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2020
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Anaesthetists' knowledge of central venous catheters in a department of anaesthesiology

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

Johannesburg, 2019

Declaration

I, Gabriel Shawn Mukucha declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



31 March 2020

Abstract

Background

Central venous catheters (CVCs) are used in the emergency department, general wards and in the peri-operative period extending into the intensive care unit (ICU). This wide usage of CVCs is accompanied by high complication rates. In South Africa there is paucity of literature regarding evaluation of healthcare workers (HCWs) knowledge of CVCs, especially amongst anaesthetists. The aim of this study was to determine the anaesthetists' knowledge of CVCs in the Department of Anaesthesiology at the University of the Witwatersrand (Wits).

Methods

A prospective, contextual, descriptive research design was employed in this study using a self-administered questionnaire developed following review of the literature. The study population consisted of all anaesthetists working in the Department of Anaesthesiology at Wits. A convenient sampling method was used and completion of the questionnaire implied consent. Adequate knowledge was defined as a score above 15.5 out of 25 (62%) as determined using the Angoff method.

Results

The anaesthetists' mean score was 13.1 (SD 3.1) 52.4% which showed inadequate knowledge of CVCs in the department. Of the 27 (21.4%) anaesthetists who had adequate knowledge, 17 (63%) were seniors and 10 (37%) were juniors. Seniors had a mean score out of 25 of 14.1 (SD 2.4) and juniors 12.1 (SD 3.6). Overall, seniors' knowledge was better than juniors' ($p=0.0005$) but there was no significant difference between the seniors and juniors who obtained adequate knowledge ($p=0.199$). Anaesthetists scored the lowest in the infection control section with a median of 4 out of 10 (40%).

Conclusion

The level of knowledge with regards to central venous catheters was inadequate. There is a need to improve this knowledge by providing more teaching and assessment around the subject particularly with regards to infection control measures.

Acknowledgements

Many thanks to my supervisors, Helen Perrie, Juan Scribante and Palesa Mogane for the hard work in accomplishing this work. I would also like to thank the Wits Department of Anaesthesia without which the research would not have been possible.

Special mention to my family, especially my wife Lusu for all the support during the entire process. A dedication to my late mother, whose entire life was given to her children's success.

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Abbreviations

AAGBI	Association of Anaesthetists of Great Britain and Ireland
ASA	American Society of Anesthesiologists
CDC	Centers for Disease Control and Prevention
CLABSI	Central line associated blood stream infections
CVC	Central venous catheter
ECG	Electrocardiogram
FV	Femoral vein
HCW	Health care worker
ICU	Intensive care unit
IJV	Internal jugular vein
SASA	South African Society of Anaesthesiologists
SCV	Subclavian vein

Statement

The Research Report consists of a literature review, draft article, study proposal and appendices. The study proposal is included for background reference and is not for examination.

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article is in keeping with the rest of the Research Report thus may not comply with the author guidelines of the South African journal of Anaesthesia and Analgesia (SAJAA), the journal to which it is intended to be submitted.

Section 1: Review of the literature

1.1 Introduction

Of all hospitalised patients, about 8% require central venous access (1). Central venous catheters (CVC) are used in the emergency department, general wards and in the peri-operative period extending into the intensive care unit (ICU). As early as 1998 there were more than 15 million cumulative catheter days per year in the United States of America (2, 3). It is therefore pertinent for health care workers (HCWs) involved in CVC insertion and management to have sound knowledge to reduce complications.

The central venous catheterisation process commences with the decision to insert the catheter and continues right up to monitoring for complications after its removal. According to Boon et al (4) this process includes indications for insertion; selection of equipment; monitoring and positioning of the patient; insertion technique; confirmation of catheter position; management of the CVC; infection control measures; removal of the catheter and management of complications during the entire process. Lack of knowledge regarding the anatomy and the procedure results in complications or even unsuccessful insertion of CVCs (4). It is important to know the HCWs' baseline knowledge with regards to central venous catheterisation to allow targeted education to reduce complications. Central venous catheterisation will be discussed regarding the classification of CVCs, indication, insertion technique, complications and the HCWs' knowledge of the guidelines around CVCs.

1.2 Central venous catheterisation

1.2.1 Classification of central venous catheters

CVCs may be classified according to the insertion site or technique, that is, peripherally or centrally inserted and tunnelled or non-tunnelled respectively. Peripherally inserted CVCs are inserted through the basilic or cephalic veins in the arm as opposed to those centrally inserted through the great vessels (5). Possible sites for central insertion are the internal jugular vein (IJV), the subclavian vein (SCV) and the femoral vein (FV). The selection of the insertion site is dependent on several factors such as the indication for central venous

catheterisation, duration of use and the HCW's experience (6). Tunnelled catheters can be inserted surgically into the central veins and then tunnelled under the skin. They allow venous access for long periods compared to non-tunnelled catheters which are inserted for short periods (7). This makes the use of non-tunnelled CVCs more common in emergency scenarios or where short term access is needed (8). Non-tunnelled, centrally inserted CVCs will be the focus of this literature review.

1.2.2 Indications and site selection

The indications for central venous catheterisation include factors such as administration of irritant drugs, administration of inotropes, rapid administration of intravascular fluid, administration of total parenteral nutrition, haemodynamic monitoring (for example, central venous pressure and oxygen saturation) and haemodialysis or hemofiltration (1). The expected duration of use of the CVC is equally important. For long term use, in a possibly ambulatory patient, a tunnelled CVC is preferred (7). It is prudent for the HCW to have an appropriate indication for the insertion of a CVC because the procedure is associated with complications that the HCW must be able to recognise and manage (9).The selection of the site is influenced by the indication for insertion. For example with haemodynamic monitoring, upper extremity sites are more appropriate because of the need to have the tip of the CVC in the thorax (10).

The insertion site may be chosen so that it does not interfere with the surgery. To reduce the rate of central line associated blood stream infections (CLABSI), the SCV is the preferable insertion site compared to the IJV and FV (11). However, the IJV and FV insertion sites allow better management of complications such as arterial trauma due to the ability to compress the damaged blood vessels (12).

Patient comorbidities should also be reflected upon when inserting a CVC. For example, in a patient with coagulopathy a site in which compression of the blood vessels is easy is preferred. According to a review by Taylor and Palagiri (13) the SCV would not be an ideal site in the setting of coagulopathy because it is not amenable to compression.

Infection control is an important factor when inserting CVCs. Conley (14) concludes that CLABSI prevention targets heavy microbial colonisation at the insertion site as one of the

key strategies. Sites with septic wounds should, therefore, be avoided since they may increase the risk of CLABSI. In a meta-analysis in 2015, Parienti et al (15) found that the SCV was superior to the IJV and FV with regards to CLABSI. However, in a review by Frykholm et al (16), in 2014, there was no difference in the rates of infection when comparing the SCV, IJV and FV sites possibly due to the implementation of the new guidelines for the prevention of CLABSI at that time.

According to Heffner and Androes (1), operator experience is related to better success rates with fewer mechanical complications in central venous catheterisation. The HCW's own experience and knowledge is thus important in determining the site at which to insert a CVC and the technique used. HCWs should use a site in which they are familiar with the technique, possible complications and the management thereof (1).

1.3 Insertion of Central Venous catheters

1.3.1 Patient preparation and equipment

Prior to central venous catheterisation the patient needs to be appropriately counselled. This must include the indications, the techniques and the possible complications (17). On commencement of the procedure patient monitoring should at least be a continuous electrocardiogram (ECG) and pulse oximetry (1).

The location in which the procedure is performed is important. In a review article, LeMaster et al (18) found that CVCs placed in the emergency department stayed in situ for longer, had higher infection rates and maximum barrier precautions were poorly adhered to when compared to those placed in other wards or departments in the hospital CVCs.

After considering the indications, the appropriate insertion site, patient factors and the HCW's capability the equipment to be used must be prepared. The equipment needed includes; a bed that allows tilt into the Trendelenburg position, chlorhexidine with alcohol wash, sterile draping, local anaesthetic, an ultrasound machine if available, a CVC set of appropriate size, diluted heparin flush, gauze, sutures, a blade and a sterile dressing (10).

The HCW performing the procedure must be scrubbed up and wear sterile gloves, a gown, cap and mask with a shield for the eyes (12).

The procedure begins with patient positioning. For insertion into the IJV or SCV, the patient should be in the Trendelenburg position to allow filling of the veins and to reduce compressibility (19). The Trendelenburg position also reduces the risk of venous air embolism during insertion as well as the removal of the CVC (20).

1.3.2 Technique for insertion of central venous catheters

Seldinger (21), in 1953, first described a method of insertion of a catheter into an artery with the use of a needle and guidewire. His technique is now widely used for other forms of venous access including CVC insertion. Ultrasound may be used to identify the vein before puncture (1).

Following insertion, the CVC is secured using sutures and covered with a clear dressing. Following placement, confirmation of the correct position can be done using chest radiography, ultrasound or fluoroscopy. Endocavitatory ECG may also be used to confirm the catheter position during insertion (22).

During the insertion and use of the CVC it is important to practice good infection control measures to reduce the risk of CLABSI. These measures include making sure the ports are wiped with an antiseptic after use, changing of administration sets regularly and removing the CVC as soon as it is no longer needed or if there are signs of infection from the CVC itself (12).

1.3.3 Complications of central venous catheterisation

The entire process from insertion to the removal of the CVC is not without complications. Complications increase the morbidity and mortality and impact on the total cost of health care. In the United States of America, according to the Centers for Disease Control and Prevention (CDC) report (2) from 1998, CLABSI costs up to US $2.3 billion per year with mortality rates as high as 35% (23). In an Italian study from 2010 by Tarricone et al (24), the mean extra cost from CLABSI was €7180 per patient. In a 2014 German study, the median costs per CVC associated blood stream infection was €29 909 (25). In a 2015

Japanese Study, the additional cost was $57 090 per case with CVC related blood stream infection (26).

The complication rates for central venous catheterisation are high and warrant stringent measures to reduce them. In a review by McGee and Gould (27), the overall complication rate for CVCs is given as about 15%, with mechanical complications ranging from 5 to 19%, infectious complications occurring in 5 to 26% of patients and thrombotic complications occurring in up to 26% of patients.

Immediate complications are those such as failure to insert the CVC, arterial puncture, bleeding, myocardial perforation during insertion, pneumothorax, haemothorax, thoracic duct injury, nerve damage, arrhythmias and air embolism whereas late complications include CLABSI, venous thrombosis, pulmonary embolus and CVC migration. Fewer mechanical complications are associated with increased operator experience, the site of insertion, the number of attempts at insertion and the use of ultrasound guidance (28).

1.4 Central venous catheterisation guidelines

In 2011, a survey was conducted during the development of the practice guidelines for central venous access by the American Society of Anesthesiologists (ASA) Task Force on central venous access asking for recommendations from experts (12). According to the authors, these guidelines (from now on referred to as ASA guidelines) “provide basic recommendations that are supported by a synthesis and analysis of the current literature, expert and practitioner opinion, open forum commentary, and clinical feasibility data ” (12). The ASA guidelines were specifically intended for anaesthesiologists, but as the authors mention, they may be used by other HCWs who are involved with patients with CVCs.

The ASA guidelines (12) address four key areas which are resource preparation, prevention of infectious complications, prevention of mechanical trauma and management of arterial trauma or other injuries from central venous catheterisation.

The CDC, in 2011, published the “Guidelines for the Prevention of Intravascular Catheter-Related Infections” (29) (from now on referred to as the CDC guidelines), replacing the

2002 guidelines. The guidelines mainly address the prevention of infectious complications but also give recommendations for the prevention of non-infectious complications.

The Association of Anaesthetists of Great Britain and Ireland (AAGBI) in “Safe Vascular Access 2016” (from now on referred to as AAGBI guidelines) summarised certain key recommendations on safe central venous catheterisation and removal (17).

The South African Society of Anaesthesiologists (SASA) Guidelines for Infection Control in Anaesthesia in South Africa 2014 (11) (from now on referred to as SASA guidelines) were aimed at the prevention of infective complications of central vascular access and say little about the prevention of mechanical complications. The recommendations in these guidelines were in line with the current literature at the time of publication.

The four key areas as outlined in the ASA guidelines (12) will be addressed incorporating the CDC (29), AAGBI (17) and SASA (11) guidelines.

1.4.1 Resource availability and preparation

The ASA guidelines (12) recommend the use of a protocol for central venous catheterisation which involves an assistant, standardised equipment and an environment that allows the use of an aseptic technique. The availability of a policy or protocol is echoed in the AAGBI guidelines (17) to help reduce complications. In the ICU setting the CDC guidelines (29) advocate for an appropriate number of nursing staff since higher patient-to-nurse ratios are associated with more central line infections.

According to the SASA guidelines (11), the SCV is the recommended site of insertion as it has the lowest incidence of infection. The use of ultrasound is recommended to reduce the number of attempts at insertion and thus reduce the possible mechanical complications (12).

The AAGBI guidelines (17) include the following important recommendations with regards to preparation. Patient counselling is to be done and consent obtained according to local guidelines. With regard to the choice of device, the recommendation is to use the device with the minimum number of ports and with the narrowest diameter possible to reduce the risk of venous thrombosis (17).

1.4.2 Prevention of infectious complications

Infectious complications may be prevented with appropriate site selection, insertion and management of the CVC (29). An insertion site in the upper body is recommended where clinically appropriate, to reduce the infection risk (29). Prophylactic intravenous antibiotics are not to be given routinely but may be considered on an individual basis in patients who are immunocompromised (12). The use of an aseptic technique is strongly advised and should include full patient draping, cap, mask, sterile gown and gloves (29). The SASA (11) and ASA (12) guidelines recommend that the cleaning solution be chlorhexidine containing and if contraindicated or unavailable, then povidone-iodine or alcohol can be used instead. The SASA (11) and CDC (29) guidelines advocate the use of a cleaning solution with at least 0.5% chlorhexidine in 70% alcohol for skin preparation.

In line with the reduction of CVC related infections, it is recommended that the catheter insertion site as well as the need for the CVC is assessed daily and that it be removed once it is no longer needed (12). For CVCs inserted under emergency circumstances or where aseptic techniques were not employed, the CDC recommends replacement of the catheter as soon as possible within the next 24 hours (29).

The SASA guidelines (11) recommend the use of antimicrobial impregnated catheters or dressings in centres where the rate of CLABSI has not been decreasing. Their use should be on a case by case basis according to both the SASA (11) and ASA (12) guidelines, however, these should not be a substitute for the use of infection control measures. Antibiotic creams or ointments should not be used on insertion sites as these may promote fungal growth (29) and transparent dressings should be replaced at least every seven days and gauze dressings at least every two days (29).

According to the SASA guidelines (11), administration sets are to be changed within the following time frames: every 12 hours for sedative drugs carried in a fat emulsion, every 24 hours for blood or blood products and for nutritional lipid emulsions not earlier than 4 days unless otherwise indicated. These guidelines on the administration sets are similar to those from the CDC (29).

The length of time that a central venous catheter remains in situ depends on clinical indications, and removal is recommended when there is no longer a need for the CVC or there is evidence of infection (12, 29). In the event of catheter related infection, a new CVC must be inserted at a different site (12) and CVC exchange avoided (29). The CDC guidelines (29) recommend the use of a sutureless securement device to help reduce the infection risk.

1.4.3 Prevention of mechanical complications

The benefits of reduced infections should always be weighed against the risks of mechanical complications when selecting an insertion site (29). The site selection, the number of insertion attempts and the use of a particular technique must be based on the HCWs own skill and experience (11, 12, 17). Coagulopathy poses a major problem with haemostasis in the event of accidental arterial puncture. In coagulopathic patients, correction is necessary when platelet count is below 50×10^9 L^{-1} or the international normalised ratio is above 1.8 (17). It is also noteworthy that prolonged clotting time has a reduced risk of bleeding as compared to thrombocytopenia during CVC insertion (1). Insertion sites where haemostasis may be aided through compression are recommended in coagulopathic patients (12).

The use of either static or real-time ultrasound is strongly advised where clinically appropriate to visualise the vessels and surrounding anatomy (11, 12, 17). According to the AAGBI guidelines (17), the guidewire should not be inserted more than 20 cm to reduce the risk of myocardial perforation. The patients that are at greatest risk are infants and those that have dilated cardiomyopathy. The recommended fixed catheter length is 15 cm for the right IJV, 20 cm for the right SCV and the left IJV and 24 cm for the left SCV (17). The CDC guidelines (29) recommend that the SCV should be avoided for haemodialysis to minimise the risk of SCV stenosis in patients with chronic kidney disease.

According to the ASA guidelines (12), on insertion of the guidewire or catheter, confirmation should be done using ultrasonography, manometry, pressure wave analysis or venous blood gas measurement. The use of blood colour or pulsatile flow is not recommended for confirmation of venous placement (12). In the placement of CVCs before or during surgery, confirmation of tip placement can be done using chest

radiography, continuous ECG or fluoroscopy as soon as possible in the post-operative period (12).

1.4.4 Management of mechanical complications.

In the event of the catheter or dilator being inserted into an artery, the ASA guidelines (12) stipulate that these should be left in situ and consultation with a surgeon (general or vascular) or an interventional radiologist be sought to determine the safest method of removal. The decision, however, should be based on the HCW's judgement and experience in the case of the paediatric population. In theatre, it is up to the HCWs involved to determine whether an elective surgery should continue or not after treatment of the complication (12).

Venous air embolism (VAE) is quoted as having an incidence of up to 0.8% by Nayeemuddin et al (30). Although this may be low, its occurrence can be fatal. This can be prevented by ensuring the catheter exit site is below the level of the heart during CVC removal. In the event of VAE, the patient may be put into the left lateral and Trendelenburg position to allow suctioning of the air through the catheter (30).

The AAGBI guidelines (17) recommend the involvement of the appropriate multidisciplinary team to manage the relevant CVC related complications. The early identification of life-threatening complications such as myocardial perforation, arrhythmias, pneumothorax, haemothorax and VAE is essential. Early imaging may not necessarily identify the presence of all complications and HCWs should be able to identify late signs (17).

The use of guidelines with regards to central venous catheterisation is intended to reduce complications when put into practice but do not guarantee the desired effect (12). Knowledge of these recommendations is important in clinical practice.

1.5 HCWs' knowledge regarding CVC

Different studies have been conducted to assess HCWs' knowledge regarding central venous catheterisation. The HCWs involved with CVCs range from the workers who insert, assist with insertion, prescribe medication, administer drugs via the CVC, maintain the

CVC and remove the CVC from the patient (29). All these individuals need to have knowledge about CVCs to be able to manage them appropriately.

Studies may assess the knowledge, attitudes or practices of HCW with regards to different aspects of CVCs. Of interest are the studies conducted to assess the knowledge of HCWs with regards to CVCs. The literature is divided into that evaluating HCWs' knowledge of central venous catheterisation regarding infection control and the insertion technique.

1.5.1 Knowledge regarding prevention of central venous catheter related infections

Labeau et al (31) developed a questionnaire to evaluate the knowledge of critical care nurses of the evidence based CDC guidelines for the prevention of CVC related infections. The questionnaire evaluated knowledge of the appropriate disinfectant to clean the insertion site, the appropriate dressings, the use of antibacterial ointment and timelines for changing the CVCs and infusion sets. The questionnaire was evaluated by a panel of seven experts who assessed it for content and face validity. The questionnaire was first completed by 762 ICU nurses and the results used to assess for the difficulty. It was then revised based on the experts' recommendations (31). Since CVC use is not limited to the ICU, this questionnaire may be applied to different HCWs, however, the limitation as noted by the author is that it may be biased because the nurses who completed the questionnaire during its development were specifically based in ICU.

The landmark study in this field is the follow up European multi-centre study by Labeau et al (32) to evaluate the knowledge of ICU nurses of the evidence based guidelines for the prevention of CVC related infections. The study spanned 22 countries and a total of 3405 questionnaires were completed. The mean score for the test was 44.4%, with the performance of nurses with more experience being significantly better than that of inexperienced nurses. The authors concede that the assumption that the nurses would have high scores in the test was not true. Although the questionnaire was based on aspects of CVCs that were the nurses' sole responsibility, they still scored lower than expected. The authors concluded that there was room for improving ICU nurses' knowledge of CVC related infection prevention guidelines (32).

The questionnaire developed by Labeau et al (31) was used in a study by Csomós et al (33) in Hungary. A total of 178 questionnaires were completed and the mean score for the test was 37%. In their findings, professional seniority was not associated with higher scores for the test. Of note is that pertinent questions regarding the use of 2% chlorhexidine as the recommended disinfectant were answered correctly by as few as 20% of the candidates in this study and 14% in the Labeau study in Europe (32). It was also concluded that the knowledge of Hungarian nurses regarding CVC-related infection was poor (33).

In a study by Dedunska and Dyk (34), a questionnaire based on the one by Labeau et al (31) was distributed amongst Polish nurses. There were 784 respondents with a mean score of 54%. The authors concluded that the nurses knew 55% of the guidelines in the questionnaire. With regards to the appropriate disinfectant, only 18.9% of the nurses who worked outside the ICU knew the correct cleaning solution to use compared to 49.9% of those who worked in ICU. Post graduate trained nurses in ICU scored higher compared to those without post graduate training. The authors concluded that there was a lack of knowledge in this field. However, some of the incorrect responses were attributed to the different hospital policies which may not align directly with the latest guidelines. Post graduate training seems to help improve the knowledge of nurses with regards to CVC (34).

Ullman et al (35) evaluated paediatric ICU nurses' knowledge and practice with regards to the prevention of CVC related infections. The mean score in this test was 55%. There was no association between years of experience or higher education and the knowledge of the recommendations for infection prevention. The authors recommended a strategy to improve the nurses' understanding and the use of the best practice based on recommendations from guidelines through nursing education and the use of bundles and checklists (35).

In a Chinese study by Chen et al (36), 455 ICU nurses answered a questionnaire based on the 2011 CDC guidelines (29). These guidelines summarised 11 points with regards to CVC insertion and maintenance to prevent infection. The mean score was 40.8%. The study found that nurses who had received guideline training scored higher than those who had

not. The study concluded that the knowledge of the nurses in China with regards to CVC related infection prevention guidelines was low and this could pose a safety risk to patients (36).

In a Greek survey of ICU HCWs regarding the knowledge and practices of prevention of CVC-related infections by Koutzavekiaris et al (37), 345 doctors and nurses completed a questionnaire. The mean score for the knowledge section was 42.9%. It is important to note that the questionnaire in this study was not validated. The study showed that doctors scored better than nurses in theoretical knowledge, whereas the nurses scored better in areas that concerned the maintenance of the CVCs. This was attributed to the fact that the nurses scored best in areas that were mainly their responsibility. In areas that concerned mainly doctors, only 13.6% of the doctors answered all the questions correctly. The study also showed an association between seniority and awareness of guidelines and higher scores. According to the authors, seniority in this study was in terms of age and therefore makes it difficult to compare with the other studies that looked at professional seniority (37).

In an Egyptian study in 2015 by Alkubati et al (38), similar results were found in that nurses had better knowledge than doctors with regards to CVC care. However, there was no significant difference in the doctors' and nurses' overall knowledge. This study also showed that the level of HCWs' knowledge with regards to CVC related infection and the guidelines was low and it recommended regular evaluation of practices and knowledge of the subject (38).

1.5.2 Knowledge regarding insertion technique and management

Studies that have assessed the knowledge of HCWs with regards to central venous catheterisation focusing on the insertion technique aimed at the reduction of the non-infective complications are not common. In a Turkish nursing study (39) in 2014, a total of 151 nurses answered a self-administered questionnaire. There were 55 questions in total, of which 32 of the questions were concerning the knowledge of the nurses regarding the application, care and complications of both peripheral and central venous catheters (39). The Turkish acceptable standard score for adequate knowledge is 70%. University educated nurses performed significantly better than college trained nurses with a 79.1%

success rate versus 62.5% respectively. The mean score for the entire questionnaire was 72.3% which is above the minimum acceptable Turkish standard. The percentage of successful candidates on central venous and peripheral venous catheterisation application, care, and complications was 73.6%. From the results of the study, the authors conclude that increased years of experience brought about more success in the test (39). Nurses who were not involved directly with the care of CVCs in their practice post insertion scored poorly compared to those who did. This seems to further reiterate that experience in CVC care may result in better knowledge of the subject. These findings, however, according to the authors, may need to be validated by a much larger study (39). Regarding knowledge of HCWs in the prevention of CVC related infections the findings in this study are similar to those by Labeau et al (32) in that the more experienced nurses performed better than inexperienced ones.

In an interventional study, the competency and knowledge of anaesthesiology residents with regards to central venous catheterisation was assessed within three days before and within three days after simulation training (40). The assessment of the anaesthetists' knowledge was based on a multiple-choice questionnaire that covered aspects regarding indications, insertion technique and complications. According to the authors, the questionnaire was based on the latest evidence at the time of the study and was validated. Before training, the mean score for the questionnaire was 76%. A significant improvement of the mean score to 87.7% was recorded after training. The mean score before training is comparable to the Turkish nurses' study where it was 72.3% in their questionnaire (39). In this interventional study, the authors conclude that training improves both competency and knowledge of central venous catheterisation. To be able to monitor effectiveness of such an intervention, it is important to regularly evaluate the level of knowledge of the HCWs. The CDC (29) recommends the continuous assessment of HCWs' knowledge and adherence to the published guidelines.

1.6 Summary

Generally, the overall knowledge of the HCWs with regards to the prevention of CVC related infections is poor. There is a paucity of literature on the evaluation of HCWs, especially doctors' knowledge with regards to central venous catheterisation guideline

aspects that are not infection related. There is a place to add to the non-infection related aspect of the evaluation of HCWs knowledge of central venous catheterisation based on available guidelines.

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Section 2: Author's guidelines

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Acknowledgements

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Cite references in numerical order in the text, in superscript format (Format> Font> Click superscript). Please do not use brackets or do not use the foot note function of MS Word.

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The following are sample references:

1. Jun BC, Song SW, Park CS, Lee DH, Cho KJ, Cho JH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.
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10. All numbers below ten, without percentages or units, must be written in words.
11. Figure numbers: Arabic, table numbers: Roman

Section 3: Draft article

Anaesthetists' knowledge of central venous catheters in a department of anaesthesiology

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Key words: Knowledge, central venous catheterisation, anaesthetists

Abstract

Background

Central venous catheters (CVCs) are used in the emergency department, general wards and in the peri-operative period extending into the intensive care unit (ICU). This wide usage of CVCs is accompanied by high complication rates. In South Africa there is paucity of literature regarding evaluation of healthcare workers (HCWs) knowledge of CVCs, especially amongst anaesthetists. The aim of this study was to determine the anaesthetists' knowledge of CVCs in the Department of Anaesthesiology at the University of the Witwatersrand (Wits).

Methods

A prospective, contextual, descriptive research design was employed in this study using a self-administered questionnaire developed following review of the literature. The study population consisted of all anaesthetists working in the Department of Anaesthesiology at Wits. A convenient sampling method was used and completion of the questionnaire implied consent. Adequate knowledge was defined as a score above 15.5 out of 25 (62%) as determined using the Angoff method.

Results

The anaesthetists' mean score was 13.1 (SD 3.1) 52.4% which showed inadequate knowledge of CVCs in the department. Of the 27 (21.4%) anaesthetists who had adequate knowledge, 17 (63%) were seniors and 10 (37%) were juniors. Seniors had a mean score out of 25 of 14.1 (SD 2.4) and juniors 12.1 (SD 3.6). Overall, seniors' knowledge was better than juniors' ($p=0.0005$) but there was no significant difference between the seniors and juniors who obtained adequate knowledge ($p=0.199$). Anaesthetists scored the lowest in the infection control section with a median of 4 out of 10 (40%).

Conclusion

The level of knowledge with regards to central venous catheters was inadequate. There is a need to improve this knowledge by providing more teaching and assessment around the subject particularly with regards to infection control measures.

Background

Central venous catheters (CVC) are used in the emergency department, general wards and in the peri-operative period extending into the intensive care unit (ICU). Up to 8% of all hospitalised patients may require central venous access during their hospital stay (1). This wide usage of CVCs is accompanied by high complication rates. In a review by McGee and Gould (2) in 2003, the overall complication rate for CVCs is given as about 15%, with mechanical complications ranging from 5 to 19%, infectious complications occurring in 5 to 26% and thrombotic complications occurring in up to 26% of patients. In a study in 2007, the incidence of adverse events was 12.2% (3). These complications are also associated with increased health care costs.

Improved patient outcomes, reduced complications and reduced health care costs have been associated with the adherence to published guidelines (4). Guidelines based on current evidence have been published for the health care workers (HCW) who are involved in the care of CVCs (5, 6). The American Society of Anaesthesiologists guidelines (5) incorporate resource preparation, prevention of infective complications and prevention and management of mechanical complications. These same aspects are also incorporated in the Association of Anaesthetists of Great Britain and Ireland guidelines (6). The South African Society of Anaesthesiologists guidelines (7) for infection control follow the Centers for Disease Control and Prevention (CDC) guidelines (4).

It has also been shown that one of the barriers to the application of evidence based guidelines is the lack of knowledge of HCWs (8) however, an improved level of knowledge does not always translate to application. Studies have looked at the HCWs knowledge of CVCs in different contexts and found it to be poor (9-12). These studies recommended educational interventions to improve the level of knowledge. However, most studies focus on knowledge of HCWs regarding central venous catheter related infections, with little focus on other aspects such as mechanical complications.

In South Africa there is a paucity of literature regarding the evaluation of HCWs knowledge of CVCs, especially amongst anaesthetists. The aim of this study is to

determine the anaesthetists' knowledge of CVCs in the Department of Anaesthesiology at the University of the Witwatersrand (Wits).

Methods

A prospective, contextual, descriptive research design was employed in this study. Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical) at Wits and other relevant authorities.

The study population consisted of all anaesthetists working in the Department of Anaesthesiology at Wits. Convenient sampling was used and the sample size was realised by the response rate. At the time of the study the department consisted of 208 anaesthetists. All anaesthetists at academic meetings were approached and a minimum response rate of 60% (125) was considered acceptable (13). Interns were excluded from the study. Junior anaesthetists were defined as medical officers and registrars in their first three years of training and senior anaesthetists as consultants, career medical officers (more than ten years of experience) and registrars with more than three years of training.

Following a review of the literature, questions from two studies, Cartier et al (14) and Labeau et al (15), were identified as appropriate for this study. Permission to use and adapt these questionnaires was received from the authors. Further questions were formulated from the reviewed literature and a draft questionnaire was developed. All questions were adapted to single best answer format. The draft questionnaire was given to three senior anaesthesiologists and one senior intensivist to review. The questionnaire was finalised following incorporation of their comments. Content validity of the questionnaire was ensured by reviewing the literature, incorporating two published questionnaires and the review by four senior physicians. Face validity was ensured by the review of the four senior physicians.

The Angoff method (16) was used to determine the definition of adequate knowledge (pass mark) cut off score of 15.5 out of 25 (62%). Each question was allocated one mark. The questionnaire consisted of the following sections: participants' demographics, indications for insertion, technique of insertion, infection control and management of complications.

The questionnaire was distributed at departmental academic meetings. One author (GM) was present during the completion of the questionnaire to answer any questions and to prevent data contamination. On completion, the participants folded the questionnaire and placed it in a sealed collection box. Return of the questionnaire implied consent.

Questionnaires returned blank were excluded from the study and questions not answered were considered incorrect. Data were captured on a Microsoft Excel spread sheet and analysed using GraphPad Instat (GraphPad.com) version 3.00. Categorical variables were reported using frequencies and percentages and scores as means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparisons between scores of senior and junior anaesthetists were done using either an unpaired t test or the Mann-Whitney test. A chi-square test was done to determine whether there was a significant difference between senior and junior anaesthetists who achieved an adequate score. A p value of less than 0.05 was considered statistically significant.

Results

A total of 154 questionnaires were handed out and 132 (85.7%) were returned. Of these, 6 (3.9%) were blank, resulting in a sample realisation of 126 (81.8%) anaesthetists representing 60.6% of the department. The characteristics of the anaesthetists are illustrated in Table I. There were 64 (50.7%) senior, 60 (47.6%) junior anaesthetists and 2 (1.6%) did not indicate their professional designation.

Table I: Characteristics of anaesthetists

Characteristics	Number	Percentage
Sex		
Male	39	30.9
Female	83	65.9
Not answered	4	3.2
Professional designation		
Medical officer	16	12.6
Registrar ≤ 3 years	44	34.9
Registrar > 3 years	14	11.1
Consultant	50	39.7
Not answered	2	1.7

The mean score obtained by the anaesthetists for the questionnaire was 13.1 (SD 3.1) out of 25. Of the 27 (21.4%) anaesthetists who had adequate knowledge, 17 (63%) were seniors and 10 (37%) were juniors. In a comparison of whether anaesthetists had adequate knowledge or not, no significant difference was found between seniors and juniors ($p = 0.199$). Neither of the 2 (1.6%) anaesthetists who did not identify their professional designation had adequate knowledge. The number of correct answers, per question, for all the anaesthetists who participated and for the seniors and juniors is shown in Table ll.

Table II: Correct answers per question

Question Description	Number of correct answers		
	Overall n = 126 n (%)	Seniors n = 64 n (%)	Juniors n = 60 n (%)
Indications			
Indication for insertion	114 (90.5)	63 (98.4)	50 (83.3)
Types of catheters and insertion risks	95 (75.4)	55 (85.9)	40 (66.7)
Replacement of CVCs	47 (37.3)	25 (39.1)	22 (36.7)
Indications for CVC removal	110 (87.3)	57 (89.1)	52 (86.7)
Technique			
Removal of CVC	33 (26.1)	23 (35.9)	9 (15)
Monitoring during insertion	119 (94.4)	61 (95.3)	56 (93.3)
Neck anatomy	48 (38.1)	23 (35.9)	23 (38.3)
Femoral anatomy	112 (88.9)	61 (95.3)	50 (83.3)
Insertion under ultrasound guidance	112 (88.9)	62 (96.9)	49 (81.7)
Subclavian vein CVC insertion	20 (15.8)	12 (18.8)	8 (13.3)
Confirming CVC placement	110 (87.3)	58 (90.6)	50 (83.3)
Placement confirmation using ECG p wave analysis	12 (9.5)	8 (12.5)	4 (6.7)
Complications			
Types of catheters and complication risks	55 (43.7)	31 (48.4)	24 (40)
Complications of CVC insertion (arrhythmias and trauma)	117(92.9)	62 (96.9)	53 (88.3)
Mechanical complications and positioning of CVC	47 (37.3)	27 (42.2)	19 (31.7)
Infection control			
Replacement of lipid emulsion infusion sets with	12 (9.5)	8 (12.5)	5 (8.3)
Replacement of blood administration sets	62 (49.2)	36 (56.3)	24 (40)
Care of the CVC	64 (50.8)	33 (51.6)	29 (48.3)
Use of prophylactic antibiotics	52 (41.3)	26 (40.6)	24 (40)
SASA guideline knowledge	57 (45.3)	30 (46.9)	26 (43.3)
Insertion site antibiotic ointment	12 (9.5)	5 (7.8)	8 (13.3)
Transducer and IV set replacement	16 (12.7)	7 (10.9)	8 (13.3)
Dressing replacement	75 (59.5)	40 (62.5)	35 (58.3)
Aseptic preparation	98 (77.8)	56 (87.5)	41 (68.3)
Catheter related infections	51 (40.5)	34 (53.1)	16 (26.7)

Comparisons were made between the senior and junior anaesthetists for the questionnaire as a whole and for each of the sections. There was a statistically significant difference between the scores with seniors achieving higher scores for all except the complications section where there was no significant difference. This is shown in Table III.

Table III: Comparison of the senior and junior anaesthetists' scores

Section	Total mark	Overall		Seniors		Juniors		P value
		Mean (SD)		Mean (SD)		Mean (SD)		
All sections	25	13.1 (3.1)		14.1 (2.4)		12.1 (3.6)		0.0005
		Med (IQR)	Range	Med (IQR)	Range	Med (IQR)	Range	
Indication	4	3 (2-4)	0-5	3 (1-4)	1-5	3 (2-4)	0-5	0.0399
Technique	8	4 (4-5)	2-7	4 (4-5)	3-8	4 (3-5)	2-6	<0.0001
Infection	10	4 (3-5)	0-8	4 (3-5)	0-7	3 (3-5)	0-8	0.0158
Complications	3	2 (1-2)	0-3	2 (1-2)	0-3	2 (1-2)	0-3	0.1174

Discussion

The CDC (4) recommends continuous assessment of HCWs to improve knowledge and adherence to guidelines . In our study, there was inadequate knowledge of CVCs amongst anaesthetists in the department regarding indications, technique, complications and infection control. The mean score of 13.1 out of 25 (52.4%) fell below the pass mark of 15.5 (62%) for this questionnaire, indicating that there is room for improvement within our context. These low scores may be attributed to a lack of training and testing of anaesthetists regarding CVCs and that guidelines knowledge is not emphasised in the department.

It was difficult to compare the results with most other research as our study focused on anaesthetists and included all aspects of CVC placement and use whereas most other studies assessed nurses and focused on infection control. Forty percent of the questionnaire in our study pertained to infection control. The median score for the infection control section was 40% which was the lowest of the four sections. Nurses, in the study by Labeau et al (15), achieved a mean score of 44.4%, which the authors stated was low. The same questionnaire was used in a study in Hungary of doctors' and nurses' knowledge and the mean was also low, being 37%, indicating inadequate knowledge with regards to CVCs and infection control (17).

In other studies, the knowledge of HCW with regards to infections was found to be poor with mean scores ranging from 40% to 55% (9-12). This is of concern, considering that the

rate of infectious complications related to CVCs range from 5 to 26 % in some centres (2, 18, 19). In a Turkish study by Arslan et al (20), however, adequate knowledge regarding CVCs was found. In this study the nurses scored a mean of 72.3% which was attributed to the fact that the nurses worked with the CVCs frequently, implying the effect of experience on knowledge. The questions obtaining the lowest scores in our study were those pertaining to antibiotic ointment, administration sets and infection control in general. This may be the case because anaesthetists in the department spend more time in theatre compared to ICU and the wards and hence have less experience concerning long term infection control measures in these settings.

Looking at the impact of CLABSI on patient morbidity, mortality and costs, the pass mark of 62% in our study may have been too low. According to the CDC report (21) from 1998, CLABSI cost up to US $2.3 billion per year with mortality rates as high as 35% (22) and more recently a 2015 Japanese study found that the additional cost was $57 090 per case with CVC related blood stream infection (23). This suggests that more emphasis needs to be placed on infection control training of anaesthetists in the department.

The median scores represented as percentages in the sections on indications (75%), technique (50%) and complications (66%) were higher than the section on infection control (40%). Overall, the applied knowledge questions had the most correct responses, particularly the questions relating to indications, monitoring and complications of insertion. This may be because anaesthetists insert CVCs frequently. The question on P wave analysis during insertion was, however, poorly answered as this is not routinely practiced in the department. P wave analysis is important to confirm catheter positioning during insertion, although radiographic confirmation is still considered the gold standard (6).

A significant difference in the knowledge of seniors and juniors was found in the European multi-centre study by Labeau et al (9), however, using the same questionnaire in Hungary, Csomós et al (17) found no difference in scores between seniors and juniors. In our study there was a statistically significant difference between scores of seniors and juniors with seniors achieving higher scores for all sections except the one regarding complications where there was no significant difference.

For the questionnaire overall, seniors achieved a mean score of 14.1 (56.4%) and juniors a mean score of 12.1 (48.4%), which was statistically significant. However, whether a difference in score of 2 out of 25 (8%) is clinically significant is questionable. The difference between seniors and juniors may be attributed to the fact that seniors have had more experience compared to juniors and that some juniors may not yet have done their ICU rotation where CVCs are frequently used. This is in keeping with the Turkish study (20) in which they attributed the difference in scores between senior and junior nurses to experience. However, both seniors and juniors in our study had a mean score below what was deemed to be adequate. Importantly, the study was done in the Wits department of anaesthesia and the findings may not necessarily represent the knowledge level of anaesthetists in South Africa.

Conclusion

The level of knowledge with regards to CVCs was inadequate especially with regards to infection control. Knowledge regarding CVCs amongst anaesthetists needs to be improved to ensure safe practice. More teaching, training and regular assessment, as well as making the guidelines available to anaesthetists could improve knowledge. It is, however, recognised that knowledge does not always translate to practice.

Conflict of interest

The authors declare that we have no financial or personal relationships which may have inappropriately influenced us in writing this paper.

Acknowledgement

This research was done in partial fulfilment of a Master of Medicine degree.

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Section 4: Proposal

Anaesthetists' knowledge of central venous catheters in a department of anaesthesiology

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4.1 Introduction and problem statement

Central venous catheters (CVC) are used in the emergency department, general wards and in the peri-operative period extending into the intensive care unit. Up to 8% of all hospitalised patients may require central venous access during their hospital stay (1). This wide usage of CVCs is accompanied by high complication rates. In a review by McGee and Gould (2) in 2003, the overall complication rate for CVCs is given as about 15%, with mechanical complications ranging from 5 to 19%, infectious complications occurring in 5 to 26% and thrombotic complications occurring in up to 26% of patients. In a study in 2007, the incidence of adverse events was 12.2% (3). These complications are also associated with increased health care costs. In a 2010 Italian study by Tarricone et al (4), the mean extra cost from central line associated blood stream infections was € 7180 per patient.

Improved patient outcomes, reduced complications and reduced health care costs have been associated with the adherence to published guidelines (5). Guidelines based on current evidence have been published for the health care workers (HCW) who are involved in the care of CVCs (6, 7). These guidelines are intended to reduce the rate of mechanical and non-mechanical complications and their associated costs.

The American Society of Anaesthesiologists guidelines (6) incorporate resource preparation, prevention of infective complications and prevention and management of mechanical complications. These same aspects are also incorporated in the Association of Anaesthetists of Great Britain and Ireland guidelines (7). The South African Society of Anaesthesiologists guidelines (8) emphasise infection control measures as in the Centers for Disease Control and Prevention (CDC) guidelines (5).

It has also been shown that one of the barriers to the application of evidence based guidelines is the lack of knowledge of HCWs (9) however, an improved level of knowledge does not always translate to application, when it is used, it may help reduce complications.

Several studies have looked at the HCWs knowledge of CVCs in different contexts and found it to be poor (10-13). These studies recommended educational interventions to improve the level of knowledge. However, most studies focus on knowledge of HCWs

regarding central venous catheter related infections, with little focus on other aspects such as mechanical complications.
In South Africa there is paucity of literature regarding evaluation of HCWs knowledge of CVCs, especially amongst anaesthetists.

Problem Statement

CVCs are widely used in medical practice. In the United States of America (USA) alone, over five million CVCs are inserted per year and this accounts for over 15 million catheter days (14). However, the use of CVC is not without complications and these range from minor to major, even including death. This warrants that HCWs be knowledgeable, enabling them to reduce and manage complications.

Several studies (10-13, 15-17) have been conducted to assess the knowledge of HCWs regarding different aspects of CVCs, however, focusing mainly on CVC related infections (CVCRI). The knowledge of HCW has been found to be poor in some studies with mean scores ranging from 40% to 55% (10-13).

HCWs knowledge of CVCs can impact on patient safety (1). The knowledge of anaesthetists with regards to CVCs is unknown in the Department of Anaesthesiology at the University of the Witwatersrand (Wits).

4.2 Aim and objectives

4.2.1 Aim

The aim of this study is to determine the anaesthetists' knowledge of CVCs in the Department of Anaesthesiology at Wits.

4.2.2 Objectives

The primary objectives of this study are to:

- describe the knowledge of the indications for insertion and removal of CVCs
- describe the knowledge of CVC insertion technique
- describe the knowledge of infection control regarding CVCs

- describe the knowledge of the management of complications of CVCs.

The secondary objective of the study is to compare the knowledge of CVCs between junior and senior anaesthetists.

4.3 Research assumptions

The following definitions will be used in the study**.**

Anaesthetist: is any qualified doctor working in the Department of Anaesthesiology including medical officers, registrars and consultants.

Medical officer: is a qualified doctor practising in the Department of Anaesthesiology under specialist supervision**.** Medical officers with more than 10 years of experience are career medical officers and are regarded as consultants.

Registrar: is a qualified doctor who is registered with the Health Professional Council of South Africa as a trainee anaesthetist.

Consultant: is a specialist anaesthetist or career medical officer.

Junior anaesthetists: include medical officers and registrars in their first three years of training.

Senior anaesthetists: include consultants and registrars with more than three years of training.

Adequate knowledge: the Angoff method (18) will be employed to determine adequate knowledge (pass mark).

4.4 Demarcation of study field

The study will be conducted in the Department of Anaesthesiology, affiliated to the Faculty of Health Sciences at Wits. The staff complement of the department is 74 consultants, 112 registrars and 22 medical officers. The following core hospitals are affiliated to the department's training platform;

- Charlotte Maxeke Johannesburg Academic Hospital
- Chris Hani Baragwanath Academic Hospital
- Helen Joseph Hospital
- Rahima Moosa Mother and Child Hospital
- Wits Donald Gordon Medical Centre.

4.5 Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical), the Graduate Studies Committee and the Head of the Department of Anaesthesiology at Wits (Appendix A).

Following approval of the study, anaesthetists will be approached at academic meetings, and following an explanation of the study, invited to participate. Those who agree will be given an information letter (Appendix B) and a questionnaire (Appendix C). The return of the completed questionnaire will imply consent.

To ensure anonymity and confidentiality, no identifying information will be requested from the participants. Upon completion, the questionnaire will be folded and inserted into a sealed collection box. Only the researcher and supervisors will have access to the raw data. The data will be stored securely in a locked cupboard for six years following completion of the study.

The study will be conducted according to the principles of the Declaration of Helsinki (19) and the South African Guidelines for Good Clinical Practice (20).

Should the level of knowledge not be adequate, an educational intervention will be recommended to the department.

4.6 Research methodology

4.6.1 Research design

A prospective, contextual, descriptive research design will be followed in this study.
A prospective study identifies a sample and follows it over time to determine outcomes (21). In this study, data will be collected from anaesthetists to determine their level of knowledge.
Contextual studies are studies that are conducted in a specific environment (21). This study will be contextual as it will be conducted in the Department of Anaesthesiology.
In a descriptive study, information or data are collected without manipulation or alteration of the environment and the findings are then presented to show certain phenomenon as they occur (21). This study will describe the anaesthetists' knowledge with regards to CVCs.

4.6.2 Study population

The study population consists of all anaesthetists working in the Department of Anaesthesiology at Wits.

4.6.3 Study sample

Sample size

The sample size will be realised by the response rate. The department consist of 208 anaesthetists. All anaesthetists at academic meetings will be approached and a minimum response rate of 60% (125) will be considered acceptable (22).

Sampling method

In this study a convenience sampling method will be used. Convenience sampling is when participants are chosen based on their easy availability and accessibility to the researcher (23). In this study, participants will be approached at academic meetings in the Department of Anaesthesiology.

Inclusion and exclusion criteria

The inclusion criteria for this study are:

- anaesthetists attending academic meetings
- anaesthetists who give consent.

The exclusion criterion in this study will be interns working in the department and anaesthetists that helped in designing and evaluating the questionnaire.

4.6.4 Data collection

Questionnaire development

Following a review of the literature, questions from two studies were identified as appropriate for this study (10, 24). Permission to use and adapt these questionnaires was received from the authors (Appendix D).

The questionnaire by Cartier et al (24) was developed in 2008 at the University of Geneva Hospital in Switzerland. The questionnaire was validated by four senior anaesthesiologists using a modified Delphi technique. The questionnaire was translated from French to English by two independent anaesthetists. The two translations were similar and were therefore regarded as accurate. This was the most comprehensive questionnaire identified in the literature.

The questionnaire by Labeau et al (25) was developed in 2008 at Ghent University Hospital in Belgium and its focus was on CVCRI. The questionnaire was evaluated by a panel of seven experts who assessed it for content and face validity. It was completed by 762 intensive care unit nurses and the results used to assess for difficulty. It was then revised based on the experts' recommendations.

Using questionnaires based on Cartier et al (24) and Labeau et al (25) and further questions formulated following an extensive literature review, a draft questionnaire was developed. All questions were adapted to single best answer format. The draft questionnaire was given to three senior anaesthesiologists and one senior intensivist to review. The questionnaire was finalised following incorporation of their comments.

Content validity of the questionnaire was ensured by reviewing the literature, incorporating two published questionnaires and the review by four senior physicians. Face validity was ensured by the review of the four senior physicians.

The Angoff method (18, 26) will be used to determine the adequate knowledge (pass mark). Each question carries 1 mark.

The questionnaire (Appendix C) consists of the following sections:

- participants' demographics
- indications for insertion
- technique of insertion
- infection control
- management of complications.

Data collection

The questionnaire will be distributed at departmental academic meetings. The researcher will ask the convener of the meetings for permission to address the anaesthetists and invite them to participate following an explanation of the study. Those that agree to participate will be given the information letter (Appendix B) and the self-administered questionnaire (Appendix C). The researcher will be present during completion of the questionnaire to answer any questions and to prevent data contamination. On completion the participants will fold the questionnaire and place it in a sealed collection box.

4.6.5 Data analysis

Questionnaires returned blank will be excluded from the study and questions not answered will be considered incorrect. Data will be captured on a Microsoft Excel spread sheet and analysed in consultation with a biostatistician. Descriptive and inferential statistics will be used. Categorical variables will be reported using frequencies and percentages and scores as means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparison between scores of junior and senior anaesthetists will be done using either an unpaired t test or the Mann-

Whitney test. A chi-square or Fisher's exact test will be done to determine whether there is a significant difference between junior and senior anaesthetists who achieve an adequate score. A p value of less than 0.05 will be considered statistically significant.

4.7 Significance of the study

The use of CVCs is not without complications and these range from minor to major, even including death. This warrants that HCWs be knowledgeable, enabling them to reduce and manage complications. Few studies have been conducted to determine the knowledge of HCW regarding aspects of CVCs other than CVCRI.

HCWs knowledge regarding CVCs can impact on patient safety (1). The results from this study may inform the departmental training program.

4.8 Validity and reliability of the study

The validity of a study is the extent to which it reflects the measured characteristics and the reliability of a study refers to the ability of the study to be repeated consistently (23).

The validity and reliability of this study will be ensured by:

- using an appropriate study design
- targeting a representative study sample
- content validity of questionnaire (comprehensive literature review, using previously published questionnaires and review by four senior physicians)
- face validity of questionnaire (review by four senior physicians)
- the researcher being present during data collection to answer any questions and to prevent data contamination
- doing data checks during data entering for accuracy
- analysing data in consultation with a biostatistician.

4.9 Potential limitations

This study is contextual being conducted in the Department of Anaesthesiology at Wits and the findings may not be generalised to other anaesthetic departments.

Data contamination could occur, as in order to ensure an adequate sample size data will need to be collected at more than one academic meeting. The researcher will however not distribute questionnaires at consecutive meetings to prevent this.

The use of convenience sampling may result in selection bias from the researcher and the sample may not be representative of the population (27).

4.10 Project outline

4.10.1 Time frame

	July 2017	Aug 2017	Sept 2017	Oct 2017	Nov 2017	Dec 2017	Feb 2018	Mar 2018	April 2018	May 201	Jun 2018	Jul 2018	AUG 2018
Literature review													
Proposal Preparation													
Proposal submission													
Ethics and Post Grad approval													
NHRC Approval													
Data collection													
Data analysis													
Write up													
Submission													

4.10.2 Budget

Item	Cost	Quantity	**Total**
Paper and printing	R1 per page	2000	R2000
Binding	R 100 per copy	3	R300
Total			**R2300**

The cost of the paper and printing will be incurred by the Department of Anaesthesiology.

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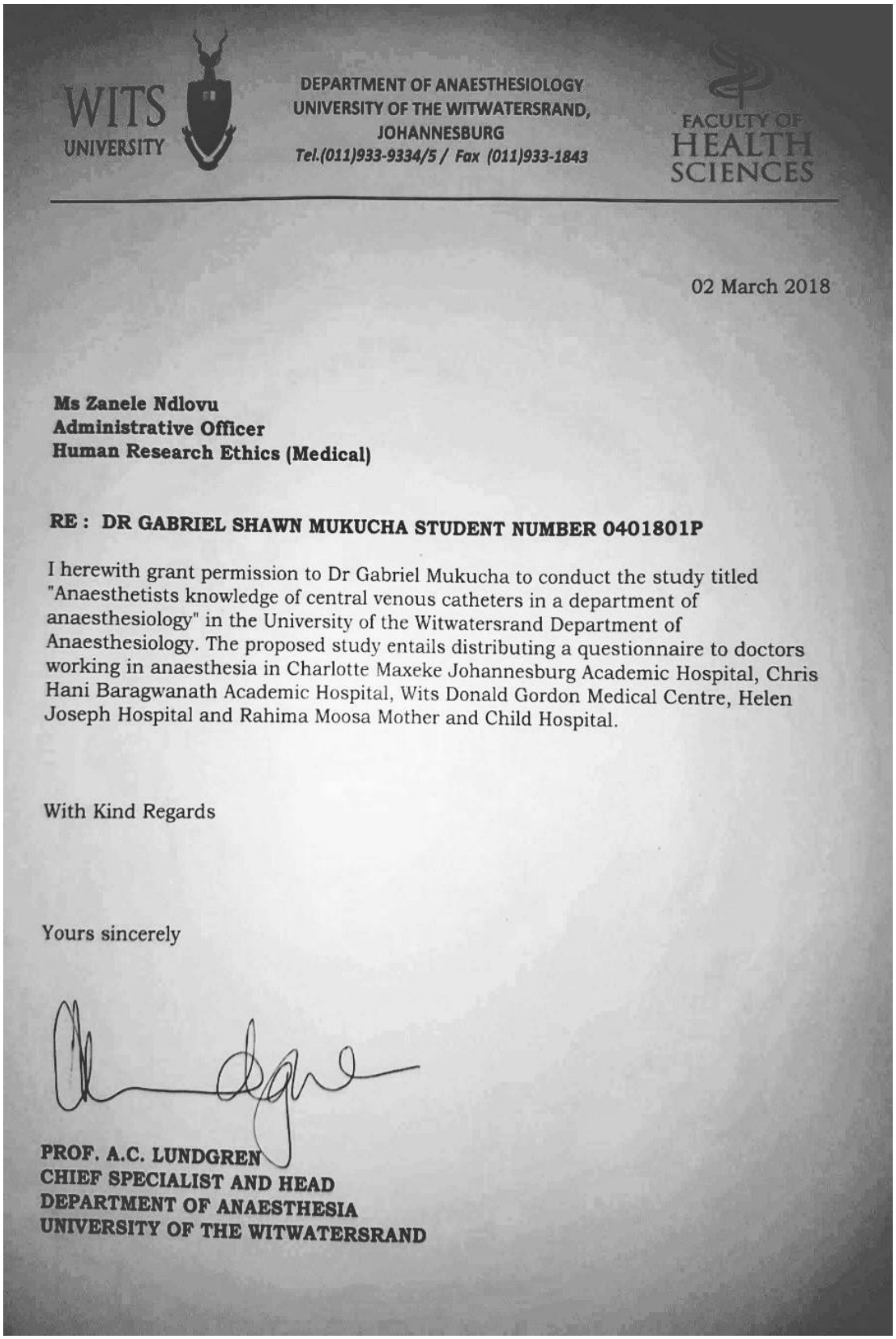
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4.12 Appendices

Appendix A: Approval Head of Department of Anaesthesiology



WITS UNIVERSITY

DEPARTMENT OF ANAESTHESIOLOGY
UNIVERSITY OF THE WITWATERSRAND,
JOHANNESBURG
Tel.(011)933-9334/5 / Fax (011)933-1843

FACULTY OF HEALTH SCIENCES

02 March 2018

Ms Zanele Ndlovu
Administrative Officer
Human Research Ethics (Medical)

RE : DR GABRIEL SHAWN MUKUCHA STUDENT NUMBER 0401801P

I herewith grant permission to Dr Gabriel Mukucha to conduct the study titled "Anaesthetists knowledge of central venous catheters in a department of anaesthesiology" in the University of the Witwatersrand Department of Anaesthesiology. The proposed study entails distributing a questionnaire to doctors working in anaesthesia in Charlotte Maxeke Johannesburg Academic Hospital, Chris Hani Baragwanath Academic Hospital, Wits Donald Gordon Medical Centre, Helen Joseph Hospital and Rahima Moosa Mother and Child Hospital.

With Kind Regards

Yours sincerely

PROF. A.C. LUNDGREN
CHIEF SPECIALIST AND HEAD
DEPARTMENT OF ANAESTHESIA
UNIVERSITY OF THE WITWATERSRAND

Appendix B: Information sheet

Dear colleague,

My name is Gabriel Mukucha. I am a registrar in the Department of Anaesthesiology at Wits. I would like to invite you to participate in my research study entitled "Anaesthetists' knowledge of central venous catheters in a department of anaesthesiology". This research report will be submitted to the Faculty of Health Science to fulfil the requirements for my M Med degree.

The aim of the study is to determine the knowledge of anaesthetists regarding central venous catheterisation using a self-administered questionnaire. It is important to know the latest guidelines and recommendations to help prevent and manage possible complications.

Participation in the study is voluntary and there is no penalty for refusal to do so. By completing the questionnaire, consent is implied. Information will be kept anonymous and confidential as none of your personal details will be required. My supervisors and I are the only people who will have access to the raw data. Completion of the questionnaire should take approximately 15 minutes. Please fold the completed questionnaire and place it in the provided sealed collection box at the door. Please do not share information during the completion of the questionnaire to allow an accurate reflection of anaesthetists' knowledge.

The Health Research Ethics Committee (HREC) (M180128) and the Wits Graduate Studies Committee have approved the study. If you have any questions, please contact me.

Gabriel Shawn Mukucha 0711262610, gsmukucha@hotmail.com

Chairperson HREC: 0117171234

Thank you for taking time to read this letter.

Yours Sincerely

Gabriel S Mukucha

Appendix C: Questionnaire

DEMOGRAPHICS

Please tick the appropriate box.

AGE	20-30	31-40	41-50	>50
	☐	☐	☐	☐

Gender	Male	Female
	☐	☐

Designation

Medical officer	☐
Registrar	1st year ☐ 2nd year ☐ 3rd year ☐ 4th year ☐
Consultant **or** **Career medical officer (>10 years' experience)**	☐

Please complete the following questions by circling the letter next to your choice. There is only one correct answer per question.

1.	**Which of the following is the most appropriate indication for insertion of the CVC**
A	To administer total parenteral nutrition to a patient for up to 2 weeks**
B	Preoperatively, in case you may need to administer inotropes for a patient with a ruptured ectopic pregnancy, currently stable.
C	All patients being admitted into an intensive care unit.
D	I do not know

2.	**Types of catheters and their risk**
A	When accessing the subclavian vein, you should prick during inspiration to avoid a pneumothorax
B	There is no risk of infection in a CVC that is not in use.
C	Recent meta-analyses show that the infectious risk between a single lumen catheter and a five-lumen catheter is the same**
D	I do not know

3.	**Concerning prophylactic antibiotics, according to the ASA practice guidelines for central venous access:**
A	A 3rd generation cephalosporin is recommended as prophylaxis routinely for CVC insertion
B	They should never be given for central venous catheterisation
C	They may be given to immunocompromised patients or high-risk neonates, on a case by case basis. **
D	I do not know

4.	**Correct aseptic preparation before CVC insertion involves:**
A	The use of at least 0.2% aqueous chlorhexidine with 70% alcohol solution
B	The use of at least 0.5% aqueous chlorhexidine with 70 % alcohol solution**
C	Skin preparation is not mandatory if catheters lined with antibiotics are being used
D	I do not know

5.	**In settings with a high rate of catheter-related infections it is recommended to use CVC coated or impregnated with an antiseptic agent**
A	Yes, in patients whose CVC is expected to remain in place for more than 5 days**
B	No, because the use of such catheters is not cost-effective
C	No, because the use of such catheters does not result in a significant decrease in the rate of catheter-related infections
D	I do not know

6.	**During insertion of a central venous catheter (CVC), the minimum form of monitoring available should be**:
A	3 lead ECG, arterial blood gas, pulse oximetry
B	blood pressure, 3 Lead electrocardiogram (ECG) and pulse oximetry**
C	blood pressure, temperature, pulse oximetry
D	I do not know

7.	**When placing a central venous catheter in the internal jugular vein, a knowledge of the anatomy is important. Which of the following is correct?**
A	As the internal jugular vein descends in the neck it lies posterior, then lateral and finally anterolateral to the internal carotid artery as it enters the thorax**
B	As the internal jugular vein descends in the neck it lies medial to the internal carotid artery throughout its course.
C	As the internal jugular vein descends in the neck it lies anterior, then lateral and finally anterolateral to the internal carotid artery as it enters the thorax
D	I do not know

8.	**During femoral insertion of a femoral vein central venous catheter, the anatomical arrangement of the femoral vein, nerve and artery from medial to lateral is as follows**:
A	nerve, artery and vein
B	vein, artery and nerve**
C	vein, nerve and artery
D	I do not know

9.	**With reference to CVC insertion under ultrasound (U/S) guidance.**
A	Use of U/S only makes insertion simpler but does not affect the rate of CVC complications
B	Use of real time U/S reduces the number of attempts and reduces the rate of complications **
C	Static ultrasound offers better outcomes in reducing the rate of complications as compared to real time U/S
D	I do not know.

10.	**When inserting a subclavian vein CVC**:
A	The needle should not be advanced beyond the sternal head of the clavicle**
B	The needle is advanced medial and posteriorly aiming for the contralateral nipple
C	The recommended needle insertion point is at the junction of the lateral and middle 1/3 of the clavicle where the subclavian vein lies inferior to the first rib
D	I do not know

11.	**When confirming correct placement of a CVC:**
A	Real time ultrasound has no role in reducing the risk of misplaced catheters
B	Absence of pulsatile flow and dark coloured blood confirms venous catheterisation
C	The absence of pulsatile flow alone should not be used to confirm venous catheterisation**
D	I do not know

12.	**With reference to ecg p wave analysis as a method of confirmation of CVC tip placement:**
A	Biphasic P waves occur with the tip in the upper superior vena cava
B	The widest p-wave occurs at the junction of the superior vena cava and right atrium. **
C	Biphasic p waves occur at the junction of the superior vena cava and the right atrium
D	I do not know

13.	**It is recommended to apply an antibiotic ointment at the insertion site of a CVC**
A	Yes, because it decreases the risk for catheter-related infection
B	No, because it causes antibiotic resistance**
C	No, because it does not decrease the risk for catheter-related infection
D	I do not know

14.	**It is recommended to replace pressure transducers and IV administration sets routinely**
A	yes, every 4 days**
B	Yes, every 8 days
C	No, only when indicated
D	I do not know

15.	**It is recommended to change the dressing on the catheter insertion site**
A	On a daily basis
B	Every 3 days
C	When indicated (soiled, loosened,) and at least weekly**
D	I do not know

16.	**According to the South African Society of Anaesthetists (SASA) guidelines on infection control, any fat-containing emulsion (nutritional lipid emulsions or drugs with a fat emulsion-based vehicle) infusion sets in continuous use may be changed at least**
A	Every 24 hours
B	Every 72 hours
C	Every 96 hours**
D	I do not know.

17.	**When blood products are administered through a CVC it is recommended to replace the administration set:**
A	Every 24 hours**
B	Every 48 hours
C	Every 96 hours
D	I do not know

18.	**With regards to care of the CVC**
A	All IV administration sets and connections should be changed daily
B	IV administration sets and connections should be changed every 7 days in case of parenteral nutrition administration
C	In the use of a CVC, a single lumen may be used intermittently, and the lumen should be flushed with heparinized saline and occluded and utilized if needed.**
D	I do not know

19.	**It is recommended to replace central venous catheters (CVCs) routinely**:
A	Yes, every 7 days
B	Yes, every 3 days
C	No, only when indicated**
D	I do not know

20.	**According to the SASA guidelines:**
A	The catheter with the most number of lumens should always be selected to allow easy use
B	The subclavian vein CVC is preferred due to its low infection risk**
C	IV antibiotics and parenteral nutrition administration can be done at the same time through the same lumen.
D	I do not know

21.	**Types of catheters and their risk**
A	The thrombotic risk is the same for internal jugular vein and subclavian vein catheters.
B	The thrombotic risk is higher in the case of internal jugular vein compared to femoral vein
C	The thrombotic risk is higher in the case of femoral vein compared to the internal jugular vein catheter**
D	I do not know

22.	**Concerning complications of CVC insertion**
A	In the case of arrhythmia observed during guidewire insertion, it must be treated with IV lignocaine as soon as possible
B	In the case of arrhythmia observed during guidewire insertion, the guidewire must be withdrawn immediately. **
C	The risk of lymphatic duct puncture is higher with catheterisation of the Right internal jugular vein as compared to the Left internal jugular vein.
D	I do not know

23.	**With regards to the mechanical complications of CVC**
A	CVC inserted via the subclavian vein approach is always well positioned
B	The distal extremity of the catheter must be inside the right atrium at the level of the carina on the control chest x-ray.
C	In adult patients the guidewire should not be advanced more than 20cm to avoid accidental perforation of the myocardium**.
D	I do not know

24.	**Indications for catheter removal**
A	In the case of a febrile patient with a CVC, you must look for the source of infection and make sure the CVC is not infected**
B	Any catheter inserted without the sterility conditions must be changed even in an unstable patient.
C	Any catheter in situ for > 3weeks should be changed through railroading.
D	I do not know

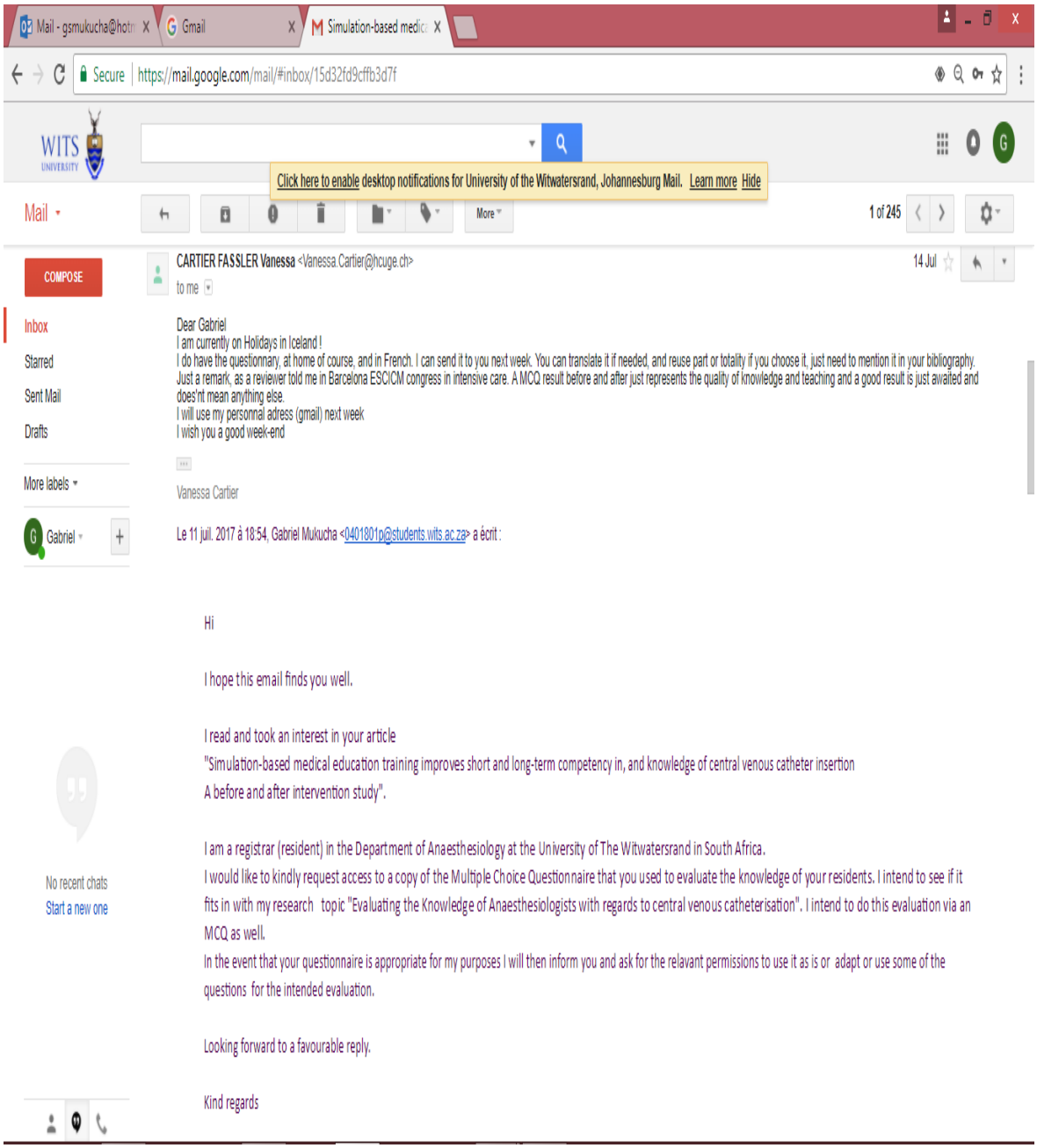
25.	**Concerning removal of CVCs**
A	This should be done in the anti-trendelenberg position for the internal jugular vein catheter
B	This must be done during deep inspiration.
C	The Valsalva manoeuvre must be done during removal of the jugular catheters**
D	I do not know

** correct responses

_____END_____

Appendix D: Permission from authors

Permission from Vanessa Cartier



Mail - gsmukucha@hotm | Gmail | Simulation-based medica

Secure | https://mail.google.com/mail/#inbox/15d32fd9cffb3d7f

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Gabriel

1 of 245

CARTIER FASSLER Vanessa <Vanessa.Cartier@hcuge.ch> 14 Jul

to me

Dear Gabriel
I am currently on Holidays in Iceland !
I do have the questionnary, at home of course, and in French. I can send it to you next week. You can translate it if needed, and reuse part or totality if you choose it, just need to mention it in your bibliography.
Just a remark, as a reviewer told me in Barcelona ESCICM congress in intensive care. A MCQ result before and after just represents the quality of knowledge and teaching and a good result is just awaited and does'nt mean anything else.
I will use my personnal adress (gmail) next week
I wish you a good week-end

Vanessa Cartier

Le 11 juil. 2017 à 18:54, Gabriel Mukucha <0401801p@students.wits.ac.za> a écrit :

Hi

I hope this email finds you well.

I read and took an interest in your article
"Simulation-based medical education training improves short and long-term competency in, and knowledge of central venous catheter insertion
A before and after intervention study".

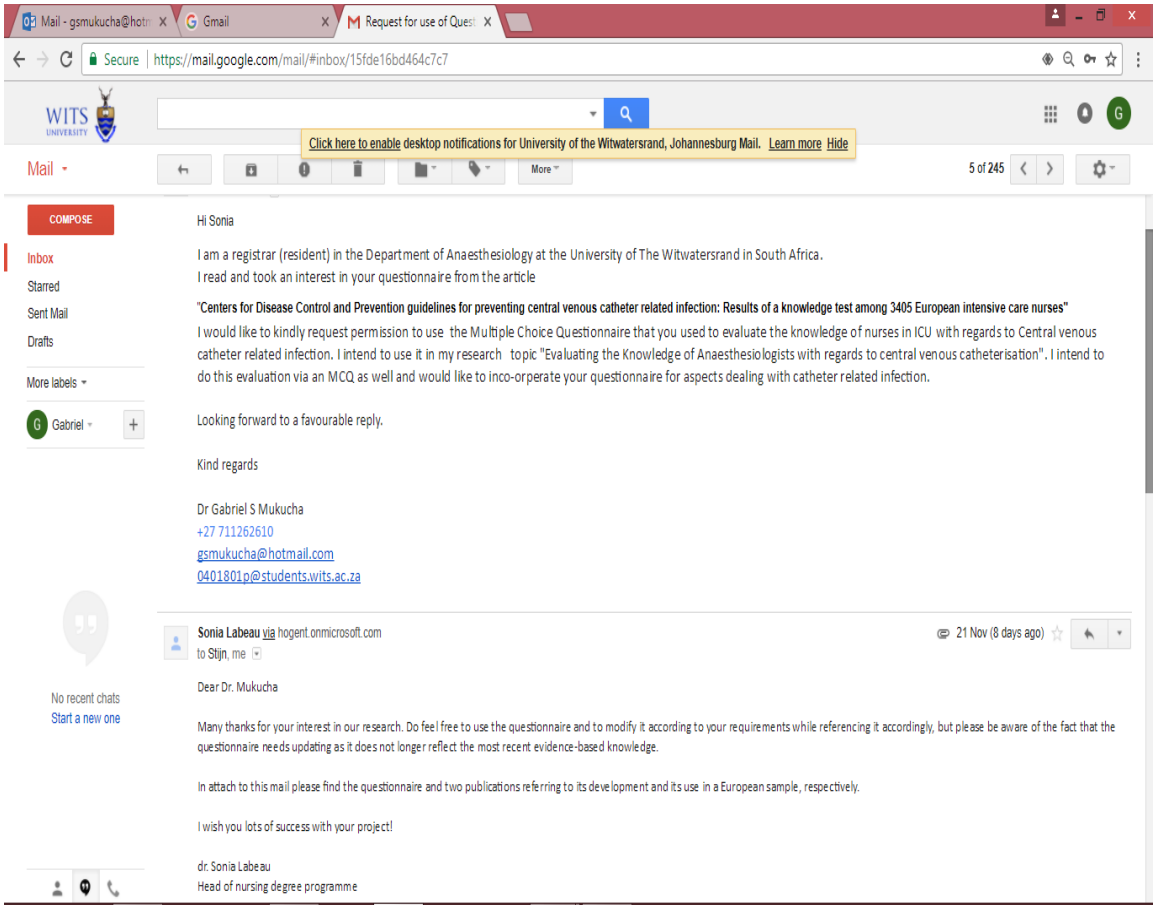
I am a registrar (resident) in the Department of Anaesthesiology at the University of The Witwatersrand in South Africa.
I would like to kindly request access to a copy of the Multiple Choice Questionnaire that you used to evaluate the knowledge of your residents. I intend to see if it fits in with my research topic "Evaluating the Knowledge of Anaesthesiologists with regards to central venous catheterisation". I intend to do this evaluation via an MCQ as well.
In the event that your questionnaire is appropriate for my purposes I will then inform you and ask for the relavant permissions to use it as is or adapt or use some of the questions for the intended evaluation.

Looking forward to a favourable reply.

Kind regards

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Permission from Sonia Labeau



Mail - gsmukucha@hotm | Gmail | Request for use of Quest

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5 of 245

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Gabriel

No recent chats
Start a new one

Hi Sonia

I am a registrar (resident) in the Department of Anaesthesiology at the University of The Witwatersrand in South Africa.
I read and took an interest in your questionnaire from the article

"Centers for Disease Control and Prevention guidelines for preventing central venous catheter related infection: Results of a knowledge test among 3405 European intensive care nurses"

I would like to kindly request permission to use the Multiple Choice Questionnaire that you used to evaluate the knowledge of nurses in ICU with regards to Central venous catheter related infection. I intend to use it in my research topic "Evaluating the Knowledge of Anaesthesiologists with regards to central venous catheterisation". I intend to do this evaluation via an MCQ as well and would like to inco-orperate your questionnaire for aspects dealing with catheter related infection.

Looking forward to a favourable reply.

Kind regards

Dr Gabriel S Mukucha
+27 711262610
gsmukucha@hotmail.com
0401801p@students.wits.ac.za

Sonia Labeau via hogent.onmicrosoft.com
to Stijn, me

21 Nov (8 days ago)

Dear Dr. Mukucha

Many thanks for your interest in our research. Do feel free to use the questionnaire and to modify it according to your requirements while referencing it accordingly, but please be aware of the fact that the questionnaire needs updating as it does not longer reflect the most recent evidence-based knowledge.

In attach to this mail please find the questionnaire and two publications referring to its development and its use in a European sample, respectively.

I wish you lots of success with your project!

dr. Sonia Labeau
Head of nursing degree programme

Section 5: Annexures

5.1 Ethics approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Gabriel Shawn Mukucha

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180128

NAME: (Principal Investigator)	Dr Gabriel Shawn Mukucha
DEPARTMENT:	Anaesthesiology
PROJECT TITLE:	Anaesthetists' Knowledge of Central Venous Catheters in a Department of Anaesthesiology
DATE CONSIDERED:	26/01/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Palesa Mogane, Juan Scribante and Helen Perrie
APPROVED BY:	Prof C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	12/04/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in January and will therefore be due in the month of January each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

13/04/2018
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

5.2 Graduate studies approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

05 February 2019
Person No: 0401801P
PAG

Dr GS Mukucha
27 waterval estate
little falls
Litte Falls
1724
South Africa

Dear Dr Gabriel Mukucha

Master of Medicine in Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled *Anaesthestists' knowledge of central venous catheters in a department of anaesthesiology* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

11 April 2018
Person No: 0401801P
PAG

Dr GS Mukucha
27 waterval estate
little falls
Litte Falls
1724
South Africa

Dear Dr Mukucha

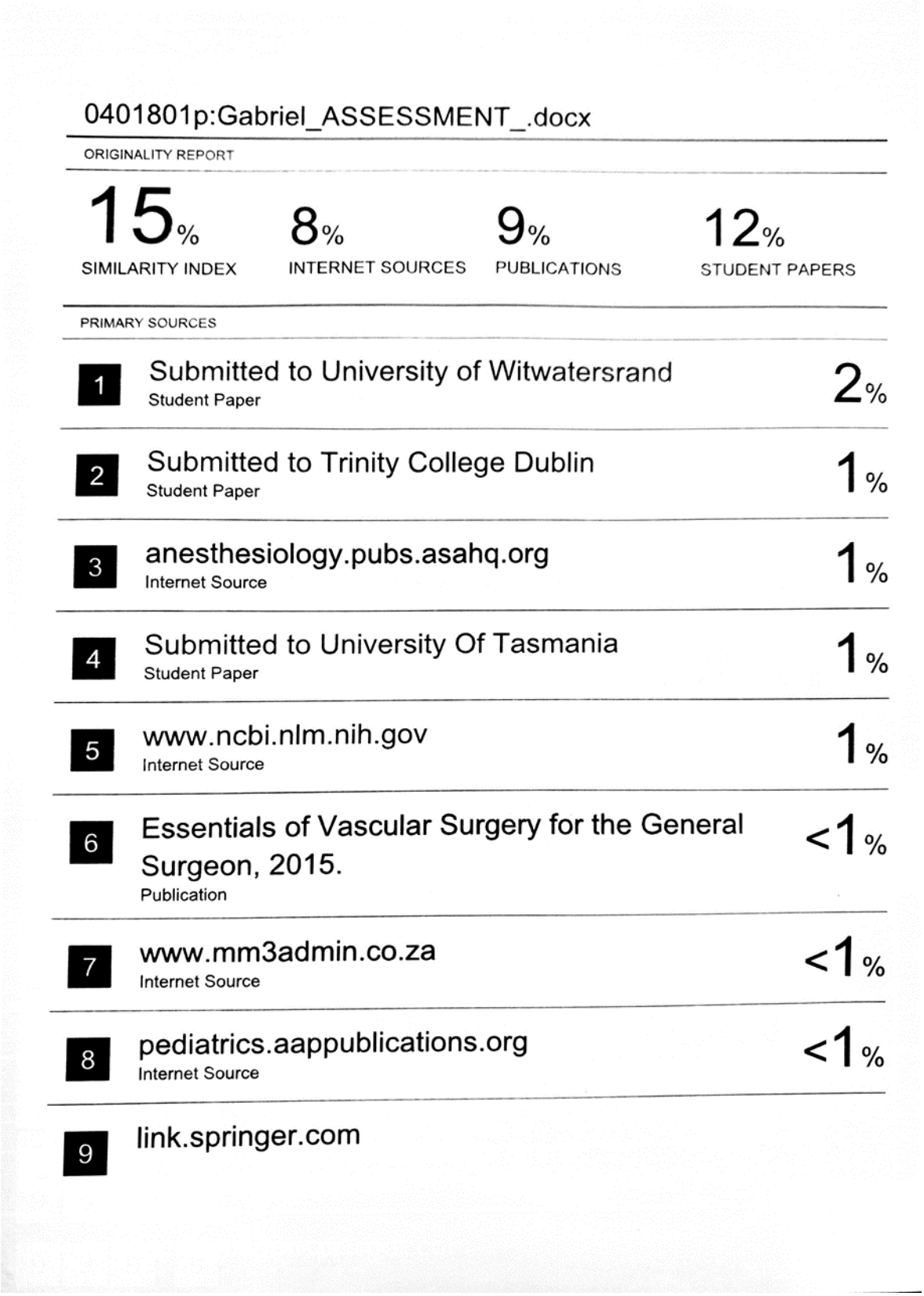
Master of Medicine in the Speciality of Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.3 Turnitin report



0401801p:Gabriel_ASSESSMENT_.docx

ORIGINALITY REPORT

15%	8%	9%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	2%
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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | FACULTY OF HEALTH SCIENCES

12th November, 2019

The Chairperson
Graduate Studies Committee
Faculty of Health Sciences
University of the Witwatersrand

Dear Madam,

Re: M Med: Anaesthetists'knowledge of central venous catheters in a department of anaesthesiology

Dr Gabriel Shawn Mukucha, student number: 0401801P, has submitted his research report to Turnitin which revealed a similarity index of 15%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of the research.

Yours sincerely,

HCPERRIE

Helen Perrie
Supervisor

1