CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACTITIONERS IN SOUTH AFRICA

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DECLARATION

I hereby declare that the compilation of this thesis is the result of my own, independent investigation. I have endeavoured to use the research sources cited in the text in a responsible way and to give credit to the authors and compilers of the references for the information provided, as necessary. I have also acknowledged those persons who have assisted me in this endeavour. I furthermore declare that this work is being submitted for the first time at this university and faculty for the purposes of obtaining the degree Philosophiae Doctor in Health Professions Education and that it has not previously been submitted to any other university or faculty for the purposes of obtaining a degree. I also declare that all information provided by study participants will be treated with the necessary confidentiality.

Shaun Donnovin Maasdorp **28 January 2024**

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DEDICATION

I dedicate this thesis to my wife Erica and my sons,
Ethan and Jonathan.

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LIST OF ABBREVIATIONS AND ACRONYMS

CCICCM	Chinese College of Intensive and Critical Care Medicine
CCSSA	Critical Care Society of South Africa
CMSA	Colleges of Medicine of South Africa
COBATRICE	Competency-based training programme in intensive care medicine
ECCCO	Emergency Medicine Critical Care Clinical Officer
EDIC	European Diploma in Intensive Care Medicine
EECC	Essential Emergency and Critical Care
GNI	Gross national income
HEQS	Higher Education Qualifications Sub-framework
HPCSA	Health Professions Council of South Africa
ICU	Intensive care unit
KAP	Knowledge, attitudes and practices
MBChB	Bachelor of Medicine and Bachelor of Surgery
NHI	National Health Insurance
NQF	National Qualifications Framework
OBE	Outcomes-based education and training
OSPE	Objective structured practical examinations
SAQA	South African Qualifications Framework
WHO	World Health Organisation

SELECTED DEFINITIONS AND TERMS

Critical Care: Critical care, also known as intensive care, is a speciality dedicated to the management of patients with or at risk of life-threatening illnesses (Marshall *et al*, 2017).

Core competency: The minimum knowledge, skills and attitudes required to perform a certain task in the real world (Matveevskii, Moore & Samuels, 2012).

District hospital: A hospital where general practitioners provide inpatient, ambulatory and emergency services to a defined population within a health district (Department of Health, 2002).

Regional hospital: A hospital in which specialised health services (internal medicine, paediatrics, obstetrics and gynaecology, and general surgery) are provided to a regional population of a province (South Africa, 2012).

Tertiary hospital: A hospital that receives referrals from regional hospitals and provides specialist-level services, including intensive care services, under the supervision of specialists or intensivists (South Africa, 2012).

Central hospital: A hospital that provides highly specialised tertiary healthcare services to patients referred from within and outside provincial borders. Usually attached to a medical school and conducts training and research (South Africa, 2012).

General practitioner: A medical doctor who completed two years of internship and one year community service, is registered at the Health Professions Council of South Africa as an independent medical practitioner and treats acute and chronic illnesses within a private primary healthcare practice (South Africa, 2007).

Intern: A newly qualified medical doctor undergoing supervised practical experience at public sector healthcare facilities (South Africa, 2004a)

Community service medical officer: A medical doctor who completed two years of internship and is providing compulsory primary healthcare services in public healthcare facilities for one year before being permitted to register as an independent medical practitioner with the Health Professions Council of South Africa (South Africa, 2004b).

Career medical officer: A medical doctor who completed two years of internship and one year community service, is registered at the Health Professions Council of South Africa as an independent medical practitioner and who treats acute and chronic illnesses at a public healthcare facility (Mash *et al.*, 2022).

General medical practitioner: A composite term used in this thesis to refer to all medical doctors (interns, community service medical officers, career medical officers, general practitioners) providing primary healthcare services that are not of a specialist nature at either public or private healthcare facilities (term specifically defined for this study).

Specialist: A medical doctor who obtained a formal postgraduate qualification in a particular subject or area in medicine (South Africa, 2001).

Intensivist: A specialist who obtained a formal postgraduate qualification in critical care medicine and is registered with the Health Professions Council of South Africa as an intensivist (South Africa, 2001).

Critical care provider: Any medical doctor, whether a specialist or not, providing critical care services to patients, either within or outside of an intensive care unit (term specifically defined for this study).

SUMMARY

Keywords: critical care, competency, curriculum, district and regional hospitals, postgraduate diploma

To prevent death or disability, critically ill patients require timeous life-sustaining interventions by competent healthcare providers. These patients often require management within an intensive care unit (ICU), although the initial resuscitation and stabilisation may happen outside of an ICU setting. Currently, there is a global shortage of intensivists or intensive care specialists. The majority of intensivists are employed at tertiary hospitals in major cities. At district and regional hospitals in South Africa, which are generally located outside major cities, critical care services are often provided by medical practitioners who are not intensivists. The problem is that the undergraduate medical curriculum does not provide dedicated critical care training and, therefore, there is uncertainty regarding the competency of non-intensivist medical practitioners to provide critical care services.

In order to address the problem stated, three research questions are addressed in this thesis:

i. *What is the current state of critical care service provision at district and regional public sector hospitals in the Free State province of South Africa?*
ii. *What is the knowledge, attitudes and practices of medical doctors who provide critical care at district and regional public sector hospitals in the Free State province of South Africa?*
iii. *What are the core competencies expected of general medical practitioners who provide critical care at a nonspecialist level of healthcare in South Africa?*

The aim of the study was to identify deficiencies in the competency of general medical practitioners who provide critical care services to patients at the district and regional levels of healthcare in South Africa, and the overall goal was to establish which core competencies are required of general medical practitioners if they are to provide critical care to patients in South Africa.

The study was conducted in three phases, with each phase addressing one of the research questions.

During phase 1, the objective was to gain deeper insight into the current state of critical care service provision in the public healthcare sector, specifically at district and regional hospitals in the Free State province of South Africa. The objective was achieved by means of a literature review and questionnaire survey among designated personnel at public sector hospitals who were knowledgeable about critical care service delivery in their respective hospitals in the Free State province and who were able to provide the required information. The findings are reported in the first draft manuscript (Title: A survey of critical care resources at district and regional public sector hospitals in the Free State province of South Africa), which describes a critical shortage of available ICU beds at regional hospitals, and reports that none of the ICUs had intensivists available.

During phase 2 of the study, the objective was to determine the knowledge, attitudes and practices of medical doctors who provide care to critically ill patients at district and regional public hospitals in the Free State province of South Africa. A survey was conducted among medical practitioners and the results indicate that medical practitioners had a severe deficiency in critical care knowledge and were of the opinion that their undergraduate medical training had not prepared them adequately to manage critically ill patients. The majority responded that additional training is required. These findings are reported in the second draft manuscript (Title: A survey of the knowledge, attitudes and practices pertaining critical care medicine among medical practitioners at district and regional hospitals in South Africa).

During phase 3 of the study, the objective was to establish core competencies expected of medical practitioners working in critical care settings or providing critical care services. A list of suggested core competencies was compiled, after which a Delphi study among international and national experts in the field of critical care medicine was conducted. The results of the Delphi study provide consensus recommendations on core competencies in critical care medicine and are reported in the third draft manuscript (Title: Core competencies in critical care for general medical practitioners in South Africa: A Delphi study).

The thesis concludes with recommendations with regard to a curriculum for a postgraduate diploma in critical care training programme, intended for medical practitioners already employed at hospitals where critically ill patients are managed. The training programme was compiled based on the findings of the three phases of the study. Such a training programme is suggested as a feasible solution to improve the critical care competencies of

medical practitioners and, thereby, mitigate the challenges posed by the shortage of intensivists at district and regional hospitals in South Africa.

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In this research project, an in-depth study of the critical care services provided at district and regional hospitals in the Free State province of South Africa was conducted, with a view to determine whether these hospitals were sufficiently equipped, and whether general medical practitioners were knowledgeable and skilled in managing critically ill patients at the primary and secondary levels of the healthcare system.

The aim of this study was, ultimately, to establish the core competencies that are required of general medical practitioners who treat critically ill patients in poorly resourced areas where specialist intensivists are not available on site. This aim was achieved by conducting an audit of critical care services, determining the knowledge, attitudes and practices of general medical practitioners, and compiling a list of core competencies that need to be mastered in order for critical care services to be provided adequately at district or regional levels of healthcare.

On 12 December 2012, the General Assembly of the United Nations adopted a resolution on universal health coverage, as a strategy to achieve the Millennium Development Goals (United Nations, 2012). In an effort to implement this resolution, South Africa, as a member state of the United Nations, created the National Health Insurance (NHI) Bill as a strategy to achieve universal healthcare service delivery, and through which all South African citizens are envisaged to have equal access to healthcare in the public or private healthcare sectors, with the government being a single payer for healthcare services provided (South Africa, 2019). Currently, the public sector provides healthcare services to 84% of the population, whereas the private healthcare sector provides healthcare to 16% of the population – mainly those who can afford to pay for those services (Department of Health, 2017). The public healthcare sector is, however, severely constrained and under-resourced to provide healthcare services to the majority of the population. The NHI is, essentially, a plan to address this inequality in healthcare services access. One of the main provisions of the NHI is that general medical practitioners will be expected to provide most of the healthcare services and will only refer patients for advanced levels of healthcare to specialists in selected cases (Department of Health, 2017).

This requirement would, however, demand a highly competent core of general medical practitioners who would be expected to manage sicker patients adequately. With the impending rollout of the NHI, with general medical practitioners forming the backbone of healthcare service delivery in South Africa, it is important to determine the competency of this group of healthcare practitioners to provide critical care, given that the current undergraduate medical curriculum does not provide critical care training, in particular (South Africa, 2009). This study was, therefore, conducted to establish core competencies, so that training programmes could be developed for general medical practitioners at a non-specialist level of the healthcare system.

The aim of Chapter 1 is to orient the reader on the research that was done. After giving a background to the research problem, the scientific research process will be described.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

1.2.1 History and development of critical care medicine

Critical care medicine is a relatively new field of specialised medicine. During a polio epidemic in Copenhagen in 1952, when more than 300 patients were affected by respiratory muscle and bulbar weakness, Dr Bjorn Ibsen, an anaesthetist at Blegdam Hospital, employed 1 000 medical and dental students to manually ventilate patients suffering from respiratory failure, via tracheostomy tubes, around the clock and, in so doing, managed to reduce the historical mortality of polio from 80% to 40% (Kelly *et al.*, 2014). Eventually, Dr Ibsen ensured that all ventilated patients were nursed in a single ward and, thereby, he founded the field of critical care medicine in 1953. Since critically ill patients were nursed in dedicated wards with a higher nurse-to-patient ratio and advanced monitoring capabilities, these wards became known as intensive care units (ICU). The term intensive care is often differentiated from critical care (also termed critical care medicine), because intensive care is provided in the setting of an ICU, whereas critical care is the care provided to a critically ill patient, irrespective of the setting, which may even be outside the ICU. During the last 70 years, critical care medicine has evolved into a highly specialised multidisciplinary field. As it is now possible to support failing organs artificially and keep patients alive for longer, the requirements for intensive care services have increased and now constitute a major expense of healthcare budgets across the globe (Vincent *et al.*, 2010).

A task force of the World Federation of Societies of Intensive and Critical Care Medicine define an ICU as,

> *an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency. Although an ICU is based in a defined geographic area of a hospital, its activities often extend beyond the walls of the physical space to include the emergency department, hospital ward, and follow-up clinic (Marshall et al., 2017:270).*

Intensive care is, therefore, "not an absolute concept, but rather a relative one defined in relation to the realities of a particular healthcare system that can vary depending on available resources and approaches to care" (Marshall *et al.*, 2017:272). Critical care encompasses the totality of care provided to patients with serious reversible diseases, and includes emergency care, and care provided by hospital systems and ICUs (Baker, 2009). Three main types of patients are usually admitted to ICUs: patients with acute, severe, potentially reversible organ failure who require organ support therapy, postoperative patients who require close monitoring, and patients who received a trial of ICU admission, but for whom further treatment is deemed futile, and comfort care is initiated (Adhikari *et al.*, 2010).

Various levels of ICUs are defined. A basic Level 1 ICU is essentially a high care or high dependency unit, where patients can receive oxygen, have their vital signs electronically monitored and experience a higher nurse-to-patient ratio than a general ward. A Level 2 ICU is able to provide invasive monitoring and active life support for a brief period. Specialised units, such as coronary care units, cardiothoracic units or neurocritical care units are examples of Level 2 units. Level 3 ICUs are usually staffed with dedicated intensivists and are usually located at large referral or academic hospitals. These units are able to provide a wide range of services, such as invasive and non-invasive patient monitoring, and active support of failing organs by means of advanced technology; these units are usually involved in intensive care research and training (Marshall *et al.*, 2017).

As intensive care developed as a speciality discipline that provides active support for failing organs, usually within a confined space or unit within a hospital, it should be recognised that critical care is indeed "a speciality without walls" (Marshall *et al.*, 2017). The principles of critical care are, in fact, applied even before the patient enters the ICU. Patients may already require life-sustaining interventions from emergency medical personnel outside the hospital environment, en route to hospital, in the trauma or emergency department, and even in general wards, where previously stable patients may acutely decompensate, and

require emergency resuscitation or care (Marshall *et al.*, 2017). Furthermore, in the past, intensivists were no longer involved in the care of patients once patients were transferred out of the ICU; however, today there is a move to intensivists actually following up on ICU survivors, and even playing a role in providing palliative care to patients, to ensure dignity at the end of life, when further life-sustaining interventions in the ICU are no longer deemed appropriate. (Marshall *et al.*, 2017).

1.2.2 Critical care in high income countries

The ideal number of ICU beds is determined by various clinical factors, such as whether high-risk surgery is performed or intensive chemotherapy is provided, and also by economic factors, such as whether health administrators are willing to invest in expensive technology needed for advanced medical treatment for which cost-benefit ratios are not always clear (Rubenfeld & Rhodes, 2014). Therefore, quite a large variation exists in the availability of ICU facilities in various regions and different economies. In so-called first-world countries, such as England, Wales and Northern Ireland, approximately 164 000 patients are admitted to ICUs annually, and approximately four million patients are admitted annually to ICUs in the United States of America (Marshall *et al.*, 2017). There is also a striking difference in bed availability between countries, even among so-called high-income countries. The United States of America has 5980 ICUs with nine ICU beds per 100 hospital beds, and 20 ICU beds per 100 000 population (Adhikari *et al.*, 2010). Germany has 4.1 ICU beds per 100 hospital beds, and 24.6 beds per 100 000 of the population, whereas the United Kingdom has 268 ICUs, 1.2 ICU beds per 100 hospital beds, and 3.5 ICU beds per 100 000 of the population (Adhikari *et al.*, 2010).

Gross national income (GNI) per capita is an economic indicator of the average income of a country's inhabitants (World Health Organization, 2023). The World Bank (2019) classifies low-income countries as countries with a GNI per capita of USD 1025 or less, lower-middle-income countries with a GNI per capita of USD 1026 to USD 3995, upper-middle-income countries as those with a GNI per capita of USD 3996 to USD 12 375, and high-income countries as those with a GNI per capita of USD 12 376 or above. In well-resourced high-income or first-world countries, critical care services are centralised in intensive care or high dependency units (Marshall *et al.*, 2017). These units are usually well staffed with dedicated intensive-care-trained medical and nursing personnel, who provide monitoring and care to patients 24 hours per day. Although patients often receive medical therapy from various healthcare providers, such as medical practitioners, nurses, physiotherapists and dieticians,

in a multidisciplinary team approach, the medical therapy is directed and supervised by a qualified intensivist. Technologically advanced and costly treatment, such as mechanical ventilatory support, continuous haemodialysis, extracorporeal membrane oxygenation and left ventricular assist devices, are usually available to support failing organs for prolonged periods (Marshall *et al.*, 2017).

1.2.3 Critical care in low and middle-income countries

As expected, there is a high variability in the number of ICU beds in different low and middle-income countries. South Africa, an example of a middle-income country, has 8.9 beds per 100 000 of the population (3.8 per 100 000 in the public sector and 5.1 per 100 000 in the private sector). In contrast, Uganda, as an example of a low-income country, has 0.1 ICU beds per 100 000 people (Marshall *et al.*, 2017). Although data is limited, a systematic review describing the ICU availability in 36 ICUs in low-income countries found that 94.1% of ICUs were located in referral hospitals of major cities (Murthy, Leligdowicz & Adhikari, 2015), with limited ICU facilities in rural areas. Nepal had 16.7 and Uganda 1 ICU bed per million of the population (Murthy, Leligdowicz & Adhikari, 2015), which indicates a critical shortage of ICU beds. An analysis of the ICU outcomes at a referral hospital in Kenya found that the median age of patients admitted was 29 years, and the ICU mortality was 53.6% (Lalani *et al.*, 2017). Comparing this figure with an ICU mortality of 8–18% in high-income countries, a clear difference can be observed (Adhikari *et al.*, 2010). The poor care provided to critically ill patients in resource-limited settings can often be attributed to a lack of emergency triage procedures, lack of ICU facilities and prioritisation thereof, and poor quality of healthcare provided to critically ill patients (Baker, 2009).

A study conducted among anaesthetists to assess the availability of critical care resources to treat patients with severe sepsis in Africa highlights the substantial limitations facing healthcare providers who treat patients in poorly resourced settings (Baelani *et al.*, 2011). The researchers found that, compared to hospitals in high-income countries, African hospitals are less likely to have ICUs (100% vs 73.8%, $p < 0.001$), and only 1.5% of all African respondents indicated that they have the resources available to implement the Surviving Sepsis Campaign guideline, which is an international guideline for the management of sepsis, in its entirety (Baelani *et al.*, 2011). Patients in Africa are twice as likely to die after surgery than patients operated on in other continents (Biccard *et al.*, 2018). Low-income countries have a disproportionately high burden of critical illness, especially related to infectious diseases, such as pneumonia, diarrhoea and malaria,

maternal complications and traffic accidents (Baker, 2009). In South Africa, 25% of medical admissions actually require high care unit admission (Baker, 2009). Clinicians in low-income countries report that their lack of training in critical care, a shortage of nurses, and low wages are obstacles to achieving well-functioning critical care services (Haniffa *et al.*, 2018).

1.2.4 Critical care in South Africa

Critical care medicine was initiated in South Africa in the late 1960s and early 1970s, with the Critical Care Society of South Africa (CCSSA) eventually being established in the early 1980s (Mathivha, 2002). ICUs in South Africa are organised into levels, from Level 1 to Level 4, depending on the resources available to treat critically ill patients in the units. This system differs from that of, for instance, the Unites States of America (cf. 1.2.1), but is similar to the system used in the United Kingdom. Level 1 units are usually closed, intensivist-led units located at academic hospitals. Level 2 units are organ-specific units, dedicated to providing, for instance, coronary care, and cardiothoracic or neurosurgical care. Level 3 units are located at community hospitals and offer only limited services related to monitoring and providing support for failing organs, whereas Level 4 units are high-dependency units (Mathivha, 2002).

South Africa has a population of 60.6 million people (Statistics South Africa, 2022). The World Bank classifies South Africa as an upper-middle-income economy. However, the country had a high unemployment rate of 27.6% during the first quarter of 2019, and an estimated 19% of the population lived in poverty in 2015 (World Bank, 2019). South Africa is challenged by a quadruple burden of disease: HIV/AIDS and tuberculosis, high mother and child death rates, an increase in the prevalence of non-communicable diseases, and a high incidence of trauma (cf. Figure 1.1). An estimated 6.4 million South Africans were living with HIV in 2012 (Department of Health, 2017). The current mortality rate for children under 5 years is 56 per 1000, and the infant mortality rate is 40 per 1000 live births – 1% of the global burden (Department of Health, 2017). Violence and trauma are important causes of Years of Life Lost, and the injury rate is estimated to be 158 per 100 000 (Department of Health, 2017). Due to the high burden of infectious diseases, accidents, interpersonal violence and non-communicable diseases, South Africa's healthcare budget takes up 15% of the total budget of the country.

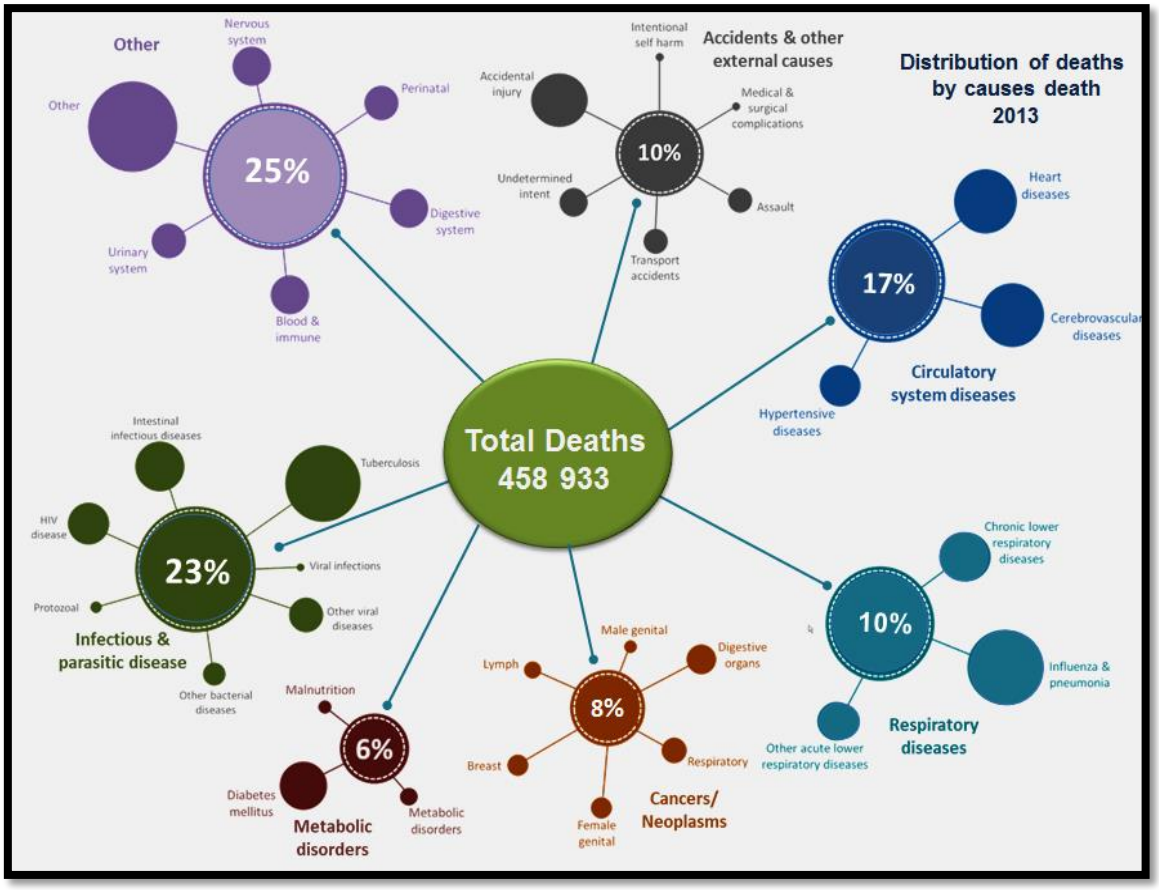

Figure 1.1: Causes of death in South Africa in 2013
(Source: Statistics South Africa, 2014)

Section 27 of the Bill of Rights of the Constitution of South Africa states that "everyone has the right to have access to healthcare services" and that "no one shall be refused emergency medical treatment" (South Africa, 1996). However, provision of healthcare services comprises a two-tier approach, with 84% of the population, mainly the rural poor, being serviced by the public healthcare sector, and 16% of the population, mainly affluent urban dwellers, by the private healthcare sector. Public health spending currently makes up 4.1% of gross domestic product, compared to 6% for other middle-income countries (Department of Health, 2017). Although the public healthcare sector provides medical services to the largest part of the South African population, it is severely underfunded and under-resourced compared to the private healthcare sector.

The NHI is a strategy to provide access to a minimum package of healthcare services to all South Africans, irrespective of their ability to pay for these services. Furthermore, the NHI of the South African Department of Health National stipulates that primary healthcare will form the backbone of healthcare service delivery in South Africa (Department of Health, 2017). There will be a move to eliminate the rural–urban divide in terms of healthcare

service availability, and healthcare will be provided close to where patients reside. This means that general practitioners will act as gatekeepers of the NHI. Since the NHI envisions providing a comprehensive package of healthcare services, including emergency medical services, to stabilise, manage and transport critically ill patients safely, critically ill patients would only be referred to specialists for advanced medical care after assessment by general practitioners at primary healthcare level. The current lack of intensive care facilities in South Africa, however, frequently results in patients being triaged or prioritised in terms of resource allocation and utilisation, and they may have to be cared for at the referring centre until an ICU bed is available at the referral centre (personal observation). Since the current curriculum of undergraduate medical studies does not provide for specific critical care training (South Africa, 2009), there is no evidence that newly qualified medical practitioners are sufficiently competent to manage critically ill patients in situations where immediate access to specialist care is not available.

Ideally, qualified and registered intensivists render critical care services. The reality in South Africa is, however, that there are only a limited number of registered intensivists. One of the reasons for this shortage is the prolonged period of training (at least 14 years) required to eventually be qualified as a critical care specialist or intensivist (South Africa, 2001). Most intensivists practice in urban areas, with very few in rural areas, where most of the population of South Africa is located (Booysen, 2003; Kong *et al.*, 2013; Naidoo & Naidoo, 2021). Considering the current rate of training and qualification of intensivists, it is unlikely that there will be sufficient registered intensivists to provide critical care services in South Africa within the foreseeable future. For this reason, medical practitioners with various levels of qualification and experience are often expected to stabilise and care for critically ill patients.

1.2.5 Critical care services in the Free State province

The Free State province is divided into one metropolitan municipality, Mangaung Metropolitan Municipality, and four districts: Xhariep district, Lejweleputswa district, Thabo Mofutsanyane district and Fezile Dabi district. Each district has district hospitals to which patients who require hospital care are referred from local clinics or community health centres. District hospitals seldom have dedicated ICUs. Critically ill patients referred from clinics or community health centres, thus, require initial stabilisation at the district hospital level and may, thereafter, be referred to a regional hospital, where dedicated ICUs are usually available for further management. The regional hospitals in the Free State are

Boitumelo, Bongani, Dihlabeng and Mofumahadi Manapo Mopeli Hospitals (South Africa, 2012). These hospitals usually have specialists, such as general surgeons, physicians and obstetricians, available on site, although medical officers are generally the primary healthcare providers for patients. For more advanced levels of care, patients are referred to provincial or tertiary hospitals, which are Universitas Academic and Pelonomi Hospitals in the Free State province (South Africa, 2012). Invariably, given the limited number of ICU beds available here, there could be a significant delay in patient transfers, and referring healthcare practitioners could be expected to stabilise and manage critically ill patients for a protracted period.

1.2.6 Critical care training

Internationally, there is no uniformity regarding the training and assessment processes of critical care practitioners, and several strategies exist. The College of Intensive Care Medicine of Australia and New Zealand (2023) requires a minimum training period of six years in critical care. The American Board of Internal Medicine (2023) requires a two-year training period in critical care after specialisation in another discipline. The European Society of Intensive Care Medicine established the European Diploma in Intensive Care Medicine (EDIC) to ensure uniformity regarding the knowledge and skills of critical care specialists across Europe (ESICM, 2017). EDIC was developed on the back of a competency-based training programme in intensive care medicine, CoBaTrICE, which was initially developed by using modified Delphi and nominal group techniques to determine internationally acceptable competencies in critical care (CoBaTrICE Collaboration, 2006). The CoBaTrICE collaborators invited national and international organisations responsible for intensive care training to participate in the project. Several experts (536 respondents from 57 countries) participated in the first online Delphi round and a total of 5241 suggestions for competencies were obtained. The CoBaTrICE collaborators analysed the suggested competencies and grouped the different competencies into several competence stems and behavioural themes. A nominal group of experts from 29 countries thereafter rated the competencies and a final list of 102 competence statements was established on which competency-based training programmes for intensive care medicine could be built (CoBaTrICE Collaboration, 2006). The training programme developed by the CoBaTrICE group was primarily aimed at establishing consensus on competencies that must be achieved during postgraduate specialisation in critical care across Europe, and therefore might not be applicable to settings with different or limited resources, such as Africa.

The Chinese College of Intensive and Critical Care Medicine (CCICCM) similarly developed core competencies in critical care that are required for postgraduate intensive care training by using a modified Delphi method in conjunction with a nominal group technique (Hu *et al.*, 2016). They used an online survey whereby invited healthcare professionals, educators, and trainees rated and commented on competencies. The results of the online survey established 199 competencies. The list of competencies was reviewed by a nominal group of 13 intensive care professionals to identify each competence for its importance. A final list of 129 competencies was identified as core competencies in critical care for the Chinese healthcare environment (Hu *et al.*, 2016). Although the final list of core competencies was developed with the view to postgraduate specialist training in intensive care, it has the potential to be form the basis from which core competencies in critical care for non-specialist medical practitioners can be established in other low- or middle-income countries. In all these training programmes, a candidate undergoes work-integrated learning by working in an ICU.

There is limited information on training programmes in critical care for non-specialist medical practitioners, however, in Kenya, where there are only two doctors for every 10 000 people and one ICU bed for every 350 000 people, it was recognised that the biggest challenge in delivering appropriate critical care services was the lack of trained personnel (Halestrap *et al.*, 2023). A training programme in emergency and critical care, termed Emergency Medicine Critical Care Clinical Officer Program (ECCCO), aimed at improving the clinical skills of clinical officers, thus non-specialist healthcare providers, was developed and subsequently formally registered as a national higher diploma in 2017 (Halestrap *et al.*, 2023). A list of core competencies using consensus techniques was first developed by a training programme development team. The competencies including, among other, bedside ultrasound skills, rapid sequence intubation, mechanical ventilation, and stabilisation of open and closed fractures (Halestrap *et al.*, 2023). The programme is provided over a 48-week period, which are divided into separate 4-week blocks, covering different components of the curriculum during each block. Each block is followed by an assessment of the knowledge and skills learnt during the block. A final assessment consisting of written and practical examinations is conducted at the end of the full training period. The ECCCO training programme essentially bridges the gap between the high burden of critically ill patients and the lack of specialist intensivists. Although clinical officers in Kenya provide medical services to patients, they obtain clinical officer registration after completing a three-year diploma and one-year internship (Halestrap *et al.*, 2023). A similar programme provided to medical officers in South Africa could potentially require much less time, since

medical graduates in South Africa complete a five- or six-year medical training programme, followed by a two-year internship.

In South Africa, to qualify as a specialist intensivist, a candidate must first qualify as medical practitioner by completing undergraduate studies for a minimum period of five years. After a medical internship period of two years, as well as community service of one year, the candidate can apply for specialisation in disciplines such as internal medicine, general surgery, cardiothoracic surgery, obstetrics and gynaecology, anaesthesiology, neurosurgery, emergency medicine or paediatrics (South Africa, 2001). Only after successfully completing the primary speciality can further subspecialisation training, for another two years, in intensive care at an HPCSA-accredited training site commence. The training requirements and qualifying exit examinations are conducted under the auspices of the CMSA. A clear syllabus that sets out the knowledge and practical skills that are required of a subspecialist in critical care at the end of the training period is stipulated by the Colleges of Medicine of South Africa, as recommended by the CCSSA (CMSA, 2017). This protracted period of training is unlikely to provide the necessary pool of human resources to address the high burden of critical illness in South Africa. Current specialist training programmes, for example for most of the surgical disciplines, stipulate a dedicated period of rotation, usually three months, in an ICU prior to sitting the intermediary examination that assesses knowledge of critical care medicine. At the level of the general practitioner or medical officer, no undergraduate training in critical care is provided, although these medical practitioners are expected to provide first-line healthcare services to critically ill patients. Competency regarding critical care at this level of healthcare is, therefore, required to fill this gap.

Figure 1.2 is an envisaged model of clinical care, showing how several trained critical care providers (non-intensivist medical practitioners) might fit into a care model for critically ill patients in an ICU. The first-line critical care providers are supervised by non-intensivist specialists who have undergone a period of training in critical care during their specialisation. An intensivist oversees and supervises the team of critical care trained specialists and critical care providers.

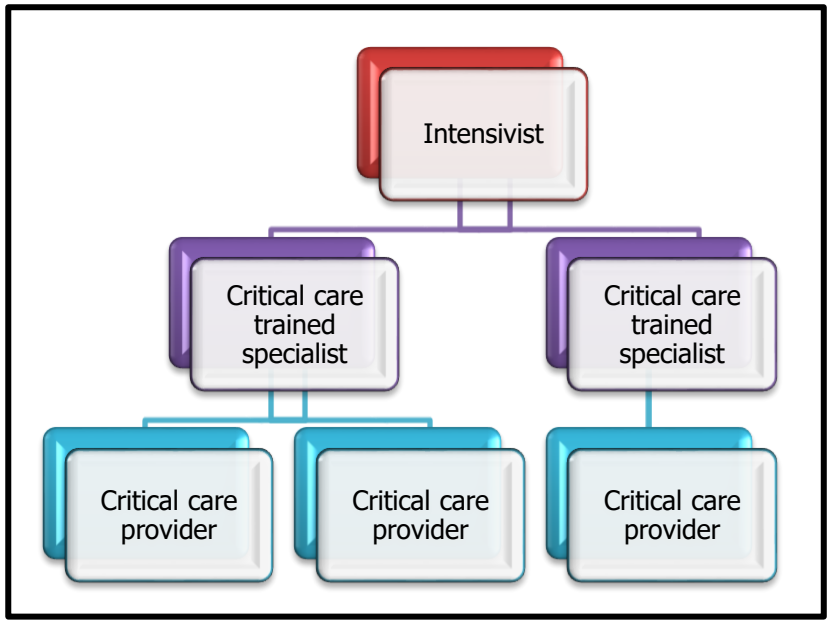

Figure 1.2: Flowchart indicating levels of critical care service provision
Compiled by researcher, Maasdorp (2020)

Adequate training of doctors and nurses working in resource-limited settings has been shown to result in meaningful improvement in ICU performance. An example of this is Nepal, where a modular training programme resulted in ICU mortality rates declining from 41% to 18% (Haniffa *et al.*, 2018). Schell *et al.* argued in 2018 that, in view of the millions of deaths globally as a result of critical illness, especially in low and middle-income countries, a pragmatic and low-cost intervention of essential emergency and critical care should be prioritised and provided by health administrators. These authors argue that emergency and critical care can be provided anywhere in a hospital, including general wards. There is now a move to earlier recognition of impending critical illness in patients admitted to general wards by so-called early warning scores, with rapid response teams led by intensivists being established to manage acutely ill patients in general wards to prevent critical illness from becoming established (Adhikari *et al.*, 2010).

It is up to academics and policymakers to decide what constitutes core elements of essential critical care services, and to design a curriculum that encompasses these elements. Prior to designing or developing a core curriculum for a training programme, a needs analysis is required to determine if a training programme is, indeed, required (Brown, 2002). A needs analysis would, thus, assist in understanding what the healthcare institutions' expectations of medical practitioners are pertaining critical care, what the knowledge and skills needs of the medical practitioners themselves are, and what professional bodies expect in terms of quality assurance of non-specialist general medical practitioners who provide critical care services (cf. Figure 1.3).

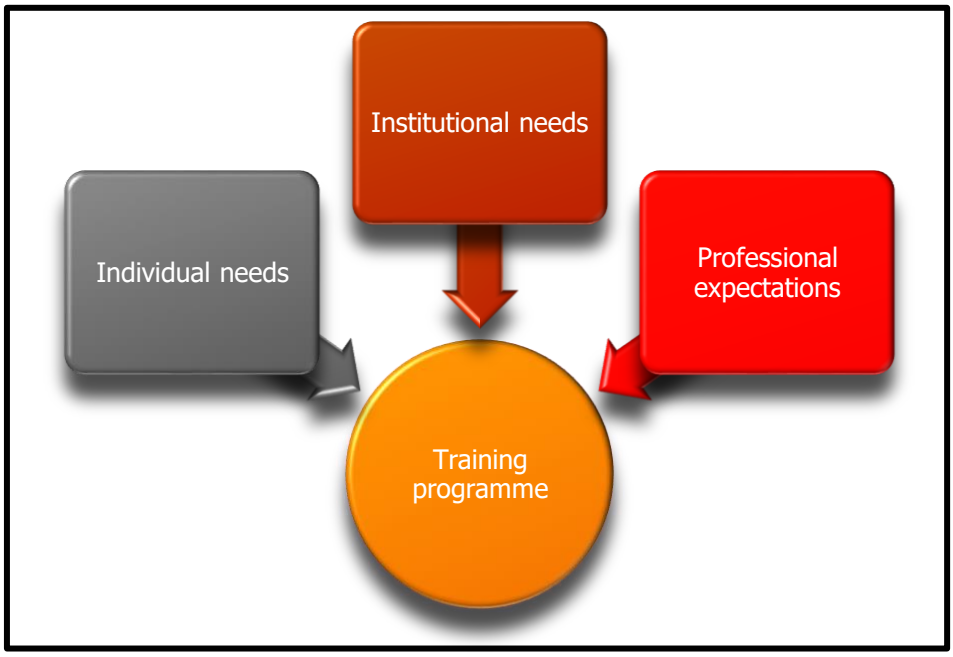

Figure 1.3: Needs analysis – a training programme should meet the needs in the squares
Compiled by researcher, Maasdorp (2020)

1.3 THEORETICAL FRAMEWORK

Learning theories provide explanations for how people learn and describe the processes of how new information is assessed and internalised to become new knowledge. (Aliakbari *et al.*, 2015). There are several learning theories applicable to this research. The theoretical framework guiding this study on core competencies in critical care for general medical practitioners will focus on learning theories relevant to adult learning and competency-based education.

Adult learning

Andragogy is a term that was initially developed by Alexander Kapp (Mukhalati & Taylor, 2019) and later proposed by Knowles as "the art and science of helping adults learn" (Knowles 1988, p. 43). Knowles (1988, p. 45) characterised adult learners as follows:

1. "Their self-concept moves from one of being a dependent personality toward a self-directed human being.
2. They accumulate a growing reservoir of experience that becomes an increasingly rich resource for learning.
3. Their readiness to learn becomes oriented increasingly to the developmental tasks of their social roles.

4. Their time perspective changes from one of postponed application of knowledge to immediacy of application, and, accordingly, their orientation toward learning shifts from one of subject-centeredness to one of performance-centeredness."
5. "The learner's need to know." (Knowles et al., 2005)
6. "Motivation to learn." (Knowles et al., 2005)

Adult learners therefore tend to find learning gained from actively doing and experiencing more meaningful than from passive learning. Their motivation for learning often stems from a desire to be more competent in their societal roles, and therefore they want to be able to apply what is learned immediately in order to fulfil their societal duties more effectively (Knowles, 1988). Adult learners therefore tend to be more interested in competence-based educational experiences, as opposed to passive cognitive learning experiences (Knowles, 1988). It should be recognised that for adult learners learning is often a choice that is made after understanding why they need to learn and how the learning can assist them in their current situation.

Competency-based medical education

Competency-based medical education is defined as "an outcomes-based approach to the design, implementation, assessment, and evaluation of a medical education program using an organizing framework of competencies" (Sultan *et al.*, 2020). Competencies are the minimal set of attributes, usually categorised as knowledge, skill, and attitudes, that an individual must have to perform a set of tasks to an appropriate standard (Sultan *et al.*, 2020). One of the most well-known competency frameworks is the CanMEDS framework that is used globally as a guide to medical education (Sultan *et al.*, 2020). Competency-based education is similar to outcome-based education in that outcomes or competency at the end of the training period is emphasised and that the learning outcomes or competencies guide the curriculum processes (Sultan *et al.*, 2020). Although competency-based education has its roots in behaviour learning theory (Morcke *et al.*, 2013), various other learning theories can be applied to adult learning. The learning theories that are important and that underpin the approach to this study are behaviourism, cognitivism, experiential learning, and constructivism.

Behaviourism

Behaviourism is a learning theory based on the belief that people learn as a result of their interaction with the surrounding environment (Mukhalalati & Taylor, 2019). Behaviourists believe that learning depends on whether people receive rewards or punishment while

interacting with their environment. Behaviour that results in rewards gets strengthened, while behaviour or actions that lead to punishment are weakened. People therefore change their behaviour according to the consequences of their actions. According to behavioural theorists, people's behaviour can be changed by manipulating the environment to encourage certain behaviours and discourage others. An analogy to behavioural theory as used in the clinical learning environment would be the "see one, do one, teach one" model, with marks used as reward for good performance. A criticism of behaviourism is that it tends to ignore aspects such as attitudes or affects, which cannot be directly observed or measured.

Cognitivism

Cognitivism focusses on mental processes such as insight, information processing, understanding, and memory, that is used in giving meaning to events and thereby promote learning (Torre *et al.*, 2006). Learning is more concerned with what learners know and the cognitive process that led to knowledge acquirement, than with what learners do (Ertmer, 2013). Typical examples of how cognitivism is applied in medical education is the use of concept maps and reflective thinking (Torre *et al.*, 2006). A key criticism of the cognitive learning theory is that it under-appreciates the effect of the external environment and the importance thereof in influencing learning (Mukhalalati, 2019).

Experiential learning

Experiential learning theory provides a holistic perspective on learning that contains elements of both behavioural and cognitive learning theories, thereby integrating elements of experience, perception, cognition and behaviour (Kolb, 1984). Kolb believes that learning is a process that is gained through experience while interacting with the environment and which is thereby a necessity for adapting to the world around us (Kolb, 1984). From a health professional education perspective, experiential learning theory is particularly valuable in emphasising the development of learning strategies in real life environments (Mukhalalati, 2019).

Constructivism

Constructivism is a learning theory that proposes that knowledge is a product of how individuals create meaning from their own experiences (Ertmer, 2013). New knowledge is

gained by the interplay between individuals' interaction with colleagues or trainers, and what they already know from past experience (Mukhalalati, 2019). Learning takes place by adjusting established ideas to accommodate new experiences (Nagowah & Nagowah, 2009). New knowledge is built on previous experiences or knowledge and is therefore actively constructed based on what the learner already knows (Bada, 2015). Vygotsky, a social constructivist, focusses on learning that occurs within a community, and posits that learning takes place when students interact with others who are more knowledgeable, including peers and trainers, and thereby expanding current knowledge and understanding (Taylor & Hamdy, 2013).

To summarise, adult learning is unique in the sense that adults make their own choices with regards to the necessity to learn. Their participation in a learning event is driven by an inherent need to improve on knowledge (cognitive learning) or skills that they require in order to perform their societal role better. They usually already have acquired knowledge and skills on which to build (constructivism) and have more value for acquiring new knowledge and skills that can be immediately applied within the workplace. A competency-based educational approach (behaviourism) within an authentic real practice environment (experiential learning) would therefore be suitable for adult learners that are established employees within critical care settings.

1.4 CONCEPTUAL FRAMEWORK

The following concepts are used in this study:

Competency

A competency is "an observable ability of a health professional, integrating multiple components such as knowledge, skills, values, and attitudes." (Frank *et al.*, 2010). In order to be considered competent, medical practitioner need to display a multitude of competencies which can be measured and assessed (Frank *et al.*, 2010). There are five characteristics of a competency: (1) it is focused on performing the end-goal of instruction; (2) it is focused on application of knowledge, not necessarily factual recall thereof; (3) it can be measured; (4) it can be judged according to criterion that all learners can achieve; (5) it clearly informs learners of what is expected of them (Albanese *et al.*, 2008). Furthermore, competence is context-specific and can change with time and experience (Frank *et al.*, 2010).

Critical care

Critical care, also known as intensive care, is a speciality dedicated to the management of patients with or at risk of life-threatening illnesses (Marshall *et al*, 2017).

General medical practitioners

A composite term specifically used in this thesis to refer to all medical doctors (interns, community service medical officers, career medical officers, general practitioners) providing primary healthcare services that are not of a specialist nature at either public or private healthcare facilities.

District and regional hospitals in South Africa

A district hospital is a public health facility where non-specialist medical practitioners provide inpatient, ambulatory and emergency services to a defined population within a health district (Department of Health, 2002), whereas a regional hospital is a public health facility in which general specialised health services (internal medicine, paediatrics, obstetrics and gynaecology, and general surgery) can be provided to a regional population of a province (South Africa, 2012).

McGaghie et al (1978) proposes that competence is context-bound and therefore shaped by the health needs and available resources of the specific healthcare system in which medical doctors perform their work. The context in which the study was conducted were district and regional public hospitals in South Africa. District hospitals provide emergency healthcare services, but do not have intensive care units (ICU's). There are no specialists available in the district hospitals. Regional hospitals have ICUs, as well as a limited number of general specialists, but do not have sub-specialists such as intensivists. Medical practitioners with various competencies provide medical services at these levels of the healthcare system. In view of the lack of specialist healthcare practitioners, community service medical officers and career medical officers, tend to provide healthcare services that are of a specialist nature, such as critical care services. District and regional hospitals tend to have limited resources and cannot provide healthcare of a highly specialised nature. It was therefore important to determine what the available resources for delivering critical

care was at district and regional hospitals in South Africa prior to determining what the competencies are that are required to provide critical care in that particular health system.

The conceptual framework for the study is depicted in figure 1.4.

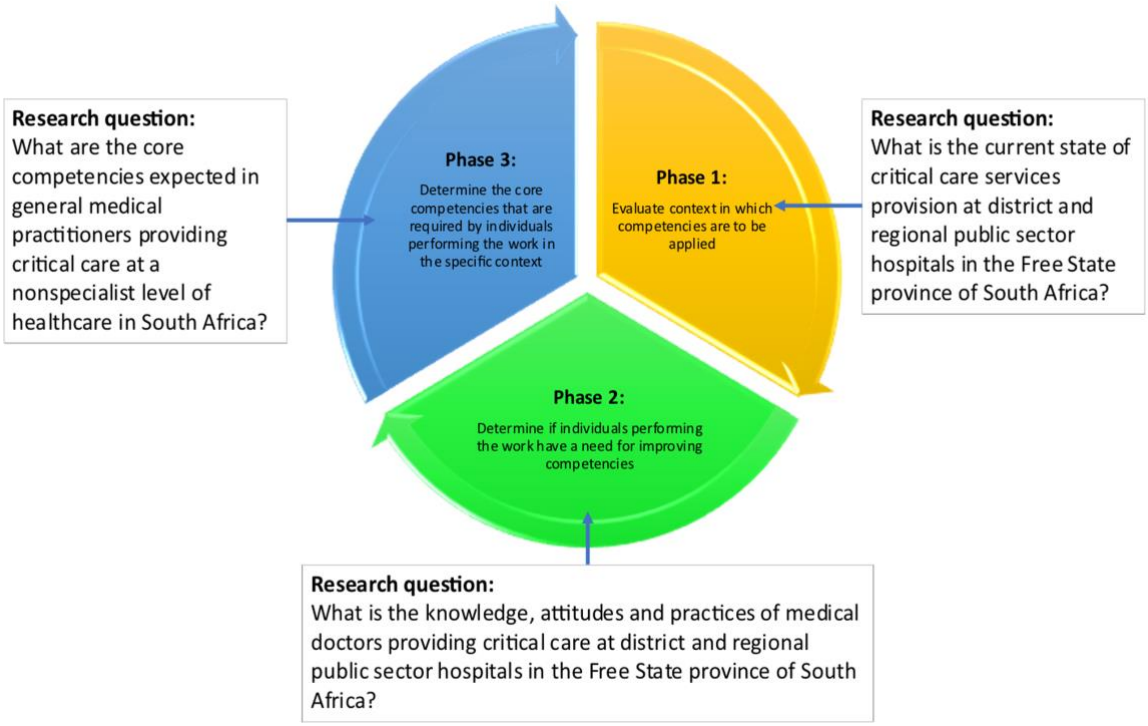

Figure 1.4: Conceptual framework for Core Competencies in Critical Care for General Medical Practitioners in South Africa
Compiled by researcher, Maasdorp (2023)

1.5 PROBLEM STATEMENT

The problem that this study addressed was that, despite a perceived need for more qualified intensivists, especially in the rural areas of South Africa, the prolonged training period and the limited number of critical care specialists qualifying annually are unlikely to fulfil the need for critical care services in the foreseeable future. With the advent of the NHI, which will expect general medical practitioners to provide the majority of healthcare services in both rural and urban areas despite a lack of dedicated critical care training in the undergraduate medicine curriculum, there is a requirement to establish the competency of general medical practitioners who provide critical care services to patients. The gap that this study addressed was to establish core competencies in critical care for general medical practitioners who manage critically ill patients in South Africa.

1.6 RESEARCH QUESTIONS

In order to address the problem stated, the following research questions were posed:

i. *What is the current state of critical care services provision at district and regional public sector hospitals in the Free State province of South Africa?*
ii. *What is the knowledge, attitudes and practices of medical doctors providing critical care at district and regional public sector hospitals in the Free State province of South Africa?*
iii. *What are the core competencies expected in general medical practitioners providing critical care at a non-specialist level of healthcare in South Africa?*

1.7 OVERALL GOAL OF THE STUDY

The overall goal of the study was to establish core competencies that are required for general medical practitioners to provide critical care to patients in South Africa. These core competencies are incorporated as learning outcomes in a proposed curriculum for a postgraduate diploma in critical care for general medical practitioners (cf. Chapter 5).

1.8 AIM OF THE STUDY

The aim of the study was to identify deficiencies and to suggest core competencies in critical care that are required by general medical practitioners who provide critical care services to patients at the district and regional levels of healthcare in South Africa.

1.9 OBJECTIVES OF THE STUDY

The objectives of the study were as follows:

i. To gain deeper insight into the current state of critical care services provision in the public healthcare sector. Medical students are often trained by qualified specialists and subspecialists in well-equipped tertiary academic hospitals where the necessary support services are generally available to provide optimal care to critically ill patients. This may, however, not prepare newly qualified medical practitioners sufficiently to work in real-world low-resource settings, especially in rural primary and secondary hospitals in South Africa, which are often poorly equipped and where medical practitioners may work without adequate supervision and frequently do not have

advanced or even all the necessary equipment and resources available to save lives. This objective, therefore, endeavoured to describe the resources available to provide critical care services at district and regional hospitals in the Free State province of South Africa (cf. Research Question 1). The objective was achieved by means of a questionnaire survey among clinical managers at public sector hospitals who were knowledgeable about critical care service delivery in their respective hospitals in the Free State province and who were able to provide the required information.

ii. To determine the knowledge, attitudes and practices of medical doctors who provide care to critically ill patients as either emergency or first-line healthcare providers at district and regional public hospitals in the Free State province of South Africa. The outcome of this objective established whether general medical practitioners expressed a need for additional training in critical care, or whether the undergraduate medical training ensured sufficient competency in qualified medical practitioners working in resource-constrained healthcare settings where specialist intensivists are not available to provide assistance or guidance in the care of critically ill patients (cf. Research Question 2). The information was gathered by conducting a questionnaire survey among medical practitioners, whose responses provided an indication of the perceived need for further training in critical care medicine from the perspective of a practicing medical practitioner.

iii. To establish the core competencies expected of medical practitioners working in critical care settings, or providing critical care services at public sector hospitals in South Africa, outside established ICUs where qualified intensivists direct medical treatment. This objective was achieved by compiling a list of suggested core competencies and then performing a Delphi study (cf. Research Question 3). International and national experts in the field of critical care medicine were identified. The results of the Delphi study provided consensus recommendations on core competencies in critical care medicine, which were used to compile a proposed curriculum for a postgraduate diploma in critical care for general medical practitioners in South Africa.

1.10 RESEARCH PARADIGM, DESIGN AND METHODOLOGY

Research paradigms or worldviews describe the philosophical assumptions or the basic set of beliefs and generalisations that guide further inquiries (Creswell & Plano Clark, 2011). Pragmatism is a philosophical worldview that is often associated with mixed methods research. From a pragmatic point of view, the research question and the consequences of research are of primary importance – even more than the research methods employed to

inform the research question. Ontology describes the philosophical assumptions related to the nature of reality (Creswell & Plano Clark, 2011). The ontology associated with pragmatism is that there is no single reality and that reality is constantly renegotiated and interpreted by considering its usefulness in new situations. Epistemology describes the method of gaining knowledge (Creswell & Plano Clark, 2011). Since there is no single reality, the epistemological assumption pertaining to pragmatism is that the best method for knowing reality is the one that solves the problem (Creswell & Plano Clark, 2011). The pragmatist will, thus, frequently use various methods and sources of data collection to answer the research question (Creswell, 2013).

Constructivism is often associated with qualitative approaches to research. Constructivists seek to understand the subjective views of individuals about the world around them. These views are often complex and shaped by individuals' interaction with others, as well as their historical and cultural backgrounds. The process of qualitative research is, thus, inductive (Creswell & Creswell, 2018).

Since this study conducted an audit of the current state of critical care services, analysed the competency of healthcare practitioners, and determined core competencies in critical care for general medical practitioners to provide effective critical care in the district and regional hospitals of South Africa, the study was conducted from the research paradigms of pragmatism and constructivism.

The research methodology for this study made use of mixed methods research, by using a multiphase design to meet the overall objectives of the study. Mixed methods research is an approach to research in which both quantitative and qualitative data are collected and integrated to provide a deeper understanding of the research problem or questions that neither quantitative nor qualitative data alone can provide (Creswell & Creswell, 2018). The core elements characterising mixed methods research are that the researcher collects both qualitative and quantitative data; uses rigorous methods for data collection, analysis and interpretation; combines the two forms of data either concurrently, sequentially to explain or build on another database, or embedding one within the other; incorporates the procedures to be used in the study into a mixed methods design; and frames the mixed methods design procedures within a philosophical worldview and theory (Creswell & Creswell, 2018).

In mixed methods research, researchers make use of visual diagrams, labels and symbols

to improve their understanding of the nature of the mixed methods approach and procedures (Creswell & Creswell, 2018). Capitalisation (QUAL, QUAN) emphasises either quantitative or qualitative data, whereas lowercase (qual, quan) implies lesser emphasis. A plus sign (+) indicates data collection occurring at the same time, whereas an arrow (→) indicates sequential collection of data. Parentheses indicates that one form of data collection is embedded within another. Double arrows (→←) indicate that activities can flow in either direction (Creswell & Creswell, 2018).

Six basic types of mixed methods are described in the literature, namely, the convergent, explanatory, exploratory, embedded, transformative and multiphase design types (Creswell & Plano Clark, 2011). The rationale for using mixed methods research methodology is to ensure that a comprehensive understanding of institutional needs, and the individual needs of first-line medical practitioners who provide critical care services at non-specialist level, is gained. The mixed method research strategy combines the strengths of both quantitative and qualitative methods, while reducing the limitations of either method. The challenges of mixed methods research include the need for extensive data gathering, the prolonged time required to analyse both qualitative and quantitative data, and that the researcher needs to be versed in both quantitative and qualitative research (Creswell & Creswell, 2018).

This study was conducted in three phases, as follows: Phase 1 (QUAN) → Analysis and Interpretation → Phase 2 (QUAN) → Analysis and Interpretation → Phase 3 (QUAL) → Analysis and Interpretation.

1.11 DESCRIPTION OF THE METHODS

The study was conducted in three phases to achieve each of the three stated objectives. Results of each of the phases will be published as research articles, as set out in the next sections.

1.11.1 Phase 1: An audit of critical care resources at district and regional public sector hospitals in the Free State province of South Africa

In order to understand the state of critical care resources at district and regional public sector hospitals, a questionnaire (cf. Appendix C), adapted from a validated tool (Leligdowicz *et al.*, 2017) to suit the local setting, was designed. This questionnaire was e-mailed to clinical managers at public sector hospitals in the Free State for further distribution to personnel, such as chief executive officers, nursing managers or clinicians who were

knowledgeable about critical care service delivery at their institutions, and who were able to provide the required answers. Since there were 22 district and regional public sector hospitals in the Free State province (Pelonomi, Universitas and Free State Psychiatric Complex hospitals were excluded, as these were tertiary academic hospitals), at least 22 survey questionnaires required completion, to gain a deeper understanding of the state of critical care resources and services that were available in the Free State province. The survey questionnaire was designed to elicit information that would lead to an understanding of the infrastructure and technical and human resources support available for providing critical care services (cf. Appendix C).

1.11.1.1 *Sample selection*

Research in health sciences often entails studying phenomena in a target population that has certain defined characteristics or traits (Berndt, 2020). Since it is seldom feasible to study the whole target population, either due to time constraints or costs, or because the size of the target population is unknown, a subset of the target population is selected and results or conclusions are then generalised to the whole target population. For results obtained from a subset or sample of the target population to be generalisable, it is important for the sample to be representative of the target population. Bias in sample selection should, thus, be limited as far as possible, to prevent incorrect inferences being made about the target population (Berndt, 2020). In quantitative research, incidental and random sampling methods are commonly employed (Polgar & Thomas, 2008). Incidental sampling involves selecting the most available individuals from the target population, but doing so carries a high risk of bias, and results may, consequently, not be generalisable to the whole target population (Polgar & Thomas, 2008). Random sampling is a sampling method in which each member of the target population has an equal chance of being selected (Polgar & Thomas, 2008:34). It carries the least risk of bias, and conclusions drawn from a study conducted on a randomly selected sample can be generalised, with confidence, to the whole target population.

In qualitative research, generalisability is still important; however, whereas the number of study participants are important in quantitative research, representativeness of the sample, which makes it possible to describe meaning and experiences of complex situations, is more important in qualitative research (Polgar & Thomas, 2008). Strydom and Delport (2011:391) state that, in qualitative research, "sample size depends on what we want to know, the purpose of the inquiry, what is at stake, what will be useful, what will have credibility, and

what can be done with the available time and resources". Purposive sampling methods, according to which study participants are selected because they face the typical situation that the researcher wants to study, are, therefore, frequently employed in qualitative research (Polgar & Thomas, 2008). Examples of purposive sampling methods include extreme or deviant case sampling, maximum variation sampling, snowball or chain sampling and theory-based sampling (Polgar & Thomas, 2008).

Purposive sampling was used in Phase 1 of this study. Knowledgeable personnel, such as chief executive officers, clinical or nursing managers, and doctors and nurses working at the intensive care units of district and regional hospitals in the Free State province of South Africa were invited to participate in the study. At least 22 study participants were expected to be included in accordance with the number of district and regional hospitals in the Free State province.

1.11.1.2 *Units of analysis*

The units of analysis are the individuals, groups of individuals, organisations, objects or elements of interest about which data will be collected by the researcher (Fouché & De Vos, 2011).

In the current study, knowledgeable personnel, such as chief executive officers, clinical or nursing managers, and doctors and nurses at public sector hospitals who were knowledgeable about critical care service delivery at their institutions, and who were able to provide the required answers, constituted the units of analysis.

1.11.1.3 *Sample size*

There were 22 district and regional hospitals in the Free State province. Representatives of district and regional healthcare facilities were approached and invited to complete the survey questionnaire. It was, therefore, anticipated that at least 22 study participants would be included in the study. The healthcare representatives were first contacted telephonically or via e-mail to introduce the researcher, after which an invitation to participate in the study was sent via e-mail.

1.11.1.4 *Description of the sample*

The sample consisted of representatives of the Free State Department of Health, which included clinical managers or designated personnel at district and regional public sector hospitals in the Free State province of South Africa, who were knowledgeable regarding critical care service delivery in their respective hospitals, who were able to provide the required answers, and who agreed to participate.

1.11.1.5 *Pilot study*

In the current study, questionnaires were provided to two doctors working in the intensive care units at Universitas Academic and Pelonomi Hospitals, in order to determine aspects such as the clarity and the distinctness of the questions and how much time was needed to complete the questionnaire, and to ensure that the questions were not biased. Since the participants in the pilot study did not meet inclusion criteria, the data of these questionnaires were not included in the final analysis of the results.

1.11.1.6 *Data gathering*

Survey questionnaires were provided to study participants via an electronic link for completion. Consent to participate in the study was inferred by completion of the questionnaires.

1.11.1.7 *Data analysis*

Data were analysed by a qualified statistician of the Department of Biostatistics at the University of the Free State. Descriptive statistics, namely, means and standard deviations or medians and percentiles, were calculated for continuous data. Frequencies and percentages were calculated for categorical data.

1.11.1.8 *Data interpretation*

In this study, the data interpretation was guided by the findings of the data collected quantitatively through the questionnaire survey. The main conclusions after interpreting the data involved determining the current state of critical care services at district and regional hospitals in the Free State province of South Africa.

1.11.2 Phase 2: A survey of the knowledge, attitudes and practices pertaining critical care among medical practitioners at district and regional hospitals in South Africa

Using the answers from Phase 1 of the study and having determined the institutional resources pertaining critical care, Phase 2 followed, and involved a quantitative research approach. Questionnaires (cf. Appendix D) were designed and distributed to doctors who managed critically ill patients at various district and regional hospitals in the Free State province, to determine if first-line medical practitioners had the required knowledge, attitudes and practices to provide critical care services at the various institutions.

1.11.2.1 *Target population*

A target population is the group of individuals with specific characteristics that the researcher is interested in and wants to study (Polgar & Thomas, 2008). In this study, the target population included all the general medical practitioners employed at regional and district public sector hospitals in the Free State province of South Africa who were providing clinical care to critically ill patients.

1.11.2.2 *Sample selection*

The Free State province has 22 district and regional hospitals. For the purpose of this study, all general medical doctors at all the district and regional hospitals were invited to participate in this phase of the study. The questionnaires were sent to all willing participants and a response rate of >20% was deemed satisfactory for data analysis. To improve on the response rate, electronic copies of the questionnaires were distributed via the chief executive officer of each hospital.

1.11.2.3 *Sample size*

The sample size was predetermined and depended on the number of medical practitioners employed at the regional and district hospitals at the time that Phase 2 of this study was conducted. At the time of the study, 94 community service medical officers and 82 career medical officers were employed at Free State district and regional hospitals (personal communication Universitas Academic Hospital Human Resources Office). An accurate number for interns could not be obtained.

1.11.2.4 *Pilot study*

A pilot study is conducted prior to the main study and is of value to test whether the measuring instrument is valid and reliable, the time it takes to complete a questionnaire, whether questions in a questionnaire are ambiguous and can be improved upon, whether the data analysis methods are suitable and whether the study is feasible (Strydom, 2011). A pilot study was conducted by submitting the questionnaire to two doctors (medical officers at the Department of Critical Care, Universitas Academic Hospital), in order to determine aspects relating to the clarity and the distinctness of the questions and how much time was needed to complete the questionnaire, and to ensure that the questions were not biased. Since participants in the pilot study did not meet inclusion criteria, the data of these questionnaires were not included in the final questionnaire survey data.

1.11.2.5 *Data gathering*

The measurement instrument that was used in this phase of the research was a summative rating scale in the form of a questionnaire. Kerlinger (1986:494) describes a rating scale as "a measuring instrument that requires the rater or observer to assign the rated object to categories or continua that have numerals assigned to them". Regarding whether a summative rating scale is an appropriate instrument for measuring knowledge, attitudes and practice, Kerlinger (1986:495) explains that an attitude "is an organized predisposition to think, feel, perceive and behave toward a referent or cognitive object".

By using a summative rating scale, respondents were able to indicate their opinions both in terms of direction (positive or negative toward the item) and intensity (how strongly their opinion was in relation to the item). An e-mail with an electronic link to the survey was sent to chief executive officers or clinical managers at the district and regional hospitals, who were requested to forward the electronic link to all the doctors working at their respective hospitals via a personnel group e-mail. Informed consent was implied when questionnaires were completed, and participants were assured that the results would be handled confidentially.

1.11.2.6 *Data analysis*

Data were analysed by a qualified statistician of the Department of Biostatistics at the University of the Free State. Descriptive statistics, namely, means and standard deviations

or medians and percentiles, were calculated for continuous data. Frequencies and percentages were calculated for categorical data.

1.11.2.7 *Data interpretation*

In this study, the data interpretation (of Phase 2) was guided by the findings of the data collected quantitatively through the questionnaire survey. The main conclusions after interpreting the data involved determining if general medical practitioners who provided critical care services at district and regional hospitals in the Free State province of South Africa had the necessary knowledge, attitudes and practices to deliver the expected quality of care as required from an institutional point of view. A predetermined pass level for the knowledge assessment section was used to decide if study participants had adequate knowledge.

On conclusion of Phases 1 and 2 of this study, a preliminary list of suggested core competencies in critical care for general medical practitioners was compiled, based on the results of the preceding phases. The preliminary list of core competencies was provided to a Delphi panel of experts in Phase 3 of the study for review and validation.

1.11.3 Phase 3: Core competencies in critical care for general medical practitioners: A Delphi study

Phase 3 of the study followed a qualitative research approach. In this phase of the study, a Delphi panel of national and international experts in critical care was assembled. A preliminary list of suggested core competencies in critical care for general medical practitioners was compiled (cf. Appendices E, F & G). The Delphi panel was requested to review and validate the preliminary list and suggest additional core competencies required for critical care by general medical practitioners in South Africa. After reaching consensus, a final list of core competencies in critical care was compiled and a curriculum for a postgraduate diploma in critical care was proposed (cf. Chapter 5).

1.11.3.1 *Sample selection and target population*

A purposive snowball sampling method was employed by identifying experts in the field of critical care at the medical schools of universities in South Africa (University of the Free State, University of the Witwatersrand, University of Pretoria, University of Cape Town,

University of Stellenbosch, University of KwaZulu-Natal, Nelson Mandela University, Sefako Makgatho Health Sciences University, Walter Sisulu University). International experts in critical care medicine were identified by screening committee lists of major international societies of intensive care medicine, recruiting heads of critical care units or departments, or identifying intensivists with at least five years' experience in critical care medicine.

1.11.3.2 *Sample size*

The academic heads of the critical care units of nine medical schools in South Africa were deemed experts in their discipline and were approached to participate, or to suggest an alternative participant for inclusion on the Delphi panel. A similar number of international experts as the national experts was identified and invited to participate in the Delphi panel. The invitation letter to participate in the study, consent forms and questionnaires were emailed to the Delphi panel members.

1.11.3.3 *Description of the sample*

The sample consisted of 11 national and 14 international critical care medicine specialists, as well as health education professionals with experience in critical care training who were willing to participate in the study.

1.11.3.4 *Pilot study*

A pilot study was conducted by submitting the questionnaire to two local specialist physicians at the Department of Critical Care at the University of the Free State, in order to determine aspects such as the clarity and the distinctness of the questions and how much time would be needed to complete the questionnaire, and to ensure that the questions were not biased. Since the participants in the pilot study did not meet inclusion criteria, the results of the pilot study were not included in the final Delphi study analysis.

1.11.3.5 *Data gathering*

Consent to participate in the study was obtained by means of written communication. Questionnaires were emailed to members of the Delphi panel and three rounds of responses were elicited. The study was stopped after agreement of more than 80% was achieved for all questions.

1.11.3.6 *Data analysis*

Phase 3 of the study was conducted by means of a modified Delphi process. A preliminary list of core competencies was compiled and sent to the Delphi panel for validation. Quantitative data could, thus, be obtained and was analysed by a qualified statistician of the Department of Biostatistics at the University of the Free State. Frequencies and percentages were calculated for the categorical data obtained by the questionnaire.

1.12 QUALITY AND RIGOR OF THE RESEARCH

1.12.1 Trustworthiness

Nieuwenhuis (2016) cites Guba (1981), who lists four criteria to which a qualitative study should conform to be trustworthy. These are credibility, transferability, dependability and confirmability.

1.12.1.1 *Credibility*

Credibility indicates that the findings of a study are based on reality and are believable (Nieuwenhuis, 2016). The credibility of this study was ensured by making use of rigorous research methods, using study designs that are appropriate for the research questions, ensuring that the selection of study participants was valid, and that data collection was comprehensive and accurate (Nieuwenhuis, 2016). Regular discussion of the data by the researcher and supervisors was conducted to ensure that the interpretation of the responses is correct.

1.12.1.2 *Transferability*

Transferability in qualitative research gives an indication of how applicable the research findings pertaining the phenomenon under study are to a similar group of individuals in a similar environment to that in which the study was conducted (Nieuwenhuis, 2016). Transferability, in the current study, was ensured by providing a detailed description of the context, purposively selecting study participants who completed questionnaires in Phases 1 and 2 of the study and providing a detailed description of the study design employed (Nieuwenhuis, 2016).

1.12.1.3 *Dependability*

Nieuwenhuis (2016:124) states that the dependability of a study "is demonstrated through the research design and its implementation; the operational detail of data gathering and the reflective appraisal of the project". Dependability in this study was similarly demonstrated by describing the research design and methodology, providing a detailed description of the process of data gathering, and stating the strengths and limitations of the study.

1.12.1.4 *Confirmability*

Confirmability is an indication that study findings were not biased by the researcher's preconceptions. Confirmability can be improved further by methods such as triangulation (Nieuwenhuis, 2016). Any difficulties or challenges that the researcher may have faced during data collection or analysis should be clearly stated, so that the reviewer can understand exactly how the data was interpreted and conclusions were arrived at (Nieuwenhuis, 2016). Limitations and challenges in conducting this study will be described in Chapter 6 of this thesis.

1.12.2 Validity and reliability

1.12.2.1 *Validity*

A measuring instrument is deemed to be valid if it measures what it was designed to measure (Pietersen & Maree, 2016). Different types of validity are recognised, among which face validity, content validity, construct validity and criterion validity (Pietersen & Maree, 2016). The validity of the current study was enhanced by having all the questions and answers of the questionnaires reviewed by the researcher's supervisors, who are experts in the field under study. Validity was ensured by performing pilot studies of questionnaires to test several aspects thereof prior to submitting the questionnaires to study participants. The validity of the final guidelines for critical care training was established through the expertise of the participants on the Delphi panel, as well as by the supportive expertise that the supervisors and the statistician provided to the researcher.

1.12.2.2 *Reliability*

The reliability of a measurement instrument refers to the extent to which the same results would be obtained if measurements are taken at different times on the same population (Pietersen & Maree, 2016). Various types of reliability are defined, including test-retest reliability, equivalent form reliability, split-halves reliability and internal reliability (Pietersen & Maree, 2016). Reliability of the measuring instruments in the current study was assured by using measuring instruments that had been validated by other studies. Test-retest reliability was not assessed, due to small sample sizes and time constraints for completing the study.

1.12.3 Generalisation

Generalisation refers to the extent to which the findings of this study can be generalised to other populations or contexts. A small number of participants limits generalisability in quantitative research. The inclusion of national and international experts in the Delphi study and the high level of consensus and alignment with findings from other international curricula may contribute to improving generalisability.

1.13 ETHICAL CONSIDERATIONS

1.13.1 Approval

Approval to conduct the research project was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (UFS-HSD2020/1524/2411) (cf. Appendix A). Approval was also obtained from the Department of Health (cf. Appendix B).

1.13.2 Informed consent

Informed consent was required from all participants, because questionnaire surveys and a Delphi study were conducted. For all three phases of the study, a short overview of the study and its purpose were provided to the participants, with an explanation of what was required of them. Consent was inferred by completion of the questionnaires by respondents.

1.13.3 Right to privacy

In Phases 1 and 2 of the study, number coding was used to ensure the confidentiality and anonymity of the participants' responses. Responses could, therefore, not be traced back to individual respondents. For Phase 3 of the study, specific permission was obtained from the Delphi panel members to list their names and affiliations as part of the author list on the manuscript for publication. No names or personal identifiers appeared on any data sheet that was sent for statistical analysis. All information was managed in a strictly professional and confidential manner.

1.13.4 Minimising the potential for misinterpretation of results

Regarding Objectives 1 and 2 of the study, misinterpretation of results was minimised by administering a questionnaire survey to participants, to reduce the variability of answers provided. Bias was minimised by sending invitations to all district and regional hospitals in the Free State. The Delphi process involved consecutive rounds, until consensus was achieved among participants. Data of all three phases were scrutinised by the researcher, supervisors and the biostatistician for anomalies.

1.13.5 Ethical procedures relating to data reporting

Data were reported anonymously, without the names of any of the study participants being mentioned. All surveys were conducted using the REDCap software programme, which is a secure platform housed by the University of the Free State and protected by the firewalls of the university. Deidentified data for all three phases were exported to Excel spreadsheets and e-mailed to the biostatistician for analysis. All of the data were stored on password protected computers located in the offices of the researcher and biostatistician.

1.13.6 Ethical procedures regarding data analysis

Data analysis was performed confidentially and anonymously. Study participants in Phases 1 and 2 of the study received study numbers and were not identifiable. Study participants in Phase 3 of the study also received study numbers, but were identifiable by the principal investigator who kept a separate password-protected list of study participant names on his personal computer, and cross-referenced participant study numbers with identifying particulars.

1.14 SCOPE OF THE STUDY

The study was interdisciplinary, as it involved health professions education and critical care medicine.

1.15 VALUE, SIGNIFICANCE AND CONTRIBUTION OF THE STUDY

1.15.1 Value

The value of this research study is that it offers guidelines on a curriculum for a postgraduate diploma in critical care that could, it was hoped, lead to training for medical practitioners involved in the care of critically ill patients.

1.15.2 Significance

The proposed study will contribute to the introduction and eventual implementation of a training programme that aims to improve the level of competency of medical practitioners related to critical care medicine at all levels of healthcare.

1.15.3 Contribution

With this study, the current gap in knowledge between the actual level of competency of medical practitioners who provide critical care services to patients in the Free State, and the expected level of competency, was determined. The contribution of this study is to establish core competencies in critical care and to provide guidelines on a curriculum for a postgraduate diploma in critical care, which will address the shortcomings in competencies of healthcare practitioners at all levels of healthcare.

1.16 SCHEMATIC OVERVIEW OF THE STUDY

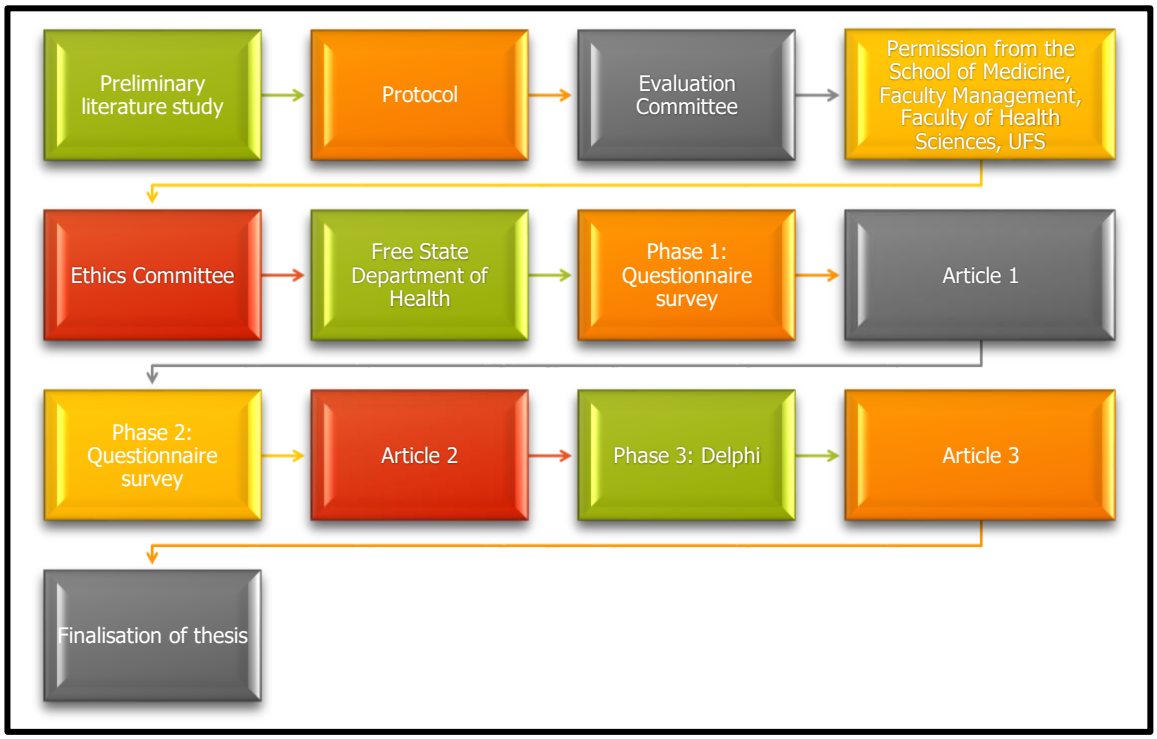

Figure 1.5: Schematic overview of the study (*Compiled by researcher, Maasdorp (2020)*

A schematic overview of the study is provided in Figure 1.5. The process started with a literature review, after which a protocol was compiled. After approval of the protocol by the protocol evaluation committee and faculty management, the protocol was evaluated and approved by the Health Sciences Research Ethics Committee at the University of the Free State, as well as the Free State Department of Health. Thereafter, the study was conducted and the final thesis compiled in the form of publishable manuscripts as per the author guidelines of the *Southern African Journal of Critical Care* (cf. Appendix L), to which all three manuscripts were submitted for publication.

1.17 CHAPTER SUMMARY

In Chapter 1, the reader was provided with background to the field of critical care. Gaps in knowledge pertaining the provision of critical care services in public sector healthcare of South Africa were highlighted. The research questions, aims and objectives of the study were stated and the research methodology was described. The results for each of the objectives of the study will be provided in Chapters 2 to 4 in the form of publishable manuscripts. Chapter 5 will highlight the contribution of the thesis in the form of guidelines for a postgraduate diploma in critical care. The thesis will conclude with Chapter 6, wherein strengths, limitations and recommendations of the study will be stated.

CHAPTER 2

ARTICLE 1: A SURVEY OF CRITICAL CARE RESOURCES AT DISTRICT AND REGIONAL PUBLIC SECTOR HOSPITALS IN THE FREE STATE PROVINCE OF SOUTH AFRICA

This article was prepared according to the submission guidelines of the Southern African Journal of Critical Care (SAJCC) (cf. Appendix L).

The SAJCC is the official journal of the Critical Care Society of Southern Africa and publishes original research in the fields of intensive care, emergency medicine and critical care nursing. The journal is accredited by the South African Department of Higher Education and Training (DoHET) and indexed with PubMed Central (PMC), Excerpta Medica (EMBASE), Biological Abstracts (BIOSIS), Science Citation Index (SCISEARCH), Current Contents/Clinical Medicine and SCIELO.

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A SURVEY OF CRITICAL CARE RESOURCES AT DISTRICT AND REGIONAL PUBLIC SECTOR HOSPITALS IN THE FREE STATE PROVINCE OF SOUTH AFRICA

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Abstract

Background: The envisaged National Health Insurance policy of South Africa makes provision for hospital-based service benefits, which include emergency medicine and critical care services. The availability of resources for providing for critical care services at public sector hospitals is, however, unknown.

Objectives: To evaluate the available critical care resources at district and regional public hospitals in the Free State province of South Africa.

Methods: A survey using an intensive care unit (ICU) resources questionnaire was conducted from 1 January 2021 to 31 March 2021 among clinical managers or other designated personnel who were knowledgeable about the ICU resources at their respective hospitals. Invitations to participate in the survey were sent to all 18 district and 4 regional hospitals in the Free State province of South Africa.

Results: In total 22 invitations were distributed, and 8 out of 18 clinical managers at district hospitals and 3 of 4 regional hospital clinical managers completed the questionnaire. There are 1.7 ICU beds per 100 000 population in the drainage area served by the hospitals in the survey. District hospitals do not have ICUs. ICUs are available at all the regional hospitals and are operated as open units, with no intensivists available to direct the care of patients. Basic equipment and medical consumables for managing emergencies are available at most of the district hospitals.

Conclusion: The lack of ICU beds, ICU-trained or qualified nursing personnel, as well as lack of ICU-trained doctors, are major limitations to providing optimal critical care services in the Free State province of South Africa.

Introduction

Critical care medicine is a relatively new field of specialised medicine, born from desperation during the 1952 polio epidemic in Copenhagen, when tracheostomy tubes were inserted into the airways of affected patients to keep them alive by means of manual positive pressure ventilation.[1] The terms 'intensive care' or 'intensive care medicine' are often used interchangeably with the terms 'critical care' or 'critical care medicine'. Intensive care is primarily provided in the setting of an intensive care unit (ICU), whereas critical care is the care provided to any critically ill patient, irrespective of the setting, even outside the ICU.[2]

During the last 70 years, critical care medicine has evolved into a highly specialised, multidisciplinary field. Due to an increased ability to support failing organs artificially and keep patients alive for longer, the requirements for intensive care services have increased and now constitute a major expense of healthcare budgets across the globe.[3] The ideal number of ICU beds is influenced by various factors. These include clinical factors, such as whether high-risk surgery is performed or intensive chemotherapy is provided, and economic factors, such as whether health administrators are willing to invest in the expensive technology needed for advanced medical treatment, for which cost-benefit ratios are not always that clear.[4] The National Health Act (Act No. 61 or 2003) of South Africa provides a framework for organising healthcare services and makes provision for health establishments to be classified according to their roles and functions, as well as the nature and level of health services they can provide within the national health system.[5] According to regulations contained in the National Health Act, district hospitals are served by general practitioners and clinical nurse practitioners who provide in-patient, ambulatory and emergency health services on a 24-hour basis.[5] Regional hospitals must be able to provide trauma and emergency services, as well as short-term ventilation, in a critical care unit.[5] The Ideal Hospital Framework was designed to address deficiencies in primary health care services by establishing a benchmark for the quality of services delivered at public hospitals, and by which hospitals are regularly assessed.[6] Standards for equipment and infrastructure that should be available in an ICU or high care unit are contained in the Ideal Hospital Framework document.[7]

The public healthcare sector provides medical services to the largest part of the South African population, but is severely underfunded and under-resourced compared to the private healthcare sector.[8] The National Health Insurance (NHI) policy seeks to provide universal health coverage to all South Africans, irrespective of their ability to pay for these services at the point of service delivery.[9] The NHI policy stipulates that primary healthcare

will form the backbone of healthcare service delivery in South Africa and that general medical practitioners (general practitioners and medical officers) will provide the majority of healthcare services.[9] Among the hospital-based service benefits described in the NHI policy document is the requirement for emergency medicine, including critical care, to be provided.[9]

The question is whether regional and district hospitals in South Africa, and general medical practitioners employed at these healthcare facilities, have adequate resources and competencies to manage critically ill patients. We, therefore, designed a study with the overall aim of establishing the core competencies that are required for non-specialist general medical practitioners who provide critical care to patients in South Africa. The study consisted of three phases that were conducted sequentially. The objective of the first phase of the study was to gain deeper insight into the state of critical care resources in the public healthcare sector of the Free State province of South Africa. Data for the first phase of the study, reported in the current manuscript, was collected by means of a survey questionnaire that was completed by clinical managers of district and regional hospitals in the Free State. Results of the second and third phases of the study are reported in separate manuscripts. Approval to conduct the study was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (UFS-HSD2020/1524/2411), as well as from the Free State Department of Health.

Methods

Study Design

This was a cross-sectional descriptive study.

Setting

The Free State province is situated in central South Africa and has a population of 2.8 million people.[10] It is composed of Mangaung Metropolitan Municipality and four district municipalities: Xhariep, Lejweleputswa, Thabo Mofutsanyana and Fezile Dabi districts[11] (Table 1).

Table 1: Number of hospitals per municipality[5,12]

District	District hospitals	Regional hospitals	Tertiary hospitals	Central hospitals
Mangaung Metropolitan Municipality	3	0	2	1
Xhariep	3	0		
Lejweleputswa	5	1*		
Thabo Mofutsanyana	3	2#		
Fezile Dabi	4	1$		

** Bongani Regional Hospital; # Dihlabeng and Mofumahadi Manapo Regional Hospitals; $Boitumelo Hospital*

Patients who require hospital care are referred from local clinics or community health centres to district hospitals. District hospitals do not have ICUs. Critically ill patients referred from clinics or community health centres would, thus, require initial stabilisation at district hospitals before being referred to regional hospitals, where ICUs are usually available. Although these hospitals employ specialists, including general surgeons, physicians and obstetricians, medical officers generally still provide the bulk of healthcare to patients. For more advanced levels of care, patients are referred to tertiary or central hospitals, namely Universitas Academic Hospital, Pelonomi Tertiary Hospital and Free State Psychiatric Complex in Bloemfontein.[5,12] As the number of ICU beds at regional and tertiary hospitals are limited, there may be delays in patient transfers, requiring referring healthcare practitioners to stabilise and manage critically ill patients for protracted periods of time.

Participants

Purposive sampling was used in this study. The target population was chief executive officers, clinical managers, nursing managers, doctors or designated personnel who could answer questions regarding critical care service delivery at the respective district and regional hospitals. Central or tertiary referral hospitals were excluded, as these hospitals are typically well staffed and have intensive care specialists to manage critically ill patients on site. There are 18 district and four regional public sector hospitals in the Free State. Invitations to participate in the study were sent via email to each of the 22 institutions.

Variables

The questionnaire used in the survey was adapted from a validated tool to suit the local setting,[13] and elicited information about the type of hospital (infrastructure), ICU facilities available (technical resources), human resources, equipment, medication to manage critically ill patients, and transport facilities. Response options for the questions in the questionnaire were based on a five-point Likert scale, and options were ‘never’, ‘rarely’,

'seldom', 'often', and 'always'. An open question for additional comments was also included in the questionnaire.

Data sources/measurement

An electronic link to the survey questionnaire on REDCap,[14,15] a secure electronic database housed at the University of the Free State, was sent to individuals who agreed to participate in the study. Consent to participate in the study was inferred by completion of the questionnaire. A pilot study was conducted with two medical practitioners working in the ICUs at Universitas Academic Hospital, to determine aspects such as the clarity, distinctness of the questions and the time required to complete the questionnaire, and to ensure that the questions were not biased. Since the participants in the pilot study did not meet the inclusion criteria, their responses were not included in the study.

Statistical methods

Data were analysed by a qualified statistician of the Department of Biostatistics at the University of the Free State, using Statistical Analyses Software (SAS 9.4). Descriptive statistics, namely, medians and percentiles, were calculated for continuous data. Frequencies and percentages were calculated for categorical data.

Results

The study was conducted between 1 January 2021 and 31 March 2021. Of the 22 invitations that were distributed, eight out of 18 clinical managers from the district hospitals and three of the four regional hospital clinical managers completed the questionnaire. This equates to a response rate of 44.4% for district hospitals and 75% for the regional hospitals. None of the district hospitals had ICUs. Questions regarding the organisation of hospital ICUs were, therefore, only relevant to regional hospitals. All the regional hospitals had both trauma and ICU facilities available and frequently received patients from district hospitals or primary care clinics. Respondents from all three regional hospitals indicated that they frequently referred patients to tertiary hospitals.

A description of the ICUs at the three regional hospitals from which completed questionnaires were obtained is provided in Table 2.

Table 2: Regional hospitals in the Free State

Hospital	Number of beds	Number of adult ICU beds	Number of separate neonatal ICU beds	Operational policy	Clinical directors for ICU	Doctor available for ICU 24 hours per day	Number of nurses on duty per shift	Nursing ranks on duty per shift	Bed occupancy rate for ICU
Hospital 1	140	5	0	Open unit	Anaesthetist	Medical officer	3	2 RPN 1 EN 1 ICU qualified nurse	76–100%
Hospital 2	312	5	4	Open unit	None	Medical officer	5	2 RPN 2 EN	76–100%
Hospital 3	450	7	16	Open unit	Specialist physician	Medical officer	4	3 RPN 1 NA	76–100%

RPN = Registered professional nurse; EN = Enrolled nurse; NA = Nursing assistant

Although no response was obtained from the fourth regional hospital in the Free State, personal communication obtained from a specialist physician working at the hospital in 2022 provided the following information. Hospital 4 is a 300-bed hospital with separate six-bed adult, one-bed paediatric and five-bed neonatal ICUs. This information was used to calculate the number of ICU beds in the Free State, but no other data were included in the analysis.

By using demographic information available for 2016 regarding the number of people over the age of 15 years in the Free State municipalities in which the regional hospitals are located,[11] and based on the described results, the number of adult ICU beds would equate to 1.7 per 100 000 of the population in these municipalities.

Table 3: Availability of ICU equipment at district and regional hospitals in the Free State

Equipment always/often available	All hospitals (n=11) n (%)	District hospitals (n=8) n (%)	Regional hospitals (n=3) n (%)
Oxygen source			
Central wall oxygen	9 (81.8)	6 (75)	3 (100)
Oxygen via medical cylinder	9 (81.8)	7 (87.5)	2 (66.7)
Tubes and catheters			
Endotracheal tubes	10 (90.9)	7 (87.5)	3 (100)
Nasogastric tubes	10 (90.9)	7 (87.5)	3 (100)
Arterial catheters	3 (27.3)	2 (25)	1 (33.3)
Central venous catheters	5 (45.5)	3 (37.5)	2 (66.6)
Urine catheters	10 (90.9)	7 (87.5)	3 (100)
Intercostal drains	8 (72.7)	6 (75)	2 (66.7)
Monitoring equipment			
Electronic non-invasive blood pressure monitor	9 (81.8)	6 (75)	3 (100)
Electronic ECG monitor	10 (90.9)	7 (87.5)	3 (100)
Pulse oximetry	9 (81.8)	6 (75)	3 (100)
Electronic respiratory rate monitor	5 (45.5)	2 (25)	3 (100)
Invasive blood pressure monitor	2 (20) *Missing = 1*	1 (14.3) *Missing = 1*	1 (33.3)
Capnography	3 (30) *Missing = 1*	2 (28.6) *Missing = 1*	1 (33.3)
Arterial blood gas machines	5 (50) *Missing = 1*	2 (28.6) *Missing = 1*	3 (100)

Intravenous infusion pumps	6 (60) *Missing = 1*	3 (42.9) *Missing = 1*	3 (100)
Oxygenation equipment			
Nasal cannulas	8 (80) *Missing = 1*	5 (71.4) *Missing = 1*	3 (100)
Venturi facemasks	6 (60) *Missing = 1*	4 (57.1) *Missing = 1*	2 (66.7)
Simple facemasks	9 (90) *Missing = 1*	6 (85.7) *Missing = 1*	3 (100)
Rebreather masks	6 (60) *Missing = 1*	3 (42.9) *Missing = 1*	3 (100)
Non-rebreather masks	6 (60) *Missing = 1*	3 (42.9) *Missing = 1*	3 (100)
High flow nasal oxygen	6 (66.7) *Missing = 2*	3 (50) *Missing = 2*	3 (100)
Non-invasive ventilation via tight-fitting masks or BiPAP	3 (30) *Missing = 1*	1 (14.3) *Missing = 1*	2 (66.7)
Invasive mechanical ventilation	5 (50) *Missing = 1*	2 (28.6) *Missing = 1*	3 (100)

EEG = electroencephalogram. BiPAP = bilevel positive airway pressure.

Responses were grouped into ‘never/rarely/seldom’ as one group and ‘often/always’ as a second group. Frequencies and percentages provided in the tables relate to resources being ‘often or always’ available. Questionnaires obtained from some of the district hospitals were incomplete and there were missing data on several of the questions. The questionnaires were, however, completed anonymously, and the respondents could, therefore, not be traced to obtain any of the missing information.

The availability of equipment at district and regional hospitals required to manage critically ill patients is indicated in Table 3. All three regional hospitals had central wall oxygen, as opposed to 25% of the district hospitals who did not have central wall oxygen. Arterial catheters, which are usually standard of care at tertiary ICUs for invasive blood pressure monitoring and arterial blood gas measurements, were only available in one of the three regional hospitals for most of the time. Swan-Ganz catheters were not available in any of the regional hospitals. Central venous catheters, which are also frequently inserted in most patients admitted to an ICU, were ‘often or always’ available in two of the three regional hospitals, but in less than 50% of the district hospitals. This result might be expected for hospitals without ICU facilities. Basic monitoring equipment, such as blood pressure monitors, ECG monitors and pulse oximetry, were available in all the regional hospitals and were ‘often or always’ available in most of the district hospitals. More advanced monitoring equipment, such as invasive blood pressure monitors, electronic central venous pressure monitors, capnography, cardiac output monitors and thromboelastography (TEG) or rotational thromboelastography (ROTEM) were ‘seldom or never’ available in regional or district hospitals. The absence of monitoring equipment could also be expected in district hospitals without ICU facilities. In regional hospitals, most of the oxygenation equipment was available, although only two of the three regional hospitals indicated that non-invasive ventilation via appropriately fitting masks or bilevel positive airway pressure (BiPAP) were ‘often or always’ available. Most of the district hospitals indicated that nasal cannulas and simple face masks were ‘often or always’ available, while 50% indicated that high-flow

nasal oxygen, which is considered an advanced modality for oxygenation, was also available most of the time. As expected, mechanical ventilation, either non-invasive or invasive, was 'seldom or never' available in most of the district hospitals.

The availability of medication commonly used in the management of critically ill patients is indicated in Table 4.

Table 4: Availability of listed medication at regional and district hospitals in the Free State

Medication often or always available	All hospitals (n=11) n (%)	District hospitals (n=8) n (%)	Regional hospitals (n=3) n (%)
Intravenous fluids and feeds			
Crystalloids	8 (80) *Missing = 1*	5 (71.4) *Missing=1*	3 (100)
Colloids	6 (60) *Missing = 1*	3 (42.9) *Missing=1*	3 (100)
Dextrose	9 (90) *Missing = 1*	6 (85.7) *Missing=1*	3 (100)
Total parenteral nutrition	4 (40) *Missing = 1*	1 (14.3) *Missing=1*	3 (100)
Enteral nutrition	7 (70) *Missing = 1*	4 (57.1) *Missing=1*	3 (100)
Vasoactive medication			
Adrenalin	9 (90) *Missing = 1*	6 (85.7) *Missing=1*	3 (100)
Phenylephrine	5 (50) *Missing = 1*	3 (42.9) *Missing=1*	2 (66.7)
Noradrenalin	5 (50) *Missing = 1*	3 (42.9) *Missing=1*	2 (66.7)
Dobutamine	6 (60) *Missing = 1*	3 (42.9) *Missing=1*	3 (100)
Dopamine	7 (70) *Missing = 1*	4 (57.1) *Missing=1*	3 (100)
Labetolol	8 (80) *Missing = 1*	5 (71.4) *Missing=1*	3 (100)
Nitroglycerin	7 (70) *Missing = 1*	4 (57.1) *Missing=1*	3 (100)
Antibiotics			
Ampicillin	7 (77.8) *Missing = 2*	5 (83.3) *Missing=2*	2 (66.7)
Penicillin	6 (66.7) *Missing = 2*	5 (83.3) *Missing=2*	1 (33.3)
Cloxacillin	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Amoxycillin/clavulanic acid	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Cefuroxime	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Ceftriaxone	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Ceftazidime	5 (55.6) *Missing = 2*	3 (50) *Missing=2*	2 (66.7)
Cefepime	4 (44.4) *Missing = 2*	2 (33.3) *Missing=2*	2 (66.7)
Piperacillin/tazobactam	4 (44.4) *Missing = 2*	1 (16.7) *Missing=2*	3 (100)
Gentamycin	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Amikacin	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Tobramycin	2 (25) *Missing = 3*	1 (20) *Missing=3*	1 (33.3)
Ciprofloxacin	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Vancomycin	5 (55.6) *Missing = 2*	2 (33.3) *Missing=2*	3 (100)
Metronidazole	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Clindamycin	6 (66.7) *Missing = 2*	3 (50) *Missing=2*	3 (100)
Acyclovir	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Fluconazole	7 (87.5) *Missing = 3*	4 (80) *Missing=3*	3 (100)
Amphotericin B	6 (66.7) *Missing = 2*	4 (66.7) *Missing=2*	2 (66.7)
Blood products			
Packed red blood cells	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Fresh frozen plasma	4 (44.4) *Missing = 2*	1 (16.7) *Missing=2*	3 (100)
Induction agents			
Propofol	6 (66.7) *Missing = 2*	3 (50) *Missing=2*	3 (100)
Ketamine	7 (77.8) *Missing = 2*	4 (66.7) *Missing=2*	3 (100)
Etomidate	7 (77.8) *Missing = 2*	5 (83.3) *Missing=2*	2 (66.7)
Midazolam	8 (88.9) *Missing = 2*	5 (83.3) *Missing=2*	3 (100)
Muscle relaxants			
Suxamethonium	6 (66.7) *Missing = 2*	3 (50) *Missing=2*	3 (100)
Rocuronium	5 (55.6) *Missing = 2*	2 (33.3) *Missing=2*	3 (100)
Cisatracurium	2 (22.2) *Missing = 2*	1 (16.6) *Missing=2*	1 (33.3)

Commonly used intravenous fluids and enteral feeds, as well as vasoactive medication, were

available for most of the time in all three regional hospitals. At district hospitals, crystalloids and dextrose-containing fluids were more commonly available than colloids, and the majority of respondents reported that total parenteral nutrition was 'seldom or never' available. Adrenaline was 'often or always' available in 85.7% of district and in 100% of regional hospitals, whereas other vasoactive medications were less commonly available. All the regional hospitals had access to antimicrobials prescribed for community-acquired infections, although antimicrobials for multidrug-resistant bacterial or fungal organisms, such as carbapenems and antifungal agents, were 'seldom or never' available. Most district-level hospitals indicated that penicillin, cloxacillin, amoxicillin/clavulanic acid and ceftriaxone were available, although none of the other classes of antibiotics were 'often or always' available. Carbapenems, including Ertapenem, Imipenem and Meropenem, were only available at regional hospitals and not at district hospitals, whereas quinolones such as Moxifloxacin and Levofloxacin were only available at district hospitals and not at regional hospitals. Antibiotics that are frequently used in the management of drug resistant infections such as Doripenem, Teicoplanin, Daptomycin, Colistin and Tigecycline were not available at any of the hospitals. Fluconazole and Amphotericin B were the only antifungal agents available at the hospitals, and none of the hospitals had access to the echinocandin class of antifungals. Packed red blood cells and fresh frozen plasma were available at all three regional hospitals, whereas platelets and cryoprecipitate were 'often or always' available at only one of the regional and one of the district hospitals. Induction agents for intubation were available in most hospitals, whereas muscle relaxants were more often available at regional hospitals than district hospitals.

Table 5: Availability of intubation and other equipment at regional and district hospitals in the Free State

Intubation and other equipment often or always available	All hospitals (n=11) n (%)	District hospitals (n=8) n (%)	Regional hospitals (n=3) n (%)
Intubation equipment			
Laryngoscope size No. 1	7 (77.8) *Missing = 2*	4 (66.7) *Missing = 2*	3 (100)
Laryngoscope size No. 2	7 (77.8) *Missing = 2*	4 (66.7) *Missing = 2*	3 (100)
Laryngoscope size No. 3	7 (77.8) *Missing = 2*	4 (66.7) *Missing = 2*	3 (100)
Laryngoscope size No. 4	7 (77.8) *Missing = 2*	4 (66.7) *Missing = 2*	3 (100)
Laryngeal mask airway	6 (66.7) *Missing = 2*	3 (50) *Missing = 2*	3 (100)
Cricothyroidotomy set	3 (33.3) *Missing = 2*	5 (83.3) *Missing = 2*	2 (66.7)
Ambubag and mask	8 (88.9) *Missing = 2*	5 (83.3) *Missing = 2*	3 (100)
Defibrillators	8 (88.9) *Missing = 2*	5 (83.3) *Missing = 2*	3 (100)
Portable or transport ventilators	4 (44.4) *Missing = 2*	2 (33.3) *Missing = 2*	2 (66.7)
Other			
ECG machines	8 (88.9) *Missing = 2*	5 (83.3) *Missing = 2*	3 (100)
Portable X-ray machine	6 (66.7) *Missing = 2*	3 (50) *Missing = 2*	3 (100)
X-ray services (not portable)	8 (88.9) *Missing = 2*	5 (83.3) *Missing = 2*	3 (100)
Bedside ultrasound machine	5 (55.6) *Missing = 2*	3 (50) *Missing = 2*	2 (66.7)
CT scan	2 (25) *Missing = 3*	0 *Missing = 3*	2 (66.7)

As indicated in Table 5, all three regional hospitals (100%) and most of the district hospitals (66.7%) indicated the availability of all sizes of laryngoscope blades. Video laryngoscope was available at only one of the regional hospitals. Advanced equipment, such as intubation and flexible bronchoscopes, were 'seldom or never' available at any hospital. Bedside ultrasonography was available at two of the three regional hospitals, as well as 50% of the district hospitals. Intermittent haemodialysis was available at all three regional hospitals, but none of the district hospitals, whereas continuous venovenous haemodialysis was available at only one of the regional hospitals. Extracorporeal membrane oxygenation (ECMO) and MRI scans were not available at any of the hospitals.

Table 6: Availability of transport services for patients referred to and from district and regional hospitals in the Free State

Transportation often or always available	All hospitals (n=9)* n (%)	District hospitals (n=6)[$] n (%)	Regional hospitals (n=3) n (%)
Frequency by which patients are generally transferred to another hospital by:			
Availability of ambulance services in general	6 (66.7)	3 (50)	3 (100)
Availability of the following skills in the ambulance transport personnel: Often or always available			
BLS[a]	7 (77.8)	4 (66.7)	3 (100)
Basic ambulance driver not able to transport critically ill patients	8 (88.9)	5 (83.3)	3 (100)
Estimated typical waiting time for a critically ill patient to be collected by ambulance personnel:			
< 4 hours	9 (100)	6 (100)	3 (100)
Distance to the usual referral hospital:			
≤ 250 km	7 (77.7)	6 (100)	1 (33.3)
251–300 km	1 (11.1)		1 (33.3)
301–600 km	1 (11.1)		1 (33.3)
Frequency of a patient being too unstable for transfer and thereby require management at the local hospital	3 (33.3)	2 (33.3)	2 (66.7)
Frequency by which critically ill patients are managed at the hospital or ICU for the following periods of time before a bed becomes available at the referral hospital: Often or always			
Less than 1 hour	4 (50)	3 (60)	1 (33.3)
1–2 hours	4 (50)	3 (60)	1 (33.3)

2–3 hours	4 (50)	3 (60)	1 (33.3)
3–4 hours	3 (37.5)	1 (20)	2 (66.7)
4–5 hours	3 (37.5)	2 (40)	1 (33.3)
5–6 hours	2 (25)	1 (20)	1 (33.3)
6–12 hours	2 (25)	1 (20)	1 (33.3)

**Data missing for two out of 11 hospitals. [$]Data missing for two out of eight district hospitals.*
#Data missing for three out of 11 hospitals. [¥]Data missing for three out of eight district hospitals.
[a]Basic Life Support. [b]Advanced Cardiac Life Support.

Table 6 indicates the availability of transport services for patients referred to and from district and regional hospitals. Road ambulance services are available at all regional hospitals, although only five out of six (83.3%) of the district hospitals indicated that road ambulance services are 'often or always' available. Air ambulance services are 'seldom or never' available at most hospitals. Ambulance services typically have basic life support personnel, whereas advanced life support and qualified paramedic services are 'seldom or never' available at district or regional hospitals. Two regional hospitals (66.7%) indicated that patients are often too unstable to be transferred, whereas only two (33.3%) district hospitals indicated this. Most of the district hospitals indicated that critically ill patients are 'often or always' managed for a period of up to three hours at their level before an ICU bed becomes available at the referral hospital. Two regional hospitals indicated that they often have to manage patients for up to 24 hours, and one regional hospital indicated that they may have to manage patients for more than 48 hours before accessing an ICU bed at the referral hospital.

Additional findings not shown in tables are that doctors were provided with continuous training on critical care topics in two of the regional hospitals and two of the district hospitals. Nursing staff received continuous education in one of the regional hospitals and one of the district hospitals. Physiotherapists received continuous training in one of the regional and none of the district hospitals. Data were missing for three of the district hospitals.

Discussion

This survey provides several useful insights related to availability of critical care resources in the Free State province.

Beds and capacity

Our results indicate that there are only 1.7 ICU beds per 100 000 population at the public healthcare regional hospitals in the drainage area where these hospitals are located. This figure is much lower than the national average as reported in an audit of the number of ICU

beds in South Africa, which found that there were 7676 critical care beds (2719 in the public sector and 4957 in the private sector), which included high care and ICU beds.[16] This equates to 4.5 beds per 100 000 in the public and 8.3 beds per 100 000 in the private sectors respectively.[16] In contrast to South Africa, the United States of America has 20 ICU beds per 100 000 of the population, Germany has 24.6 beds per 100 000 of the population, and the United Kingdom has 3.5 ICU beds per 100 000 of the population.[17] Uganda, as an example of a low-income country, has 0.1 ICU beds per 100 000 people.[2] Within the framework of a paucity of data, a systematic review describing the ICU availability in 36 ICUs in low-income countries found that 94.1% of the ICUs were located in referral hospitals located in major cities, with limited ICU facilities available in the rural areas.[18]

An analysis of the ICU outcomes at a referral hospital in Kenya demonstrated an ICU mortality of 53.6%.[19] This is in striking contrast to the observed ICU mortality of 8–18% in high-income countries.[17] Patients in Africa are twice as likely to die following surgery than patients operated upon in other continents.[20] The poor outcomes of critically ill patients in resource-limited settings are often attributed to a lack of emergency triage procedures, lack of ICU facilities and prioritisation thereof, and the poor quality of healthcare provided to critically ill patients.[21] ICU bed occupancy rates in our study were between 76 and 100% (Table 2), implying that the number of ICU beds available at the regional hospitals in the Free State were utilised at full capacity. An increase in the number of ICU beds is required, however, this would also require an increase in the number of ICU-trained nurses. There is, however, a shortage of ICU-trained nurses in South Africa, which hampers the ability to increase ICU capacity, irrespective of whether physical ICU bed numbers are increased.[22]

Staffing and operations

ICUs at regional hospitals tend to function as open units, in which patients are co-managed by different specialities, as opposed to closed ICUs that are typical of tertiary hospitals, where the clinical management of patients are directed by intensivists. Open units are the result of a shortage of intensivists, and doctors preferring to work at larger city hospitals. Training in the form of a diploma in a critical care might offer a viable solution to improve on the knowledge and skills of doctors currently working at the district and regional hospitals.

Nursing staff shortages are another limiting factor for operationalising ICU beds.[22] In this study, we found that only one of the regional hospitals had an ICU qualified nurse available in the ICU, whereas the rest of the hospitals had only registered professional

nurses, enrolled nurses and/or nursing assistants. The registered nurse-to-patient ratio for the hospitals in our study were consistently more than 1:2. Enrolled nurses seem to be supplementing the number of registered professional nurses, despite neither having received dedicated ICU training to the same extent as ICU-qualified nurses. Critical care nursing is complex, involves specialised equipment, is provided to patients with life-threatening illnesses and injuries, and includes care that is provided at the onset of critical illness, at the emergency department, during transportation or within an intensive care unit.[23] The nurse-to-patient ratio in ICUs is typically 1:1. In high dependency areas, the nurse-to-patient ratio can be 1:3 or 1:4, depending on the acuity level of the patients.[23] The general shortage of qualified nurses, and high nursing vacancy rates at health facilities in South Africa requires urgent redress if the ability of ICUs to manage increasing numbers of patients is to improve.[24]

Equipment and infrastructure

South African ICUs are graded from level I to level IV, based on the organisational structure and level of care offered.[25] Level I units are usually located at tertiary referral hospitals, and have highly sophisticated equipment and manage complicated disease conditions.[25] Level II units are designed to manage specific disease conditions, such as coronary diseases, while Level III units are community hospital ICUs, and Level IV are high care units.[25] The basic equipment for providing critical care services as Level III ICUs, and as per the Ideal Hospital Framework[6,7] is available at regional hospitals most of the time. Advanced equipment and medication that are typically available at Level I ICUs at tertiary levels of care are, however, not available.

Despite not having ICUs, district hospitals are required to treat and stabilise critically ill patients before transferring them to regional hospital ICUs for further management. Most of the district hospitals in our study indicated that the basic equipment required to treat emergency cases is available. A set of norms and standards for the package of service delivered by district hospital were compiled by the Department of Health.[26] The District Hospital Service Package for South Africa establishes the role of district hospitals as that of supporting primary health, as well as being a gateway to specialist care. General medical practitioners provide clinical services at these hospitals. District hospitals must provide 24-hour emergency services, including resuscitation services, advanced trauma and cardiac life support, treatment and observation of medical and surgical emergencies, and the management obstetric emergencies. The District Hospital Service Package stipulates equipment that should be available on the emergency trolley at the casualty division of each

hospital, as well as the medicines and supplies that should be available to manage emergencies. In our study however, we found that district hospitals did not have all the medication that are deemed to be essential medicine for each healthcare facility by the World Health Organisation (WHO).[27] Anaesthetic agents such as Ketamine or Propofol, and muscle relaxants such as Suxamethonium, that are required for emergency surgical procedures or rapid sequence induction and intubation, are not available at all district hospitals as per the WHO recommendations. The lack of these emergency medications poses a risk to patients requiring urgent establishment of an artificial airway or mechanical ventilation, prior to referral to a regional hospital where ICUs are available. Antibiotics such as Ceftriaxone, which are essential in the management of patients with meningitis and often used in the management of severe pneumonia, are also not readily available at district hospitals. Delays in appropriate antibiotic therapy can potentially result in a poor outcome for critically ill patients. The Essential Emergency and Critical Care (EECC) care package was compiled by a group of collaborators from different specialist fields across the world as a low-cost minimum set of resources and care bundles that all hospitals in the world should be able to offer to reduce the number of preventable deaths globally.[28] The district and regional hospitals in our study were reasonably well resourced as per the EECC list of minimum resources to be able to initiate the care of any critically ill patient, even in the absence outside of an ICU.

As per the national norms and standards for district hospitals, emergency services offered should include advanced trauma and cardiac life support, stabilisation and preparing seriously ill patients for transfer, and close collaboration with district ambulance services.[26] The majority of the district hospitals in our study indicated that their referral hospitals are within a 200 km distance from them, but that it may take three to four hours before critically ill patients can access ICU beds or ambulance transportation to referral hospitals. Ambulance services also lack qualified ACLS or paramedic personnel, who are integral for transporting critically ill patients safely. It would, therefore, be prudent for these hospitals to ensure availability of mechanical ventilation, as well as vasoactive medication to provide hemodynamic support while awaiting transfer of the patient.

Limitations

The low response rate of district hospital managers and the fact that only three of the four regional hospitals participated in the study was a limitation. However, a few district hospital managers indicated that they managed two or three smaller district hospitals simultaneously, and that they completed only one questionnaire representing services of more than one

institution. This would imply that, although the response rate was low, the results may be representative of district hospitals in general, as they offer similar services. The services provided at the district hospital level are prescribed by legislation and should be similar across all the district hospitals.[5,26] A further limitation is the incomplete responses given to the questions, which limited the data available for analysis and interpretation. Despite a pilot study that recommended that no changes to the questionnaires were needed, the missing data could have been due to either questions not being understood well, or respondents not completing the questionnaire if they deemed the item being enquired about not available at or relevant to their institution. The impact of the COVID-19 pandemic on resources at public healthcare institutions, as well as the administration of the questionnaire, is not reported in this paper. The survey was, however, conducted during a peak period of COVID-19 and this may have influenced the response rate.

Generalisability

The district and regional hospitals in the Free State province of South Africa provide similar services across the province for their level of care. The results obtained from the hospitals participating in this study are, thus, likely generalisable to similar levels of care in the province. Generalisability to other provinces cannot be inferred, considering the regional disparities in critical care services across South Africa.[29] There is a need for other provinces to ascertain their own critical care service landscape.

Conclusion

Our study describes the critical care resources available in the Free State province of South Africa. Most of the district hospitals were able to provide critically ill patients with emergency treatment, but were unable to manage critically ill patients for prolonged periods of time. There was a limited number of ICU beds available at regional hospitals in the Free State. The ICUs in the regional hospitals were, however, equipped with the basic resources to provide critical care services. The shortage of trained or qualified nursing personnel, as well as a shortage of ICU-trained doctors, are major limitations to increasing the number of patients that can be managed in ICUs at regional hospitals. Further studies are required to determine the most appropriate way to increase ICU capacity, given the shortage of human resources.

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CHAPTER 3

ARTICLE 2: A SURVEY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES PERTAINING CRITICAL CARE MEDICINE AMONG MEDICAL PRACTITIONERS AT DISTRICT AND REGIONAL HOSPITALS IN SOUTH AFRICA

This article was prepared according to the submission guidelines of the Southern African Journal of Critical Care (SAJCC) (cf. Appendix L).

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A SURVEY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES PERTAINING CRITICAL CARE MEDICINE AMONG MEDICAL PRACTITIONERS AT DISTRICT AND REGIONAL HOSPITALS IN SOUTH AFRICA

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Abstract

Background: There is a limited number of registered intensive care specialists (intensivists) in South Africa and most practice in urban areas. Medical practitioners with a variety of qualifications and experience often stabilise and care for critically ill patients, especially in rural areas, but the extent of their training and competence with regard to critical care has not been studied.

Objectives: To determine the knowledge, attitudes and practices of medical practitioners who provide care to critically ill patients at district and regional public hospitals in the Free State province of South Africa.

Methods: A survey using a knowledge, attitudes and practices (KAP) questionnaire was conducted between 1 May 2021 and 28 February 2022 among medical practitioners at district and regional hospitals in the Free State province of South Africa.

Results: A total of 49 medical practitioners completed the questionnaire (13 interns, 19 community service medical officers, 17 career medical officers). Interns and community service medical officers obtained a median score of 0/10, whereas career medical officers had a median score of 3/10 for the knowledge component of the questionnaire. None of the respondents believed that their undergraduate training had prepared them well enough to manage critically ill patients. The majority expressed that they would benefit from additional training in critical care.

Conclusion: In our survey, we found poor knowledge scores regarding critical care medicine, which possibly reflects the lack of undergraduate training in this discipline. Medical practitioners had positive attitudes toward the management of critically ill patients and were of the opinion that additional postgraduate courses in critical care would be beneficial.

Introduction

In 2017, a task force of the World Federation of Societies of Intensive and Critical Care Medicine defined an Intensive Care Unit (ICU) as a well-structured system by which critically ill patients receive specialised medical and nursing care, close monitoring and organ support, usually within a specific area at a hospital.[1] Critical care, on the other hand, encompasses the totality of care provided to patients with serious, reversible diseases, and includes emergency care, and care provided by hospital systems and ICUs.[2] In well-resourced, high-income countries, critical care services are centralised in ICUs or high dependency units (HDU).[3] Technologically advanced and costly life support equipment is usually available to sustain organ function for variable duration.[3] These units tend to be well staffed with dedicated critical-care-trained medical and nursing personnel, who provide monitoring and care to patients, 24 hours per day. Although patients receive medical therapy from a multidisciplinary team, it is typically coordinated by an intensivist.[3]

ICU bed distribution varies globally.[1,4,5] Compared to hospitals in high-income countries, African hospitals are less likely to have ICUs.[6] Clinicians in low-income countries report that their lack of training in critical care, a shortage of nurses, and low salaries are barriers to providing critical care services.[7] There is a limited number of registered intensive care specialists (intensivists) in South Africa, and most practice in urban areas.[8–10] Medical practitioners with variable qualifications and experience often stabilise and care for critically ill patients, especially in rural areas, but their training and competence has not been studied. In this paper, we determined the knowledge, attitudes and practices of medical practitioners who provide care to critically ill patients as either emergency or first-line healthcare providers at district and regional public hospitals in the Free State province of South Africa. This study formed part of a larger study aimed at establishing core competencies for non-specialist general medical practitioners providing critical care to patients in South Africa. Ethical approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (UFS-HSD2020/1524/2411), as well as the Free State Department of Health.

Methods

Study design

This was a cross-sectional descriptive study.

Setting

The Free State province of South Africa consists of a population of 2.8 million people.[11] The province is divided into several district municipalities. These are: Mangaung Metropolitan municipality, Xhariep, Lejweleputswa, Thabo Mofutsanyana and Fezile Dabi district municipalities.[12] Entry into health services start at the local clinics and community health centres, from where patients who are sick enough to be admitted to hospitals, are referred to the nearest district hospital. ICUs are not available at district hospitals. Patients who are critically ill should be stabilised first at the district hospital. Thereafter, once stable enough for transporting, the patient can be referred to a regional hospital for further management in an ICU. There are four regional hospitals in the Free State. These are Boitumelo (Kroonstad), Bongani (Welkom), Dihlabeng (Bethlehem) and Mofumahadi Manapo Mopeli (Phuthaditjhaba) Hospitals.[13,14] Despite the availability of specialists, such as general surgeons, physicians and obstetricians, at regional hospitals, the first-line healthcare providers for patients are often interns and medical officers. If patients require more advanced levels of care that cannot be provided at regional hospitals, they are generally referred to tertiary hospitals. Universitas Academic and Pelonomi Hospitals in Bloemfontein are the tertiary hospitals for the Free State.[13,14] In view of the limited number of ICU beds at regional and tertiary hospitals, a significant delay in patient transfers can be anticipated. This often require referring healthcare practitioners to stabilise and manage critically ill patients for prolonged periods prior to an ICU bed becoming available.

Participants

Purposive snowball sampling was used in this study. The target population was all non-specialist medical practitioners employed at district or regional hospitals in the Free State. Non-specialist medical practitioners were interns (doing mandatory internship training following graduation from undergraduate medical programmes), community service medical officers (doing mandatory community service following internship) or career medical officers employed at public sector hospitals after community service. There are 22 district and regional hospitals in the Free State. A total of 94 community service medical officers and 82 career medical officers were employed at Free State district and regional hospitals (information obtained from the Human Resources Division at Universitas Academic Hospital) during the study period. No information was available about the number of interns employed at these hospitals during this time. All medical practitioners at these hospitals were invited to participate.

Variables

A knowledge, attitudes and practices (KAP) questionnaire was designed and distributed to doctors who manage critically ill patients at the various district and regional hospitals in the Free State province of South Africa. A pre-determined pass level of 80% for the knowledge assessment section was used to define adequate knowledge in critical care.

Data sources/measurement

An invitation to participate in the study, as well as an electronic link to the KAP questionnaire on REDCap (Research Electronic Data Capture), was sent to the hospital managers of all 22 district and regional hospitals in the Free State province, with a request to forward it to the doctors working at their hospitals. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of the Free State. REDCap is a secure, web-based software platform designed to support data capture for research studies.[15,16] Consent to participate was inferred by completion of the questionnaires. A response rate of ≥ 20% was deemed satisfactory for data analysis. A pilot study was conducted with two medical officers at the division of critical care, Universitas Academic Hospital, and these data were not included in the data analysis. The final electronic questionnaire was distributed to study participants and data collected between 1 May 2021 and 28 February 2022.

Statistical methods

Data were analysed by a statistician of the Department of Biostatistics at the University of the Free State, using Statistical Analyses Software (SAS 9.4). Descriptive statistics, namely, means and standard deviations or medians and percentiles, were calculated for continuous data. Frequencies and percentages were calculated for categorical data.

Results

Demographic characteristics of study participants are indicated in Table 1. A total of 49 medical practitioners completed the electronic questionnaire (13 interns, 19 community service medical officers (response rate 20%), 17 career medical officers (response rate 20.7%)). The median age of study participants was 27 years (interquartile range [IQR] 26-31). The majority of participants were female (n = 26; 53%). An MBChB or equivalent degree was the highest level of qualification possessed by most of the study participants

(93.9%). Most of the study participants worked in the Lejweleputswa district (n = 20; 40.8%), followed by Mangaung Metropolitan District (n = 10; 20.4%), Thabo Mofutsanyana (n = 10; 20.4%), Fezile Dabi (n = 6; 12.2%), and Xhariep Districts (n = 3; 6.1%). A similar number worked at district (n = 25; 51.0%) and regional hospitals (n = 23; 46.9%). One intern incorrectly indicated working at a central hospital. The questionnaire was only distributed to district and regional hospitals, and not to tertiary or central hospitals. The majority of participants indicated that they saw between one and five critically ill patients per week, who required intubation, inotropic or vasopressor support, or who may have benefitted from ICU admission.

Table 1: Demographic characteristics of study participants and hospital settings

	Total n (%)	**Interns n (%)**	**Community Service Medical Officers n (%)**	**Career Medical Officers n (%)**	**p-value**
Total *n*	49	13	19	17	
Age in years *median (25th;75th)*	27 (26;31)	26 (25;28)	26 (26;27)	44 (31;48)	< 0.0001
Gender					
Male	23 (46.9)	6 (46.2)	7 (36.8)	10 (58.8)	
Female	26 (53.1)	7 (53.9)	12 (63.2)	7 (41.2)	
Free State District					0.2469
Lejweleputswa	20 (40.8)	5 (38.5)	9 (47.4)	6 (35.3)	
Mangaung Metropolitan	10 (20.4)	4 (30.8)	2 (10.5)	4 (23.5)	
Thabo Mofutsanyana	10 (20.4)	1 (7.7)	6 (31.6)	3 (17.7)	
Fezile Dabi	6 (12.2)	3 (23.1)	0	3 (17.7)	
Xhariep	3 (6.1)	0	2 (10.5)	1 (5.9)	
Hospital level					0.0020
District hospital (Level 1)	25 (51.0)	2 (15.4)	15 (79.0)	8 (47.1)	
Regional hospital (Level 2)	23 (46.9)	10 (76.9)	4 (21.1)	9 (52.9)	
Provincial hospital (Level 3)	0	0	0	0	
Central hospital (Level 3 and 4)	1 (2.0)	1 (7.7)	0	0	

Knowledge was assessed using 10 questions on various aspects related to critical care medicine. A score of 1 was given for a correct answer and 0 for either an incorrect or unanswered question.

As indicated in Table 2, interns and community service medical officers obtained a median score of 0/10, whereas career medical officers obtained a median score of 3/10. There were no significant differences in the knowledge of interns, community service medical officers or career medical officers. Only 20 of the 49 study participants, however, entered at least one answer for the 10 questions asked. For the 20 study participants who answered at least one question, the median score for interns, community service medical officers and career medical officers is 1/10, 4/10 and 4/10 respectively. Only one career medical officer

obtained a pass mark (score of 8/10).

Table 2: Critical care knowledge of early career medical officers in the Free State

Total N = 49	**Interns**	**Community Service Medical Officers**	**Career Medical Officers**
Total *n*	13	19	17
Knowledge score (Total = 10 *median (min;max)*	0 (0;3)	0 (0;7)	3 (0;8)
Knowledge score out of total of 10 for study participants who answered at least one of the questions *median (min;max)*	N = 6 1 (0;3)	N = 5 4 (3;7)	N = 9 4 (2;8)

With regards to attitudes, only 18 of 49 study participants provided answers to this section of the questionnaire. The majority of the study participants agreed with the statement that they spend time discussing patients' prognosis and end-of-life care with relatives (n = 15; 83.3%). None of the study participants indicated that they would sedate patients to prevent being called too often at night. Only four (22.2%) indicated that they were uncomfortable about withholding or withdrawing treatment for patients with poor prognoses, and less than half the study participants (n=8; 44.4%) would discuss end-of-life care with patients or relatives and implement palliative treatment. Most of the career medical officers (n=5; 55.6%) and community service medical officers (n=3; 75%) would like to be able to treat their critically ill patients by themselves within an ICU, and none of the interns would like to do this. Five (27.8%) study participants agreed with the statement that they would rather transfer a patient, whereas 10 (55.6%) of the study participants disagreed that they would transfer a patient because of feeling incompetent to treat the patients themselves. Nevertheless, only one of the career medical officers felt confident about managing critically ill patients unassisted if their hospital had an ICU, whereas 13 (72%) of the respondents disagreed. Seventeen (94.4%) respondents indicated that they would feel more comfortable managing patients in an ICU if they had completed a short course or diploma in critical care. Moreover, none of the respondents believed that their undergraduate training prepared them well enough to manage critically ill patients.

Pertaining practices in critical care medicine, only one career medical officer indicated that he/she regularly use an ultrasound at the bedside to localise and drain pleural effusions. The majority of the respondents indicated that they use lung protective ventilation strategies on all patients when ventilating them. It was notable that career medical officers regularly

inserted arterial catheters, but not central venous catheters in the subclavian or jugular veins, as opposed to interns and community service medical officers, who indicated that they do not insert arterial catheters regularly. Although 9 (56.3%) of the respondents indicated that they performed cardioversion or defibrillation, only 3 (17.6%) (one community service medical officer and two career medical officers) reported that they can perform cardiac pacing. Career medical officers (n=5; 55.6%) and community service medical officers (n=3; 75%) would, however, be able to perform pericardiocentesis if needed, as opposed to only one (25%) of the interns. It is notable that one (25%) of the interns, two (50%) of the community service medical officers and one (11.1%) of the career medical officers were able to perform and interpret non-invasive cardiac output monitoring, as this is a skill that is seldom required outside of an ICU or operating theatre. Career medical officers (n=5; 55.6%) were more knowledgeable about managing renal replacement therapy, as opposed to none of the interns or community service medical officers. Both interns and career medical officers were more confident in the post-operative assessment of a high-risk patient than the pre-operative cardiopulmonary evaluation, in contrast to community service medical officers, of whom none were confident about the post-operative assessment. With regard to trauma patients, it is notable that 50% of the interns and community service medical officers were confident about managing these patients, as opposed to 44.4% of the career medical officers. Additional core competencies that interns deemed important at their level of care include point-of-care ultrasonography, especially echocardiography and lung ultrasonography, recognising the critically ill patient, sedation strategies, and mechanical ventilation. Community service medical officers deemed advanced cardiac life support and paediatric advanced life support courses important.

Discussion

The critical care knowledge scores of medical practitioners working at the district and regional public sector hospitals in the Free State province of South Africa were low. Only one study participant, a career medical officer, achieved a knowledge score of 8/10 (80%), which was set as the pass mark for the knowledge section. The poor knowledge regarding critical care among recently qualified or early career medical practitioners most likely reflects the lack of critical care training during the undergraduate medical training period. This deficiency in critical care training for undergraduate students is not unique to South Africa. Al Ansari *et al.*[17] found the mean average score for critical care knowledge among final year medical students in Saudi Arabia to be 45.2%. Only 4.3% of the respondents in that study were satisfied with the content of their critical care education and < 2% were

satisfied with their exposure to critical care.[17] A global survey conducted among English-speaking medical schools found that 63% had no intensive care syllabus and only 31% offered compulsory intensive care teaching.[18] Australia and New Zealand medical schools fared better, since critical care training was mandatory in 56% of schools, and optional in a further 22% of survey respondents, although the majority of medical schools offered less than one week of critical care contact.[19] Aspects of the management of critically ill patients are often covered in a fragmented way by different disciplines during the undergraduate training period.[20] The integration of knowledge and the holistic management of critically ill patients is, however, not explicitly addressed in the undergraduate training curriculum.[20]

Most of the community service medical officers that participated in our study worked at district hospitals where ICU facilities are not available. It is, therefore, not surprising that half the community service doctors responded that they frequently transferred critically ill patients to a referral hospital where ICU facilities are available. ICU resources in Africa are limited.[21] In a previous study evaluating ICU resources at the district and regional hospitals in the Free State province of South Africa (unpublished data), we found that there were 1.7 ICU beds/100 000 of the population. The responses of participants in this study could, thus, reflect the shortage of available ICU facilities and not necessarily their inherent competency. Interns and medical officers had positive attitudes towards the management of critically ill patients. The medical practitioners generally expressed a sense of understanding that some patients with poor prognosis required end-of-life care, and that it needed to be discussed in a sensitive and transparent way with the relatives of the patients. The study participants also expressed a sense of understanding of the limitations of the healthcare setting in which they were employed at the time, above and beyond their level of competence. These attitudes are important, since it is acknowledged that critical care resources are scarce, and that difficult rationing and triage decisions are often required.[22] Consensus guidelines on ICU triage in South Africa are, however, available to assist healthcare workers in these decisions.[23]

Practices applied by medical practitioners pertaining critical care medicine varied, although this finding most likely reflects the availability of resources between and within the different hospital settings, rather than the preferences or skills of the medical practitioners. In general, the more experienced study participants, especially career medical officers, were more confident about using advanced additional devices and equipment to manage critically ill patients. Since 52.9% of career medical officers worked at regional hospitals where ICU facilities were available, they may have developed competencies in performing practices typically associated with critical care medicine. In a study among

junior doctors in South Africa, the authors found that the level of confidence in managing critically ill patients increased as doctors progressed from the first intern year, to the second, and consequent community service years.[24] Only 13.3% of junior doctors were, however, comfortable about setting and adjusting ventilator settings independently, and 57% were uncomfortable about making critical care triage decisions.[24] Medical practitioners at all levels were, however, of the opinion that their undergraduate training did not prepare them adequately to manage critically ill patients and they expressed that they would benefit from additional training in the form of a postgraduate short course or diploma in critical care. Our results are similar to that of Dairi *et al*.,[25] who found that 59.3% of final-year medical students and interns were of the opinion that they had not been trained adequately, and 54% believed that they needed to improve their critical care skills.[25]

Limitations and strengths

This study had several limitations. The response rate to the electronic questionnaire was satisfactory, but low. The reasons for the low response rate may be that the questionnaire was distributed to the various district and regional hospital managers at a time that most of the healthcare workers were primarily engaged managing the COVID-19 pandemic in 2021 and 2022. The principal investigator, however, encouraged the response rate by visiting the district and regional hospitals in the Free State province in person and making follow-up phone calls, and sending emails to the hospital managers of the various hospitals to encourage distribution of the anonymous survey link to the medical practitioners working at these hospitals. Another limitation was the large number of incomplete questionnaires. The results, therefore, reflect only the opinions of study participants who provided answers to the questions in the questionnaire. The findings may well only be applicable to the participants that responded.

An unanticipated strength of the study was the number of interns who completed the questionnaire. The inclusion of results from interns illustrated that the confidence level of doctors increased as they progressed from interns to community service medical officers, and thereafter career medical officers.

Conclusion

In this survey on the knowledge, attitudes and practices of critical care medicine of medical practitioners at district and regional hospitals in the Free State province of South Africa, we found that they possessed poor knowledge regarding critical care medicine, which possibly reflects the lack of undergraduate training in this discipline. Medical practitioners have

positive attitudes toward the management of critically ill patients and believed that additional postgraduate courses would benefit them. We recommend establishing core competencies in critical care medicine for non-specialist general medical practitioners working at the district and regional hospitals in South Africa, to inform curricula for postgraduate courses in critical care in order to address this need.

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CHAPTER 4

ARTICLE 3: CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACTITIONERS IN SOUTH AFRICA: A DELPHI STUDY

This article was prepared according to the submission guidelines of the Southern African Journal of Critical Care (SAJCC) (cf. Appendix L).

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CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACTITIONERS IN SOUTH AFRICA: A DELPHI STUDY

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Abstract

Background: Despite a high burden of disease that requires critical care services, there are a limited number of intensivists in South Africa. Medical practitioners at district and regional public sector hospitals frequently manage critically ill patients in the absence of intensivists, despite these medical practitioners having had minimal exposure to critical care during their undergraduate training.

Objectives: To identify core competencies in critical care for medical practitioners who provide critical care services at public sector hospitals in South Africa where intensivists are not available to direct patient management.

Methods: A preliminary list of core competencies in critical care was compiled. Thereafter, 13 national and international experts were requested to achieve consensus on a final list of core competencies that are required for critical care by medical practitioners, using a modified Delphi process.

Results: A final list of 153 core competencies in critical care was identified.

Conclusion: The core competencies identified by this study could assist in developing training programmes for medical practitioners, to improve the quality of critical care services provided at district and regional hospitals in South Africa.

Introduction

South Africa is plagued by a high burden of HIV/AIDS, tuberculosis, non-communicable diseases, maternal conditions, and trauma that often require immediate critical care.[1] Specialists other than intensivists, as well as medical practitioners with varying levels of expertise and experience, are predominantly involved in the care of these critically ill patients, especially in non-university-affiliated hospitals.[2] This situation is largely attributed to a paucity of registered intensivists in South Africa.

The population of South Africa comprises approximately 60 million people[3] and it is estimated that between 50 and 75 registered intensive care specialists (intensivists) work in intensive care units (ICUs) in the country.[4] Most healthcare workers practice in urban areas, with very few practicing in the rural areas, where the majority of the population resides.[5] Every year, only a small number of intensivists complete their training and qualify, and the lack of dedicated subspecialist training posts in South Africa contributes substantially to the limited number of registered intensivistsTherefore, it is unlikely that there will be sufficient intensivists to provide critical care services in South Africa within the foreseeable future.[2]

Despite this shortage, there is little exposure to critical care at undergraduate medical education level. Critical care specialisation requires speciality training, and there are, furthermore, no postgraduate diploma courses to bridge the gap in competency between undergraduate and ICU specialist levels. Several short courses in critical care for non-specialist healthcare professionals have been designed. Joynt *et al*.[6] conducted a systematic review of eight short courses for teaching critical care skills to non-specialist doctors working in ICUs. They found that these varied regarding content and that only the Basic Assessment and Support in Intensive Care (BASIC) and Fundamental Critical Care Support (FCCS) courses (both available in South Africa) included curriculum content that was similar to the guidelines prescribed by the Society of Critical Care Medicine and the Australia and New Zealand College of Anaesthetists for residents in training.[6] BASIC is a two-day course that focuses on essential aspects of intensive care[7] and is designed for doctors who are new to the ICU environment. The two-day FCCS course aims to train non-intensivists to manage critically ill patients for the first 24 hours, or until a critical care consultation can be undertaken.[8] None of the courses, however, include experiential learning or assess whether specific competencies have been achieved.[6]

Graduates of undergraduate medical programmes in South Africa work either as general practitioners (private practice) or medical officers (public health service). These general practitioners and medical officers are frequently expected to provide first-line healthcare

services to critically ill patients, despite critical care not being specified as an essential requirement for national undergraduate medical training in South Africa.[9] Exposure and training in critical care can, however, increase the knowledge, skills and confidence of doctors.[10] An additional benefit is reported by Haniffa *et al*., who found that, if doctors and nurses working in resource-limited settings received dedicated training, ICU mortality rates declined from 41% to 18%.[11] Training of primary care physicians will have an impact on the burden and outcomes of patients who are admitted to ICUs in South Africa, many of whom are unplanned.[12] Adequate 'high care dependency units' for postoperative care of elective surgical patients has the potential to decrease the burden on critical care resources in South Africa by 23%. Singh *et al*.[13] found that, in KwaZulu Natal, patients who were referred to the ICU were young and had a high burden of medical and trauma conditions. Similar findings were reported from the Eastern Cape.[14] Decisions to accept patients to ICU are limited by available resources, and there was a need to apply ICU triage.[13]

We sought to address the problem of a lack of training in critical care for general practitioners and medical officers in South Africa. Specifically, the findings reported in this paper identify the core competencies in critical care that could be reasonably expected of medical practitioners working in critical care settings, or providing critical care services at public sector hospitals in South Africa in the absence of intensivist supervision. Ethical clearance to conduct the study was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (UFS-HSD2020/1524/2411).

Methods

The study used a modified Delphi process. Researchers of the Rand Corporation first developed the Delphi process as ‘a method of eliciting and refining group judgements’.[15] In this study, members of the study group answered several rounds of questionnaires anonymously, until final consensus was reached. In the modified Delphi process used for this study, curricula of international critical care training programmes, including CoBaTrICE[16] and the Chinese Critical Care Society[17] were reviewed to identify competencies deemed essential to critical care training programmes. The core competencies compiled by the Chinese Critical Care Society were deemed suitable for low and middle-income countries[17] and were therefore used to compile the questionnaire. The questionnaire made use of a 5-point Likert scale and options for answers were ‘strongly disagree’, ‘disagree’, ‘neutral’, ‘agree’ and ‘strongly agree’. A pilot study was conducted first, by submitting the questionnaire to two physicians working in the Department of Critical Care

at the University of the Free State, to determine aspects such as clarity of the questions, the time required to complete the questionnaire, and to ensure that the questions were not biased. No changes were made to the questionnaire after the pilot study. Since the participants in the pilot study did not meet inclusion criteria (see further) for the study, the results of the pilot study were not included in this analysis.

National and international experts in critical care were identified and invited to participate in the modified Delphi process. The academic heads of critical care units at nine medical schools in South Africa were deemed to be national experts in their field and were approached to participate, or to suggest an alternative participant with at least five years' experience in critical care medicine for inclusion on the Delphi panel. International experts in critical care medicine were also identified by perusing the council membership of international societies of intensive care medicine or critical care medicine.

The invitation to participate was sent via email to all identified experts. Consent to participate in the study was inferred by participation. A link to an electronic questionnaire using REDcap[18,19], was sent via email to all experts who accepted the invitation and who, thus, became Delphi panel members. Consensus was defined as agreement of more than 80% for individual questions on the questionnaire. Several rounds of the Delphi process were performed until agreement of more than 80% was achieved. Answers of 'agree' or 'strongly agree' were deemed to be agreement, and questions on which 80% or more agreement were achieved during the first round were removed for subsequent rounds. This process was repeated until consensus was reached for all questions. Additional competencies suggested by Delphi panel members were included in the subsequent rounds. Descriptive statistics, namely frequencies and percentages, were calculated for the categorical data, and the analysis was performed by the Department of Biostatistics of the University of the Free State. Data analysis was performed with SAS Software, version 9.4 Copyright 2002-2012 by SAS Institute Inc., Cary, NC, USA.

Results

In total 25 experts were invited (11 national and 14 international). Of these, 13 (52%) (seven national and six international) accepted the invitation and completed the first round of the Delphi process (171 questions). Consensus was reached for 126 of the core competencies. These were removed for the second round of the Delphi process, which comprised 45 questions, on which agreement was reached for 14. There were 27 core competencies for which the responses were 'strongly disagree', 'disagree' or 'neutral' during these two rounds

of the Delphi process. These competencies were excluded from further rounds, as there was consistency in responses by the panel. An additional seven core competencies were suggested by members of the panel during the first round. These included that trainees should be able to liberate patients from ventilation; list indications for tracheostomy; perform elective and crash induction and intubation using anaesthetic drugs; discuss indications, benefits, and risks of prone positioning; discuss indications and risks of bronchoscopy; be aware of the ICU triage process and assess both in and out-of-hospital telephonic referrals to the ICU; recognise the care limits of the current setting and identify patients requiring a higher level of care early. These competencies were, therefore, only included on the questionnaire during the second round and only have results for round two of the Delphi process. In the third round, six remaining core competencies were circulated. Of these, consensus was reached for only one, with the other five not agreed on. The final list of core competencies is shown in Table 1.

Table 1: Final list of core competencies in critical care (agreement through Delphi process)

Questions	Agreement (%)		
	Round 1	Round 2	Round 3
1. Resuscitation and initial stabilisation:			
By the end of critical care training, the trainee...			
1.1 Adopts a structured and timely approach to the recognition, assessment and stabilisation of the acutely ill patient with disordered physiology	100		
1.2 Performs cardiopulmonary resuscitation	100		
1.3 Manages post-resuscitation cerebral protection	100		
1.4 Triages and prioritises patients appropriately, including timely admission to ICU	100		
1.5 Assesses and provides initial management of the trauma patient	84.6		
2. Diagnosis:			
By the end of critical care training, the trainee...			
2.1 Obtains a medical history and performs an accurate clinical examination	100		
2.2 Requests timely and appropriate laboratory and imaging investigations	100		
2.3 Interprets and acts on the results from non-invasive hemodynamic monitoring	100		
2.4 Performs point-of-care ultrasound	92.3		
2.5 Describes indications for echocardiography (transthoracic and transoesophageal)	100		
2.6 Performs electrocardiography and interprets the results	84.6		
2.7 Obtains appropriate microbiological samples and interprets results	100		
2.8 Interprets the results from blood gas samples	100		
2.9 Interprets chest radiographs	100		
2.10 Liaises with radiologists to organise and interpret clinical imaging	100		
2.11 Monitors and responds to trends in physiological variables	100		
2.12 Integrates clinical findings with laboratory investigations to form a differential diagnosis	100		
3 Disease management:			
By the end of critical care training, the trainee...			

3.1 Describes the implications of chronic and comorbid disease in the acutely ill patient	100	
3.2 Recognises and manages different types of shock	100	
3.3 Assesses and manages life-threatening arrhythmias	100	
3.4 Recognises and manages left ventricular failure and/or acute pulmonary oedema	100	
3.5 Recognises and manages right heart failure	100	
3.6 Assesses and manages myocardial infarction and acute coronary syndrome	100	
3.7 Recognises and manages hypertension crisis	100	
3.8 Describes physiological changes of the cardiovascular system under acute conditions	92.3	
3.9 Assesses and manages acute and chronic respiratory failure	100	
3.10 Assesses and manages acute exacerbations of chronic obstructive pulmonary disease	100	
3.11 Assesses and manages status asthmaticus	100	
3.12 Assesses and manages smoke inhalation and airway burns	92.3	
3.13 Assesses and manages upper airway obstruction (due to infection or foreign body)	84.6	
3.14 Recognises (diagnosis and grading) of and thereafter manages ARDS	92.3	
3.15 Manages life-threatening haemoptysis	84.6	
3.16 Describes effects of positioning on respiratory physiology	69.2	84.6
3.17 Recognises (diagnosis and grading) and manages acute kidney injury	92.3	
3.18 Manages critically ill patients with chronic renal failure	84.6	
3.19 Manages patients with coma	100	
3.20 Assesses and manages patients with drug overdose and intoxication	100	
3.21 Assesses and manages cerebral vascular accidents	84.6	
3.22 Manages status epilepticus	100	
3.23 Recognises and manages intracranial infection	84.6	
3.24 Assesses and manages patients with increased intracranial pressure	92.3	
3.25 Assesses and manages spine injury	69.2	84.6
3.26 Recognises and manages adrenal crisis	92.3	
3.27 Recognises and manages diabetes insipidus	92.3	
3.28 Recognises and manages diabetic ketoacidosis	100	
3.29 Recognises and manages hypo- or hyperthyroidism	92.3	
3.30 Recognises and manages sepsis, severe sepsis, and septic shock	100	
3.31 Assesses and manages severe community acquired infection (e.g., severe community-acquired pneumonia)	100	
3.32 Recognises and manages nosocomial infection	92.3	
3.33 Assesses and manages fever in critically ill patients	100	
3.34 Describes antimicrobial resistance	84.6	
3.35 Recognises intra-abdominal infection and gastrointestinal perforation	100	
3.36 Assesses and manages HIV-related diseases	84.6	
3.37 Has knowledge of and uses anti-infective agents appropriately	100	
3.38 Manages coagulopathy	100	
3.39 Assesses and manages thromboembolic disease (including pulmonary embolism)	92.3	
3.40 Manages disseminated intravascular coagulation	100	
3.41 Manages traumatic coagulopathy	92.3	
3.42 Manages thrombocytopenia	84.6	
3.43 Investigates and manages causes of anaemia	84.6	
3.44 Has knowledge of transfusion triggers	100	
3.45 Assesses and manages gastrointestinal bleeding	69.2	92.3
3.46 Assesses and manages patients with liver failure	69.2	84.6
3.47 Assesses and manages pancreatitis	84.6	
3.48 Assesses and manages abdominal compartment syndrome	92.3	
3.49 Assesses and manages acute illness in pregnancy	92.3	

3.50 Assesses and manages antepartum haemorrhage	53.8	84.6	
3.51 Assesses and manages postpartum haemorrhage	92.3		
3.52 Assesses and manages hypertensive disorders during pregnancy	84.6		
3.53 Assesses and manages HELLP syndrome	92.3		
4. Therapeutic interventions:			
By the end of critical care training, the trainee...			
4.1 Manages anaphylaxis	100		
4.2 Assesses and manages fluid and electrolyte disorders	92.3		
4.3 Assesses and manages acid-base disorders	92.3		
4.4 Describes and provides enteral nutrition support	92.3		
4.5 Provides nutrition support for patient with severe acute pancreatitis	84.6		
4.6 Provides nutrition support for patient with renal failure	84.6		
4.7 Provides nutrition support for patient with liver failure	84.6		
4.8 Provides nutrition support for patient with sepsis and septic shock	92.3		
4.9 Provides nutrition support for post-gastrointestinal surgery patients	84.6		
4.10 Assesses and manages pain in critically ill patients	100		
4.11 Describes principle and assessment of sedation	100		
4.12 Provides assessment, prevention, and treatment of delirium	100		
4.13 Describes indication and choice of neuromuscular blockade	92.3		
4.14 Manages fluid therapy	100		
4.15 Manages vasoactive/inotropic medication therapy	100		
4.16 Describes principles of drug dose adjustment in renal failure	100		
4.17 Explains and appraises management of severe sepsis and septic shock	100		
4.18 Describes principles of antimicrobial agent selection and dosing in critically ill patients	100		
4.19 Describes principles of anticoagulation and anti-fibrinolytic therapy	100		
4.20 Describes principles of blood component transfusion	92.3		
4.21 Describes stress ulcer prophylaxis	100		
4.22 Assesses and manages hypothermia and hyperthermia	92.3		
5. Practical procedures:			
By the end of critical care training, the trainee...			
5.1 Performs bedside ultrasound to localise pleural effusion and ascites	84.6		
5.2 Maintains an open airway in the non-intubated patient	100		
5.3 Performs bag-mask ventilation	100		
5.4 Performs tracheal intubation	100		
5.5 Performs tracheal aspiration	92.3		
5.6 Manages pneumothorax	100		
5.7 Administers oxygen therapy	100		
5.8 Manages non-invasive and invasive mechanical ventilation: indications, rationale, complications, and weaning	100		
5.9 Performs thoracentesis via a chest drain	92.3		
5.10 Performs peripheral venous catheter insertion	84.6		
5.11 Performs arterial puncture and cannulation	100		
5.12 Performs central venous catheter insertion	100		
5.13 Performs cardioversion and defibrillation	100		
5.14 Performs transthoracic cardiac pacing	76.9	84.6	
5.15 Performs lumbar puncture	100		
5.16 Performs nasogastric tube placement	100		
5.17 Performs abdominal paracentesis	92.3		
5.18 Performs and interprets intra-abdominal pressure monitor	92.3		
5.19 Performs urinary catheterisation	61.5	92.3	
5.20 Liberates patients from ventilation		92.3	
5.21 Lists indications for tracheostomy		92.3	
5.22 Performs elective and crash induction and intubation using anaesthetic drugs		92.3	
5.23 Discusses indications, benefits, and risks of prone positioning		92.3	
5.24 Discusses indications and risks of bronchoscopy		53.8	100
6. Perioperative care:			
By the end of critical care training, the trainee...			

6.1 Manages postoperative assessment and care of high-risk surgical patient	84.6		
6.2 Manages the preoperative and postoperative care of the trauma patient	84.6		
7. Comfort and recovery:			
By the end of critical care training, the trainee...			
7.1 Ensures early mobilisation of patients	92.3		
7.2 Identifies and attempts to minimise the physical and psychosocial consequences of critical illness for patients and families	100		
7.3 Prevents, recognises and manages pain and delirium	100		
7.4 Manages the safe and timely discharge of patients from the ICU	92.3		
7.5 Communicates the continuing care requirements of patients at ICU discharge to healthcare professionals, patients and relatives	100		
8. End-of-life care:			
By the end of critical care training, the trainee...			
8.1 Manages the process of withholding or withdrawing treatment with the multidisciplinary team	92.3		
8.2 Discusses end-of-life care with patients and their families/surrogates	92.3		
8.3 Provides palliative care for the critically ill patient	92.3		
8.4 Performs brainstem death testing	84.6		
9. Transportation:			
By the end of critical care training, the trainee...			
9.1 Assesses the patient before transport	100		
9.2 Prepares equipment for transport	92.3		
9.3 Performs intra-hospital transport	100		
10. Health and safety management:			
By the end of critical care training, the trainee...			
10.1 Complies with infection control measures	100		
10.2 Identifies environmental hazards and promotes safety for patients and staff	92.3		
10.3 Identifies and minimises risk of incidents and adverse events, including complications of critical illness	92.3		
10.4 Organises a case conference	84.6		
10.5 Critically appraises and applies guidelines, protocols and care bundles	92.3		
10.6 Conducts morbidity and mortality meetings	92.3		
10.7 Should be aware of the ICU triage process and assess both in and out of hospital telephonic referrals to the ICU accordingly		84.6	
10.8 Should recognise the care limits of the current setting and identify patients requiring a higher level of care early on		100	
11. Professionalism:			
By the end of critical care training, the trainee...			
11.1 Communicates effectively with patients and relatives	100		
11.2 Communicates effectively with members of the healthcare team	100		
11.3 Maintains accurate and legible records or documentation	100		
11.4 Involves patients (or their surrogates if applicable) in decisions about care and treatment	100		
11.5 Demonstrates respect for cultural and religious beliefs and an awareness of their impact on decision-making	100		
11.6 Respects privacy, dignity, confidentiality, and legal constraints on the use of patient data	100		
11.7 Collaborates and consults with appropriate healthcare providers	100		
11.8 Promotes effective teamwork	100		
11.9 Ensures continuity of care through effective handover of clinical information	100		
11.10 Supports clinical staff outside the ICU to enable the delivery of effective care	84.6		
11.11 Recognises and manages burnout in themselves and members of the healthcare team	92.3		
11.12 Takes responsibility for safe patient care	100		
11.13 Formulates clinical decisions with respect for ethical and legal	100		

principles			
11.14 Seeks learning opportunities and integrates new knowledge into clinical practice	100		
12. Pre-training certification:			
Before the start of critical care training, the trainee...			
12.1 Successfully completed a Basic Life Support Course	76.9	84.6	

Discussion

This study used a modified Delphi process to identify a list of core competencies that could be expected of non-intensivist medical practitioners working in healthcare settings where intensivists are often not available to direct medical treatment. The final list of core competencies included components of resuscitation and stabilisation of critically ill patients, disease management, practical procedures, health and safety management, transportation, and end-of-life care.

Most core competencies were agreed upon after only one round. The following competencies were, however, only agreed upon after a second round: effects of positioning on respiratory physiology; assessment and management of spinal injury, gastrointestinal bleeding, liver failure, antepartum haemorrhage; performing transthoracic cardiac pacing and urinary catheterisation; discussion of indications and risks of bronchoscopy; and, finally, the need to have successfully completed a basic life support course. It is possible that some of the Delphi panel members deemed many of these conditions, such as spine injury, liver failure, gastrointestinal bleeding, antepartum haemorrhage and cardiac pacing, to areas specific to specialist care and not necessarily core competencies for non-specialists. South Africa does, however, have a high rate of death due to pregnancy and trauma-related complications[20] which requires competency for managing these conditions at all levels of the healthcare system. Although urinary catheterisation is often performed by nursing personnel, doctors are invariably required to perform this procedure and should be sufficiently skilled to do so. Bronchoscopies are usually performed by pulmonologists, but it is important for clinicians working with intubated patients to know the indications for bronchoscopy, and the risks involved. The requirement of Basic Life Support Course certification was only agreed upon during the second round of the Delphi process. It may, thus, be that some Delphi panel members deemed pre-training courses irrelevant, since the accepted core competencies included cardiopulmonary resuscitation, which is the key component of the Basic Life Support Course.

The core competencies for general medical practitioners identified in our study are similar to those previously identified by Perkins *et al*. as important for undergraduate student training as part of the Acute Care Undergraduate Teaching (ACUTE) Initiative,[21] but are

not as extensive as the competencies suggested for specialist intensivists.[16,17] In South Africa, intensivist certification is provided by the Colleges of Medicine of South Africa (CMSA).[22] The syllabus for critical care training is designed as subspeciality training for already qualified specialists in a non-ICU discipline. This syllabus is also linked to the requirement for a dedicated two years, full time ICU placement to acquire practical and procedural expertise. This is clearly an impractical approach to training already busy medical practitioners. A dedicated syllabus, including only the requirement for core competencies in critical care at a postgraduate diploma level, would be better suited to improve the performance of non-intensivists in dealing with critical care emergencies. Although not currently available in South Africa, a diploma in critical care is in development (personal communication F. Paruk).

Compared to the curriculum contents of the CMSA Sub-Speciality Certificate in Critical Care,[22] the ACUTE initiative contains 53 of the 306 (17.3%) components, whereas our study contained 115 (37.6%) (Appendix H). This is not unexpected, as the former is targeted at undergraduate medical students, whilst the core competencies identified in our study are more applicable to a training programme for qualified medical doctors who are faced with the need for a wider skill set. There is considerable overlap between the attitude and the mandatory practical skills components required for intensivists and the core components for non-intensivists identified in our study. The advisable or optional components of the subspeciality curriculum usually require specialised equipment that would not generally be available at regional or district hospitals in South Africa and were also not identified in our study as core competencies for general medical practitioners. There was less overlap with regard to knowledge of specific disease management, especially immunology and transplantation medicine. The curriculum of the subspeciality certificate in critical care included mandatory organisational and administrative components, which did not form part of the suggested competencies for undergraduate students or the core competencies for critical care for general medical practitioners. The competencies for general medical practitioners identified in our study can be considered as providing sufficient additional skills to address the large gap between undergraduate and specialist training.

Regarding the list of core components, the Delphi panel did not reach consensus on the intensive care management of paediatric patients. Neonatal and paediatric patients are typically managed by specialist neonatologists and paediatricians in dedicated intensive care units and may therefore not be deemed a core competency for general medical practitioners at district or regional hospitals in South Africa. One may, however, argue that, in a resource-

constrained environment with limited availability of paediatricians or paediatric intensivists, skills training in paediatrics could be beneficial.[23]

In a study among medical officers at a South African hospital, Van Deventer[24] found that the majority of the respondents lacked essential knowledge of intubation and mechanical ventilation. Similarly, junior South African doctors expressed a keen interest in managing critically ill patients, although only 13.3% were comfortable with mechanical ventilation.[25] The fixed duration of medical training limits the time that is available to add additional modules in critical care during undergraduate medical training, which reinforces the need for a short course or postgraduate diploma in critical care after graduation. The ideal postgraduate diploma would include supervised workplace-based training for a short period of 3–6 months, to achieve improved competence for non-intensivists. An appropriate workplace assessment process can be incorporated into a competency-based training programme, supplemented by a summative knowledge-based component to drive learning and establish consistent standards.

A strength of our study is that core competencies for general medical practitioners were identified by national experts who were heads of academic critical care departments in South Africa. In addition, most of the international experts were either knowledgeable of the South African critical care environment or had experience of working in low or middle-income countries. This is important for selecting core competencies relevant to the South African healthcare setting and that could easily be fed into a training programme. All participants had an equal opportunity to voice their opinion in a blinded fashion, since separate links to the electronic questionnaires were sent to each member of the panel individually. Individual Delphi panel members were unaware of the answers provided by other members until all three rounds had been completed and results reported. This eliminated the potential for the opinion of a panel member to be influenced by dominant or prominent panel members in the field of critical care.

There were several limitations to our study. Firstly, all the experts who were invited did not respond to the invitations. The email invitations were sent out three times every 72 hours to encourage participation. The experts who did not respond may have had different opinions regarding core competencies of critical care. This deficiency might be addressed by viewing the current list of core competencies as a minimum list to which can be added, if needed. In addition, the core competencies were not weighted in terms of importance, as occurred with the curriculum contents for subspecialists in critical care,[22] where some components are mandatory and others optional.

Our study aimed to identify core competences required and did not rank their importance. As discussed above, consensus on competencies for paediatric intensive care could not be achieved. This deficit could be corrected in the future, as an additional or optional competency.

Another limitation was the timing of the data collection. The study was conducted between January and August 2022, after the peak periods of the COVID-19 pandemic in South Africa. During the peak periods of COVID-19, practitioners at regional and district hospitals in South Africa were managing critically ill COVID-19 patients that would otherwise have been referred to central hospitals. The expectations of the experts about what would be core competencies may have been influenced by the severity of illness that they would be likely to see at regional and district hospitals. It is, however, unlikely that this factor would have significantly influenced the opinions of the Delphi panel members since the panel members were highly experienced and knowledgeable of the South African critical care setting.

Finally, the core competencies in the final list were compiled for general medical practitioners working at South African hospitals and cannot be generalised to countries with different healthcare structures to South Africa.

Conclusion

By using a modified Delphi technique, a list of core competencies in critical care for medical practitioners was compiled. These competencies consist of the minimum knowledge, attitudes and skills required by medical practitioners providing critical care services outside of settings where intensivists direct the treatment of patients. By ensuring the competence of medical practitioners, the quality of critical care provided at district and regional hospitals in South Africa may be improved.

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CHAPTER 5
CURRICULUM FOR A POSTGRADUATE DIPLOMA IN CRITICAL CARE

5.1 INTRODUCTION

When undergraduate medical students have completed their medical training, internship and compulsory community service, they still lack critical care knowledge and competency. A subspecialist qualification in critical care is required to work as an intensivist, but this requires a protracted period of studying, so it will not solve the immediate problem of a shortage of competent medical practitioners at district and regional hospitals in South Africa.

A postgraduate diploma in critical care, designed to improve critical care knowledge and skills, would therefore bridge the gap between undergraduate training and subspecialisation. Based on the National Qualifications Framework (NQF), a postgraduate diploma at an NQF level 8, where learners must be able to demonstrate knowledge of a field, discipline or practice, understand how to apply this knowledge in a particular context, use a range of specialised skills to address complex problems, identify and address ethical issues, have the ability to operate effectively within a system, and take full responsibility for their own work, decision-making and use of resources, would be an appropriate qualification (SAQA, 2012). A draft proposal for a syllabus and assessment methods for a postgraduate diploma in critical care was compiled by the CCSSA (personal communication F. Paruk and K. de Vasconcellos), however, each training institution still requires a well-structured curriculum or training programme in order to be accredited as a training facility. In this chapter, guidelines for a curriculum for a postgraduate diploma in critical care will be provided, based on the findings of this research.

5.2 CURRICULUM DESIGN

A curriculum is not only a list of topics or a syllabus that is taught as part of a training programme. It is more comprehensive and describes the objectives of the training programme, learning outcomes, teaching strategy and assessment methods, and requires careful planning (Quirk & Harden, 2017). Figure 5.1 summarises components of a curriculum for a postgraduate diploma in critical care.

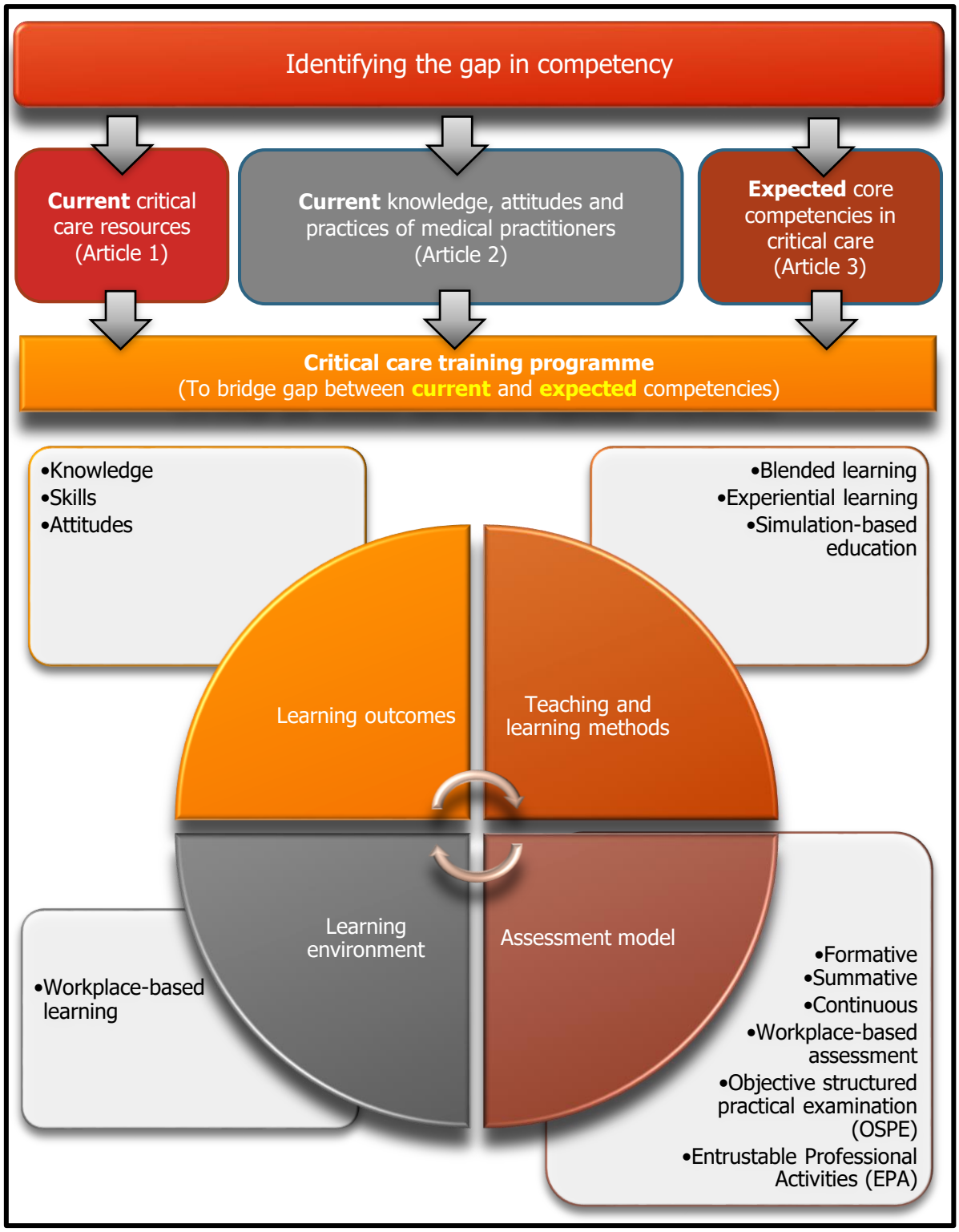

Figure 5.1: Components of a curriculum for a postgraduate diploma in critical care
Compiled by the researcher, Maasdorp (2023)

As illustrated in Figure 5.1, a curriculum describes the learning outcomes, teaching and learning methods, the learning environment and assessment model of the training programme. A description of a postgraduate diploma in critical care based on the Higher Education Qualifications Sub-framework (HEQS) is provided in Appendix K. Prior to developing a training programme, it must be determined if there actually is a need for

additional training. This is determined by identifying a gap in the skills required by the institution, as well as that expected in a competent service provider, and the skills that the employee actually has to offer. Harden (1986) identified 10 questions that need to be answered during the process of curriculum planning. These 10 questions will be addressed in the following sections.

5.2.1 Identifying the need

A training programme should be relevant to the health system in which the learner will practice and meet the needs of the population served (Quirk & Harden, 2017). By investigating the current state of critical care in the Free State province (cf. Chapter 2), we found that there is a scarcity of ICU beds and ICU-qualified healthcare personnel at regional hospitals and none at district hospitals. Medical practitioners working at district and regional hospitals do not feel competent managing critically ill patients, and require further training in critical care medicine (cf. Chapter 3). There is, therefore, a clear need for competent critical care providers, and for non-intensivist medical practitioners to be more knowledgeable and skilled in critical care.

5.2.2 Establishing learning outcomes

A training programme is usually designed with an expectation that the level of knowledge, skills and attitudes acquired by the end of the training period would fulfil the need that was addressed by the programme. The overall aim of the training programme is specified by explicitly stating the learning outcomes.

The outcomes-based education and training (OBE) model currently used by various medical schools worldwide, recognise that medical practitioners must acquire various competencies and abilities to provide a high quality and safe healthcare service to patients (Holmboe & Harden, 2017). The focus in OBE is on learning outcomes that are compiled with the end-product or vision in mind. Since critical care requires certain competencies to be achieved, a competency-based education model would be suitable for a postgraduate diploma in critical care (Carraccio *et al.*, 2016). Instructional methods, including formal lectures, cased-based learning, morbidity and mortality discussions, bedside teaching and simulation-based learning, must be planned and structured with the learning outcomes in mind. Formative and summative assessment methods must also be planned with constructive alignment to the learning outcomes in mind. These assessment methods may include formal written

examination, orals, objective structured practical examinations (OSPE) or workplace-based assessments. Figure 5.2 illustrates how the different knowledge, skills and attitudes learning outcomes should be aligned with an authentic learning environment. Different assessment methods and tools appropriate for, and that align with the learning outcomes to be assessed, can be used in the design of the curriculum.

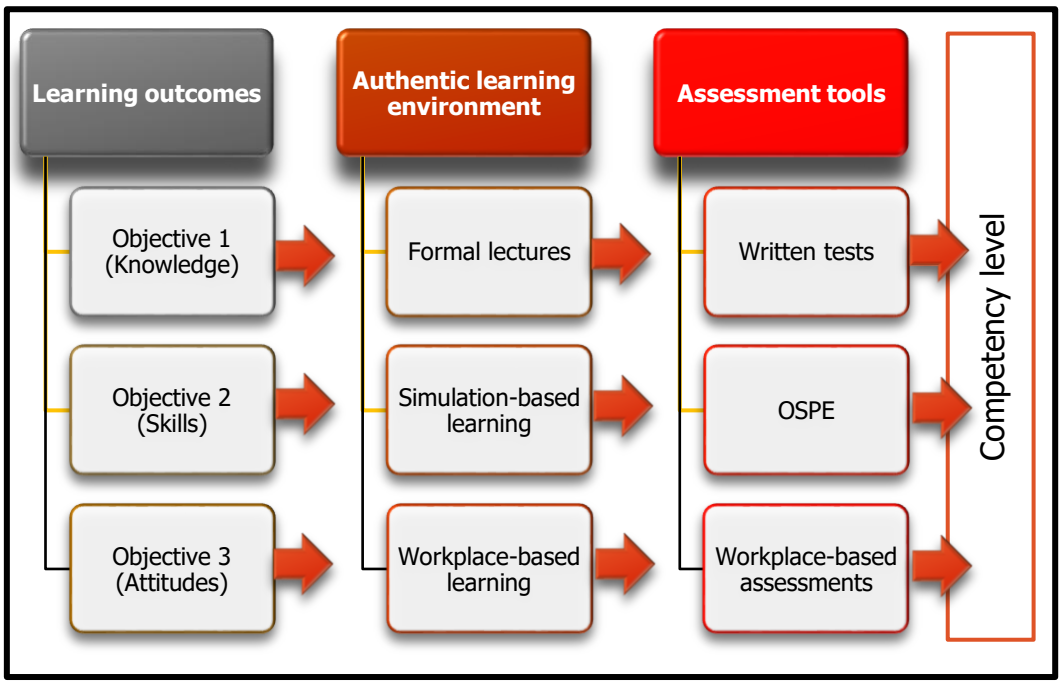

Figure 5.2: Constructive alignment between learning outcomes, learning environment and assessment tools in curriculum design
Source: Compiled by the researcher, Maasdorp (2023)

Consensus on core competencies in critical care was obtained by performing a Delphi study with national and international experts in the field of critical care (cf. Chapter 4). These core competencies informed the compilation of learning outcomes for the proposed postgraduate diploma in critical care. The outcomes are stated as exit-levels outcomes (the overall product of the programme), module outcomes (for each module in the programme) and theme/unit outcomes (what students will know/do after participating in teaching and learning activities) (cf. Appendix I).

5.2.3 Agree on the content

The content of a curriculum is usually described within a syllabus. For critical care, it is important that the curriculum is closely related to the work of the clinician, so that it is authentic (Lombardi & Oblinger, 2014). The emphasis should, therefore, not be on knowledge only, but also include skills and attitudes. By conducting a Delphi study

(cf. Chapter 4), we obtained consensus on the core competencies required for general medical practitioners attending to critically ill patients.

5.2.4 Organising the content

In the critical care curriculum, new learning is built on previous knowledge acquired during undergraduate studies (Harden, 1999). Topics are revisited at higher levels of difficulty, by focusing specifically on acute or emergency presentations and management. The content can be organised in such a way that didactic lectures on diseases are provided in a blended way (face-to-face and online). This will ensure that standardised lectures are provided to students who might be working at different hospitals and who may not be able to attend face-to-face lectures. Practical training sessions can be organised within a simulation facility, if available.

5.2.5 Decide on the educational strategy

The SPICES model (Harden, Sowden & Dunn, 1984) describes educational strategies useful for planning or evaluating curricula (cf. Figure 5.3). There are six strategies in the curriculum that need to be considered individually. Each strategy contains two extremes, and a training programme could fall anywhere on a spectrum closer or further from one or the other extreme.

Student-centred----------Teacher-centred
Problem-based----------Information gathering
Integrated----------Discipline-based
Community-based----------Hospital-based
Electives----------Standard programme
Systematic----------Apprenticeship-based or opportunistic

Figure 5.3: SPICES model of educational strategies
Source: Harden et al. (1984)

With a student-centred approach, the student takes more responsibility for their own learning, whereas, with a teacher-centred approach, the teacher tends to provide formal lectures and the student is more passive in the learning process. A postgraduate diploma in critical care for adult learners lends itself to a student-centred approach, since the trainees are full-time employees and may not always be available to attend didactic lectures. It is also important that the students stay motivated and take responsibility for their own

learning at their own pace, and that they continue the process of lifelong learning, even after completing the course (Berkhout *et al.*, 2018).

Medical training programmes tend to impart a large body of knowledge to students, which students often find difficult to apply to clinical problems they encounter after graduating from medical school. With a problem-based learning approach, students are presented with a problem and are required to learn the relevant basic sciences, pathogenesis and pathophysiology, and diagnostic and therapeutic approaches for the particular presenting problem (Wood, 2003). The advantages of problem-based learning in a postgraduate diploma in critical care is that trainees can develop and improve their problem-solving skills, which is more appropriate in clinical practice.

An integrated approach aims to reduce fragmentation between different disciplines and to provide a holistic view of patient problems. Since medical practitioners participating in a postgraduate diploma training programme would have already undergone discipline-specific training during their undergraduate years, the emphasis during postgraduate training should be on integrating knowledge from the various disciplines to solve the clinical problem at hand. Furthermore, the integrated approach is important in the work-based learning environment, where high-order thinking is required to immediately apply newly-gained knowledge and skills in the clinical environment.

Although critical care medicine is not confined only to ICUs, most of the intensivists or critical care providers who would be trainers in a postgraduate diploma programme practice within the confines of ICUs. The Postgraduate Diploma in Critical Care training programme would, thus, be hospital-based, rather than community-based. However, the hospitals would be located away from the tertiary academic training centres, reflecting to some extent that the training would take place closer to the communities served by the various institutions.

Electives refer to the opportunity students have to choose subjects they have a particular interest in, which they study in depth, or a work-based learning environment in which specific skills are mastered. For the Postgraduate Diploma in Critical Care, the training programme would be standardised, since learning takes place within the ICU where the trainees are employed. There may, however, be variations in the types of ICUs at different healthcare facilities, for example, trauma/surgical versus general medical ICUs, and this

may lead to trainees applying to facilities where the exposure to disease conditions is geared toward their primary interests.

Training in critical care invariably follows a model of apprenticeship, since trainees generally spend the whole of the training period within the same unit under the supervision of the same trainers (Rassie, 2017). The patients and illnesses that the trainees are exposed to are unpredictable and based on the prevailing disease profile. A systematic approach is, however, more advisable, since this would standardise the training programme and ensure that trainees acquire the necessary competencies to master their field. Teachers should not only teach on topics that are of interest to them, but should ensure that teaching and learning match the prescribed learning outcomes. A well-structured curriculum will ensure that learning outcomes are clearly stipulated, that students know exactly which skills they need to master and that will be assessed, and that a portfolio of learning or logbook is kept by students to keep track of and reflect on their learning.

5.2.6 Deciding on the teaching methods

A suggested training model is intended for students enrolled for the Postgraduate Diploma in Critical Care who will work in an ICU for a period of six months. During this time, a formal didactic lecture programme that discusses various illnesses as per the learning outcomes, can be provided. In view of the benefits of case-based learning, the programme can include case-based discussions prepared and presented by students (McLean, 2016). Learning also takes place during morbidity and mortality discussions. Students should also participate in journal clubs to ensure a habit of lifelong learning.

Within the ICU, teaching and learning takes place at the bedside, while clinical cases and the management thereof are discussed (Narayanan & Nair, 2020). Trainers act as role models and mentors for trainees, and guide their professional development and attitudes in the workplace (Nimmons, Giny & Rosenthal, 2019). Procedures conducted in the ICU should be performed under supervision, to ensure that skills are developed and competency achieved (Lovell, 2018). It is very common for peer learning to occur, with more experienced students teaching less experienced students how to perform certain procedures (Brierley, Ellis & Reid, 2022).

The teaching methods, therefore, provide for a strategy using a structured curriculum that is combined with ad hoc learning during ward rounds as part of routine patient care, as per the SPICES model.

5.2.7 Prepare for assessment

Quality assessment is essential to ensure that practitioners are competent and possess the required knowledge, skills and attitudes, including resilience, to make quick, life-saving decisions in a highly stressful environment. It is essential that the level of competency of healthcare practitioners in terms of managing critically ill patients in an ICU environment is assessed effectively by the time the supervised working period comes to an end. This competency assessment includes adherence to validity, reliability, fairness, consistency and positive impact on learning (Norcini *et al.*, 2011). In critical care medicine, formative assessment can be performed during academic and post-intake ward rounds, when patients are presented and management plans discussed. Summative assessment would be used to assess the achievement of predetermined learning outcomes. A wide range of assessment methods would, however, need to be employed to comprehensively assess the level of knowledge, attitudes and skills achieved in critical care. Assessment types may include exams or OSPEs. Workplace-based assessment of different skills can be performed and logbooks or portfolios kept as a record of procedures performed. Assessment of entrustable professional activities (EPA) as part of workplace-based assessment is important to ensure that satisfactory competence is achieved for independent practice. Oral examinations are useful for assessing communication skills and for exploring topics in depth.

Assessment instruments are instruments designed with the purpose of making the assessor's use of assessment methods more practical, consistent and effective. Traditional assessment often employs instruments such as multiple-choice questionnaires to test knowledge of a particular subject. It is, however, very difficult, if not impossible, to test certain skills using a written questionnaire. Authentic assessment, on the other hand, promotes assessment in a practical format based on tasks required of the student in the real world. This would be a more authentic method of demonstrating competency than a written test, especially in critical care where practical skills are required. An example of an assessment instrument is provided in Appendix J.

5.2.8 Communication about the curriculum

The primary stakeholders of critical care medicine are the Department of Health, CCSSA, academic departments of critical care at universities, intensivists and all medical practitioners managing critically ill patients. The Delphi panel in our study included academic heads of departments of critical care, members of the CCSSA, as well as experts involved in the development of a postgraduate diploma in critical care under the auspices of the CMSA. Representatives of relevant stakeholders were, thus, involved in the study. The study, therefore, allowed for communication and discussion regarding core competencies for a critical care training programme.

5.2.9 Promoting an appropriate educational environment

The HPCSA regularly conducts inspections of and accreditation visits to hospitals in South Africa where academic training is conducted. The various training facilities are responsible for creating and maintaining an appropriate educational environment. The requirements include having an adequate number of medical and nursing personnel to manage the workload within the ICUs, the availability of the necessary equipment, such as ventilators and monitoring equipment that are routinely used in ICUs, as well as having experienced trainers available who can train the students. Tertiary hospitals are usually linked with academic departments of critical care, with well-designed training programmes and facilities. ICUs that are not affiliated with universities should, therefore, strive to maintain their ICU resources in order to provide effective workplace-based training.

It is also important that clinical teachers understand that they are shaping the professional development of their students by acting as role models during their interactions with patients or students (Burgess, Oates & Goulston, 2016). Positive role models demonstrate a high level of clinical knowledge and competence, excellent teaching skills and compassion towards patients (Passi *et al.*, 2013).

5.2.10 Manage the curriculum

The CCSSA is the patron of critical care medicine in South Africa and will be responsible for reviewing the learning outcomes and syllabus content of the Postgraduate Diploma in Critical Care. The CMSA is responsible for ensuring high quality assessments of all postgraduate medical qualifications in South Africa, including the envisioned Postgraduate

Diploma in Critical Care. The heads of critical care departments or units at the various training institutions will, however, be responsible for planning and structuring the teaching and learning methods of the curriculum content, as well as implementing and monitoring the training programme to ensure that the objectives of the programme are achieved.

5.3 CONCLUSION

A well-designed curriculum for the Postgraduate Diploma in Critical Care, in which learning occurs within an authentic learning environment, and of which the learning outcomes align with assessment methods, could fill the gap in critical care competence of newly qualified general medical practitioners.

CHAPTER 6
CONCLUSION, RECOMMENDATIONS, AND LIMITATIONS

6.1 INTRODUCTION

This research was undertaken to improve critical care services in South Africa, specifically at district and regional hospital levels in South Africa. District hospitals provide emergency services, whereas regional hospitals provide emergency and ICU services, but there is shortage of competent critical care providers who can direct the management of critically ill patients at these levels of the healthcare sector. The protracted training period for intensivists and limited number of training posts available make it unlikely that the number of intensivists qualifying annually will be sufficient to satisfy the need for critical care services at these hospitals. In this chapter, the key findings and conclusions of this thesis, which addressed the need for competent critical care providers, will be highlighted. Recommendations will be made, limitations will be stated, and the chapter will conclude with final remarks.

6.2 OVERVIEW OF THE STUDY

The gap in the knowledge related to whether doctors managing critically ill patients are competent to do so using the available, even if limited, resources at the healthcare settings where they worked. In South Africa, general medical practitioners provide the majority of emergency healthcare services in both rural and urban areas, despite a lack of dedicated critical care training in the undergraduate medicine curriculum. The overall goal of the study was to establish core competencies that are required for general medical practitioners to provide critical care to patients in South Africa. These core competencies may ultimately inform critical care curricula and training programmes for general medical practitioners.
In order to address the problem, three research questions were stated.

6.2.1 Research Question 1: What is the current state of critical care services provision at district and regional public sector hospitals in the Free State province of South Africa?

The first objective of the study was to determine if healthcare institutions have adequate resources to provide critical care services to patients, and it was determined by describing the resources available for critical care services at district and regional hospitals in the Free

State province of South Africa. This was achieved by conducting a survey among chief executive officers, clinical managers, nursing managers, doctors, or other designated personnel at public sector hospitals who were knowledgeable about critical care service delivery in their respective hospitals in the Free State province and who were able to provide the required information. The survey (cf. Chapter 2) found that there are very few ICU beds available for the population serviced by these hospitals. No intensivists were employed at district or regional hospitals and critical care services are primarily provided by non-intensivist medical practitioners. Regional hospitals do, however, have the basic equipment and medication available for providing essential ICU services, although specialised ICU equipment is not available. District hospitals do not have ICU facilities. The researcher, thus, concludes that there is a gap between the need for and availability of ICU services at the district and regional hospital levels of healthcare. Basic equipment and resources are available, but there is a lack of competent or trained personnel to manage critically ill patients. There is, thus, an urgent need for increasing both critical care resources and training competent healthcare personnel at the district and regional healthcare levels in South Africa.

6.2.2 Research Question 2: What is the knowledge, attitudes and practices of medical doctors providing critical care at district and regional public sector hospitals in the Free State province of South Africa?

The second objective was to determine the need for further training in critical care medicine from the perspective of practicing medical practitioners. A knowledge, attitudes and practices (KAP) questionnaire was, therefore, administered among non-specialist medical practitioners at district and regional hospitals in the Free State province of South Africa (cf. Chapter 3). The findings indicate that medical practitioners did not have sufficient knowledge pertaining critical care. The researcher concludes that non-intensivist medical practitioners, especially recently qualified interns and community service medical officers, do not have the necessary competency to provide prolonged care to critically ill patients. Undergraduate medical training did not adequately prepare entry-level healthcare practitioners to provide critical care, indicating the need for additional training.

6.2.3 Research Question 3: What are the core competencies expected in general medical practitioners providing critical care at a non-specialist level of healthcare in South Africa?

The third objective was to compile a list of suggested core competencies through a literature review and to conduct a Delphi study involving international and national experts in the field of critical care medicine. The findings of the Delphi study (cf. Chapter 4) provided consensus recommendations on a list of core competencies in critical care medicine for future curriculum and training programme development for general medical practitioners in South Africa.

6.3 CONCLUSION

The rationale for the study was that there was a perceived lack of intensivists (intensive care specialists), and uncertainty regarding the competence of medical practitioners currently managing critically ill patients at district and regional hospitals in South Africa.

We, therefore, designed a mixed methods study that was conducted in three phases. The first phase of the study was conducted as a survey among clinical managers of district and regional hospitals in the Free State province of South Africa, to determine the resources available for managing critically ill patients at this level of healthcare. We found (cf. Chapter 2) that regional hospitals had a limited number of ICU beds (1.7 per 100 000 population), and that there were no intensivists to manage critically ill patients. District hospitals did not have ICUs, but had emergency departments where critically ill patients could be stabilised before they were transferred to a hospital with ICU facilities. In Phase 2 of the study, we conducted a survey among medical practitioners working at district and regional hospitals in the Free State, that asked questions on KAP relating to critical care. We found that medical practitioners had poor knowledge regarding critical care and did not feel that they had been adequately trained in critical care during their undergraduate training period (cf. Chapter 3). The medical practitioners expressed a need for further training in critical care. During Phase 3 of the study, we performed a Delphi study. A list of core competencies in critical care for non-intensivist medical practitioners was compiled and validated by national and international experts in the field of critical care (cf. Chapter 4).

The final product of the research was to provide guidelines on a curriculum for the Postgraduate Diploma in Critical Care, designed specifically for general medical practitioners in South Africa, based on the findings of this study (cf. Chapter 5).

6.4 RECOMMENDATIONS

A viable solution to increase the number of critical care providers at district and regional hospitals in South Africa is to provide additional training to the available medical practitioners at these healthcare levels to improve their competence in critical care.

The following recommendations are made based on this research:

i. The product of this study, curriculum guidelines for a Postgraduate Diploma in Critical Care, should be reviewed and considered by the CCSSA for establishing the Postgraduate Diploma in Critical Care in South Africa. The CCSSA is the custodian of critical care in South Africa and provides assessment criteria for critical care assessments in collaboration with the CMSA (2023).
ii. Training institutions, including universities and healthcare facilities under the auspices of the Department of Health, should identify critical care providers at their institutions who can provide training in critical care as per the curriculum for the Postgraduate Diploma in Critical Care suggested in the abovementioned recommendation.
iii. A blended learning approach should be applied, which allows for off-site training for medical practitioners at remote locations via electronic means, if no on-site trainers are available.
iv. Training institutions, such as universities and the CMSA, should promote the Postgraduate Diploma in Critical Care, by listing it among the academic courses and examinations that are provided by these institutions, once it is accredited.
v. A quality assurance process for the Postgraduate Diploma in Critical Care should be a CCSSA imperative.

6.5 LIMITATIONS

There are several limitations in this study, including the following:

i. Critical care resources at public healthcare institutions and KAP among general medical practitioners (cf. Chapters 2 & 3) were evaluated in only one of the nine provinces of

South Africa. There are marked discrepancies in healthcare provision between the different provinces of South Africa (Kong *et al.*, 2013) and the findings of this study can, therefore, not be generalised to the rest of South Africa. The Delphi study (cf. Chapter 4), however, involved national experts in critical care across South Africa. The core competencies in critical care thus established for the Postgraduate Diploma in Critical Care may be generalised as applicable to all non-intensivist medical practitioners working in South Africa.

ii. The response rate to the KAP questionnaire among medical practitioners (cf. Chapter 3), was low. The medical practitioners who chose not to participate in the study may have provided different responses than those who did participate in the study. The responses provided by the study participants were, however, consistent with findings from literature and it is unlikely that a greater number of respondents would have altered the findings significantly.

iii. The core competencies established by means of the Delphi study (cf. Chapter 4), were not weighted in terms of importance. All of the listed core competencies were, thus, deemed equally important and none were considered optional. This is, however, not a significant limitation, since the objective was specifically to establish core competencies that all medical practitioners should possess to manage critically ill patients in the South African healthcare environment. Additional competencies can, therefore, be added if required by curriculum developers.

6.6 FINAL REMARKS

Competent critical care providers are urgently needed, especially at the district and regional healthcare levels in South Africa. These healthcare facilities are usually located in the semi-urban or rural areas of South Africa. The shortage of subspecialist training posts and the prolonged training period of intensivists means that a focus solely on attempts to increase the number of intensivists will not provide a viable solution to the problem. However, by establishing a training programme in critical care that can be delivered to medical practitioners already working in these areas, critical care service delivery could be improved in a much shorter period. The contribution of this study is a list of core competencies that are required by general medical practitioners managing critically ill patients in South Africa. It also provides recommendations for a curriculum of a postgraduate diploma in critical care, aimed at improving competence in critical care in non-intensivist general medical practitioners, as a solution to the shortage of critical care providers at district and regional hospitals in South Africa.

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APPENDICES

APPENDIX A:

HEALTH SCIENCES RESEARCH ETHICS COMMITTEE APPROVAL

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

05-Nov-2020

Dear **Dr Shaun Maasdorp**

Ethics Clearance: **CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACTITIONERS IN SOUTH AFRICA**
Principal Investigator: **Dr Shaun Maasdorp**
Department: **Critical Care Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2020/1524/2411**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00011992; REC 230408-011; IORG 0010096; FWA 00027947
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa

APPENDIX B:

FREE STATE DEPARTMENT OF HEALTH APPROVAL

health
Department of Health
FREE STATE PROVINCE

29 October 2020

Dr S Maasdorp
Dept. of Critical Care
UFS

Dear Dr S Maasdorp

Subject: Core competencies in critical care for general medical practitioners in South Africa.

- Please ensure that you read the whole document, Permission is hereby granted for the above – mentioned research on the following conditions:
- Participation in the study must be voluntary & a written consent by each participant must be obtained.
- Serious Adverse events to be reported to the Free State department of health and/ or termination of the study
- Ascertain that your data collection exercise neither interferes with the day to day running of **Boitumelo, Mafube, Metsimaholo, Parays, Tokollo, Bongani, Katleho, Mohau, Nala, Thusanong, Winburg, Dr JS Moroka, Mantsopa, National, Pelonomi, Universitas, E Ross. JD Newberry, MMM, Nketoana, Phekolong, Phumelela, Phuthuloha, Thebe, Diamond/Diamant Embekweni & Stoffell Coetzee** nor the performance of duties by the respondents or health care workers.
- Confidentiality of information will be ensured and please do not obtain information regarding the identity of the participants.
- **Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).**
- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of the Free State and to Free State Department of Health.
- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the University of the Free State and to Free State Department of Health.
- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to** sebeelats@fshealth.gov.za / makenamr@fshealth.gov.za **before you commence with the study**
- No financial liability will be placed on the Free State Department of Health
- **Please discuss your study with Institution Manager on commencement for logistical arrangements see 2nd page for contact details.**
- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study
- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)
- **As part of feedback you will be required to present your study findings/results at the Free State Provincial health research day**

Trust you find the above in order.

Kind Regards

Dr D Motau
HEAD: HEALTH
Date: 30/10/2020

Head : Health
PO Box 227, Bloemfotein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfotein
Tel: (051) 408 1646 Fax: (051) 408 1556 e-mail:khusemi@fshealth.gov.za@fshealth.gov.za/chikobvup@fshealth.gov.za

APPENDIX C:

ICU RESOURCES SURVEY QUESTIONNAIRE

Confidential

ICU Resources Survey

Dear Study Participant

My name is Dr Shaun Maasdorp and I am a Specialist Physician at Universitas Academic Hospital.

In view of your knowledge pertaining critical care resources at your health facility, I would like to invite you to participate in this ICU resources survey which is one phase of a larger PhD study titled: Core Competencies in Critical Care for General Medical Practitioners in South Africa. This phase of the study aims to determine the current state of critical care services at district and regional hospitals in the Free State province of South Africa. The questionnaire will take approximately 30 minutes to complete. Your assistance is sincerely appreciated.

The information provided will be treated with strict confidentiality and the necessary professional discretion. To ensure this, numerical codes will be used and there will be no references to participants' names when the research results are reported. Your responses will not be traceable to you. Participation is entirely voluntary and there will be no financial compensation for participants. You may withdraw from this study at any given moment during completion of the questionnaire. Your consent to participate in this study will be inferred from your completing this questionnaire.

The aim of this study is, ultimately, to establish core competencies in critical care for general medical pracitioners in South Africa.

My supervisors are:

1. Dr L Van der Merwe (Department of Basic Sciences, Faculty of Health Sciences, University of the Free State)

2. Prof F Paruk (Department of Critical Care, Faculty of Health Sciences, University of Pretoria)

Should you have any questions, please fell free to contact me.

Yours faithfully,

Dr SD Maasdorp

Cell number: 0731137768

E-mail: maasdorpsd1@gmail.com

Thank you for your participation in this project.

What is the name of your hospital? (This field will be de-identified during data analysis and is only required with the view to future collaboration)	_____
At which type of hospital are you employed?	◯ District hospital ◯ Regional hospital ◯ Tertiary hospital ◯ Central hospital
Does your hospital have a trauma or casualty division?	◯ Yes ◯ No
How many beds does your hospital have?	_____
How often does your hospital accept transfers from other hospitals?	◯ Never ◯ Rarely ◯ Sometimes ◯ Frequently ◯ Very frequently

How often does your hospital transfer patients out to a referral hospital?	◯ Never ◯ Rarely ◯ Sometimes ◯ Frequently ◯ Very frequently
In which area of your hospital are critically ill patients requiring intensive care primarily managed?	◯ Intensive Care Unit ◯ High Care Unit ◯ Post-operative recovery area ◯ Trauma/casualty unit ◯ Regular ward ◯ Other
If other, please specify.	_____
How many ICU beds are available? (total number including paediatrics if there are different ICU's)	_____
How many adult ICU beds are available at your hospital?	_____
How is the ICU services in the hospital organized?	◯ Single unit ◯ Different units
What is the operational policy of the ICU?	◯ Open ICU ◯ Closed ICU ◯ Hybrid unit (Co-management)
How many ICU beds can actively be used?	_____
Does your hospital have a separate high care unit?	◯ Yes ◯ No
What is the age range of critically ill patients that are admitted to your ICU?	☐ Neonates (< 28 days of age) ☐ Children (28 days to 12 years) ☐ Adolescents and adults (> 12 years of age)
Does your hospital have a separate neonatal ICU?	◯ Yes ◯ No
Does your hospital have a separate pediatric ICU?	◯ Yes ◯ No
Are neonates or pediatric patients routinely admitted to a general ICU where adult patients are also admitted?	◯ Yes ◯ No
How many nurses work in the ICU on a typical shift (total number in all ICUs if more than one unit)?	_____
How many ICU qualified nurses are typically on duty for a normal shift (total number in all ICUs if different units)?	_____

How many registered professional nurses are typically on duty on a normal shift (total number if different units)?	_____
How many enrolled nurses are typically on duty for a normal shift (total number if different units)?	_____
How many nursing assistants would typically be on duty for a normal shift in ICU (total number if different units)?	_____
How many nursing students would typically be on duty in the ICU for a normal shift in ICU (total number if different units)?	_____
Is there a specific consultant in charge of ICU?	◯ Yes ◯ No
What is the specialty of the consultant in charge of ICU?	◯ Intensivist ◯ Pulmonologist ◯ Internal medicine specialist ◯ Anaesthetist ◯ Paediatrician ◯ Other type of specialist ◯ Medical officer ◯ Other
Please specify the type of specialty.	_____
Please specify.	_____
Does your ICU have a doctor physically on the floor of the hospital for 24 hours per day?	◯ Yes ◯ No
What is the highest post category of the doctors performing 24 hour duty in the ICU?	◯ Specialist ◯ Registrar ◯ Medical officer ◯ Community service doctor ◯ Intern
What percentage of ICU beds are typically occupied on an average day?	◯ 0 - 25% ◯ 26 - 50% ◯ 51 - 75% ◯ 76 - 100%
How many ICU patients can be ventilated at any one time?	_____

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Central wall oxygen	○	○	○	○	○
Oxygen via medical cylinder	○	○	○	○	○
Oxygen via industrial cylinder	○	○	○	○	○
Oxygen by concentrator	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Endotracheal tubes	○	○	○	○	○
Nasogastric tubes	○	○	○	○	○
Arterial catheters	○	○	○	○	○
Central venous catheters	○	○	○	○	○
Swan-Ganz catheters	○	○	○	○	○
Urine catheters	○	○	○	○	○
Intercostal drains	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Electronic non-invasive blood pressure monitor	○	○	○	○	○
Electronic ECG monitor	○	○	○	○	○
Pulse oximetry	○	○	○	○	○
Electronic respiratory rate monitor	○	○	○	○	○
Electronic central venous pressure monitor	○	○	○	○	○
Invasive blood pressure monitor	○	○	○	○	○
Capnography	○	○	○	○	○
Arterial blood gas machines	○	○	○	○	○
Intravenous infusion pumps	○	○	○	○	○
Cardiac output monitor	○	○	○	○	○
TEG/ROTEM	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Nasal cannules	○	○	○	○	○
Venturi facemasks	○	○	○	○	○
Simple facemasks	○	○	○	○	○
Rebreather masks	○	○	○	○	○
Non-rebreather masks	○	○	○	○	○
High flow nasal oxygen	○	○	○	○	○
Non-invasive ventilation via tight-fitting masks or BiPAP	○	○	○	○	○
Invasive mechanical ventilation	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Crystalloids	○	○	○	○	○
Colloids	○	○	○	○	○
Dextrose	○	○	○	○	○
Total parenteral nutrition	○	○	○	○	○
Enteral nutrition	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Adrenalin	○	○	○	○	○
Phenylephrine	○	○	○	○	○
Noradrenalin	○	○	○	○	○
Dobutamine	○	○	○	○	○
Dopamine	○	○	○	○	○
Labetolol	○	○	○	○	○
Nitroglycerine	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Ampicillin	○	○	○	○	○
Penicillin	○	○	○	○	○
Cloxacillin	○	○	○	○	○
Amoxycillin-clavulanic acid	○	○	○	○	○
Cefuroxime	○	○	○	○	○
Ceftriaxone	○	○	○	○	○
Ceftazidime	○	○	○	○	○
Cefepime	○	○	○	○	○
Piperacillin/tazobactam	○	○	○	○	○
Gentamycin	○	○	○	○	○
Amikacin	○	○	○	○	○
Tobramycin	○	○	○	○	○
Ciprofloxacin	○	○	○	○	○
Moxifloxacin	○	○	○	○	○
Levofloxacin	○	○	○	○	○
Ertapenem	○	○	○	○	○
Meropenem	○	○	○	○	○
Imipenem	○	○	○	○	○
Doripenem	○	○	○	○	○
Vancomycin	○	○	○	○	○
Teicoplanin	○	○	○	○	○
Linezolid	○	○	○	○	○
Daptomycin	○	○	○	○	○
Metronidazole	○	○	○	○	○
Clindamycin	○	○	○	○	○
Colistin	○	○	○	○	○
Tigecycline	○	○	○	○	○
Acyclovir	○	○	○	○	○
Fluconazole	○	○	○	○	○
Caspofungin	○	○	○	○	○
Mycafungin	○	○	○	○	○
Anidulafungin	○	○	○	○	○
Amphotericin B	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Packed red blood cells	○	○	○	○	○
Fresh frozen plasma	○	○	○	○	○
Platelets	○	○	○	○	○
Cryoprecipitate	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Propofol	○	○	○	○	○
Ketamine	○	○	○	○	○
Etomidate	○	○	○	○	○
Midazolam	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Suxamethonium	○	○	○	○	○
Rocuronium	○	○	○	○	○
Cisatracurium	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Laryngoscope size no. 1	○	○	○	○	○
Laryngoscope size no. 2	○	○	○	○	○
Laryngoscope size no. 3	○	○	○	○	○
Laryngoscope size no. 4	○	○	○	○	○
Video laryngoscope	○	○	○	○	○
Intubation bronchoscope	○	○	○	○	○
Laryngeal mask airway	○	○	○	○	○
Cricothyroidotomy set	○	○	○	○	○
Ambubag and mask	○	○	○	○	○
Defibrillators	○	○	○	○	○
Portable or transport ventilators	○	○	○	○	○

Please indicate the general availability of the following items in the hospital or ICU:					
	Never	Rarely	Sometimes	Often	Always
Flexible bronchoscope	○	○	○	○	○
ECG machines	○	○	○	○	○
Portable X-ray machine	○	○	○	○	○
X-ray services (not portable)	○	○	○	○	○
Bedside ultrasound machine	○	○	○	○	○
Intermittent hemodialysis	○	○	○	○	○
Continuous venovenous hemodialysis	○	○	○	○	○
Extracorporeal membrane oxygenation (ECMO)	○	○	○	○	○
CT-scan	○	○	○	○	○
MRI-scan	○	○	○	○	○

How often are patients generally transferred from your hospital or ICU to another hospital by the following means?

	Never	Rarely	Sometimes	Frequently	Very frequently
Air ambulance (helicopter)	○	○	○	○	○
Air ambulance (fixed-wing airplane)	○	○	○	○	○
Road ambulance	○	○	○	○	○

How readily available is ambulance services in general?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Always

How readily available is the following skills in the ambulance transport personnel?

	Never	Rarely	Sometimes	Often	Always
BLS	○	○	○	○	○
ACLS	○	○	○	○	○
Qualified paramedic	○	○	○	○	○
Basic ambulance driver not able to transport critically ill patients	○	○	○	○	○

How often does a doctor have to accompany a patient because of a lack of skilled ambulance personnel?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Always

What is the average waiting time for a critically ill patient to be collected by ambulance personnel?

- ○ < 1 hour
- ○ 1 - 2 hours
- ○ 2 - 3 hours
- ○ 3 - 4 hours
- ○ 4 - 5 hours
- ○ 5 - 6 hours
- ○ 6 - 12 hours
- ○ 12 - 24 hours
- ○ > 24 hours

What is the distance to the usual referral hospital?

- ○ < 50 km
- ○ 50 - 100 km
- ○ 101 - 150 km
- ○ 151 - 200 km
- ○ 201 - 250 km
- ○ 251 - 300 km
- ○ 301 - 600 km
- ○ > 600 km

In your opinion, how often is a patient too unstable to be transferred and thereby require management at the local hospital?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Frequently
- ○ Very frequently

How often are critically ill patients managed at your hospital or ICU for the following periods of time before a bed becomes available at the referral hospital?

	Never	Rarely	Sometimes	Frequently	Very frequently
Less than 1 hour	○	○	○	○	○
1 - 2 hours	○	○	○	○	○
2 - 3 hours	○	○	○	○	○
3 - 4 hours	○	○	○	○	○
4 - 5 hours	○	○	○	○	○
5 - 6 hours	○	○	○	○	○
6 - 12 hours	○	○	○	○	○
12 - 24 hours	○	○	○	○	○
24 - 48 hours	○	○	○	○	○
> 48 hours	○	○	○	○	○

How often is training on critical care topics provided to the following personnel at your hospital?					
	Never	Rarely	Sometimes	Frequently	Very frequently
Nursing staff	○	○	○	○	○
Doctors	○	○	○	○	○
Physiotherapists	○	○	○	○	○

Any other comments?

APPENDIX D:

CRITICAL CARE-RELATED KNOWLEDGE, ATTITUDE AND PRACTICES (KAP) OF NON-SPECIALIST GENERAL MEDICAL PRACTITIONERS IN THE FREE STATE PROVINCE OF SOUTH AFRICA QUESTIONNAIRE

Confidential

Critical Care-related knowledge, attitude and practices (KAP) of non-specialist general medical practitioners in the Free State province of South Africa

Dear Study Participant

My name is Shaun Maasdorp and I am a specialist physician at Universitas Academic Hospital.

In view of your employment as a medical practitioner at a district or regional hospital in the Free State province of South Africa, I would like to invite you to participate in this knowledge, attitude and practices (KAP) questionnaire which is one phase of a larger PhD study titled: Core Competencies in Critical Care for General Medical Practitioners in South Africa. This phase of the study aims to ascertain the current state of critical care services provided at district and regional hospitals in the Free State province of South Africa, with a view to determine whether medical practitioners are knowledgeable and skilled in managing critically ill patients at the primary and secondary levels of the healthcare system and if additional training in critical care medicine would be of benefit. The aim of this study is, ultimately, to establish core competencies in critical care for general medical practitioners in South Africa. Your assistance will be sincerely appreciated. The data collection for this component of the study is in the form of a questionnaire and will take approximately 10-15 minutes to complete.

The information provided will be treated with strict confidentiality and necessary professional discretion. To ensure this, numerical codes will be used and there will be no references to participant's names when the research results are reported. Your responses will not be able to be traced to you. Participation is entirely voluntary and there will be no financial compensation for participants. You may withdraw from this study at any given moment during completion of the questionnaire. Your consent to participate in this study will be inferred from your completing this questionnaire.

The aim of this study is, ultimately, to establish core competencies in critical care for general medical practitioners in South Africa.

My supervisors are:

1. Dr L Van der Merwe (Department of Basic Sciences, Faculty of Health Sciences, UFS).

2. Prof F Paruk (Department of Critical Care, Faculty of Health Sciences, University of Pretoria)

Should you have specific questions, please feel free to contact me.

Yours faithfully

Dr S. Maasdorp

Cellular number: 0731137768

E-mail address: maasdorpsd1@gmail.com

General questions regarding healthcare setting and experience of healthcare provider

1) How old are you?

_____

2) Please indicate your gender.
- ◯ Male
- ◯ Female
- ◯ Other

3) In what year did you complete your undergraduate medical training?

_____

4) Please indicate your current highest academic qualification.
- ◯ MBChB or equivalent
- ◯ MMed or equivalent
- ◯ PhD or equivalent

5) In which district of the Free State province are you working?
- ◯ Mangaung
- ◯ Xhariep
- ◯ Lejweleputswa
- ◯ Fezile Dabi
- ◯ Thabo Mofutsanyana

6) In which type of hospital are you currently working?
- ◯ District hospital (Level 1)
- ◯ Regional hospital (Level 2)
- ◯ Provincial hospital (Level 3)
- ◯ Central hospital (Level 3 and 4)

7) What is your current employment level?
- ◯ Intern
- ◯ Community Service
- ◯ Medical Officer
- ◯ Registrar
- ◯ Specialist

8) How many critically ill patients do you see during an average week?
- ◯ 0
- ◯ 1 - 5
- ◯ 6 - 10
- ◯ > 10

9) How many critically ill patients that you see during an average week require intubation?
- ◯ 0
- ◯ 1 - 5
- ◯ 6 - 10
- ◯ > 10

10) How many critically ill patients that you see during an average week require inotropic or vasopressor support?
- ◯ 0
- ◯ 1 - 5
- ◯ 6 - 10
- ◯ > 10

11) How many critically ill patients that you see during an average week do you think would benefit from intensive care unit admission?
- ◯ 0
- ◯ 1 - 5
- ◯ 6 - 10
- ◯ > 10

12) How many intensive care unit beds do you have available at the hospital where you are currently working?

_____

13) If applicable, are there separate adult and paediatric intensive care units at your hospital?
- ◯ Yes
- ◯ No

14) How is the intensive care service at your hospital organized?
- ◯ General ICU
- ◯ Separate specialist ICUs
- ◯ Not applicable

15) How many ventilators do you have available at your hospital, even if it is not within an intensive care unit setting?

_____

16) How often do you refer critically ill patients for intensive care unit admission to another hospital?
- ◯ Never
- ◯ Seldom
- ◯ Often
- ◯ Always

17) What is the average time that you usually have to attend to a critically ill patient while waiting for the patient to be admitted to the intensive care unit or for emergency medical services (EMS) transport to transfer the patient to another hospital?
- ◯ < 1 hour
- ◯ 1 - 2 hours
- ◯ 2 - 3 hours
- ◯ 3 - 4 hours
- ◯ 4 - 6 hours
- ◯ 6 - 12 hours
- ◯ 12 - 24 hours
- ◯ > 24 hours
- ◯ Not applicable

18) What is the longest time that you personally spent attending to a critically ill patient that required intensive care unit admission before the patient was eventually transferred to an intensive care unit?
- ◯ < 1 hour
- ◯ 1 - 2 hours
- ◯ 2 - 3 hours
- ◯ 3 - 4 hours
- ◯ 4 - 6 hours
- ◯ 6 - 12 hours
- ◯ 12 - 24 hours
- ◯ > 24 hours
- ◯ Not applicable

19) Do you have critical care specialists or intensivists available at your hospital?
- ◯ Yes
- ◯ No

The following questions assess knowledge pertaining critical care medicine.

20) In septic shock, all of the following statements are true, except:
- ◯ Noradrenalin is the preferred vasoactive agent.
- ◯ Corticosteroid therapy is contra-indicated in sepsis.
- ◯ Crystalloids are preferred over colloids.
- ◯ Adrenalin can increase lactate levels.

21) In patients with acute pulmonary embolism and shock:
- ◯ Alteplase is contra-indicated in pregnant patients.
- ◯ Enoxaparin cannot be given to patients with renal failure.
- ◯ Phenylephrine is a preferred vasoactive agent.
- ◯ May require indefinite anticoagulation therapy if no reversible risk factors are identified.

22) Acute respiratory distress syndrome is characterized by:
- ◯ P/F ratio > 300
- ◯ High tidal volume, low PEEP ventilation
- ◯ Poor lung compliance
- ◯ Excellent response to corticosteroid therapy

23) Each of the following is an indication for hemodialysis in acute renal failure, except:
- ◯ Anaemia
- ◯ Hyperkalemia
- ◯ Pericardial effusion
- ◯ Metabolic acidosis

24) Guilliane-Barre syndrome can be treated by all of the following except:
- ◯ Plasma exchange
- ◯ Prednisone
- ◯ Immunoglobulin therapy
- ◯ Ventilation

25) Thyroid storm with atrial fibrillation and hypotension is treated by all of the following, except:
- ◯ Iodine
- ◯ Neomercazole
- ◯ Propranolol
- ◯ Amiodarone

26) An example of an antibiotic with concentration-dependent pharmacodynamic characteristics would be:
- ◯ Penicillin
- ◯ Amikacin
- ◯ Clindamycin
- ◯ Meropenem

27) In a patient presenting with confusion, renal dysfunction, thrombocytopenia and fragmentation hemolysis, all of the following conditions should be considered except:
- ◯ Immune thrombocytopenic purpura
- ◯ Thrombotic thrombocytopenic purpura
- ◯ Disseminated intravascular coagulation
- ◯ Scleroderma crisis

28) A 55-year-old male was admitted to the intensive care unit 10 days ago after emergency surgery for peptic ulcer perforation. During this time, he was ventilated and treated with broad-spectrum antibiotics (Meropenem) as well as total parenteral nutrition since admission. He currently has sepsis. After appropriate cultures were obtained, which of the following would be a reasonable consideration for empiric therapy:
- ◯ Acyclovir
- ◯ Imipenem
- ◯ Fluconazole
- ◯ Metronidazole

29) A pregnant patient with posterior reversible encephalopathy syndrome reported on CT of the brain requires which of the following interventions:
- ◯ Mannitol
- ◯ Corticosteroid therapy
- ◯ Antihypertensives
- ◯ Antibiotics

The following questions relate to attitude pertaining critical care medicine. Please state whether you disagree, are neutral, or agree with each of the following statements:

		Disagree	Neutral	Agree
30)	I often spend time to discuss my patient's prognosis with his/her relatives in order to make combined decisions for the patient's treatment.	○	○	○
31)	I prefer keeping critically ill patients sedated to prevent the nurses from bothering me too much during the night.	○	○	○
32)	I am very uncomfortable in deciding whether to withhold or withdraw treatment from a patient and seldom make such a decision, even if I think that the prognosis is poor.	○	○	○
33)	I make it a point to discuss end of life care with patients and their families/surrogates and implement palliative treatment for patients in whom the prognosis is poor.	○	○	○
34)	I would like to be able to treat my critically ill patients in an intensive care unit environment by myself.	○	○	○
35)	I frequently transfer critically ill patients to a referral hospital, because I do not feel competent enough to treat them myself.	○	○	○
36)	If my hospital had an intensive care unit available, , I feel that I am in a position to competently manage these patients myself.	○	○	○
37)	I would feel more comfortable managing patients in an intensive care unit if I completed a short course or diploma in critical care.	○	○	○
38)				

I think that my undergraduate medical training prepared me well enough to manage critically ill patients and thus I do not require any additional training in critical care medicine.	○	○	○

The following questions pertain to practices in critical care medicine. For each of the following statements, please select whether you disagree, are neutral, or agree:

		Disagree	Neutral	Agree
39)	I regularly use an ultrasound at the bedside in order to localize and drain pleural effusions.	○	○	○
40)	I use lung protective ventilation strategies on all my patients when ventilating them.	○	○	○
41)	I regularly insert arterial catheters for monitoring my patient's blood pressure.	○	○	○
42)	I regularly place central venous catheters either in the subclavian or internal jugular vein.	○	○	○
43)	I am able to recognize any patient requiring electrical cardioversion or defibrillation and can institute this form of treatment confidently.	○	○	○
44)	If the patient's condition warrants it, I can perform transthoracic cardiac pacing.	○	○	○
45)	If needed, I will perform pericardiocentesis.	○	○	○
46)	I can perform and interpret non-invasive cardiac output and derived haemodynamic monitoring.	○	○	○
47)	I know how to manage renal replacement therapy.	○	○	○
48)	I am comfortable in performing preoperative cardiopulmonary evaluation of a high-risk patient.	○	○	○
49)	I can confidently manage the postoperative assessment and care of a high-risk surgical patient.	○	○	○
50)	I can confidently manage the preoperative and postoperative care of the trauma patient.	○	○	○

51) Please use free text to add any additional core competencies that you deem important to be included as a core competency for the general medical practitioner attending to critically ill patients. _____

APPENDIX E:
CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACITIONERS: DELPHI QUESTIONNAIRE (ROUND 1)

Confidential

Core competencies in critical care for general medical practitioners: Delphi questionnaire

Dear Delphi Panel Member

My name is Dr Shaun Maasdorp and I am a Pulmonologist at Universitas Academic Hospital.

In view of your expertise pertaining critical care medicine, I would like to invite you to participate in this Delphi study which is one phase of a larger PhD study titled: Core Competencies in Critical Care for General Medical Practitioners in South Africa. This phase of the study aims to establish the core competencies expected of medical practitioners working in critical care settings, or providing critical care services at public sector hospitals in South Africa outside established ICUs where qualified intensivists direct medical treatment.

A list of suggested core competencies were compiled and international and national experts in the field of critical care medicine, such as yourself, were identified and invited to participate in the study. The questionnaire will take approximately 30 minutes to complete. Your assistance is sincerely appreciated.

The information provided will be treated with strict confidentiality and the necessary professional discretion. We would however like to acknowledge the participants on the Delphi panel, as well as their institutions in any publications, unless indicated otherwise. Participation is entirely voluntary and there will be no financial compensation for participants. You may withdraw from this study at any given moment during completion of the questionnaire. Your consent to participate in this study will be inferred from your completing this questionnaire.

The aim of this study is, ultimately, to establish core competencies in critical care for general medical pracitioners inSouth Africa.

My supervisors are:
1. Dr L Van der Merwe (Department of Basic Sciences, Faculty of Health Sciences, University of the Free State)
2. Prof F Paruk (Department of Critical Care, Faculty of Health Sciences, University of Pretoria)

Should you have any questions, please fell free to contact me.

Yours faithfully,

Dr SD Maasdorp
Cell number: 0731137768
E-mail: maasdorpsd1@ufs.ac.za

Thank you for your participation in this project!

For each of the following statements, please indicate if you agree or disagree by using the 5-point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.

Resuscitation and initial stabilization:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1)	Adopts a structured and timely approach to the recognition, assessment and stabilisation of the acutely ill patient with disordered physiology	○	○	○	○	○
2)						

	Performs cardiopulmonary resuscitation	○	○	○	○	○
3)	Manages post-resuscitation cerebral protection	○	○	○	○	○
4)	Triages and prioritises patients appropriately, including timely admission to ICU	○	○	○	○	○
5)	Assesses and provides initial management of the trauma patient	○	○	○	○	○
6)	Assesses and provides initial management of the patient with burns	○	○	○	○	○
7)	Describes the management of mass casualties	○	○	○	○	○

Diagnosis:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
8)	Obtains medical history and performs accurate clinical examination	○	○	○	○	○
9)	Requests timely and appropriate laboratory and imaging investigations	○	○	○	○	○
10)	Appropriately requests, interprets and acts on the results of TEG/ROTEM	○	○	○	○	○
11)	Interprets and acts on the results from non-invasive hemodynamic monitoring	○	○	○	○	○
12)	Monitors and responds to intracranial pressure changes	○	○	○	○	○
13)	Performs point-of-care ultrasound	○	○	○	○	○
14)	Describes indications for echocardiography (transthoracic and transoesophageal)	○	○	○	○	○
15)	Performs electrocardiography and interprets the results	○	○	○	○	○
16)	Obtains appropriate microbiological samples and interprets results	○	○	○	○	○
17)	Interprets the results from blood gas samples	○	○	○	○	○
18)	Interprets chest radiographs	○	○	○	○	○
19)	Liaises with radiologists to organise and interpret clinical imaging	○	○	○	○	○
20)	Monitors and responds to trends in physiological variables	○	○	○	○	○
21)	Integrates clinical findings with laboratory investigations to form a differential diagnosis	○	○	○	○	○

Disease management:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
22)	Describes the implications of chronic and comorbid disease in the acutely ill patient	○	○	○	○	○
23)	Recognizes and manages different types of shock	○	○	○	○	○
24)	Assesses and manages life-threatening arrhythmia	○	○	○	○	○
25)	Recognizes and manages left ventricular failure and/or acute pulmonary edema	○	○	○	○	○
26)	Recognizes and manages right heart failure	○	○	○	○	○
27)	Assesses and manages myocardial infarction and acute coronary syndrome	○	○	○	○	○
28)	Recognizes and manages rupture of aneurysm (bleeding and cardiac tamponade)	○	○	○	○	○
29)	Recognizes and manages hypertension crisis	○	○	○	○	○
30)	Describes physiological changes of the cardiovascular system under acute conditions	○	○	○	○	○
31)	Assesses and manages acute and chronic respiratory failure	○	○	○	○	○
32)	Assesses and manages acute exacerbation of chronic obstructive pulmonary disease	○	○	○	○	○
33)	Assesses and manages status asthmaticus	○	○	○	○	○
34)	Assesses and manages smoke inhalation and airway burns	○	○	○	○	○
35)	Assesses and manages upper airway obstruction (due to infection or foreign body)	○	○	○	○	○
36)	Recognizes (diagnosis and grading) and manages ARDS	○	○	○	○	○
37)						

	Manages life-threatening hemoptysis	○	○	○	○	○
38)	Describes effects of positioning on respiratory physiology	○	○	○	○	○
39)	Recognizes (diagnosis and grading) and manages acute kidney injury	○	○	○	○	○
40)	Manages critically ill patients with chronic renal failure	○	○	○	○	○
41)	Manages patients with coma	○	○	○	○	○
42)	Assesses and manages patients with drug overdose and intoxication	○	○	○	○	○
43)	Assesses and manages cerebral vascular accident	○	○	○	○	○
44)	Manages status epilepticus	○	○	○	○	○
45)	Manages myasthenia gravis	○	○	○	○	○
46)	Manages Guillian-Barre syndrome	○	○	○	○	○
47)	Recognizes and manages intracranial infection	○	○	○	○	○
48)	Assesses and manages patients with increased intracranial pressure	○	○	○	○	○
49)	Assesses and manages spine injury	○	○	○	○	○
50)	Recognizes and manages adrenal crisis	○	○	○	○	○
51)	Recognizes and manages diabetes insipidus	○	○	○	○	○
52)	Recognizes and manages diabetic ketoacidosis	○	○	○	○	○
53)	Recognizes and manages hypo-or hyperthyroidism	○	○	○	○	○
54)	Recognizes and manages sepsis, severe sepsis, and septic shock	○	○	○	○	○
55)	Assesses and manages multiorgan dysfunction syndrome	○	○	○	○	○
56)	Assesses and manages severe community acquired infection (e.g., severe community-acquired pneumonia)	○	○	○	○	○
57)	Recognizes and manages nosocomial infection	○	○	○	○	○
58)						

	Assesses and manages fever in critically ill patients	○	○	○	○	○
59)	Describes antimicrobial resistance	○	○	○	○	○
60)	Recognizes intra-abdominal infection and gastrointestinal leakage	○	○	○	○	○
61)	Assesses and manages HIV-related diseases	○	○	○	○	○
62)	Manages tuberculosis	○	○	○	○	○
63)	Assesses and manages multi-drug and extensively drug resistant pathogens	○	○	○	○	○
64)	Has knowledge of and uses anti-infective agents appropriately	○	○	○	○	○
65)	Manages coagulopathy	○	○	○	○	○
66)	Manages hemolytic disorders	○	○	○	○	○
67)	Assesses and manages thromboembolic disease (including pulmonary embolism)	○	○	○	○	○
68)	Manages disseminated intravascular coagulation	○	○	○	○	○
69)	Manages traumatic coagulopathy	○	○	○	○	○
70)	Manages thrombocytopenia	○	○	○	○	○
71)	Investigates and manages causes of anemia	○	○	○	○	○
72)	Has knowledge of transfusion triggers	○	○	○	○	○
73)	Assesses and manages gastrointestinal bleeding	○	○	○	○	○
74)	Assesses and manages patient with liver failure	○	○	○	○	○
75)	Assesses and manages pancreatitis	○	○	○	○	○
76)	Assesses and manages abdominal compartment syndrome	○	○	○	○	○
77)	Assesses and manages acute illness in pregnancy	○	○	○	○	○
78)	Assesses and manages antepartum haemmorhage	○	○	○	○	○
79)	Assesses and manages postpartum haemmorhage	○	○	○	○	○
80)						

	Assesses and manages hypertensive disorders during pregnancy	○	○	○	○	○
81)	Assesses and manages HELLP syndrome	○	○	○	○	○
82)	Assesses and manages psychiatric illnesses with acute psychosis	○	○	○	○	○

Therapeutic interventions:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
83)	Manages anaphylaxis	○	○	○	○	○
84)	Assesses and manages fluid and electrolyte disorders	○	○	○	○	○
85)	Assesses and manages acid-base disorders	○	○	○	○	○
86)	Describes and provides parenteral nutrition support	○	○	○	○	○
87)	Describes and provides enteral nutrition support	○	○	○	○	○
88)	Provides nutrition support for patient with severe acute pancreatitis	○	○	○	○	○
89)	Provides nutrition support for patient with renal failure	○	○	○	○	○
90)	Provides nutrition support for patient with liver failure	○	○	○	○	○
91)	Provides nutrition support for patient with sepsis and septic shock	○	○	○	○	○
92)	Provides nutrition support for postgastrointestinal surgery patients	○	○	○	○	○
93)	Assesses and manages pain in critically ill patients	○	○	○	○	○
94)	Describes principle and assessment of sedation	○	○	○	○	○
95)	Provides assessment, prevention, and treatment of delirium	○	○	○	○	○
96)	Describes indication and choice of neuromuscular blockade	○	○	○	○	○
97)	Manages fluid therapy	○	○	○	○	○
98)	Manages vasoactive/inotropic medication therapy	○	○	○	○	○
99)	Describes principles of drug dose adjustment in renal failure	○	○	○	○	○
100)						

Describes principles of continuous renal replacement therapy	○	○	○	○	○
101) Describes principles of peritoneal dialysis	○	○	○	○	○
102) Explains and appraises management of severe sepsis and septic shock	○	○	○	○	○
103) Describes principles of antimicrobial agent selection and dosing in critically ill patients	○	○	○	○	○
104) Describes principles of anticoagulation and anti-fibrinolytic therapy	○	○	○	○	○
105) Describes principles of blood component transfusion	○	○	○	○	○
106) Describes stress ulcer prophylaxis	○	○	○	○	○
107) Assesses and manages hypothermia and hyperthermia	○	○	○	○	○

Practical procedures:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
108) Performs bedside ultrasound to localize pleural effusion and ascites	○	○	○	○	○
109) Maintains an open airway in the non-intubated patient	○	○	○	○	○
110) Performs bag-mask ventilation	○	○	○	○	○
111) Performs tracheal intubation	○	○	○	○	○
112) Performs tracheal aspiration	○	○	○	○	○
113) Manages pneumothorax	○	○	○	○	○
114) Administers oxygen therapy	○	○	○	○	○
115) Manages noninvasive and invasive mechanical ventilation: indications, rationale, complications, and weaning	○	○	○	○	○
116) Explains and performs recruitment maneuver: principle and practice	○	○	○	○	○
117) Performs thoracocentesis via a chest drain	○	○	○	○	○
118) Performs peripheral venous catheter insertion	○	○	○	○	○
119) Performs arterial puncture and cannulation	○	○	○	○	○
120) Performs central venous catheter insertion	○	○	○	○	○
121) Performs cardioversion and defibrillation	○	○	○	○	○
122) Performs transthoracic cardiac pacing	○	○	○	○	○
123) Describes how to perform pericardiocentesis	○	○	○	○	○
124) Performs and interprets cardiac output and derived haemodynamic monitoring	○	○	○	○	○
125) Performs lumbar puncture	○	○	○	○	○
126) Performs nasogastric tube placement	○	○	○	○	○
127)					

Performs abdominal paracentesis	○	○	○	○	○
128) Performs and interprets intra-abdominal pressure monitor	○	○	○	○	○
129) Manages continuous renal replacement therapy	○	○	○	○	○
130) Performs urinary catheterisation	○	○	○	○	○

Perioperative care:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
131) Performs preoperative cardiopulmonary evaluation of high-risk patient	○	○	○	○	○
132) Manages postoperative assessment and care of high-risk surgical patient	○	○	○	○	○
133) Manages the preoperative and postoperative care of the trauma patient	○	○	○	○	○

Comfort and recovery:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
134) Ensures early mobilisation of patients	○	○	○	○	○
135) Identifies and attempts to minimise the physical and psychosocial consequences of critical illness for patients and families	○	○	○	○	○
136) Prevents, recognizes and manages pain and delirium	○	○	○	○	○
137) Manages the safe and timely discharge of patients from the ICU	○	○	○	○	○
138) Communicates the continuing care requirements of patients at ICU discharge to health care professionals, patients and relatives	○	○	○	○	○

End-of-life care:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
139) Manages the process of withholding or withdrawing treatment with the multidisciplinary team	○	○	○	○	○
140) Discusses end-of-life care with patients and their families/surrogates	○	○	○	○	○
141) Provides palliative care for the critically ill patient	○	○	○	○	○
142) Performs brainstem death testing	○	○	○	○	○

Paediatric care:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
143) Describes the recognition of the acutely ill child and initial management of paediatric emergencies	○	○	○	○	○
144) Describes national legislation and guidelines relating to child protection and their relevance to critical care	○	○	○	○	○

Transportation:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
145) Assesses patient before transport	○	○	○	○	○
146) Prepares equipment for transport	○	○	○	○	○
147) Performs intra-hospital transport	○	○	○	○	○

Health and safety management:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
148) Complies with infection control measures	○	○	○	○	○
149) Identifies environmental hazards and promotes safety for patients and staff	○	○	○	○	○
150) Identifies and minimises risk of incidents and adverse events, including complications of critical illness	○	○	○	○	○
151) Organises a case conference	○	○	○	○	○
152) Critically appraises and applies guidelines, protocols and care bundles	○	○	○	○	○
153) Describes commonly used scoring systems for assessment of severity of illness	○	○	○	○	○
154) Conducts regular audits of clinical diseases managed in the intensive care unit	○	○	○	○	○
155) Conducts morbidity and mortality meetings	○	○	○	○	○

Professionalism:

By the end of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
156) Communicates effectively with patients and relatives	○	○	○	○	○
157) Communicates effectively with members of the health care team	○	○	○	○	○
158) Maintains accurate and legible records or documentation	○	○	○	○	○
159) Involves patients (or their surrogates if applicable) in decisions about care and treatment	○	○	○	○	○
160) Demonstrates respect of cultural and religious beliefs and an awareness of their impact on decision making	○	○	○	○	○
161) Respects privacy, dignity, confidentiality and legal constraints on the use of patient data	○	○	○	○	○
162) Collaborates and consults with appropriate healthcare providers	○	○	○	○	○
163) Promotes effective team-working	○	○	○	○	○
164) Ensures continuity of care through effective hand-over of clinical information	○	○	○	○	○
165) Supports clinical staff outside the ICU to enable the delivery of effective care	○	○	○	○	○
166) Recognizes and manages burnout in themselves and members of the healthcare team	○	○	○	○	○
167) Takes responsibility for safe patient care	○	○	○	○	○
168) Formulates clinical decisions with respect for ethical and legal principles	○	○	○	○	○
169) Seeks learning opportunities and integrates new knowledge into clinical practice	○	○	○	○	○

Pre-training certification:

Before the start of critical care training, the trainee...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
170) Successfully completed a Basic Life Support Course	○	○	○	○	○
171) Successfully completed an Advanced Cardiac Life Support Course	○	○	○	○	○

172) Please use free text to add any additional core competencies that you deem important for the non-specialist/non-intensivist critical care provider. _____

APPENDIX F:
CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACITIONERS: DELPHI QUESTIONNAIRE (ROUND 2)

Confidential

Core competencies in critical care for general medical practitioners: Delphi questionnaire Round 2

Dear Delphi Panel Member

Thank you for having participated in the first round of the Delphi process. More than 80% concensus were obtained for the majority of the questions during the first round of the process.

Please assist with the second round of the Delphi process by completing the shortened questionnaire in the link provided. This should take less than 5 minutes to complete.

Remember that the study aims to establish the core competencies expected of non-specialist medical practitioners or medical officers working in critical care settings, or providing critical care services at public sector hospitals in South Africa outside established ICUs where qualified intensivists direct medical treatment.

Should you have any questions, please fell free to contact me.

Yours faithfully,

Dr SD Maasdorp
Cell number: 0731137768
E-mail: maasdorpsd1@ufs.ac.za

Thank you for your participation in this project!

For each of the following statements, please indicate if you agree or disagree by using the 5-point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.

Resuscitation and initial stabilization:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1)	Assesses and provides initial management of the patient with burns	○	○	○	○	○
2)	Describes the management of mass casualties	○	○	○	○	○

Diagnosis:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3)	Appropriately requests, interprets and acts on the results of TEG/ROTEM	○	○	○	○	○
4)	Monitors and responds to intracranial pressure changes	○	○	○	○	○

Disease management:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
5)	Recognizes and manages rupture of aneurysm (bleeding and cardiac tamponade)	○	○	○	○	○
6)	Describes effects of positioning on respiratory physiology	○	○	○	○	○
7)	Manages myasthenia gravis	○	○	○	○	○
8)	Manages Guillian-Barre syndrome	○	○	○	○	○
9)	Assesses and manages spine injury	○	○	○	○	○
10)	Assesses and manages multiorgan dysfunction syndrome	○	○	○	○	○
11)	Manages tuberculosis	○	○	○	○	○
12)	Assesses and manages multi-drug and extensively drug resistant pathogens	○	○	○	○	○
13)	Manages hemolytic disorders	○	○	○	○	○
14)	Assesses and manages gastrointestinal bleeding	○	○	○	○	○
15)	Assesses and manages patient with liver failure	○	○	○	○	○
16)	Assesses and manages antepartum haemmorhage	○	○	○	○	○
17)	Assesses and manages psychiatric illnesses with acute psychosis	○	○	○	○	○
18)	Recognizes and manage critical complications of acute leukemia	○	○	○	○	○
19)	Recognizes and manage complications of newer oncologic therapies such as immune checkpoint inhibitors and CAR-T therapy	○	○	○	○	○

Therapeutic interventions:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
20)	Describes and provides parenteral nutrition support	○	○	○	○	○
21)	Describes principles of continuous renal replacement therapy	○	○	○	○	○
22)	Describes principles of peritoneal dialyisis	○	○	○	○	○

Practical procedures:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
23)	Explains and performs recruitment maneuver: principle and practice	○	○	○	○	○
24)	Performs transthoracic cardiac pacing	○	○	○	○	○
25)	Describes how to perform pericardiocentesis	○	○	○	○	○
26)	Performs and interprets cardiac output and derived haemodynamic monitoring	○	○	○	○	○
27)	Manages continuous renal replacement therapy	○	○	○	○	○
28)	Performs urinary catheterisation	○	○	○	○	○
29)	Liberates patients from ventilation	○	○	○	○	○
30)	Lists indications for tracheostomy	○	○	○	○	○
31)	Performs percutaneous tracheostomy	○	○	○	○	○
32)	Performs surgical tracheostomy	○	○	○	○	○
33)	Performs elective and crash induction and intubation using anesthetic drugs	○	○	○	○	○
34)	Discusses indications and risks of bronchoscopy	○	○	○	○	○
35)	Discusses indications, benefits and risks of prone positioning	○	○	○	○	○

Perioperative care:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
36)	Performs preoperative cardiopulmonary evaluation of high-risk patient	○	○	○	○	○

Paediatric care:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
37)	Describes the recognition of the acutely ill child and initial management of paediatric emergencies	○	○	○	○	○
38)	Describes national legislation and guidelines relating to child protection and their relevance to critical care	○	○	○	○	○

Health and safety management:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
39)	Describes commonly used scoring systems for assessment of severity of illness	○	○	○	○	○
40)	Conducts regular audits of clinical diseases managed in the intensive care unit	○	○	○	○	○
41)	Should be aware of the ICU triage process and assess both in- and out or hospital telephonic referrals to the ICU accordingly	○	○	○	○	○
42)	Should recognize the care limits of the current setting and identify patients requiring a higher level of care early	○	○	○	○	○

Pre-training certification:

Before the start of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
43)	Successfully completed a Basic Life Support Course	○	○	○	○	○
44)	Successfully completed an Advanced Cardiac Life Support Course	○	○	○	○	○
45)	Successfully completed an Advanced Trauma Life Support Course	○	○	○	○	○

46) Please use free text to add any additional core competencies that you deem important for the non-specialist/non-intensivist critical care provider. _____

APPENDIX G:
CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACITIONERS: DELPHI QUESTIONNAIRE (ROUND 3)

Confidential

Core Competencies In Critical Care For General Medical Practitioners Delphi Round 3

Dear Delphi Panel Member

Thank you for having participated in the 1st and 2nd rounds of the Delphi process. We had a 100% response rate in both rounds and more than 80% concensus were obtained for the majority of the questions during the first two rounds of the process.

There are 6 questions left for which we still require stability and concensus, therefore neccessitating a 3rd round. Please assist with round 3 of the Delphi process by completing the short questionnaire in the link provided. This should take less than 1 minute to complete.

Remember that the study aims to establish the core competencies expected of non-specialist medical practitioners or medical officers working in critical care settings, or providing critical care services at public sector hospitals in South Africa outside established ICUs where qualified intensivists direct medical treatment.

Should you have any questions, please fell free to contact me.

Yours faithfully,

Dr SD Maasdorp
Cell number: 0731137768
E-mail: maasdorpsd1@ufs.ac.za

Thank you for your participation in this project!

Disease management:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1)	Recognizes and manages critical complications of acute leukemia	○	○	○	○	○
2)	Recognizes and manages complications of newer oncologic therapies such as immune checkpoint inhibitors and CAR-T therapy	○	○	○	○	○

Practical procedures:

By the end of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3)	Performs percutaneous tracheostomy	○	○	○	○	○
4)	Performs surgical tracheostomy	○	○	○	○	○
5)	Discusses indications and risks of bronchoscopy	○	○	○	○	○

Pre-training certification:

Before the start of critical care training, the trainee...

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6)	Successfully completed an Advanced Trauma Life Support Course	○	○	○	○	○

7) Please use free text to add any additional core competencies that you deem important for the non-specialist/non-intensivist critical care provider. _____

APPENDIX H:

COMPARISON BETWEEN COLLEGES OF MEDICINE OF SOUTH AFRICA (THE COLLEGES OF MEDICINE OF SOUTH AFRICA, 2022), SUGGESTED COMPETENCIES FOR MEDICAL STUDENTS AT THE TIME OF GRADUATION (PERKINS *ET AL.*, 2005) AND CORE COMPETENCIES IN CRITICAL CARE FOR GENERAL MEDICAL PRACTITIONERS

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		**Competencies for medical students**	**Core competencies in critical care**
General/attitude	Identification and management of life-threatening or other emergency situations		
	Identification of essential elements and assignment of priorities in diagnostic procedures and treatment in complex clinical situations		
	Application of pathophysiological concepts in individual patient problems		
	Assessment of the pros and cons of diagnostic and therapeutic options		
	Responsibility for comprehensive patient care		
	Search for ways of improving daily patient care		
	Awareness of and ability to cope with the psychological and social effects of life-threatening illness on patients and their relatives		
	Compassion for and humane approach to the critically ill and their relatives		
	Ability to work in a multidisciplinary team		
	Awareness of costs (and cost benefit ratios) of ICU procedures		
Respiratory problems; their recognition, assessment and management:			
Airway management			
Mandatory	Maintenance of open airway		
	Intubation (oral, nasotracheal) and maintenance of this airway		
Advisable	Cricothyrotomy/transtracheal catheterisation		
Optional	Tracheostomy		
Ventilation			
Mandatory	Oxygen therapy		
	Ventilation by bag and mask		
	Use of mask ventilation (with PEEP) eg. CPAP, NIPPV		
	Mechanical ventilation: all aspects including weaning and complications		
Pulmonary aspects	Management of pneumothorax (needle, chest tube insertion, drainage systems)		
	Interpretation of arterial (and mixed venous) blood gases and assessment of pulmonary gas exchange (A-a gradients, shunt fraction, VD/VT, etc)		
	Basic interpretation of a bedside chest x-ray		
	Performance of bedside pulmonary function tests and assessment of pulmonary mechanics		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Chest physiotherapy, incentive spirometry		
	Extracorporeal respiratory assist devices		
	Hyperbaric Oxygen therapy		
For neonatal paediatric intensive care the following items are added:	**Choice of adequate endotracheal tubes**		
	Prevention of subglottic tracheal stenosis		
	High frequency ventilation		
Cardiovascular:			
Recognition, assessment and management of acute circulatory problems and advanced cardiopulmonary resuscitation			
Mandatory	Assessment and treatment of ECG abnormalities and rhythm disturbances		
	Arterial puncture and blood sampling		
	Insertion of monitory lines, both arterial and venous, including pulmonary arterial catheters		
	Also the measurement of indices made possible by these devices eg. CVP, cardiac output, wedge pressure etc		
	Cardioversion (electrical and medical)		
	Transcutaneous pacing		
Advisable	Pericardiocentesis		
	Echo-doppler cardiovascular techniques including knowledge of transoesophageal echocardiography (interpretation of results)		
	Application and regulation of intra-aortic assist devices		
	Transvenous pacing		
	Application of cardiovascular echo-doppler techniques		
	Use of ventricular assist devices		
Neurological/Psychiatric:			
Mandatory	Assessment of coma depth		
	Assessment of brain death		
	Lumbar puncture		
	Intracranial pressure monitoring		
	Head injuries		
	Basic interpretation of brain CT scan		
	Monitoring of neuromuscular blockade		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
Optional	EEG monitoring		
	Interpretation of brain and brain stem evoked potentials		
	Measurement of jugular venous oxygen saturation		
	Measurement of cerebral Doppler velocities and cerebral blood flow		
	Implementation of epidural anaesthesia		
	Local or regional anaesthesia		
For paediatric intensive care the following is added:	**Ventricular drainage**		
Recognition, assessment and treatment of (common) acute metabolic and endocrine crisis (diabetic keto-acidosis, metabolic coma, overdose etc)			
Mandatory	Monitoring and assessment of nutritional support		
	Implementation of fluid therapy		
	Interpretation of acid-base abnormalities		
	Implementation of enteral and parenteral nutrition		
	Management of hypothermia and hyperthermia		
For neonatal paediatric care the following items are added:	**Management of acute decompensations of congenital metabolic abnormalities**		
	Phototherapy		
	Exchange transfusion		
Gastrointestinal:			
Recognition, assessment, treatment of gastrointestinal crises (gastrointestinal bleeding, acute pancreatitis, acute abdomen, etc)			
Mandatory	Insertion of nasogastric tube		
	Insertion of an oesophageal balloon (bleeding varices)		
	Implementation of stress ulcer prophylaxis		
	Gastric lavage in overdose		
Optional	Placement of duodenal jejunal feeding tube		
For neonatal paediatric intensive care the following items are added:	**Induced emesis**		
	Use of activated charcoal		
	Duodenal drainage		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
Haematological:			
Mandatory	Interpretation of a coagulation profile		
	Implementation and control of anticoagulant and fibrinolytic treatment		
	Utilisation of blood component therapy and artificial colloids		
	Management of massive transfusion		
Optional	Autotransfusion		
	Plasma exchange		
	Management of haemodilution		
Infection:			
Recognition, assessment and treatment of (suspected) infection			
Mandatory	Sampling for cultures (blood and other sites) and interpretation of lab reports		
	Use of aseptic techniques and prevention of nosocomial infection		
	Management of wounds and drains		
Renal:			
Recognition, assessment and basic management of acute renal failure			
Mandatory	Establishment of a fluid and electrolyte balance		
	Insertion of haemo- and peritoneal dialysis catheters		
	Management of continuous renal replacement techniques (CAVH, CAVHD, CVVH, CVVHDF)		
	Haemoperfsion		
Trauma:			
(Initial) assessment and (initial) treatment of the (poly) trauma patient			
Mandatory	Recognition and management of spinal cord injury		
	ATLS		
	(Initial) management of the burn patient		
Optional	Temporary immobilisation of fractures		
Monitoring and Life Support Devices:			
Mandatory	Utilisation, zeroing, calibration of transducers		
	Use of amplifiers and recorders		
	Assessment of reliability of measured data		
	Operation of ventilators		
	Trouble-shooting equipment		
Pharmacology:			
Mandatory	Implementation and control of adequate sedation and analgesia		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Knowledge of most used drugs (also in renal, hepatic failure)		
	The use of muscle relaxants		
Ethical:			
Mandatory	Exposure to ethical aspects of intensive care		
	Ability to appreciate and implement patient's expressed wishes/will		
	Implementation of ethical guidelines of the hospital		
	Ability to consider and discuss (dis)continuation or restriction of treatment (also with relatives)		
	Implementation of DNR and treatment limitation		
For neonatal paediatric intensive care the following item is added	Integration of the family's wishes into the treatment plan		
Organisational:			
Mandatory	Structure of daily patient care		
	Structured patient file with strategies for diagnostic procedures and management of individuals patients		
	Quality management (use of scoring systems, outcome measures etc)		
	Adequate and timely reports to the primary care/referring physician		
	Allocation of human, spatial and technical resources		
	Implementation of cost containment		
	Management and risk estimation of transport of critically ill patients (radiology department transfer, etc)		
	Co-ordination of activities of the intensive care team (nurses, residents, physiotherapists etc)		
	Use of data management systems		
For neonatal paediatric intensive care the following item is added:	**Use of neonatal paediatric transport systems**		
Theoretical knowledge			
General:			
Mandatory	Multi-organ system failure		
	Systemic inflammatory response syndrome (SIRS)		
	Multisystem disorders		
	Transport of the critically ill		
Respiratory:			
Mandatory	Pulmonary function tests		
	Pulmonary oedema, ARDS		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Pulmonary embolus		
	Smoke inhalation, airway burns		
	Near drowning		
	Status asthmatics		
	Aspiration/chemical pneumonitis		
	Acute broncho-pulmonary infection		
	Chest trauma (blunt and penetrating)		
	Oxygen therapy (including delivery systems)		
	Mechanical ventilation (invasive and non-invasive)		
	Respiratory pharmacotherapy		
Optional	Extracorporeal respiratory assist devices		
	Hyperbaric oxygen therapy		
For neonatal paediatric intensive care the following items are added:	**Physiology of growth and development**		
	Surfactant system		
	Croup and epiglottis		
	Congential anomalies of upper and lower airways		
	Pulmonary hypoplasia congenital diaphragmatic hernia		
	Hyaline membrane disease		
	Meconium aspiration syndrome		
	Persistent pulmonary hypertension of the newborn		
	Bronchopulmonary dysplasia		
	Bronchiolitis		
	Cystic Fibrosis		
Cardiovascular:			
Mandatory	Haemodynamic instability and shock		
	Circulatory (patho-) physiology (determinants of myocardial performance, perfusion oxygen transport, microcirculation, endothelial cell function etc)		
	Acute myocardial infarction (and complications) and unstable angina		
	Cardiac arrhythmia (diagnosis and treatment)		
	Acute left heart failure and cardiogenic pulmonary oedema		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Hypertensive crises		
	Acute pericardial disease and cardiac tamponade		
	Acute valvular disorders, myocarditis, cardiomyopathy, endocarditis		
	Peripheral vascular disorders		
	Infusion therapy (crystalloids, colloids), fluid challenge		
	Vasoactive and inotropic drug therapy		
	Thrombolytic therapy		
	Haemodynamic effects of mechanical ventilation		
	Complications of angioplasty		
	Intra-aortic balloon pump, right and left heart assist devices, extracorporeal circulation		
	Postoperative care after cardiovascular and thoracic surgery		
	Haemodynamic monitoring		
For neonatal paediatric intensive care the following items are added:	Physiology of growth and development		
	Management of congenital heart disease, including postoperative care		
	Manipulation of Ductus arteriosus		
	Management of pulmonary hypertension		
Neurological/psychiatric:			
Mandatory	Cerebral perfusion, metabolism and monitoring		
	Coma: metabolic, traumatic, vascular, anoxic, ischaemic, infectious, drug overdose, mass lesion		
	Postanoxic brain damage		
	Head injury epilepticus		
	Acute cerebral oedema, intracranial hypertension including monitoring		
	Meningitis, encephalitis		
	Cerebrovascular accident		
	Cardiovascular effects of acute intracranial processes, cerebral vasospasm		
	Acute neuromuscular disorders (eg. Guillain-Barr syndrome, myasthenia gravis, tetanus)		
	Spinal cord injury		
	Brain death evaluation and certification		
	Persistent vegetative states		
	Postoperative neurosurgical care		
	Malignant hyperthermia, malignant neuroleptic syndrome		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Psychiatric emergencies, including suicide attempts, delirium, depression, acute confusional states		
	Psychiatry of intensive care medicine		
For neonatal paediatric intensive care, the following items are added:	Physiology of growth and development		
	Congenital anomalies of CNS		
	Intracranial haemorrhage		
	Hydrocephalus		
	Acute decompensations of neuromuscular diseases		
	Raye's syndrome		
	Principles of rehabilitation		
Renal (including electrolytes, acid-base balance:			
Mandatory	Renal regulation of fluid, acid-base and electrolyte balance		
	Electrolyte disturbances (eg. Hypernatraemia, hyponatraemia, Osmolar gap, hyperkalaemia)		
	Derangements in fluid balance and osmolality		
	Acid-base disorders, anion gap		
	Oliguria, polyuria and acute renal failure		
	Principles of renal replacement therapy: haemodialysis, peritoneal dialysis, ultrafiltration, CAVH, CVVH, CAVHD, CVVHDF		
	Pharmacokinetics in renal failure		
For neonatal paediatric intensive care the following items are added:	**Physiology of growth and development**		
	Haemolytic-uraemic syndrome		
Infection:			
Mandatory	Infection control, prevention of infection, aseptic techniques		
	Severe infections (aerobic, mycoplasma, virus, parasitic, fungi)		
	Sepsis, mediator systems, granulocyte endothelial interaction		
	Hospital-acquired and opportunistic infections in the critically ill		
	Infections in the immunocompromised patient (including AIDS)		
	Toxic shock syndrome		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Antimicrobial therapy		
	Immunotherapy, immunomodulation		
	Infections risks for ICU health care workers		
Haematological:			
Mandatory	Acute defects in haemostasis: thrombocytopaenia, DIC (role of mediators, endothelium)		
	Acute coagulation disorders		
	Acute haemolytic disorders		
	Acute and chronic anaemia		
	Anticoagulation, fibrinolytic therapy		
	Principles of blood component therapy: platelet transfusions, packed red cells, fresh frozen, cryoprecipitate, artificial colloids plasma, specific coagulation factor concentrates, albumin, stroma-free haemoglobin		
	Acute syndromes associated with neoplastic disease and acute neoplastic therapy		
	Acute disorders of immunosuppressed patients		
	Sickle cell crises		
	Plasmapheresis		
For neonatal paediatric intensive care the following items are added:	**Congenital abnormalities of coagulation**		
	Acute haemolysis in the neonate, hyperbilirubinaemia		
	Dyshaemoglobinaemias		
	Acute disorders in immunocompromised patients, including congenital immunodeficiency syndromes		
Gastrointestinal:			
Mandatory	Upper and lower gastrointestinal bleeding		
	Stress ulcer prophylaxis		
	Acute pancreatitis		
	Acute peritonitis, perforated viscus, abdominal sepsis		
	Bowel obstruction, acute vascular of the intestines (including mesenteric infarction)		
	Toxic megacolon, pseudomembranous colitis		
	Perforated oesophagus		
	Acute inflammatory bowel disease		
	Preservation of intestinal blood flow		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Abdominal trauma		
	Post-abdominal surgery care		
	Acute, fulminant and chronic hepatic failure		
	Pharmakinetics in hepatic failure		
For neonatal paediatric intensive care the following items are added:	**Congenital anomalies of GI tract (oesophageal and intestinal atresias, Hirschsprung's disease etc)**		
	Biliary atresia		
	Necrotising enterocolitis		
	Acute gastroenteritis, severe dehydration		
	Chronic intractable diarrhoea		
	Ingestion of corrosives		
Obstetric/Urogenital:			
Mandatory	Toxaemia of pregnancy, eclampsia		
	HELLP syndrome		
	Amniotic fluid embolism		
	Obstetric haemorrhage		
	Ovarian hyperstimulation syndrome		
	Obstructive uropathy, acute urine retention		
	Urinary tract bleeding		
	Uterine sepsis		
Metabolic and endocrinology:			
Mandatory	Enteral/parental feeding, nutritional requirements		
	Thyroid hyper and hypo secretion adrenal function		
	Diabetes mellitus (keto-acidotic and nonketotic hyperosmolar coma, hypoglycaemia		
	Disorders of antidiuretic hormone metabolism		
	Phaeochromocytoma		
	Disorders of calcium, phosphorus and magnesium balance		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
For neonatal paediatric intensive care the following item is added:	**Inborn errors of metabolism (aminoacids, urea-cycle anomalies, organic acidaemias etc**		
Drug overdose and intoxication:			
Mandatory	Acute intoxication (general specific)		
	Antidotes (general specific)		
	Addiction and withdrawal		
Immunology and transplantation:			
Mandatory	Principles of transplantation (organ donation, procurement, organ preservation, transportation, allocation, implantation, national organisation of transplantation activities)		
	Donor management		
	Immunosuppression rejection		
	Pathophysiology of the transplant patient		
	Different organ transplantation: postoperative care		
Trauma, burns and environmental insults:			
Mandatory	Initial approach to the management of multisystem trauma		
	CNS injury (brain, spinal cord)		
	Skeletal trauma, including spine		
	Chest trauma (blunt, penetrating, cardiac)		
	Abdominal trauma (blunt, penetrating)		
	Crash injury		
	Burns		
	Hypo- and hyperthermia, heat stroke		
	Near drowning, asphyxia		
	Electrocution, radiation, chemical injuries		
	Animal bites, insect stings		
	Anaphylaxis		
	Decompression syndromes		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
For neonatal paediatric intensive care the following item is added:	**Child abuse**		
Sedation, analgesia, pharmacology:			
Mandatory	Sedation		
	Monitoring of sedation		
	Analgesia (general, loco-regional)		
	Pharmacology, pharmacokinetics and interactions of drugs commonly used in ICU		
Monitoring:			
Mandatory	Principles of electrocardiographic monitoring, transcutaneous measurements		
	Invasive haemodynamic monitoring		
	Noninvasive haemodynamic monitoring		
	Respiratory monitory: airway pressure, intrathoracic pressure, tidal volume, dead space-to-tidal volume ratio, compliance, resistance, pulse oximetry, capnography		
	Pneumotachography		
	Brain monitoring: intracranial pressure, cerebral blood flow, cerebral metabolic rate, transjugular venous saturation, EEG, evoked potentials		
	Metabolic monitoring: Oxygen consumption, carbon dioxide production, respiratory quotient		
	Evaluation and integration of obtained data and subsequent medical decisions		
	Basic understanding of chest and plain abdominal x-ray, echography, echocardiography, CT scan, MR imaging, radionuclide techniques		
	Application of computers in intensive care medicine		
Organisational/Administrative:			
Mandatory	Organisation of intensive care: design of units, organisational structure, personnel, staffing, supply, isolation, stat-laboratory, on call systems		
	Selection and evaluation of equipment		
	Prognostic indices, severity and therapeutic intervention scores		
	Admission and discharge procedures		
	Training of physicians and nurses in intensive care		
	Medical record keeping in intensive care (problem-orientated, system-oriented)		
	Priorities in the care of the critically ill or injured patient		
	Budgeting, cost benefit and cost containment principles		
	Quality management		

Colleges of Medicine of South Africa Sub-Speciality Certificate in Critical Care Curriculum Contents		Competencies for medical students	Core competencies in critical care
	Principles of triage and resource allocation		
	Medico-legal aspects		
Ethical:			
Mandatory	Hospital ethical guidelines related to intensive care		
	Initiation and discontinuation of intensive care life-sustaining treatment		
	Care of the dying patient		
	DNR (do not resuscitate) concept		
	Role of relatives in decision making		
	Rights of patients; the right to refuse treatment		
	Living wills, advance directions		
	Ethical problems related to clinical research		
	Psychosocial aspects		

Components in green are similar or identical, and components in yellow are partially similar to sub-specialist curriculum requirements.

APPENDIX I:

POSTGRADUATE DIPLOMA IN CRITICAL CARE LEARNING OUTCOMES

Exit level outcomes:

At the end of the training period, the successful candidate should have the knowledge, skills and professional attitude to:

- competently evaluate and manage critically ill patients
- competently perform basic procedures essential to the practice of critical care medicine
- make ethical decisions related to the management of critically ill patients
- function independently and responsibly in a critical care setting
- proactively manage resilience and wellbeing as a healthcare practitioner
- work efficiently and resiliently in a highly stressful environment

Module outcomes

Module: Core competencies in critical care

After successful completion of this module, the successful candidate should:

- demonstrate comprehensive theoretical knowledge and understanding of the underlying physiological changes and pathophysiological processes resulting in critical illness and organ dysfunction
- comprehensively evaluate critically ill patients and devise an appropriate management strategy
- apply the most appropriate diagnostic procedures and treatment modalities in a critically patient
- discuss and apply ethical principles of managing patients in critical care settings

Specific theme/unit outcomes

An example of how specified unit outcomes can be used to establish assessment criteria is given below.

Unit: Respiratory Medicine

On successful completion of this unit, students will be able to demonstrate the following procedural competencies**:**

Learning outcomes	***Assessment criteria***
a) Airway management	
Demonstrate the ability to maintain an open airway	Competently performs chin-lift or jaw-thrust manoeuvre. Chooses an appropriate size oral and nasopharyngeal airway for patient size. Performs correct placement of oral and nasopharyngeal airway.
Perform intubation (oral or nasotracheal) and maintain this airway	Choose appropriate size endotracheal tube for patient size. Checks endotracheal tube cuff for leaks. Competently performs endotracheal or nasotracheal intubation. Checks for correct endotracheal tube placement by three-point auscultation and capnography.
Perform laryngeal mask intubation for the difficult-to-intubate airway and know the options of cricothyrotomy, transtracheal catheterisation and fibreoptic intubation in this scenario (the ability to perform these procedures is optional)	Competently performs laryngeal mask intubation. Checks for correct placement of laryngeal mask by three-point auscultation and capnography. Competently discusses algorithm for difficult airway management when prompted.
Know the indications, complications and contra-indications for performing tracheostomy (the ability to perform tracheostomy is optional)	Lists indications, complications and contra-indications for performing tracheostomy.
b) Ventilation	
Demonstrate the ability to apply oxygen therapy	Provide oxygen therapy using various masks

	and cannula.
Demonstrate ventilation by means of ambu-bag and mask	Demonstrate ventilation by means of ambu-bag and mask. Tight face-mask seal must be ensured and chest rise must be witnessed. Correct rate of ventilation must be demonstrated.
Demonstrate the ability to perform non-invasive ventilation by means of tight-fitting mask (with PEEP) e.g., CPAP, NIPPV and know the indications and contra-indications of these procedures	Perform non-invasive ventilation. Tight face-mask seal must be ensured. Indications and contra-indications must be listed if prompted.
Demonstrate the ability to perform mechanical ventilation, including the ability to wean a patient from mechanical ventilation as well as understanding the complications associated with ventilation	Perform mechanical ventilation of patients by choosing appropriate mode per indication, correct ventilatory settings and listing complications when prompted.
c) Pulmonary aspects	
Demonstrate the ability to manage a pneumothorax by means of needle decompression, chest tube insertion and underwater drainage systems using appropriate techniques	Perform needle decompression, chest tube insertion and underwater drainage systems on mannikins. Correct intercostal space must be utilised. Proper sterile technique must be demonstrated.
Demonstrate the ability to interpret arterial (and mixed venous) blood gases as well assess pulmonary gas exchange (A-a gradients, shunt fraction, VD/VT, etc)	Correctly interpreted arterial (and mixed venous) blood gas results. Suggest appropriate treatment based on blood gas results.
Demonstrate basic interpretation of a basic chest x-ray and discuss appropriate management	Interpret and report basic chest x-rays. Suggest appropriate management based on findings of x-ray
Demonstrate performance of bedside pulmonary function tests	Demonstrate bedside pulmonary function tests on patients or volunteers. Correctly interpret results of pulmonary function tests. Suggest appropriate management.
Demonstrate understanding ofthe role of chest physiotherapy and incentive spirometry	Discuss the role of chest physiotherapy in ICU.
Demonstrate understanding of the role of extracorporeal respiratory assist devices	Discuss the role of extracorporeal respiratory assist devices in ICU. List indications and contra-indications of extracorporeal respiratory assist devices.
Demonstrate understanding of the role of hyperbaric oxygen therapy in the management of patients	Discuss the role of hyperbaric oxygen therapy in the management of patients. List indications and contra-indications for the use of hyperbaric oxygen therapy in patients.

APPENDIX J:

ASSESSMENT INSTRUMENT

Airway and ventilation management performance task:

Instructions to candidate:
This patient (mannikin) has acute respiratory distress syndrome (ARDS). By using the mannikin provided, demonstrate proper airway and ventilation management by:
1. Performing rapid-sequence intubation on the mannikin provided
2. Connect mannikin to ventilator after intubation and demonstrate selection of proper ventilator settings in patients with ARDS

The student is tasked to demonstrate specific skills and competencies and to apply the knowledge and skills that they have mastered. An example of a scoring rubric by which task performance is evaluated, is given below:

Critical Care Performance Task Scoring Rubric: Airway management and ventilation

Criteria	Levels of Achievement				
	Unacceptable	Marginal	Proficient	Exemplary	Score
	1	2	3	4	
Pre-oxygenation	Pre-oxygenation not performed.	Pre-oxygenation poorly performed.	Pre-oxygenation performed satisfactorily.	Confidently performed for the correct duration of time with 100% oxygen.	
Airway placement and ambubag-mask ventilation	Unable to or struggles to perform.	Inefficient management of airway and ambubag-mask ventilation.	Satisfactory management of airway and ambubag ventilation.	Rapid and confident airway placement with efficient ambubag-mask ventilation.	
Intubation	Unable to or struggles to perform.	Inefficient intubation technique with high risk of injuring patient.	Satisfactory intubation technique.	Rapid and confident intubation technique.	
Mechanical ventilation	Incorrect ventilatory settings used with high risk to patient.	Demonstrates uncertainty regarding correct ventilator settings.	Demonstrates competency by choosing appropriate ventilator settings for patient condition.	Confidently selects appropriate ventilator settings for patient condition. Able to demonstrate advanced ventilation techniques.	
Total score					

APPENDIX K:

DESCRIPTION OF A POSTGRADUATE DIPLOMA IN CRITICAL CARE BASED ON THE HIGHER EDUCATION QUALIFICATIONS SUB-FRAMEWORK

POSTGRADUATE DIPLOMA

Type specifications
NQF Exit Level 8
Minimum total credits: 120
Minimum credits at Level 8: 120
HEQSF credits are a measure of the volume of learning required for a qualification. One credit is equivalent to 10 notional study hours. Therefore, a minimum credit rating of 120 is equal to a minimum of 1200 notional study hours that is required for achieving the learning outcomes of the qualification.

Designators
Not applicable

Qualifiers
Postgraduate Diploma in Critical Care

Abbreviations
PGDip (Critical Care)

Purpose and characteristics
A Postgraduate Diploma in Critical Care serves to strengthen and deepen the student's knowledge in critical care. The primary purpose of the qualification is to enable working professionals to undertake advanced reflection and development by means of a systematic survey of current thinking, practice, and research methods in critical care. This qualification demands a high level of theoretical engagement and intellectual independence, as well as the ability to relate knowledge to a range of contexts in order to undertake professional or highly skilled work. A sustained research project is not required, but the qualification may include conducting and reporting research under supervision. In some cases, a Postgraduate Diploma carries recognition by an appropriate professional or statutory body.

Minimum admission requirements
The minimum admission requirement is an MBChB or equivalent degree.

Progression
A Postgraduate Diploma in Critical is not an entry requirement for admission to a Master's Degree. A qualification will not be awarded for early exit from a Postgraduate Diploma.

APPENDIX L:

SOUTHERN AFRICAN JOURNAL OF CRITICAL CARE AUTHOR GUIDELINES

General formatting guidelines

Preparing an article for anonymous review

To ensure a fair and unbiased review process, submissions may include an anonymized version of the manuscript.

Submitting a manuscript that needs additional blinding can slow down your review process, so please be sure to follow these simple guidelines as much as possible:

- An anonymous version should not contain any author, affiliation or particular institutional details that will enable identification.
- Please remove title page, acknowledgements, contact details, funding grants to a named person, and any running headers of author names.
- Mask self-citations by referring to your own work in third person.

General article format/layout

Submitted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction prior to being sent for review, which will delay publication.

General:

- Manuscripts must be written in UK English (this includes spelling).
- The manuscript must be in Microsoft Word or RTF document format. Text must be 1.5 line spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes). Pages and lines should be numbered consecutively.
- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.
- Medical drugs should be referred to by their generic name although the trade name may be used in brackets in the text once if unique.

If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

Illustrations/photos/scans

- If illustrations submitted have been published elsewhere, the author(s) should provide evidence of consent to republication obtained from the copyright holder.

- Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'.
- Each figure must have a caption/legend: Fig. 1. Description (any abbreviations in full).
- All images must be of high enough resolution/quality for print.
- All illustrations (graphs, diagrams, charts, etc.) must be in PDF form.
- Ensure all graph axes are labelled appropriately, with a heading/description and units (as necessary) indicated. Do not include decimal places if not necessary e.g. 0; 1.0; 2.0; 3.0; 4.0 etc.
- Each image must be attached individually as a 'supplementary file' upon submission (not solely embedded in the accompanying manuscript) and named Fig. 1, Fig. 2, etc.

Tables

- Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged.
- Embed/include each table in the manuscript Word file - do not provide separately as supplementary files.
- Number each table in Arabic numerals (Table 1, Table 2, etc.) consecutively as they are referred to in the text.
- Tables must be cell-based (i.e. not constructed with text boxes or tabs) and editable.
- Ensure each table has a concise title and column headings, and include units where necessary.
- Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

References

NB: *Only complete, correctly formatted reference lists in Vancouver style will be accepted.*
If reference manager software is used, the reference list and citations in text are to be unformatted to plain text before submitting.

- Authors must verify references from original sources.
- Citations should be inserted in the text as superscript numbers between square brackets, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6]
- All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order).
- Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.
- Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al.
- Volume and issue numbers should be given.
- First and last page, in full, should be given e.g.: 1215-1217 **not** 1215-17.
- Wherever possible, references must be accompanied by a digital object identifier (DOI) link). Authors are encouraged to use the DOI lookup service offered by CrossRef:
    - On the Crossref homepage, paste the article title into the 'Metadata search' box.
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- *Journal references:* Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289(1):350-355. DOI:10.1000/hgjr.182
- *Book references:* Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101.
- *Chapter/section in a book:* Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.
- *Internet references:* World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: WHO, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).
- Legal references
- Government Gazettes:

National Department of Health, South Africa. National Policy for Health Act, 1990 (Act No. 116 of 1990). Free primary health care services. Government Gazette No. 17507:1514. 1996.

In this example, 17507 is the Gazette Number. This is followed by :1514 - this is the notice number in this Gazette.

- Provincial Gazettes:

Gauteng Province, South Africa; Department of Agriculture, Conservation, Environment and Land Affairs. Publication of the Gauteng health care waste management draft regulations. Gauteng Provincial Gazette No. 373:3003, 2003.

- Acts:

South Africa. National Health Act No. 61 of 2003.

- Regulations to an Act:

South Africa. National Health Act of 2003. Regulations: Rendering of clinical forensic medicine services. Government Gazette No. 35099, 2012. (Published under Government Notice R176).

- Bills:

South Africa. Traditional Health Practitioners Bill, No. B66B-2003, 2006.

- Green/white papers:

South Africa. Department of Health Green Paper: National Health Insurance in South Africa. 2011.

- Case law:

Rex v Jopp and Another 1949 (4) SA 11 (N)

Rex v Jopp and Another: Name of the parties concerned

1949: Date of decision (or when the case was heard)

(4): Volume number

SA: SA Law Reports

11: Page or section number

(N): In this case Natal - where the case was heard. Similarly, (C) woud indicate Cape, (G) Gauteng, and so on.

NOTE: no . after the v

- *Other references (e.g. reports) should follow the same format:* Author(s). Title. Publisher place: Publisher name, year; pages.
- Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'.
- Unpublished observations and personal communications in the text must **not** appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.

APPENDIX M:

LANGUAGE EDITOR DECLARATION

Declaration

16 July 2023

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hettie.human@gmail.com

Thesis: Core competencies in critical care for general medical practitioners in South Africa

Student: Dr S.D. Maasdorp

I confirm that I edited the thesis, checked and formatted the references, and recommended changes to the text.

MA Language Practice

Hettie Human
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APPENDIX N:

TURNITIN REPORT

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