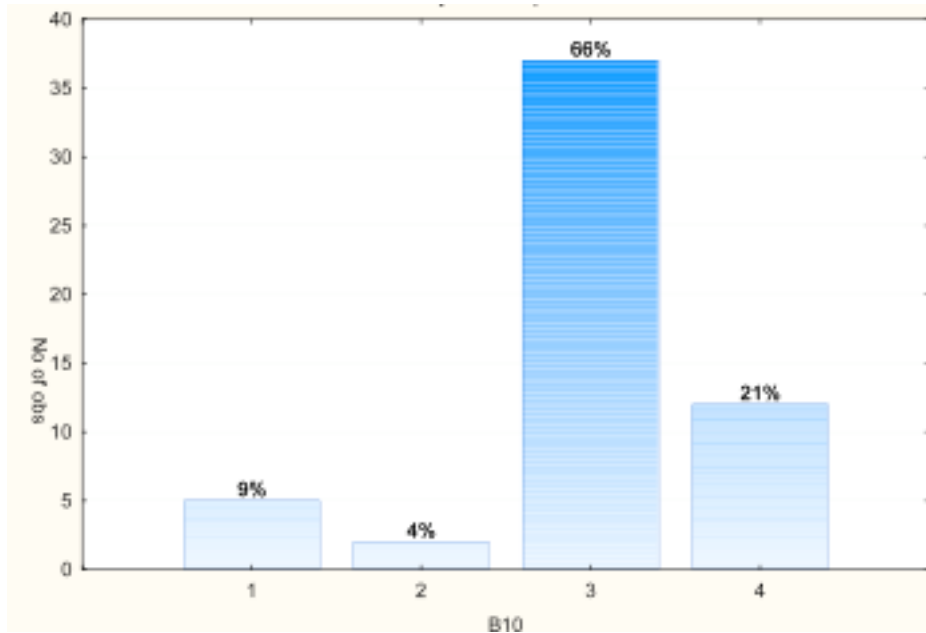


Figure 4.19 Histogram of responses to statement B10

The majority of the nurses ( $n = 51$ ; 87%) disagreed with the statement, commenting that the fluid balance was only recorded on the ICU daily observation chart. Seven nurses (13%) agreed that the fluid balance was recorded in too many different places on the critical care observation and patient records.

The final statement was Statement B11: The person responsible for a correct fluid balance calculation is:

- 1) The registered nurse
- 2) The doctor
- 3) The enrolled nurse auxiliary
- 4) The enrolled nurse

The responses to this are summarised in the histogram below.

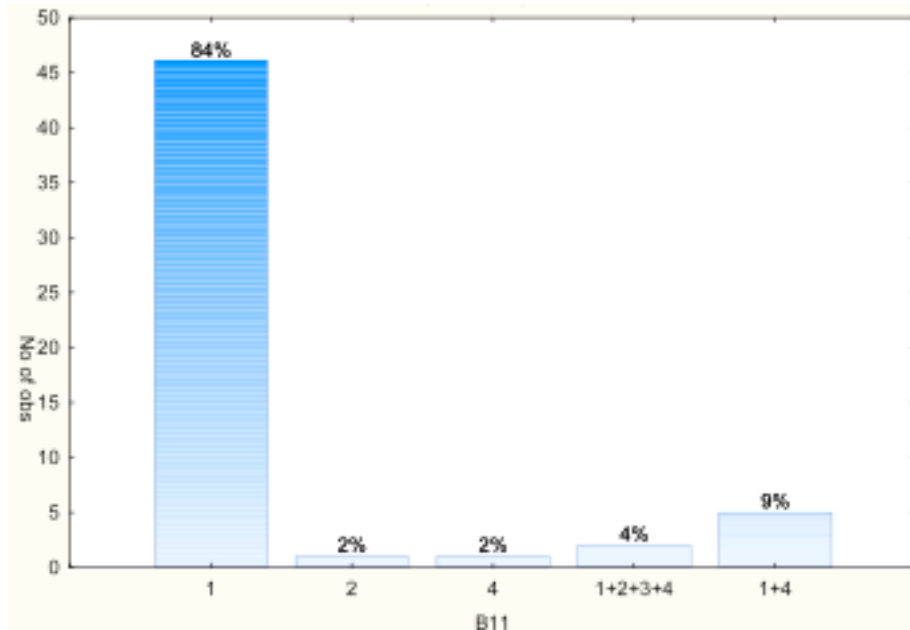


Figure 4.20 Histogram of responses to statement B11

Eighty-four percent of the participants ( $n = 46$ ) shared the opinion that the person responsible for a correct fluid balance was the registered nurse. Four percent ( $n = 2$ ) said the registered nurse was not responsible for the correct fluid balance, and 13% ( $n = 7$ ) indicated that the allocated person was responsible for a correct fluid balance. In the scope of practice of the registered nurse, according to the SANC regulations, the registered nurse is responsible for fluid balance monitoring, whether or not he or she has an additional qualification (SANC, 2006:n.p.).

#### 4.6.3.4 Section C: open-ended questions on perspectives of nurses

Open-ended questions request participants to provide their own answers (Babbie, 2007:246). Open-ended questions are used mostly in qualitative research, but can also be used in questionnaires (Babbie, 2007:246). This part of the study gives more information on the perspectives of the registered nurses with regard to fluid balance monitoring. The discussion is arranged according to the questions, providing the answers to each and a brief discussion.

Question C1:

*The doctor's prescriptions regarding the daily fluid intake for your patient are often prescribed in different places of the patient documentation. Indicate the patient document/record you feel the most appropriate place for these fluid orders to be prescribed:* the ICU patient flow chart was the most preferred location where the doctor should write the prescription. Also acceptable were the non-prescription forms.

During the research period the hospital group changed the design of the daily chart, providing a special area on the daily chart where the doctor could write his prescription for the daily fluids. The responses to this question showed that the nurses were in favour of this change.

Question C2:

*List the most important aspects you feel impact on the registered nurse's ability to ensure accuracy fluid balance monitoring, recording and calculation:* workload and time management, lack of training, inexperience, inaccuracy of the measuring equipment, communication with other health-care workers, distractions and uninformed visitors.

Similar aspects were stated in previous studies by Scales and Pilsworth (2008:57) and Reid et al. (2004:36). Reid et al. (2004:36) showed ways in which practice development occurred. Particular attention was paid to fluid balance. These researchers recognised the problem as being a shortage of nursing staff, a deficit in knowledge and a heavy workload. They designed a survey, a quiz and an audit with the following outcomes: nobody felt responsible for the accurate documentation of the fluid balance, insufficient information was given in reports or to colleagues, and there was inadequate training of the nursing staff. The research team suggested training, a notification at the patient's bedside, simplifying the fluid balance chart, and a space for the nurse to sign that the documentation was her responsibility. With regard to applying best practice principles to fluid balance assessment in the critically ill patient, Scales and Pilsworth (2008:57) emphasised the comprehension of nurses with regard to fluid balances in patients. They

stated that the nurse was the primary person responsible for the monitoring of the fluid balance. To improve the knowledge of nurses about fluid balance monitoring, they offered online questionnaires called “learning zones” where nurses could test their understanding of fluid balance physiology. By means of recommendations about fluid balance practice, these researchers could foresee an enhancement in the practice of fluid balance monitoring. Scribante and Bhagwanjee (2007:1315) showed that South Africa has an alarming shortage of registered nurses, especially those with training in intensive care units. Workload is recognised as an important issue in nursing, and workload is therefore a great challenge in nursing in South African at present.

Question C3:

*List your potential solutions or recommendations to support the registered nurse in improving fluid balance assessment, monitoring, and recording:* training of all staff, clear standardised charts, clear prescriptions from doctor, calculator at bedside, documentation audits, information signs at the bedside, basic calculation training and infusion pumps.

Henderson is a recognised nursing theorist who published *Basic principles of nursing* in 1997 (George, 2002:87). She stated that the nurse fulfils a unique, central role of being the patient’s helper. Among other components she emphasised maintenance of the fluid balance monitoring of the patient. The solutions proposed by the registered nurses to improve fluid balance monitoring are suitable within the role description offered by Henderson. Thus it is reasonable for registered nurses to implement and participate in the development of these proposed solutions.

#### **4.7 Conclusion**

This chapter provided an analysis and discussion of the data deriving from the audit and the questionnaire. The audit showed an inaccuracy of 90% in the calculation of the fluid balances in the patient records in the critical care units (tolerated deviation 0-10ml) and 79% were inaccurate if a deviation of 50ml would be tolerated. Furthermore, a Mann-Whitney U test was performed and presents a correlation between the deviation of the



patient record calculation and the control calculation and the administration of diuretics. The questionnaire presents a rich review of the perspectives of nurses with regard to fluid balance monitoring, with recommendations for the practice.

Chapter 5 will present the conclusions, limitations and recommendations of the study.

## **Chapter 5: Conclusions and recommendations**

### **5.1 Introduction**

This chapter provides a reflection on the findings in Chapter 4, and presents conclusions supported by the study data. Recommendations are made on the basis of the findings. The limitations of the study are also discussed.

This study was guided by the following aim: to describe the perspectives and practices of registered nurses working in critical care units with regard to fluid balance monitoring. The researcher used a questionnaire to capture the perspectives of registered nurses and performed an audit on the fluid balances in patient records in order to obtain the data for the study. To achieve the aim of the study, the study was directed by the following objectives:

- To identify and describe the current clinical practices related to fluid balance monitoring and recording in critical care units.
- To describe the perspectives and knowledge of nurses in critical care units with regard to fluid balance monitoring and recording.

The conclusions drawn from the study data will be discussed under each of the objectives.

### **5.2 Conclusions**

#### **5.2.1 Objective 1: to identify and describe the current clinical practices related to fluid balance monitoring and recording in critical care units**

In patients in critical care, a daily observation sheet is used to record all vital signs, nursing interventions, medical procedures and the fluid balance of that day. The fluid balance comprises the intake of fluids over a 24-hour period and the output of fluids over 24 hours by the patient. The difference between the volumes is calculated to provide the 24-hour fluid balance (Scales & Pilsworth, 2008:53). Monitoring the patient's fluid

balance is of great importance in understanding and managing a patient's clinical status. Therefore, accurate fluid balance monitoring plays an essential role in patient care management (Elliot et al., 2007:440,445-446).

The current clinical practices were determined through an audit of fluid balance monitoring records. A comparison was made between the original calculation recorded in the patient records and a control calculation done by the researcher. The findings of the calculation check showed a disconcerting deviation between the recorded 24-hour balance and the control calculation. Out of the 103 fluid balance records that were checked, only ten records (10%) displayed a deviation of 0-10ml between the recorded balanced and the control check, 21% were correct if a deviation of 50ml was tolerated. Of greater concern was the number of records where the deviation was more than 500 ml between the recorded and checked calculation ( $n = 27$ ; 26%). This indicates that treatment decisions are based on inaccurate information, which may have significant negative implications for the patient.

The additional fluid balance-related monitoring data (e.g. administration of diuretics, number of continuously given drug infusions, CVP, matching doctor's prescription, administration of blood products; see Chapter 4) was also audited and a correlation test using the Mann-Whitney U test was performed. This was done to determine whether a relationship exists between the inaccurate fluid balance recording and another variable. Of all the variables tested, a significant statistical relationship was shown between the administration of diuretics and inaccurate fluid balances. This provides food for thought, as diuretics are used purposively to manage the fluid balance. Although statistical significance does not by definition mean clinical significance, further research is needed to investigate this relationship (LoBiondo-Wood & Haber, 2010:340-341). When a clinical decision has to be made with regard to the recommended fluid balance therapy, one should be aware that the calculated fluid balance might not be completely free from error. Calculation errors can be solved with basic mathematics training, and a constructive attitude in being accountable for the monitoring of the fluid balance.

Thus, the current clinical practices demonstrate that the appropriate monitoring was implemented in terms of the variables that are monitored and measured by the nursing personnel with regard to fluid balance. However, the study demonstrates that the 24-hour balance calculation is questionable and that there is a relationship between fluid balance accuracy and diuretics administration.

### **5.2.2 Objective 2: To describe the perspectives and knowledge of nurses in critical care units with regard to fluid balance monitoring and recording**

Secondly, the perspectives and knowledge of nurses in critical care units with regard to fluid balance monitoring and recording were obtained by way of a questionnaire. The questionnaire was designed by the researcher, and was improved through the expert opinions of nurses and tested in a pilot study. A total of 140 questionnaires were distributed.

Although the researcher had contact with 121 registered nurses in personal conversations, during which she motivated the participants and explained the questionnaire, the return of the questionnaires was disappointing. Reasons could be heavy workload or a lack of interest. One of the participants supported the researcher by motivating her colleagues: “this is bedside research, very appropriate and interesting for nurses at the bedside”.

The demographics of the participants shows an average age of 42 years, and that 95% were female, with a mean of 13 years of experience as a registered nurse. Fifty percent of the nurses had an additional qualification in critical care nursing, with an average of 12 years of experience in the critical care environment.

The first section of the questionnaire tested their knowledge. Knowledge in nursing is difficult to define, since nursing is a profession that is in the process of developing (Hall, 2005:34). The answering of the questions in the first section showed sufficient understanding by the participants, although the mathematic part in the knowledge question posed great difficulty. Only 70% of the participants could answer this part

correctly. Combined with the outcome of the fluid balance deviation in relation to diuretic administration, the nurses' mathematics skills need extra attention.

The next section of the questionnaire reflected the perspectives of registered nurses with regard to fluid balance monitoring. A majority of the nurses said that fluid balance monitoring was an important part of patient nursing care, and that inaccuracy can pose a risk to the patient. The nurses feel responsible for performing fluid balance monitoring correctly, even when they are occupied with other nursing activities.

The daily chart sheet has been discussed and is accepted as a suitable format. However, 25% of the participants felt the space provided for writing the numbers of fluids was too small.

The time of the end calculation of the 24-hour fluid balance is clearly 06:00, as it was given in all hospitals of the hospital group. The main reason for the timing of the end calculation is to have the fluid balance fully prepared before the doctor's rounds. Positive collaboration between the doctor and the nursing staff is important for excellent patient care (Schmalenberg & Kramer, 2009:74).

There is a strong feeling of responsibility among the registered nurses with regard to fluid balance monitoring. Furthermore, the registered nurses are aware of inaccurate fluid balance calculations. The reasons for the incorrect calculations and the recommendations from the nurses on this subject will be presented section 5.3.

The last section in the questionnaire was the open-ended questions, in relation to which the nurses could express their opinions. The research reveals that nurses prefer to have the fluid balance orders for the day on the daily chart sheet. Coincidentally, while this research was being done, the hospital group introduced a new daily chart sheet with a designated field where the doctor can write the daily fluid orders.

The second question asked the nurses about the cause of inaccuracy in the fluid balance monitoring, giving rise to the following answers: workload with related distractions, training deficiency and insufficient communication.

To solve the abovementioned problems, the nurses suggested more training, especially in mathematics, clear charts and prescriptions, a calculator at the bedside, and regularly audits of the documentation.

Thus, the nurses are aware of the importance of the fluid balance, and recognise the inaccuracies in fluid balance monitoring.

### **5.3 Recommendations**

Hall (2005:34) describes nursing as an art, and nursing is learnt by personal experience obtained in practice situations. Nurses nowadays need knowledge on a higher academic level. For registered nurses working in the critical care environment, nursing knowledge can mean a better outcome for the patient. Nursing today is a science, and nursing knowledge has become more complicated than in the past. Nurses should show appropriate skills and are expected to justify their actions; these actions should be based on evidence-based research. This recommendation supports the conceptual framework of evidence-based practice.

Simple mathematics training programmes implemented on a regular basis are of the utmost importance. Mathematics training should be offered by recognised training institutions with acknowledged certification. That errors are made in the notation of positive or negative numbers is not acceptable. Here a responsible and positive attitude is required from the nurses with respect to the consequences of mathematical mistakes. Nurses should take ownership of their responsibilities. A simple calculator with a print function at the patient's bed/nurse's desk can establish an audit on the fluid balance at the end of every shift. The printout can be stapled to the daily chart as proof of correct calculation.

Furthermore the recommendations of the participating registered nurses (see Chapter 4, question C3) are of great value. The recommendations of the registered nurses comprised training of all staff, especially basic calculation training, clear standardised charts, clear prescriptions from doctor, a calculator at the bedside, documentation audits, information signs at the bedside and the use of infusion pumps.

#### **5.4 Recommendations for further research**

Of interest could be more in-depth research on the administration of diuretics in relation to the inaccuracy of the fluid balance calculation and an investigation of what leads to this inaccuracy.

#### **5.5 Limitations of the study**

A qualitative research approach in the form of interviews could give more profound perspectives of the nurses with regard to fluid balance monitoring. Also, a qualitative approach to the fluid balance records could give different aspects of fluid balance monitoring, specifically the administration of diuretics compared to the inaccuracy in the fluid balance calculation. The use of only one hospital group could have limited the generalisation of the study. Furthermore, the small size of the sample might have influenced the study results.

#### **5.7 Summary**

As no similar research on fluid balance monitoring has been done in South Africa, the results show that the situation in South Africa is not better than in the rest of the world. With our limited resources, both financial and in terms of nursing staff, the solutions have to be very basic and practical.

Training, especially in mathematics, calculators and regular audits are part of solving the problem. Furthermore, a positive attitude from nurses in the profession will result in a better outcome.



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<b>ADDENDUM A</b>	Identification no:
Hospital category:	
FLUID BALANCE Source document	Audit no:
Tick off if recorded: NIBP ... HR ... CVP ... ArtBP ... Resp. Rate ... Temp ... Other ... (list)	Tick off if recorded: Electrolytes ... Ur ... Crea ... Sat O2 ...
Prescription orders: ml/h (TPN, NGT, maintenance, drugs, antibiotics)	Fluid: ... ml/h
Prescription orders: Where? Daily sheet... Prescription chart... or ... missing ...	
Readable prescription orders?	Yes/no
Prescription match given fluids	Yes/no
Diarrhoea:	Yes/no
Blood products:	Yes/no, Hb ...
More than two continuous drugs	Yes/no, specify
Urinary catheter:	Yes/no
Dialysis:	Yes/no
Combur test:	Yes/no
Weight:	Yes/no, ... kg
Q1. Input patient folder, in ml.	
Q2. Output patient folder, in ml.	
Q3. Balance patient folder, in ml.	
Q4. Input check, in ml.	
Q5. Output check, in ml.	
Q6. Balance check, in ml.	
Q7. Input check 2, in ml.	
Q8. Output check 2, in ml.	
Q9. Balance check 2, in ml	
Q10. Deviation no 6 minus no 3, in ml.	
QA No readable balance, tick off if so	
QB	
QC Diuretics given, if yes, what is given	
QD Remarks on any action regarding balance:	

## **ADDENDUM B**

Dear Colleague,

This questionnaire is part of a thesis to be submitted as a requirement for obtaining a MCur degree in the Department of Nursing at Stellenbosch University, titled “Fluid balance monitoring in critically ill patients”.

The aim of the study is to describe and determine the nursing practices in critical care units with regard to fluid balance monitoring.

The purpose of the questionnaire is to determine the perspectives and knowledge of registered nurses in critical care units concerning fluid balance monitoring.

It will take approximately 20 minutes to complete this questionnaire. The information you provide will help to gain insight into how fluid balance monitoring, calculation and recording are applied in the critical care unit.

### **Instructions for completing the questionnaire:**

- Do not write your name on the questionnaire
- Mark the appropriate box with an X to indicate your choice for each of the statements in this survey tool. Should you need to change your choice, please clearly darken the incorrect choice like this λ and select your preferred choice
- Please indicate only one choice per statement
- After completion, please place the questionnaire in the provided envelope, seal it and deposit it in the box provided for the purpose

Your response will be anonymous.

Thank you for taking time to complete this questionnaire

Annette Diacon

## Demographics

1. Age:

2. Gender:

Male:	Female:
-------	---------

3. Number of years working experience as a registered nurse working in any critical care unit ...

4. Do you have an additional qualification in intensive nursing science registered by the South African Nursing Council?

- 1) No
- 2) Yes

5. If you have answered YES to the above question, indicate how many years' experience you have as a registered critical care nurse ...

6. Are you permanent or agency staff?

- 1) Permanent
- 2) Agency

## Section A

Consider the following statements, and mark your choice with an X

1. Fluid balance assessment does not include the following data:
  - 1) Weight, central venous pressure, peripheral pulses
  - 2) Electrolytes, oedema, crackles
  - 3) Vancomycin level, airway pressure, pupil reaction
  - 4) Jugular vein distension, specific gravity changes, oxygen saturation
  
2. Adequate urine output is determined as follows:
  - 1) 50 ml/kg bodyweight/hour
  - 2) 0.5 ml/kg bodyweight/hour
  - 3) 20 ml/kg bodyweight/min
  - 4) 5 ml/kg bodyweight/hour
  
3. On average an adult patient requires a fluid intake (excluding solids) per day of approximately:
  - 1) 500-1000 ml
  - 2) 1000-1500 ml
  - 3) 1500-2000 ml
  - 4) 2500-3000 ml
  
4. These three vital signs are usually part of assessing your patient's fluid balance assessment:
  - 1) Temperature, limb movements, heart rate
  - 2) Fluid intake, urine production, nasogastric drainage
  - 3) Urine production, Glasgow Coma Scale, respiratory rate
  - 4) Blood pressure, pulmonary arterial wedge pressure, bowel activity
  
5. These clinical signs are most likely to occur in a patient who is hypervolemic:
  - 1) Dyspnoea, tachypnoea, tachycardia
  - 2) Arrhythmia, dyspnoea, desaturation
  - 3) Anuria, thirst, hypertension,
  - 4) Hypotension, oedema, petechia
  
6. During the past hour your patient has not passed any urine in the catheter bag. The first thing you do, is
  - 1) Phone the doctor
  - 2) Check if the urinary catheter is free flowing
  - 3) Remove the urinary catheter
  - 4) Increase the infusion rate of Cordarone X® (= Amiodarone)

7. An audit was done to determine if 24-hour fluid balance calculations were done accurately. A patient has a 24-hour total positive fluid balance of 2000 ml, after recalculating the total balance was 2600 ml. This is a difference of 600 ml, more than 25% higher than the original calculation. What percentage incorrect fluid balance calculation do you consider acceptable when managing a critically ill patient:

- 5) 0-5%, in this case 0-100 ml
- 6) 5-10%, in this case 100 ml or more, less than 200 ml
- 7) 10-25%, in this case 200 ml or more, less than 500 ml
- 8) >25%, in this case 500 ml or more

8. Blood products are included in the fluid balance

- 1) Unsure
- 2) Yes
- 3) No
- 4) Depends on unit policy

9. Which of the following fluids or drugs does not have to be infused using an infusion control pump:

- 1) Nimotop®, TPN, Adrenaline, Ringer's Lactate®
- 2) Blood, FFP (fresh frozen plasma), Solu-Cortef®, Perfalgan®
- 3) Cisplatin®, Dobutrex®, Actrapid®, Albumin 20%®
- 4) Diprivan®, Potassium chloride, Vancomycin®, Dormicum®

Section B

The following statements provide some of the reasons for inaccurate fluid balance assessment and monitoring as determined in other studies in various nursing environments. Indicate your level of agreement with these statements with reference to your critical care environment. Please use the comment block to elaborate on your choice

1. There are many other patient care activities that are more important for me to attend to than recording the intake and output every hour

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:

2. There are too many people who fill in one patient's fluid balance chart

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:

3. As a registered nurse I am responsible for more than one patient, and so it is difficult to supervise all the fluid balance activities

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:

4. I am satisfied with the design of the fluid balance chart sheet, it is straightforward to complete

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:

5. The space to write the fluid numbers on the chart is:

- 1) Too small
- 2) Adequate
- 3) Too big

6. The final 24-hour fluid balance is correctly calculated all the time

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

7. If I could decide, I would choose to calculate the final (totals) 24-hour fluid balance at:

- 1) 12:00, midday
- 2) 06:00, morning
- 3) 18:00, evening
- 4) 10:00, midmorning

Comment:

8. Fluid balance assessment is important to guide nursing care in critically ill patients

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:


9. Inaccurate fluid balance calculation can be a risk for the critically ill patient

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree

Comment:

10. Fluid balance information is recorded in too many different places on critical care observation and patient records

- 1) Strongly agree
- 2) Agree
- 3) Disagree
- 4) Strongly disagree


11. The person responsible for a correct fluid balance calculation is

- 1) The registered nurse
- 2) The doctor
- 3) The enrolled nurse auxiliary
- 4) The enrolled nurse



### Section C

1. The doctor's prescriptions regarding the daily fluid intake for your patient are often prescribed in different places of the patient documentation. Indicate the patient document/record you feel the most appropriate place for these fluid orders to be prescribed:


2. List the most important aspects you feel impact on the registered nurse's ability to ensure accuracy fluid balance monitoring, recording and calculation:


3. List your potential solutions or recommendations to support the registered nurse in improving fluid balance assessment, monitoring, and recording:


Thank you for your participation in this survey. If you have any questions you can contact me, Annette Diacon, on 082 420 1678.

## Addendum C

### **PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM**

TITLE OF THE RESEARCH PROJECT: Fluid balance monitoring in critically ill patients

REFERENCE NUMBER: N11/06/195

PRINCIPAL INVESTIGATOR: Annette Diacon

Master's student, Stellenbosch University

ADDRESS: 11 Ludlow Road, Vredehoek, Cape Town 8001

adiacon@mac.com

CONTACT NUMBER: 082 420 1678

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Committee for Human Research at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

**What is this research study all about?**

The aim of the study is to explore the perspectives and knowledge of nurses with regard to fluid balance monitoring. The study contains an audit of fluid balance records and a survey among registered nurses.

**Why have you been invited to participate?**

You are invited to participate as you are a registered nurse working in a critical care unit.

**What will your responsibilities be?**

To complete the questionnaire as requested.

**Will you benefit from taking part in this research?**

There is no direct benefit for you, but the benefit might improve patient care.

**Are there risks involved in your taking part in this research?**

There is no risk taking part in this survey.

**Will you be paid to take part in this study and are there any costs involved?**

No, you will not be paid to take part in the study. There will be no costs involved for you if you do take part.

**Is there anything else that you should know or do?**

You can contact the Committee for Human Research at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your researcher.

You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I ..... agree to take part in a research study entitled “Fluid balance monitoring in critically ill patients”.

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

Signed at (place) ..... on the (date) .....  
20...

.....

Signature of participant

.....

Signature of witness

Declaration by investigator

I, Annette Diacon, declare that:

- I explained the information in this document to ...
- I encouraged the participant to ask questions and took adequate time to answer them.
- I am satisfied that the participant adequately understands all aspects of the research, as discussed above.
- I did not use an interpreter.

Signed at Cape Town on 23 February 2012

A handwritten signature in black ink, appearing to read 'Annette Diacon', written in a cursive style.

Signature of investigator

Signature of witness

## Addendum D



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY  
UNIVERSITY OF STellenbosch

04 October 2011

MAILED

Mrs A Diacon  
Department of Nursing  
2nd Floor  
Teaching Block

Dear Mrs Diacon

Fluid Balance Monitoring in Critically Ill Patients.

**ETHICS REFERENCE NO: N11/06/165**

**RE: APPROVED**

It is a pleasure to inform you that a review panel of the Health Research Ethics Committee has approved the above-mentioned project, including the ethical aspects involved, for a period of one year from this date.

This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project number in ALL future correspondence. You may start with the project. Notwithstanding this approval, the Committee can request that work on this project be halted temporarily in anticipation of more information that they might deem necessary.

Please note a template of the progress report is obtainable on [www.sun.ac.za/rds](http://www.sun.ac.za/rds) and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly and subjected to an external audit.

Translations of the consent document in the languages applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372  
Institutional Review Board (IRB) Number: IRB0006239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Please note that for research at primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health ([healthres@gwc.gov.za](mailto:healthres@gwc.gov.za) Tel: +27 21 483 9907) and Dr Hélène Visser at City Health ([Helene.Visser@capetown.gov.za](mailto:Helene.Visser@capetown.gov.za) Tel: +27 21 400 3931). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

Approval Date: 01 October 2011

Expiry Date: 01 October 2012

18 October 2011 12:48

Page 1 of 2



Verbind tot Optimale Gesondheid - Committed to Optimal Health



Afdeling Navorsingsontwikkeling en -steun - Division of Research Development and Support  
Postbus/PO Box 10053 - Tygerberg 7605 - Suid-Afrika/South Africa  
Tel: +27 21 836 8075 - Faks/Fax +27 21 831 5352



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY  
FOR ADVANCEMENT • FOR KNOWLEDGE • FOR BETTER

Yours faithfully

**MRS MERTRUDE DAVIDS**  
RESEARCH DEVELOPMENT AND SUPPORT  
Tel: 021 938 9207 / E-mail: mertrude@sun.ac.za  
Fax: 021 931 3362

19 October 2011 12:48

Page 2 of 2



Rekultuur Gesondheidswetenskappe • Faculty of Health Sciences



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Afdeling Navorsingsontwikkeling en -steun • Division of Research Development and Support  
Postbus/PO Box 19063 • Tygerberg 7505 • Suid-Afrika/South Africa  
Tel: +27 21 938 9076 • Faks/Fax: +27 21 931 3362

## **Addendum E**

### **Waiver of informed consent to access patient documentation**

Title of the research project: **Fluid balance monitoring in critically ill patients**

Ethics reference no: N11/06/195

Principal investigator: Annette Diacon

Supervisor: Mrs Janet Bell

Address: 11, Ludlow Road, Vredehoek, Cape Town, 8001

Contact number: 082 420 1678

For this study a data supportive audit will be performed on medical record information. The researcher assures that no information of the medical records can be linked to a person.

It would not be possible to contact all patients for written informed consent. The research will not pose any risk or harm to the subjects involved and does not involve procedures where written consent is essential.

The waiver of documentation is only applicable on to the access to the medical records and the audit thereof. The performed audit will give additional information within the scope of fluid balance monitoring accuracy.

Signed at Cape Town on 23 February 2012

Annette Diacon, investigator





## Addendum F



Netcare Limited

Tel: + 27 (0)11 301 0000  
Fax: Corporate +27 (0)11 301 0499  
76 Maude Street, Corner West Street, Sandton, South Africa  
Private Bag X34, Bermore, 2010, South Africa

### RESEARCH COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: UNIV-2012-0003

Ms Annette Diacon

E mail: [adiacon@msc.com](mailto:adiacon@msc.com)

Dear Ms Diacon

RE: FLUID BALANCE MONITORING IN CRITICALLY ILL PATIENTS

The above-mentioned research was reviewed by the Research Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at Netcare Kulis River, N1 City, UCT Private Academic & Christian Barnard Memorial Hospitals, has been approved, subject to the following:

- i) Research may now commence with this FINAL APPROVAL from the Academic Board of Netcare (Research Committee).
- ii) All information with regards to Netcare will be treated as confidential.
- iii) Netcare's name will not be mentioned without written consent from the Academic Board of Netcare (Research Committee).
- iv) All legal requirements with regards to patient rights and confidentiality will be complied with.
- v) Insurance will be provided and maintained for the duration of the research. This cover provided to the researcher must also protect both the staff and the hospital facility from potential liability
- vi) In accordance with MCC approval, that medicine will be administered by or under direction of the authorised Trialist
- vii) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2000)
- viii) Netcare must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from Academic Board of Netcare (Research Committee) as well as a FINAL REPORT with reference

A handwritten signature in blue ink, appearing to be "SJA".

Executive Directors: R H Friedland (CEO), V S Fittan (CFO), V L J Lubbekken

Non-Executive Directors: S J Vilakazi (Chairman), T Besser, A P H Jamieson, J M Kuhn, M J Kurbak, H R Levin, K D Maroka, M I Sibus, N Welman

Company Secretary: L Sagarwan Reg. No. 1998/00242/00

to intention to publish and probable journals for publication, on completion of the study.

- ix) A copy of the research report will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.
- x) Netcare has the right to implement any Best Practice recommendations from the research.
- xi) Netcare reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects/Netcare or should the researcher not comply with the conditions of approval.

We wish you success in your research.

Yours faithfully



Prof Dion du Plessis  
Full member Research Committee & Medical Practitioner evaluating research applications as per  
Management and Governance Policy  
Date: 9/2/2012

Shannon Neil   
Chairperson: Research Committee  
Network Healthcare Holdings Limited (Netcare)  
Date: 19/2/2012



## Addendum G



Anzio Road  
Observatory  
Cape Town  
PO Box 13619, Mowbray, 7705  
Tel: 021 442 1800  
Fax: 021 442 1851  
E-mail: [info@ucthospital.co.za](mailto:info@ucthospital.co.za)  
[www.ucthospital.co.za](http://www.ucthospital.co.za)

Anette Diacon  
11 Ludlow Road  
Vredehoek  
Cape Town  
8001  
[adiacon@mac.com](mailto:adiacon@mac.com)

23 November 2011

**RE: APPLICATION TO CONDUCT NON CLINICAL RESEARCH.**

This letter serves to confirm that UCT Private Academic hospital has taken note of the research application titled: "Fluid balance monitoring in critically ill patients".

Subject to the final approval from Dr CW Folscher as project manager for bursaries and research we hereby give permission for the research to continue at this facility.

Your contact person at the facility will be Sr. Ellis Fry who is the unit manager of the ICU.

Should any further queries arise please do not hesitate to contact me.

Kind Regards

A handwritten signature in black ink that reads "Becker".

Christo Becker

## Addendum H



Netcare Kullis River Hospital

Tel: +27 (0) 21 966 8000  
Fax: +27 (0) 21 960 0005  
33 Van Riebeeck Road, Kullis River, 7580, South Africa  
P O Box 1200, Kullis River, 7579, South Africa  
[www.netcare.co.za](http://www.netcare.co.za)

25 January 2012

Ms A Diacon  
11 Ludlow Road  
Vredehoek  
CAPE TOWN  
8001

**LETTER CONFIRMING KNOWLEDGE OF NON-CLINICAL FOCUS RESEARCH TO BE CONDUCTED IN THIS NETCARE FACILITY**

Dear Annette Diacon,

Re: Fluid balance monitoring in critically ill patients

We hereby confirm knowledge of the above named research application to be made to the Netcare Research Committee and in principle agree to the research application for Netcare Kullis River Hospital, subject to the following:

- i) That the research may not commence prior to receipt of FINAL APPROVAL from the Academic Board of Netcare (Research Committee).
- ii) That the researcher will notify the Academic Board of Netcare (Research Committee) of the proposed date of commencement of the project, in writing.
- iii) A copy of the research report will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.
- iv) Netcare has the right to implement any Best Practice recommendations from the research.
- v) That the Hospital Management reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects / Netcare or should the researcher not comply with the conditions of approval.

We wish you success in your research.






Yours faithfully

  
Signed by Hospital Management  
Nursing Services Manager

Date: 26 January 2012

Netcare Hospitals (Pty) Ltd T/A Netcare Kullis River Hospital  
Directors:  
J Du Plessis, R H Friedland, J Soemmer  
Company Secretary: L Dagwarden Reg. No. 1995/006501/07

Distribution list – Ethics Committee Approval Research Project: NON-CLINICAL FOCUS RESEARCH TO BE CONDUCTED IN NETCARE KUILS RIVER HOSPITAL: FLUID BALANCE MONITORING IN CRITICALLY ILL PATIENTS

	Approved	Not Approved
TRAUMA DEPARTMENT		
Ampath Laboratory		
Mark J		
Suite 206 Lombard L		
Suite 205 De Wet C		
4 <sup>th</sup> Floor		
Suite 402 Dr Trevor K		
Suite 405 Saalman A		
ADMIN :		
Mr Nolan Daniels		
Ms Vanessa Cilliers		
Mrs Adelle Wilbers		
Ms Corine de Boer		

Date : 2011.11.22 – 1<sup>st</sup> circulation  
2012.01.20 – 2<sup>nd</sup> circulation

Distributed By : VANESSA CILLIERS  
(PA:Miranda Marais – x6003)  
PLEASE – IT IS IMPORTANT TO CALL MIRANDA WHO WILL TAKE IT TO THE NEXT PERSON

## Addendum I



Netcare N1 City Hospital

Louwtjie Rothman Street, Goodwood, 7460  
P O Box 12581, Goodwood, 7463  
Tel: +27 (0) 21 590 4444  
Fax: +27 (0) 21 595 2304  
[www.netcare.co.za](http://www.netcare.co.za)

21 November 2011

**LETTER CONFIRMING KNOWLEDGE OF NON-CLINICAL FOCUS RESEARCH TO BE  
CONDUCTED IN THIS NETCARE FACILITY**

Dear Annette Diacon

**RE: FLUID BALANCE MONITORING IN CRITICALLY ILL PATIENTS**

We hereby confirm knowledge of the above named research application to be made to the Netcare Research Committee and in principle agree to the research application for Netcare N1 City Hospital, subject to the following:

- i) That the research may not commence prior to receipt of FINAL APPROVAL from the Academic Board of Netcare (Research Committee).
- ii) That the researcher will notify the Academic Board of Netcare (Research Committee) of the proposed date of commencement of the project, in writing.
- iii) A copy of the research report will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.
- iv) Netcare has the right to implement any Best Practice recommendations from the research.
- v) That the Hospital Management reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects / Netcare or should the researcher not comply with the conditions of approval.

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Netcare Hospitals (Pty) Ltd T/A Netcare N1 City Hospital  
Directors:  
J Du Plessis, R H Friedland, I Soomra  
Company Secretary: L Bagwandeem Reg. No. 1996/006591/07

We wish you success in your research.

Yours faithfully



Signed by Hospital Management

21 November 2011

Date

**HOSPITAL MANAGER**

(Specify designation)



## Addendum J



Netcare Christiaan Barnard Memorial Hospital

Tel: +27 (0) 21 480 6111  
Fax: +27 (0) 21 424 0826  
181 Longmarket Street, Cape Town, South Africa  
PO Box 15364, Vlaeberg, 8018, South Africa  
[www.netcare.co.za](http://www.netcare.co.za)

18 November 2011

**LETTER CONFIRMING KNOWLEDGE OF NON-CLINICAL FOCUS RESEARCH TO BE CONDUCTED  
IN THIS NETCARE FACILITY**

Dear Ms Diacon

**RE: Fluid balance monitoring in critically ill patients**

We hereby confirm knowledge of the above named research application to be made to the Netcare Research Committee and in principle agree to the research application for Netcare Christiaan Barnard Memorial Hospital, subject to the following:

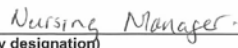
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- ii) That the researcher will notify the Academic Board of Netcare (Research Committee) of the proposed date of commencement of the project, in writing.
- iii) A copy of the research report will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.
- iv) Netcare has the right to implement any Best Practice recommendations from the research.
- v) That the Hospital Management reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects / Netcare or should the researcher not comply with the conditions of approval.

We wish you success in your research.

Yours faithfully

  
\_\_\_\_\_  
Signed by Hospital Management

  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
(Specify designation)

Netcare Hospitals (Pty) Ltd T/A Netcare Christiaan Barnard Memorial Hospital  
Directors:  
J Du Ploessis, V E Firman, R H Friedland, M I Sacks, I Soomra  
Company Secretary: L Bagwandeem Reg. No. 1996/006591/07





