DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PRACTICE PROGRAMME

By

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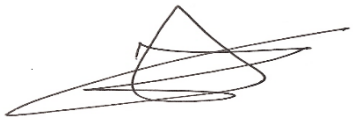
DECLARATION

I hereby declare that the work submitted here is the result of my own independent investigation. Where help was sought, it was acknowledged. I further declare that this work is submitted for the first time at this university/faculty towards a Master's degree in Health Professions Education and that it has never been submitted to any other university/faculty for the purpose of obtaining a degree.



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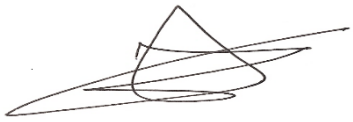

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DEDICATION

I dedicate this dissertation to my wonderful parents, who have been my consistent inspiration, support and source of wisdom and who offered me unconditional love and support throughout the course of this dissertation.

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Sadly, my late Father was unable to see the fruits as he reached the mercy of God during the conclusion of this dissertation. May the Almighty shower his mercy upon him. Aameen

****

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ABCP:	American/Australian Board of Cardiovascular Perfusion
ACLS:	Advanced cardiac life support
AC-PE:	Accreditation Committee – Perfusion Education
ARDS:	Adult respiratory distress syndrome
B. Sc:	Bachelor of Science
B.-Tech:	Baccalaureus Technologiae
CAD:	Coronary artery disease
CAPE:	Clinical Application in Perfusion Examination
CHE:	Council on Higher Education
CHF:	Congestive Heart Failure
COPD:	Chronic obstructive pulmonary disease
CPB:	Cardio Pulmonary Bypass
CPS:	Cardio Pulmonary Support
CQI:	Continuous Quality Improvement
CT:	Computer Topography
CTS:	Cardiothoracic Surgery
CUT:	Central University of Technology
DoH:	Department of Health
D. Tech:	Doctor Technologiae
DUT:	Durban University of Technology
EACTA:	European Association for Cardio-thoracic Anaesthesiologists
EACTS:	European Association of Cardiothoracic Surgery
EBCP:	European Board of Cardiovascular Perfusionists
ECG:	Electrocardiography
ECMO:	Extracorporeal Membrane Oxygenation
ESCVS:	European Society for Cardiovascular Surgery
HEQC:	Higher Education Quality Committee
HEQSF:	Higher Education Qualifications Sub Framework
HILP:	Hyperthermic Isolated-Limb Perfusion
HIPEC:	Hyperthermic Intra-Peritoneal Chemotherapy
HIT:	Heparin Induced Thrombocytopenia

HPCSA:	Health Professions Council of South Africa
HPE:	Health Professions Education
IABP:	Intra-aortic Balloon Pump Counterpulsation
M.B.Ch.B:	Bachelor of Medicine and Bachelor of Surgery
MRI:	Multiple Resonance Imaging
MSc:	Master of Science
M. Tech:	Magister Technologiae
ND:	National Diploma
NQF:	National Qualifications Framework
NRF:	National Research Foundation
NSC:	National Senior Certificate
OBE:	Outcomes-based Education
PBSE:	Perfusion Basic Science Examination
RSA:	Republic of South Africa
RWOPS:	Remunerative Work Outside Public Service
SA:	South Africa
SAQA:	South African Qualifications Authority
SC:	Senior Certificate
TIA:	Transient Ischaemic Attack
TRALI:	Transfusion related acute lung injury
TUT:	Tshwane University of Technology
UFS:	University of the Free State
UK:	United Kingdom
USA:	United States of America
VAD:	Ventricular Assist Device
WHO:	World Health Organisation
WIL:	Work Integrated Learning

SUMMARY

Key terms: Cardiovascular Perfusion; Higher education; Outcomes and essential content; Work integrated learning; Questionnaire survey; Delphi process; Quantitative design with qualitative elements.

Cardiovascular perfusion is a field of practice whereby the function of the heart and lungs is replaced or supported by equipment and machines in a hospital theatre setting so that a surgical procedure to correct or reverse a cardiac-related pathology can be carried out. In addition to possessing the above mentioned skill the perfusionist is also required to carry out various other clinically related tasks. Faced with the challenges of changes taking place in the disease profile of patients, changes in surgical indications, advancement in medical technology, therapeutic and surgical techniques and the widening of the scope of practice beyond the traditional practice norms, the cardiovascular perfusion programme needs to keep up pace in order to deal with these challenges. Furthermore the three universities of technology which offer the programme in South Africa (SA) do not have uniform outcomes and content thereby producing graduates who lack many skills required for current and future practice.

In view of the abovementioned challenges the research is based on the hypothesis that the current outcomes and essential content of cardiovascular perfusion programmes are either not described at all or are inadequate for producing graduates who are able, immediately after qualifying, to provide the wide range of skills required by current and future cardiovascular perfusionists.

The research question was thus formulated: *What should the outcomes and essential contents of a perfusion practice programme in South Africa include?*

The overall goal of the study was to describe the outcomes and essential content of a cardiovascular perfusion programme specific to the South African context, with a view to developing a standardised, uniform and relevant curriculum for perfusion in SA, which will lay the foundation for producing highly skilled and knowledgeable cardiovascular perfusionists who are able to fulfil the requirements of a current and future cardiovascular perfusion practice.

The aim of the study was to describe the outcomes and essential content of a cardiovascular perfusion practice programme that will address the requirements of a current and future cardiovascular perfusion practice in SA.

To achieve the aim of the study four objectives were pursued with regards to determining the current content and outcomes of the programmes, the adequacy and validity of the currents programmes and to determine the required outcomes and essential content of the programme.

These objectives were achieved by means of a literature study that included a document analysis of SA and international curricula, an electronic questionnaire survey to obtain statements for a Delphi technique survey that followed the questionnaire survey based on the online EvaSys survey-management system.

After ethics committee approval and a successful pilot study, which required no amendments, an information document explaining the survey was distributed to 14 identified perfusionists which was followed by the actual online questionnaire. The questionnaire survey was conducted at the end of which 71% of participants originally identified had responded. The data collected from the questionnaire survey was analysed, interpreted, discussed and documented. After careful analysis of the results the researchers decided that all the questions posed in the survey would form part of the Delphi.

The first round of the Delphi questionnaire was distributed to 18 experts identified by preselected criteria after a successful pilot study. Of these experts, 44.4% responded. Consensus was achieved on most statements in the first round. After the completion of the first round feedback was given to the respondents.

For the second round of the Delphi 100% response was achieved. The results and the discussion of the findings of the Delphi survey were presented in the form of graphs, and analysed, interpreted and discussed accordingly. Statements on which consensus was achieved were included as part of the outcomes and essential content for a cardiovascular perfusion practice programme which has been presented in a tabular format in this dissertation.

A uniform and standardised cardiovascular practice curriculum and training programme will enhance the field of cardiovascular perfusion and service delivery to the residents of SA. This research study was by no means an exhaustive one but has provided a basis upon which further perfusion and other healthcare related research can be done.

OPSOMMING

Sleutelterme: Kardiovaskulêre perfusie, Hoër onderwys, Uitkomste en noodsaaklike inhoud, Werkgeïntegreerde leer, Vraelysopname, Delphi proses, Kwantitatiewe ontwerp met kwalitatiewe elemente

Kardiovaskulêre perfusie is ‘n praktyk waardeur die funksie van die hart en longe in ‘n hospitaal- teateropset vervang of ondersteun word deur toerusting en masjiene, sodat ‘n chirurgiese prosedure om ‘n patologie wat met die hart verband hou, uitgevoer kan word. Benewens die genoemde vaardigheid, moet die perfusietegnoloog ook verskeie verwante kliniese take kan uitvoer. In die lig van uitdagings wat verband hou met veranderinge wat in die siekteprofiel van pasiënte plaasvind, veranderinge in chirurgiese aanduidings, vooruitgang in mediese tegnologie, terapeutiese en chirurgiese tegnieke en ‘n verbreding van die omvang, verder as die tradisionele praktyknorme, van die praktyk, moet ‘n kardiovaskulêre perfusieprogram voortdurend vernuwe ten einde hierdie uitdagings die hoof te bied. Verder het die drie universiteite van tegnologie wat perfusieopleidingsprogramme in Suid Afrika aanbied, nie dieselfde uitkomste en inhoud nie, en daarom lewer hulle gegradueerdes wat nie al die vaardighede besit wat vir huidige en toekomstige praktyk nodig is nie.

In die lig van bogenoemde uitdagings, is hierdie navorsing gebaseer op die hipotese dat die huidige uitkomste en noodsaaklike inhoud van kardiovaskulêre perfusieprogramme òf glad nie, òf net gedeeltelik beskryf word, en gevolglik word gegradueerdes gelewer wat nie dadelik nadat hulle gekwalifiseer het, die wye verskeidenheid vaardighede wat deur huidige en toekomstige perfusietegnoloë vereis word, kan uitvoer nie.

Die navorsingsvraag is dus soos volg geformuleer: *Wat moet die uitkomste en noodsaaklike inhoud van ‘n perfusiepraktykprogram in Suid-Afrika insluit?*

Die oorhoofse doel van die studie was om die uitkomste en noodsaaklike inhoud van ‘n kardiovaskulêre perfusieprogram wat spesifiek op die Suid-Afrikaanse konteks van toepassing is, te beskryf, met die doel om ‘n gestandaardiseerde, eenvormige en relevante kurrikulum vir perfusie in Suid-Afrika te ontwikkel, wat die grondslag sal lê om uiters vaardige en kundige kardiovaskulêre perfusietegnoloë lewer, wat in staat is om

aan die vereistes van ‘n moderne en toekomstige kardiovaskulêre perfusieprogram te voldoen.

Die doel van die studie was om die uitkomstes en noodsaaklike inhoud van ‘n kardiovaskulêre perfusieprogram te ontwikkel wat die vereistes van ‘n moderne en toekomstige kardiovaskulêre perfusiepraktyk in Suid-Afrika sal aanspreek.

Ten einde die doel van die studie te bereik, is vier doelwitte nagestreef. Die doelwitte hou verband met die bepaling van huidige inhoud en uikomste van die programme, die toereikendheid en geldigheid van die huidige programme en bepaling van die vereiste uitkomste en noodsaaklike inhoud van die program.

Hierdie doelwitte is bereik deur middel van ‘n literatuurstudie, wat ‘n dokumentontleding van Suid-Afrikaanse en internasionale kurrikula behels het, en ‘n elektroniese vraelysopname. Die vraelysopname het inligting versamel deur middel van die Delphi-tegniek, wat die vraelysopname, wat van die aanlyn EvaSys opnamebestuurstelsel gebruik gemaak het, gevolg het.

Na die etiese komitee goedkeuring gegee het en ‘n loodsstudie suksesvol afgehandel is en geen veranderinge vereis het nie, is ‘n inligtingsdokument wat die opname verduidelik aan 14 geïdentifiseerde perfusietegnoloë versprei. Dit is gevolg deur die aanlyn vraelys. Die vraelysopname het response van 71% van die deelnemers wat oorspronklik geïdentifiseer is, ontlok. Die data wat deur die vraelysopname versamel is, is ontleed, geïnterpreteer, bespreek en aangeteken. Na sorgsame ontleding van die resultate het die navorser besluit dat al die vrae wat in die vraelys ingesluit is, deel van die Delphi sou vorm.

Die eerste ronde van die Delphi-vraelys is aan 18 deskundiges gestuur, wat deur voorafbepaalde kriteria in ‘n suksevolle loodsstudie geïdentifiseer is. Van hierdie deskudiges het 44.4% gereageer. Konsensus is op die meeste van die stellings in die eerste ronde behaal. Na voltooiing van die eerste ronde is terugvoer aan die respondente gegee.

‘n 100% reaksiekoers is vir die tweede ronde van die Delphi behaal. Die resultate en die bespreking van die bevindinge van die Delphi-opame is in die vorm van grafieke

aangebied, ontleed, geïnterpreteer en ooreenkomstig bespreek. Stellings waaroor daar konsensus bereik is, is as deel van die uitkomste en noodsaaklike inhoud vir ‘n toekomstige program ingesluit – dit word in tabelformaat in hierdie verhandeling aangebied.

‘n Eenvormige en gestandaardiseerde kurrikulum en opleidingsprogram vir kardiovaskulêre praktyk sal die veld van kardiovaskulêre perfusie versterk en dienslewering aan die burgers van Suid-Afrika verbeter. Hierdie navorsing was geensins omvattend nie, maar het ‘n grondslag voorsien waarop verdere navorsing in die veld van perfusie en ander gesondheidsorgkwessies uitgevoer kan word.

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PRACTICE PROGRAMME

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Barely five decades ago the outer wall of the living human heart presented an impenetrable barrier to the scalpel of even the most skilful of surgeons, but thanks to the development of a creative therapeutic procedure involving the use of cardiopulmonary bypass (CPB) through extracorporeal circulation, cardiac surgery has become routine throughout the world (Lillehei 2008:3).

Cardiovascular perfusion technology is faced with the challenge of keeping pace with significant changes taking place in disease profiles of patients presented for cardiac surgery, changes in surgical indications and surgical techniques, as well as advancing technology. The three universities of technology in South Africa (SA) that offer the perfusion programme have different programme content and outcomes and therefore emphasise different aspects of cardiovascular perfusion. This has led to variable success being achieved in producing cardiovascular perfusionists who are able to exploit the potential scope of practice of modern perfusion fully (Medtronic Perfusion Congress 2012:Personal communication). Added to this, there is a worldwide trend in the cardiology and cardiothoracic surgical professions towards a merger, with both professions requiring interventional technologists able to provide skills and expertise encompassing both fields (Smit 2013; Landauer 2014:Personal communication).

Cardiovascular perfusion is a field of practice whereby the function of the heart and lungs is replaced or supported by equipment and machines in a hospital theatre setting so that a surgical procedure to correct or reverse a cardiac-related pathology can be carried out. In addition to carrying out the above-mentioned procedure the perfusionist is also required to possess the skills required to carry out other procedures, which include red-blood-cell salvage for a patient experiencing severe blood loss during surgery, and performing

isolated-limb perfusion, a process whereby very high doses of chemotherapeutic agents are administered via artificial circulation in an isolated limb to treat limb tumours. A perfusionist's expertise is also required in liver transplantation.

These skills require that the perfusionist possesses knowledge associated with carrying out the above-mentioned tasks. This knowledge includes knowledge of anatomy, physiology, pathophysiology, pharmacology, anaesthesia, haematology, and mechanical circulatory support and clinical practice (CUT 2013:394-395; DUT 2013:18-45; Ottens 2002:Online).

In this research project an in-depth study was carried out to describe the outcomes and essential content required for a cardiovascular perfusion programme. The study also addressed the requirements of current and future cardiovascular perfusion practices. These objectives were achieved by means of a literature study that included a document analysis of international curricula, by applying an electronic questionnaire survey to obtain statements for a Delphi survey that followed the questionnaire survey based on the online EvaSys survey-management system.

This study can serve as a basis upon which a standardised cardiovascular perfusion programme/curriculum can be enhanced or developed–a programme/curriculum that can be used by all three institutions in SA–which can serve as a framework upon which international perfusion programmes can be enhanced or developed. The findings of this study may also be useful to higher education institutions wishing to develop or enhance specialist health sciences programmes, especially clinical technology specialties and cardiothoracic surgery.

The aim of this first chapter is to orientate the reader to the study that was carried out by the researcher. The background to the research problem is explained, followed by the problem statement and the research question. The overall goal, aim, and objectives are then discussed. Thereafter the scope of the study is demarcated, and the value and significance of the study are explained. A brief overview of the research design and methods of the questionnaire survey and Delphi survey is then presented. The layout of the subsequent chapters brings the first chapter to a close.

1.2. BACKGROUND TO THE RESEARCH PROBLEM

In her speech at the sixth World Congress of Paediatric Cardiology and Cardiac Surgery in Cape Town in February 2013, South Africa's deputy health minister, Gwen Ramokgopa, stated that, worldwide, 17.3 million people die of cardiovascular disease each year, and of these, 80% are in the developing world. Only 40% of South African children in need of life-saving surgery receive that care (Molopyane in *The New Age* 21 February 2013:2). According to Children's Heartlink report (2007:12) less than 1% of congenital-heart-disease patients in Africa receive the surgery they need.

The World Health Organisation (WHO) projects that ischaemic heart disease will be the leading cause of death among humans in the developing world by the year 2020 (Smit & Linegar 2010:8,personal communication). Considering that Africa has only one centre offering cardiac-surgery treatment per 33 million people, and that only 18 open-heart operations per million people are performed annually–the majority of these operations taking place in SA–it is clear that much work must be done to address this shortcoming (Children's Heartlink 2007:13). One of the factors contributing to the lack of access to medical treatment for patients in Africa is a shortage of personnel with adequate training and educational qualifications to perform the required tasks (Children's Heartlink 2007:16). Perfusion is one of the main components of the work of the cardiac surgical team, and the first step towards providing highly qualified perfusionists who possess the required expertise and knowledge, involves describing the relevant outcomes and essential content of a cardiovascular perfusion programme.

The field of cardiovascular perfusion is a relatively new field in healthcare—it has existed for less than 70 years. Working in the field demands a high level of theoretical knowledge, practical skills and dedication. The work includes controlling a patient's physiological parameters during CPB by managing the extracorporeal circulation through the heart-lung machine and application of technologies related to haemodynamic, metabolic and haematological monitoring.

Extracorporeal circulation refers to the technologies required to maintain blood circulation and adequate perfusion of tissue and organ systems during open-heart surgery, when the heart is temporarily stopped or its function suppressed to such an extent as to render the cardiac output insufficient for perfusion of organs.

The perfusionist therefore forms an integral part of the cardiothoracic surgical team and must work in close cooperation with the surgeon, anaesthesiologist and scrub nurse (College of Clinical Perfusion Scientists of Great Britain and Ireland 2008:Online).

The concept of extracorporeal circulation was first suggested in 1812, when Caeser Le Gallios proposed the idea of maintaining cardiac output artificially by means of a system that could deliver adequate blood and oxygen to the body's vital organs while simultaneously removing excessive carbon dioxide from the blood. However, this idea was not to become a reality until the 1950s, when Dr. John Gibbon performed the first open-heart operation in 1953 in Massachusetts, United States of America (US) (College of Clinical Perfusion Scientists of Great Britain and Ireland 2008:Online).

Prior to the establishment of cardiovascular perfusion as a profession, the requirements of extracorporeal circulation were managed by an unstructured team of surgeons, anaesthesiologists and laboratory assistants (Toomasian, Searles & Kurusz 2003:257). In certain units diesel mechanics were used, due to their knowledge of fluid flows and tubing systems (Smit 2013:Personal communication).

Today, South African cardiovascular perfusionists are qualified personnel who are registered with the Health Professions Council of South Africa (HPCSA) and they are subject to a national code of ethics.

The scope of practice in cardiovascular perfusion includes the following:

Cardiopulmonary bypass and variations thereof for open-heart surgery in adults, children and neonates;
Management of ventricle assist devices;
Intra-aortic balloon counter pulsation therapy;

- Extracorporeal membrane oxygenation (ECMO) for patients with compromised lung function;
- Management of technologies for intra-operative blood conservation, e.g. cell saving; and
- Haematological technologies aimed at haemostasis e.g. platelet sequestration (Medtronic Perfusion Congress 2012:Personal communication).

In addition to the above there is a growing need that the cardiovascular perfusionists provide the following clinical services (Medtronic Perfusion Congress 2012:Personal communication; European Association of Cardiothoracic Surgery (EACTS) Perfusion Symposium 2011: Personal communication):

- Intra-operative echocardiography;
- Advanced haematological monitoring technology;
- Advanced peri-operative haemodynamic monitoring;
- Ventricular assist devices (VADs) for the failing ventricle;
- Extracorporeal membrane oxygenation (ECMO);
- Blood transfusion services;
- Bedside monitoring in the intensive care unit;
- Plasma pheresis and platelet gel formation;
- Lung perfusion;
- Liver perfusion;
- Hyperthermic isolated-limb perfusion (HILP) to treat limb cancers; and
- Hyperthermic intra-peritoneal chemotherapy (HIPEC).

Not all the above services are presently covered by the various cardiovascular perfusion programmes, nor have they been listed as outcomes to be achieved by the graduating perfusionist. There is a growing demand from the healthcare system to include these topics in the outcomes and essential content of a cardiovascular perfusion programme (Medtronic Perfusion Congress 2012:Personal communication; European Association Of Cardiothoracic Surgery (EACTS) Perfusion Symposium 2011:Personal communication).

A cardiovascular perfusion practice programme should achieve a symbiosis with the health services and communities in which the health professional will serve, thus the values that underlie the programme should enhance health-service provision. To ensure that the programme maintains its usefulness, it must be responsive to changes in patient health status, increasing scope of practice and values and expectations in education. On a larger scale, the results of this study could be used to enhance the current curricula in use at the three institutions.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTION

Cardiovascular perfusion is facing many challenges relating to demands to keep pace with the effects on the profession of changes in cardiovascular surgery. The research is based on the hypothesis that the current outcomes and essential content of cardiovascular perfusion programmes are either not described at all or are inadequate for producing graduates who are able, immediately after qualifying, to provide the wide range of skills required by current and future cardiovascular perfusionists. This hypothesis necessitates a description of the outcomes and content of a perfusion programme that expands the scope of practice of the cardiovascular perfusionist, develops the profession of cardiovascular perfusion, creates opportunities for fulfilling careers for its practitioners and provides a highly professional patient service.

No study (recent or otherwise) into the outcomes and essential content of a perfusion programme relevant to SA or Africa could be traced electronically or otherwise. A few articles regarding the competencies, practice and education of perfusionists in Europe and the USA were found. Among these studies were the following: Perfusion education and training in Europe (Merkle 2006), The evolution of perfusion education in America (Toomasian *et al*. 2003), and Perfusion education in Europe (Merkle & Weitkemper 2007). These articles will be discussed further in Chapter 2, in the literature study.

An electronic search using keywords (e.g. cardiovascular perfusion, programmes, perfusion, extracorporeal technology, clinical technology, education, perfusion science, and practice), alone and in combination, was conducted with the search engines PubMed, Medline, Sage, EBSCOhost, Google Scholar and the University of the Free State's (UFS) electronic library, as well as the National Research Foundation's (NRF) website. The Frik Scott Library at the Faculty of Health Sciences and the main library of the UFS were also consulted, which yielded no relevant results regarding outcomes and essential content of a perfusion programme, especially in SA or Africa. Furthermore, references were sourced from perfusion-related websites relevant to the research.

Overall, the researcher was not able to find any (recent or old) scientific studies or research related to outcomes and/or content of perfusion programmes in SA or Africa as a whole.

Considering the above-mentioned problem the following research question was formulated

and addressed by means of this study.

What should the outcomes and essential contents of a perfusion practice programme in South Africa include?

1.4 OVERALL GOAL, AIM AND OBJECTIVES OF THE STUDY

1.4.1 Overall goal of the study

The overall goal of the study was to describe the outcomes and essential content of a cardiovascular perfusion practice programme specific to the South African context, with a view to developing a standardised, uniform and relevant curriculum for perfusion in SA, which will lay the foundation for producing highly skilled and knowledgeable cardiovascular perfusionists who are able to fulfil the requirements of a current and future cardiovascular perfusion practice.

1.4.2 Aim of the study

The aim of the study was to describe the outcomes and essential content of a cardiovascular perfusion practice programme that will address the requirements of current and future cardiovascular perfusion practice in SA.

1.4.3 Objectives of the study

The following objectives were pursued in order to achieve the aims of the study:

a) To determine the current outcomes of the current cardiovascular perfusion practice programmes.
b) To determine the current essential programme content of the cardiovascular perfusion practice programmes.

These two objectives were pursued by means of document analysis of the current programme content of the perfusion curriculum of the Central University of Technology (CUT) by studying the CUT prospectus (2013), the Durban University of Technology (DUT) handbook (2013) and the Tshwane University of Technology (TUT) prospectus (2012), as

well as the South African Qualifications Authority (SAQA) document on registered qualifications (clinical technology). Analysis of international perfusion programmes was also carried out and a literature study of available articles was done. These local and international programmes will be explained and discussed in detail in Chapter 2.

c) To determine the adequacy and validity of the current outcomes and programme content of the cardiovascular perfusion practice programmes and obtain statements for the Delphi survey.

A questionnaire survey of qualified perfusionists from various academic hospitals involved in education and training of perfusionists was carried out to pursue the above-mentioned objective.

d) To determine the required outcomes and essential content of a cardiovascular perfusion practice programme.

This objective was achieved, by means of the application of a Delphi survey using a group of experts, who formed the Delphi panel. The Delphi survey process will be explained in detail in Chapter 3.

Using the results of the above, appropriate and relevant outcomes are described and essential programme content for a cardiovascular perfusion programme is presented in Chapter 6 to achieve the aims of the study.

All of the above research questions addressed the research question.

1.5 DEMARCATION OF THE FIELD AND SCOPE OF THE STUDY

This study was carried out in the fields of health professions education (HPE) and cardiothoracic surgery (CTS) at the University of the Free State (UFS) and lies in the domain of academic programme development. Cardiovascular perfusion is an essential component of cardiothoracic surgery and, because the findings of the study will have a direct impact in this field, the study was carried out in this field. Since the focus of the study concerns the description of the outcomes and essential content of the perfusion practice programme it is logical that the field of HPE be directly involved. Therefore, the demarcation of the study

can be classified as interdisciplinary.

The focus was on describing the outcomes and essential content of a cardiovascular perfusion practice programme specific to the South African context, with a view to contribute to the provision of highly skilled and knowledgeable graduates in the field of cardiovascular perfusion. A thorough analysis of documents was carried out and an extensive study of literature from the fields of cardiothoracic surgery, perfusion and higher education was conducted to gain thorough knowledge, in order to contextualise and conceptualise all aspects related the study.

A questionnaire survey (explained in detail in Chapter 3) was distributed to participants who are qualified perfusionists involved in educating and training student perfusionists in SA. The survey was carried out from 11 April 2014 to 21 July 2014. The Delphi survey (explained in detail in Chapter 3) took place from 7 November 2014 to 23 February 2015. The Delphi panellists comprised individuals with specific expertise in cardiovascular perfusion, cardiothoracic surgery, anaesthesia, and education.

The findings of this study will be presented to the various institutions offering this programme and it may enhance and reform their current curricula. The findings will also be presented at congresses and seminars, and articles will be published in accredited peer-reviewed journals as part of professional development and sharing of knowledge worldwide.

In a personal context, the researcher is a qualified cardiovascular perfusionist who obtained his B-Tech degree in Clinical Technology (Cardio Vascular Perfusion) cum laude from CUT, Bloemfontein, in 2007. He had been supervising the training of students since qualification and was employed as a senior perfusionist at the Universitas Academic Hospital, Bloemfontein from 2008 until 2014. He also rendered services to private hospitals in Bloemfontein in that period. He also served as a part-time lecturer of perfusion-related subjects at CUT from January 2009 to December 2012. It is during this time that the seeds of his interest in higher education were sowed. Currently, the researcher is employed as deputy director of Clinical Technology at Pietersburg Hospital in Polokwane and is actively involved in the development of Cardiology and Cardiothoracic Surgery units at the Pietersburg hospital.

The researcher has vast experience in CPB, having done or supervised over a thousand cases, as well as in ECMO, VADs, blood-cell salvage and other perfusion-related skills. He has vast experience of educating and training students, who have gone on to apply their skills and knowledge successfully at various hospitals in SA, the Netherlands and the United Kingdom (UK).

He successfully completed the ECMO specialist training course in 2011 at Glenfield Hospital in Leicester, UK, the largest adult ECMO centre in the world.

The researcher has attended and presented papers at various conferences related to cardiovascular perfusion, cardiothoracic surgery and higher education. Interaction with many peers and other students, as well as experience in lecturing perfusion subjects led him to realise that description of outcomes of perfusion programmes is lacking, and the content of the programmes that are offered at the various institutions in SA are either outdated or irrelevant. This lead to his interest in this particular study.

1.6 THE VALUE AND SIGNIFICANCE OF THE STUDY

1.6.1 Value of the study

The study of the description of the outcomes and essential content of a cardiovascular perfusion practice programme will yield:

- A clear understanding of the changing environment of cardiac surgery and perfusion science and the way the changes impact on the role of cardiovascular perfusionists in the South African context in particular;
- A comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice;
- A complete set of outcomes, which will form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion;
- Essential programme content for the graduate degree in the field of perfusion; greatly enhanced curricula for cardiovascular perfusion programmes.
- Possible standardisation of cardiovascular perfusion programmes, at least in SA; and
- Invaluable information and content for possible new cardiovascular perfusion programmes internationally.

1.6.2 Significance of the study

Although this study will be focused on cardiovascular perfusion programmes in SA, the outcomes and essential programme content that will be described and many of its components will be applicable internationally.

The findings of this study will be used directly to enhance, reform or develop the programme of cardiovascular perfusion at the CUT in particular, and possibly other institutions offering or planning to offer the programme in SA and internationally.

1.7 RESEARCH DESIGN OF THE STUDY AND METHODS OF INVESTIGATION

1.7.1 Research design of the study

The research design that was implemented comprised descriptive quantitative research with qualitative elements using a questionnaire survey and Delphi survey. The quantitative elements formed the bulk of the questionnaire survey and the Delphi survey, whilst the qualitative elements were used to abstract further information for certain closed questions that required further elucidation or allowed the participants to elaborate further on a particular answer to a question, if they so desired. The qualitative elements thereby complemented the quantitative elements, provided a better understanding of the research question and provided the researcher with further information that he could use to interpret the research findings even more thoroughly.

The research design, questionnaire survey and the Delphi survey are explained in detail in Chapter 3, as are the quantitative and qualitative methods of data collection.

1.7.2 Methods of investigation

The methods that were used and that formed the basis of the study comprised a literature study and document analysis, questionnaire survey, and the Delphi survey.

The literature study and document analysis were used to contextualise and conceptualise the problem against related theory, practice and research. It also enabled the researcher to gain sufficient knowledge about the problem statement and the subject of the study.

The questionnaire survey was used to obtain statements that were to be included in the Delphi survey. The questionnaire survey was distributed to lecturers at CUT and DUT who are or were involved in tutoring perfusion students, and supervisors at various academic hospitals involved in the training of perfusionists. Managers/heads of perfusion at the academic hospitals were not included in the questionnaire survey because they were used as panellists in the Delphi survey.

Panellists in the Delphi survey are experts in the field of cardiovascular perfusion, cardiac anaesthesia, cardiothoracic surgery and perfusion education in SA and abroad. The results of the document analysis, literature review and Delphi survey were used to define the outcomes and essential content of a cardiovascular perfusion practice programme.

A detailed description of the survey population, sampling methods, data collection and analysis, as well as reporting and ethical considerations, are given in Chapter 3.

A schematic overview of the study is given in Figure 1.1.

The following figure provides an overview of the study.

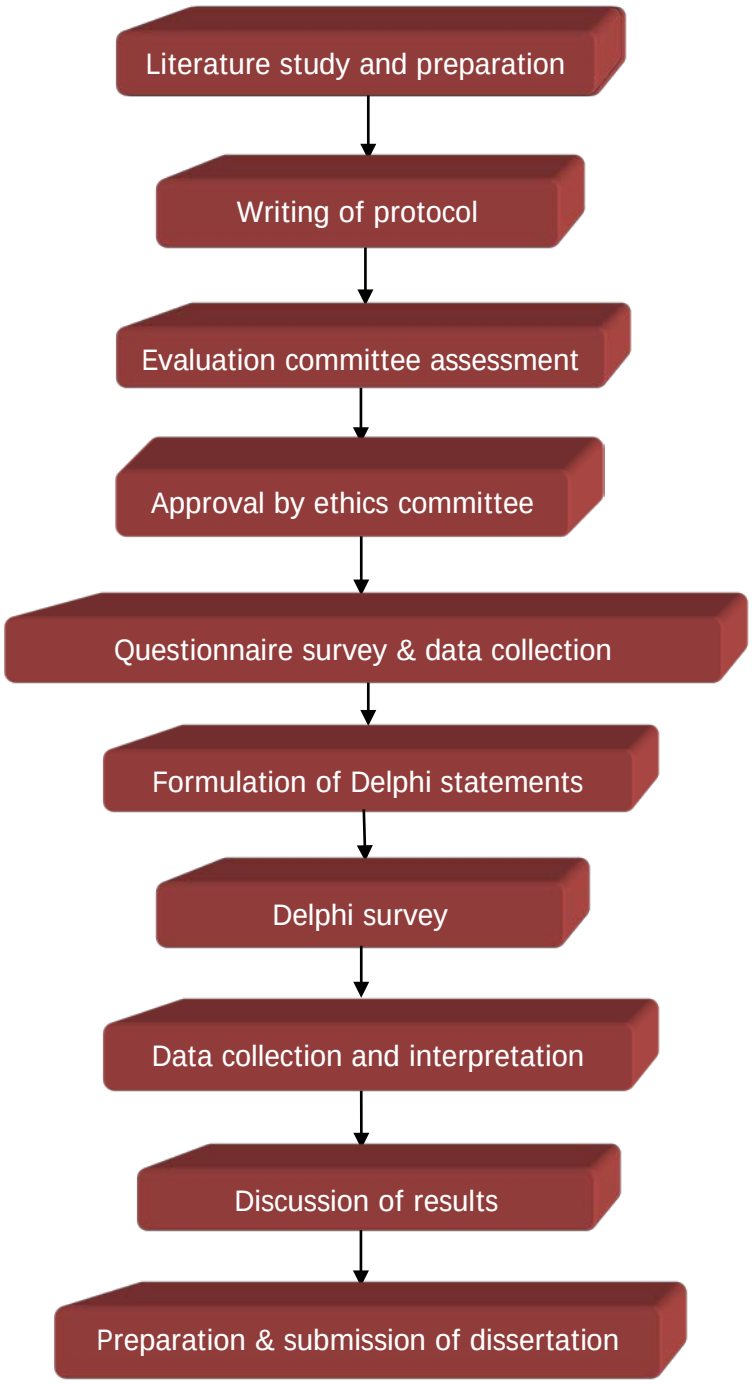

Figure 1.1: Schematic overview of the study (compiled by the researcher Musa 2014)

1.8 IMPLEMENTATION OF FINDINGS

The findings of this study will be made public to the School of Medicine UFS, the Department of Health Sciences CUT, Department of Biomedical and Clinical Technology DUT, Department of Biomedical Sciences TUT and other educationists in higher education in SA and beyond its borders. It will be recommended that the findings be used to enhance or develop the respective institutions' perfusion programmes.

The findings of this research will also be presented through oral or paper/poster presentations at conferences and seminars, and will be submitted for publication through articles in applicable journals.

1.9 ARRANGEMENT OF THE REPORT

The report of the research findings, which will provide the reader with more insight into the topic, and the methods through which the aim of the study and the final outcome of the study was achieved is set out as follows:

Chapter 1, which is this particular chapter, ***Orientation to the study,*** gives the reader a brief overview of the study, to acquaint him/her with what is to follow. A brief background to the research problem and the research question was stated. The aims, objectives, and methods employed to achieve them were discussed briefly. The demarcation of the field and the scope of the study, its value and significance, and the implementation of the findings were also explained.

Chapter 2, ***Perfusion education and training outcomes and content,*** will provide the theoretical perspectives of the study. It will explain the development of perfusion into a career and how the field has progressed to what it involves today. Various literature will be discussed. South African and international curricula will be analysed, compared and discussed.

Chapter 3, ***Research design and methods,*** will provide a thorough description of the design of the study as well as an explanation of the two data-collection methods, i.e. the questionnaire survey and the Delphi. Questions that will be answered are: what was the purpose of each method, how the techniques were implemented, who was included in the

sample population and what its size was. The EvaSys electronic survey-management system will also be explained.

Chapter 4, ***Results, analysis, interpretation and the discussion of the findings of the questionnaire survey,*** will present the results of the questionnaire survey and discuss and explain the interpretations and findings.

Chapter 5, ***Results and the discussion of the findings of the Delphi,*** will report the results of the Delphi survey and discuss and explain interpretations and findings.

Chapter 6, ***Description of Outcomes and Essential Content for a Cardiovascular Perfusion Practice Programme,*** will present the outcomes and essential content, as derived from the research study, in a tabular format.

Chapter 7, ***Conclusions, limitations and recommendations,*** will state the conclusion of the dissertation and make recommendations for future study.

References and appendices are found after Chapter 7, within this dissertation.

1.10 CONCLUSION

This first chapter provided an orientation to the study, background to the problem, problem statement, scope, and overall goal and aim, together with a brief introduction to the research design and research methods. The chapter concluded by providing an outline of the dissertation.

The following chapter, Chapter 2, entitled ***Perfusion education and training-outcomes and content,*** will present a study and discussion of various literature sources and documents related to perfusion and education.

CHAPTER 2

PERFUSION EDUCATION AND TRAINING

2.1 INTRODUCTION

In Chapter 1, *Orientation to the study,* the reader was given a brief overview of the study to acquaint him/her to what is to follow. A brief background to the research problem with the research question was stated. The aims, objectives, and methods employed to achieve them were briefly discussed. The demarcation of the field and the scope of the study, its value and significance, and the implementation of the findings were also explained.

This Chapter provides the theoretical perspectives of the study. It deals with the development of perfusion into a career and how it has progressed to what it is today. A study of various literature has been discussed. South African and international curricula are analysed, compared and discussed.

2.2 PERFUSION PROGRAMMES IN AFRICA

The first open-heart surgery in SA was conducted in 1958 by the pioneer of heart transplants, Professor Chris Barnard, in Cape Town, using the same heart-lung machine that he later used for the first heart transplant (Barnard 1993:14). Just like elsewhere in the world during these early stages of heart surgery, the heart-lung machine was manned by a physician trained in anaesthesia, and by technically trained engineers with mechanical or instrument-making backgrounds.

In the 1960s a dedicated team of in-hospital-trained personnel operated the heart-lung machine in SA (Groenewald 2009:Online), among them Johan van Heerden and Dene Friedmann (Barnard 1993:37). Perfusion education was formalised in 1981, when successful perfusion candidates, after having completed theoretical and practical training using a didactic method, received diplomas and were required to register with the South African Medical and Dental Council (now HPCSA) as clinical technologists (perfusion). Since 1990 clinical technologists have been required to obtain B. Tech degrees as prerequisite for working without supervision (Groenewald 2009:Online).

Currently, three Universities of Technology in SA, namely, DUT, CUT and TUT offer the programme. It is supplemented by practical exposure in the form of work-integrated learning (WIL), provided as part of the course at various HPCSA accredited units in South Africa.

The programme duration at all institutions is the same, the programme content and training philosophies vary considerably. There is no standardisation regarding entrance criteria for the perfusion programme. Similarly, there has been no clearly explained description of outcomes and competencies required of a cardiovascular perfusionist and therefore no standardisation of programme content and no uniform national exit examination (Medtronic Perfusion Congress 2012:Personal communication).

The programme at all the universities of technology, consists of a 3-year National Diploma (ND) and a 4-year B.- Tech degree in Clinical Technology. The first two years are dedicated to basic sciences and the theoretical basis of Clinical Technology. The third and fourth years are focused on the student's chosen specialty field viz. cardiology, *cardiovascular perfusion*, critical care, nephrology, neurophysiology, pulmonology and reproductive biology. Training includes full-time practical exposure at an HPCSA-accredited training unit simultaneously with a part time theoretical course. i.e. The practical aspects of the studies are carried out at a training institution on a full time basis covering a forty hour per week work schedule plus overtime while the students only attend classes for theory for about 3 hours per week. After successfully completing the training and theoretical course work, the clinical technologist may then register with the HPCSA as an independent practitioner in his/her chosen specialty.

2.2.1 ND: Clinical Technology

Qualification Type: National Diploma (ND)
Designator: Clinical Technology
Qualifier: Cardiovascular Perfusion
NQF exit level 6
Credits: 360
Duration: 3 years

Explanation of qualification type, designator, qualifier, NQF exit level and credits is given in Chapter 6 (cf. 6.2).

Minimum Admission Requirements for ND

To register for the ND: Clinical Technology the applicant must have the minimum admission requirements:

For holders of the National Senior Certificate (NSC) (Those who matriculated after 2007) with a Bachelor Degree endorsement, must include the following subjects at the stated ratings.

Compulsory Subjects NSC	**Rating**
English	3
Life Orientation	4
Mathematics	4
Life Science	4
Physical Science	4
And one 20 Credit Subject	3

The minimum admission requirement for holders of the Senior Certificate (SC) (those who matriculated before 2008) is matriculation exemption with the following subjects at the stated ratings.

Compulsory Subjects	**HG**	**SG**
Mathematics	D	C
Physical Sciences	D	C
Biology / Life Sciences / Physiology	D	C

Additional to the NSC/SC exam results, a placement test and interviews are also carried out.

Final selection for placement are based on results in the SC / NSC exams and placement tests as well as on recommendations from the interview panel.

The current programme content consists of the following subjects:

First year

Anatomy I

Physiology I

Calculations and Statistics

Chemistry I

Physics I

Computer Applications I

Psycho-Dynamics I

Second year

Biomedical Apparatus and Procedures II

Organ and System Pathophysiology II

Pharmacology II

Anatomy and Physiology II

(CUT 2016: 37-38; DUT 2013: 394-395; TUT 2012: 41-44)

The curriculum content in the first two years across all universities of technology is fairly uniform and standardised. Assessment methods are also similar to one another. At the end of the second year the student chooses one of the specialty fields mentioned in the above paragraph. Students are required to apply towards the middle of the second year to the relevant specialty departments at the training hospital. Interviews are conducted by the specialty departments and after the successful completion of the second year and acceptance by the specialty department, students begin their training at the accredited specialty department. For cardiovascular perfusion, students apply to the department of cardiothoracic surgery at any of the accredited training units. The selection into the training programme is at the discretion of the training unit and not a university of technology.

Full time training is conducted in the form of work integrated learning (WIL) in conjunction with theoretical subjects stated below. WIL is provided at seven units in SA (cf. 3.3.1.3) for a complete period of 2 years at all the training units besides the Cardiothoracic Surgery Unit at Steve Biko Academic Hospital which requires that student complete 3 years of training at their unit to be eligible for a B.-Tech. degree (Marais 2016:Personal communication). The methods of training, training philosophies, types of procedures and the number of procedures conducted by the unit differ from unit to unit.

Third year (Cardiovascular Perfusion)

Clinical Technology Practice III
Biomedical Apparatus III
Clinical Practice III

The ND serves as the first qualification. At the end of the successful completion of the third year a university of technology confers a National Diploma (ND) in Clinical Technology (Perfusion) to the candidate which allows him/her to register as a *clinical technologist (perfusion) under supervision* to be eligible for employment at a unit where perfusionists are required. According to HPCSA regulations a person with a ND qualification can only work under supervision and not independently. However all cardiothoracic units in SA do not employ perfusionists with only a ND qualification as they need perfusionists who can work independently and therefore prefer to employ perfusionists with a B.-Tech. degree (Medtronic Perfusion Congress 2012:Personal communication).

2.2.2 B.-Tech.: Clinical Technology

Qualification Type: B.-Tech.
Designator: Clinical Technology
Qualifier: Cardiovascular Perfusion
NQF exit level 7
Credits: 120
Duration: 1 year

Minimum Admission Requirements for B.-Tech.: Clinical Technology (Cardiovascular Perfusion)

Admission into the B.-Tech. requires students to have completed the ND: Clinical Technology or equivalent. Applicants who are in possession of the ND: Nursing or equivalent are required to comply with the following:

- Have a minimum of 3 years work experience in a specialized category. For Cardiovascular Perfusion the work experience should be related to Cardiovascular Perfusion or Cardiac Surgery environment.

- Complete three (3) third year subjects at the ND: Clinical Technology level in the specialist category, Cardiovascular Perfusion i.e. Biomedical Apparatus, Clinical Practice and Clinical Technology Practice and
- Complete a course in Pharmacology 2.

The admission policy for nurses into the B.- Tech. programme was developed by the DUT and is applicable only to the DUT. Nurses wishing to register at the CUT or TUT need to apply for conferment of status.

The following subjects are offered for B.-Tech. Clinical Technology (Perfusion) qualification:

Fourth year (Cardiovascular Perfusion)

Perfusion IV which includes a research dissertation
Research Methodology: Natural Sciences
Principles of Management I

A dissertation on a cardiovascular perfusion related research topic conducted by the student needs to be handed in and presented at the end of the academic year to attain the B-Tech. degree.

After the successful completion of the fourth year (fifth year if WIL was carried out at Steve Biko Academic Hospital) the university of technology confers a B.- Tech. Clinical technology (Perfusion) degree to the student who is then eligible to practise the profession independently wherever his/her services are required after registration with the HPCSA as a Graduate Clinical Technologist. A person holding the B.-Tech. degree is also allowed to train and supervise students in an accredited unit.

The focus of this study is the outcomes and contents of the specialist category cardiovascular perfusion (third and fourth year). Although the names of the subjects of the third and fourth year are the same at all three universities of technology, the subject content however is different. There is no standardised content nor are the outcomes clearly defined nor are the assessment methods uniform throughout all universities of technology (Medtronic Perfusion Congress 2012:Personal communication).

The DUT handbook (2013:23) states that Research Methodology and Perfusion IV which includes the research project does not have a final exam. The results for these subjects are determined through a weighted combination of assessments. One subject (Principles of Management 1) has a final examination at the DUT. At the CUT there are no final exams for Research Methodology and Principles of management 1. The results of these subjects are determined through a weighted combination of assessments while there is a final oral exit exam for assessing the complete perfusion programme (EACTS Perfusion Symposium 2011; Researchers personal experience). The TUT requires that their students write exams for Principles of Management and Research methodology while there is no final exam for Perfusion IV (Marais 2016:Personal communication). Practical assessments are carried out throughout the third and fourth year to assess student's competence at all units.

In order to determine if the student has achieved total clinical competence all the Universities of Technology require students to complete Competence Based Tests and to hand in a portfolio (containing the number and type of procedures performed) at the end of the fourth year. The CUT requires that the student completes at least 120 adult CPB cases and 20 Paediatric/neonatal cases for him/her to be eligible to sit in the final exit examination for Perfusion (EACTS Perfusion Symposium 2011; Researchers personal experience). At the TUT the student is required to complete a minimum of 880 clinical hours under the direct supervision of a qualified cardiovascular perfusionists to be deemed competent (TUT 2012:45). The DUT has no set protocol, as far as number of cases or hours to be completed are concerned, regarding achievement of competence besides the practical assessments carried out throughout the third and fourth year (EACTS Perfusion Symposium 2011). The DUT and TUT do not require their students to complete paediatric or neonatal CPB cases therefore the two confer B.-Tech degrees to their students even though the students may have not been exposed to paediatric or neonatal cases.

The use of time as the standard of determining competence as done by TUT may not be ideal as different students learn differently. Whilst one student might take an hour to learn a particular task another might take two hours. Furthermore a student might fulfil the time required but might not have been exposed to certain components of perfusion due to various reasons such as inadequate case-loads, staff or financial issues which lead to not carrying out certain services or the unit simply does not provide a certain service. That is the case with students at certain training units who are not exposed to paediatric perfusion but are still conferred a B.-Tech degree.

The disparity in programme content, training philosophies, assessment methods etc. as explained above does not equip students to be able to take up employment just anywhere and allow them to apply their competency. Many newly qualified graduates find themselves at huge disadvantage and find it difficult to cope with work when their services are required at a unit where certain services are rendered but the new graduate employee doesn't have the knowledge or/and the competency to carry that service out.

2.2.3 Recent Developments

According to the Higher Education Qualifications Sub Framework (HEQSF),
"Existing qualifications and programmes that are currently offered by higher education institutions must conform over time with the requirements of the revised HEQSF policy or must be de-registered and withdrawn. The Minister of Higher Education and Training will determine appropriate transitional arrangements after consultation with the CHE, SAQA and higher education institutions. Data pertaining to the alignment of existing programmes must be supplied to the CHE according to its HEQSF Implementation Plan in order to ensure continued accreditation" (CHE 2013:23).

It further states,
"The implementation date for the revised HEQSF policy will be the date on which it is gazetted by the CHE as a policy document in the Government Gazette. However, as higher education institutions will need time to phase out their existing qualifications in terms of this policy, there will be a transition period to full compliance "(CHE 2013:23).

In compliance to the HEQSF policy the ND and B.-Tech. Clinical Technology qualifications are being phased out by the universities of technology. The clinical technology qualification has been re-registered with the South African Qualifications Authority (SAQA) with a new name i.e. Bachelor of Clinical Technology (cf. 6.2.3). The universities of technology are currently in the transition phase in order to comply with the revised HEQSF policy. All students will be required to complete at least a four year Bachelor's degree in clinical technology in the near future to be eligible for employment (Vermaak 2013:Personal communication).

The researcher has not been able to identify any training programmes in Africa outside of SA. Perfusionists working in African countries outside SA such as Zimbabwe, Mauritius,

Madagascar, Ghana, Uganda and Kenya gained their theoretical and practical experience in India, Europe or the US (Medtronic Perfusion Congress 2012:Personal communication).

2.3 INTERNATIONAL PROGRAMMES

There is considerable variation between international cardiovascular perfusion programmes that have been developed independently in response to the specific requirements of the individual countries (Merkle 2006:3)

2.3.1 Perfusion programme in Australia

In Australia a two-year postgraduate course in cardiovascular perfusion is offered through correspondence by perfusion schools. It offers a combination of theoretical and practical training in a modular method and is provided at a hospital approved by the Australian Board of Cardiovascular Perfusionists (ABCP) under the guidance of a supervisor. The prerequisites for entry into the course are a Bachelor's degree in Science or Applied Science from an Australian or New Zealand university and employment as a trainee perfusionist in an ABCP-accredited hospital. The following modules make up the Australian course:

a) Anatomy
b) Pathology
c) Physiology
d) Pharmacology
e) Physics and chemistry
f) Biomedical electronics
g) Instrument and measurement
h) Introduction to perfusion technology
i) Details of perfusion techniques
j) Perfusion equipment
k) Clinical application of bypass techniques
l) Support of operating theatre procedures
m) Occupational aspects of perfusion

Once the candidate has passed three-hour exams set by the ABCP for all 13 modules and has completed a log book with 200 cases, including 10 paediatric cases in an adult unit and

10 adults in a paediatric unit, he/she is eligible for the final exam, which consists of a written and a 50-minute oral exam (Ottens 2002:Online).

2.3.2 Perfusion programmes in Europe

European countries developed their individual perfusion programmes according to their particular needs. There is no uniform programme across Europe or within individual countries. Certain countries provide a university degree course, others provide on-the-job training while many provide it as a postgraduate course. Graduates who want to join the European Board of Cardiovascular Perfusionists (EBCP) have to pass an EBCP-set examination (Merkle & Weitkemper 2007).

The EBCP was formed in 1991 as an overseeing body for equality of standards in both training and professional status within Europe. It is made up of representatives from the perfusion societies of all European countries which, at that time, were members of the European Common Market or the European Free Trade Association. The EBCP is supported by organizations such as the European Association for Cardio-thoracic Surgery (EACTS), the European Society for Cardiovascular Surgery (ESCVS), and the European Association for Cardio-thoracic Anaesthesiologists (EACTA).

The objectives of the European Board of Cardiovascular Perfusion are to:

- Establish, monitor, and maintain equality of standards in education and training;
- Set out essentials and guidelines for training programmes;
- Set a common examination;
- Issue a 'European Certificate in Cardiovascular Perfusion';
- Establish a common certification and re-certification process in Europe.

The EBCP has various committees, one of which is an academic committee consisting of a certification committee and an accreditation committee. The certification committee is in charge of matters regarding the certification of the individual perfusionist whereas the accreditation committee leads in matters regarding accreditation of perfusion schools and training centres. (von Segesser 1997:24)

The EBCP is represented by 20 countries, course structure differs considerably between member countries and within individual countries. In 10 countries it is considered an academic qualification, in 9 countries it is regarded as a non-academic qualification and in 1 country (Germany) it has both academic and non-academic status. On the job training is provided in Croatia, France, Germany, Greece and Switzerland. In Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Ireland, Malta, Netherlands, Norway, Poland, Portugal, Spain, Sweden and Switzerland perfusion is offered as a post graduate course at an academic and a non-academic level. Prerequisite for academic level is a degree in cardiac anaesthesia, bio electronic/biomedical engineering, Physician, Bachelor of Science (B.Sc), B. Sc. Nursing. In Finland a medical degree is a requisite. Prerequisite for non-academic is nursing, laboratory assistant, radiology technologist/assistant and medical technician. In Italy and Germany it is offered as a basic university course (Merkle & Weitkemper 2007; Mascitelli 2003:4).

Italy is the only country in Europe which seems to have a uniform programme for cardiovascular perfusion. The duration of the programme is 3 years for the basic degree known as the "Medical degree in Cardiovascular Physiopathology and Cardiovascular Perfusion". The criteria for admission for the degree is a high school diploma and a pass in a multiple choice entrance exam. The student is required to achieve 60 credits per year with a total of 180 credits to be eligible for qualification. 25 hours equals 1 credit. The programme consists of didactic training, clinical observation, laboratory experience and research. The student is trained under the supervision of a certified perfusionist. The student is expected to complete a certain number of bypass procedures under supervision and certain number independently. In the last six months of the course the student has to carry out a research project and prepare a research thesis and present it to the director of the university. Final assessment in the form of written, oral and practical examination is carried out. Upon graduation the perfusionist becomes a member of the Italian Society of Perfusionists which is a member of EBCP (Mascitelli 2003:1-5).

Below is the summary of the contents of the syllabus provided by the EBCP to institutions applying for the accreditation of their cardiovascular perfusion programme:

2.3.2.1 Summary of the EBCP syllabus

Anatomy and Pathophysiology

a) General Anatomy

- Cell structure and genetic control
- Tissue structure, composition and function
- The general structure of arteries, veins and microcirculation
- The lymphatic system
- Skeletal, smooth and cardiac muscle
- The endocrine system

b) Embryology and the Anatomy of the new born

- The embryonic period and foetal development of the cardiovascular and
- respiratory systems
- Congenital malformations of the cardiovascular and respiratory systems
- Cardiovascular and respiratory changes at birth

c) Cardiac and Respiratory Anatomy

- The major structures of the thorax
- The structure of the heart: Chambers, valves and coronary circulation
- The upper respiratory tract and larynx
- The tracheo-bronchial tree
- The lungs: Alveolar structure, pulmonary circulation

d) The Nervous system and Neuropathology

- The basic organisation of the central and peripheral nervous systems
- The brain and the spinal cord
- The autonomic nervous system: Sympathetic and parasympathetic divisions, ganglia
- Cerebral trauma
- Cerebrovascular disease: Thrombosis and emboli, permanent stroke, transient ischaemic attack (TIA), subarachnoid and intracerebral haemorrhage
- Brain oedema

e) Congenital Heart Disease and Surgical Treatment

- Atrial septal defects
- Ventricular septal defects
- Persistent atrioventricular canal defects
- Patent ductus arteriosus
- Coarctation of the aorta
- Aortic stenosis
- Hypoplastic left heart syndrome
- Right ventricular outflow obstructions
- Tetralogy of Fallot
- Tricuspid atresia
- Ebstein anomaly of the tricuspid valve
- Transposition of the great arteries
- Total and partial anomalous pulmonary venous return
- Univentricular heart
- Malposition of the heart
- Anomalous left coronary artery arising from the pulmonary artery
- Cardiac Transplantation

f) Acquired Heart Disease and Surgical Treatment

- Atherosclerosis
- Ischaemic heart disease
- Valvular heart disease
- Cardiac hypertrophy and hypertensive heart disease
- Cor pulmonale and pulmonary hypertension
- Myocarditis
- Cardiomyopathies
- Pericardial disease
- Endocrines and the heart
- Heart tumors
- Arrhythmias and conduction disorders
- Diseases of the aorta: Aneurysms and dissections
- Cardiac Transplantation

g) Diseases of the Respiratory system

- Congenital anomalies
- Carcinoma
- Infections
- Adult respiratory distress syndrome: ARDS
- Transfusion related acute lung injury: TRALI
- Chronic obstructive pulmonary disease: COPD
- Pulmonary hypertension
- Lung Transplantation
- Lung reduction surgery

h) The Abdomen and the Kidneys

- The major structures of the abdomen: Kidneys, liver, pancreas and
- gastrointestinal tract
- Glomerulo-nephritis, nephrosis
- Renal hypertension: Renin-angiotensin system
- Renal insufficiency: Chronic and acute renal failure
- Renal transplantation
- Hepatitis: A, B and C
- Liver cirrhosis and portal hypertension
- Heart failure and the liver
- Hepatic failure
- Liver transplantation
- Diabetes mellitus: metabolic effects and complications

i) The Immune system

- The concept of immunity: Non-specific and specific
- B-lymphocytes: antibodies, the complement system
- Allergy and anaphylaxis
- T-lymphocytes and histocompability
- Autoimmune diseases

j) Inflammation

- Vaso-active mediators, complement system and inflammatory cascades, arachidonic acid metabolism
- Injury produced by polymorphonuclear leukocytes
- Increase in vascular permeability
- Systemic manifestations of inflammation
- Acute and chronic inflammation

k) Death and Dying

- The concept of death
- Organ donation and transplantation

Physiology

a) Cellular Membrane Function

- Membrane structure and function
- Membrane transport of non-electrolytes (diffusion and osmosis)
- Membrane transport of electrolytes (membrane potentials)

b) General Circulation Principles

- Haemodynamics: Physics of blood, blood flow and pressure
- Blood volume and fluid spaces of the body
- Intrinsic regulations of the circulation
- Blood flow through specific areas: Cerebral, renal and skin circulation

c) Respiratory Physiology

- Ventilation of the lungs
- Transport of oxygen and carbon dioxide to the tissues
- Regulation of respiration
- Ventilation/perfusion relationship

d) Renal Physiology and Acid Base Management

- Glomerular filtration and tubular function
- Plasma clearance
- Regulation of acid-base balance

e) Cardiac Physiology

- Rhythmic excitation of the heart
- The mechanical performance of the heart
- The sensory systems involved in cardiovascular regulation
- Electrocardiography

f) Haematology

- Blood cells
- Blood coagulation
- Immunity
- Allergy
- Transfusion

Pharmacology

a) Basic Pharmacological Concepts

- Drug-receptor interactions
- Pharmacokinetic considerations in the use of cardiovascular drugs

b) Clinical Pharmacology

- Inotropic agents
- Antiarrhythmic drugs
- Antianginal agents
- Drugs affecting skeletal muscle
- Anaesthetics
- Analgesics
- Antithrombotic agents
- Diuretic therapy in congestive heart failure

c) Solutions: Composition and Therapy

- Volume and tonicity
- Specific electrolytes
- Blood substitutes

Perfusion Technology

a) Historical Perspectives

b) ECC Techniques

- The components of the cardiopulmonary bypass circuit
- Priming composition and methods
- Clinical management of cardiopulmonary bypass
- Temperature management during cardiopulmonary bypass
- Arterial blood gas strategies: a and ph-stat
- Supplementary measurements: Online blood gas measurement systems, cerebral saturation measurement, myocardial ph-measurement
- Coagulation management
- Emergencies during cardiopulmonary bypass
- Special CPB techniques for specific operations
- Legal and ethical aspects

c) Myocardial Protection

- Basic goals and concepts in myocardial protection
- Applied clinical methods
- Adaptation of applications to patient needs

d) Pathological Effects of Cardiopulmonary Bypass

- Effects of hypothermia
- The inflammatory response
- Fluid balance and interstitial fluid accumulation
- Nervous system
- Renal function
- The lungs
- The liver

e) General Physics

- Natural laws pertaining to gas and fluid flow
- Dynamics of gas and fluid flow
- Materials and material properties
- Applied circulatory and respiratory dynamics

f) Applied Microbiology

- Microbes: the nature of and relation to infection and immunity
- Microbes: destruction and inhibition of growth
- Aseptic technique
- Methods and principles of sterilisation techniques

g) Mechanical Circulatory Support

- Indications for use of circulatory support systems
- Intra-aortic Balloon Pump Counterpulsation (IABP)
- Ventricular assist devices (VAD)
- Methods of Extracorporeal Membrane Oxygenation (ECMO)
- Implantable devices (Berlin Heart Incor, Novacor etc.)

h) Blood Conservation and Salvage

- Risks of blood transfusion
- Blood conservation techniques

i) Related Technologies

- Non-invasive radiological techniques
- Echocardiography
- Invasive cardiac diagnosis
- Magnetic resonance imaging
- Nuclear cardiology
- Blood and blood gas analysis techniques

j) Clinical Evaluation of Research Data

- Principles of designing a study
- Principles of publication
- Critical evaluation of research data
- Statistical considerations

(EBCP 2013)

2.3.3 Perfusion programmes in the USA

In the USA, the first organised training of perfusionists was established in 1963 at the Cleveland Clinic. In 1968 the Ohio State University was the first university to offer a formal university based perfusion programme. Since then formal perfusion programmes gained momentum and by 1993 the number of programmes reached 32. After reaching its peak in 1993 perfusion programmes have gradually declined (Toomasian *et al.* 2003: 261-263). Currently there are 18 programmes running in the USA. The programme content, duration, requirements for entry into the programme, and qualification conferred after the successful completion of the programme differ from university to university. The majority of the programmes are offered at post graduate level with the course duration being 12 months to 24 months depending on the university. Majority of the universities require candidates to have a Bachelor of Science (BSc) degree for acceptance into their post graduate perfusion programme. Some of the universities require candidates to have some clinical experience in a cardiac care environment in addition to the BSc degree. Upon the successful completion of the programme certain universities confer a Master of Science (MSc) in Perfusion degree and some universities award a post graduate certificate.

Two universities viz. Barry University in Florida and SUNY Upstate University offer perfusion as an undergraduate programme. Entrance requirements to their programmes include completion of prerequisite courses in the science and mathematics field after matriculation. The complete undergraduate programme duration spans 4 years with prerequisite courses taking 2 years and placement at training in a clinical environment for another 2 years. Upon successful completion of the programme a BSc in Cardiovascular Perfusion is conferred upon successful candidates. All the programmes offer the didactic method of training. All graduates whether they are post graduates or undergraduates have to write the American Board of Cardiovascular Perfusionist (ABCP) examinations to be eligible for certification (Perfusion.com 2016:Online).

The ABCP is the certifying body of graduating perfusionists. It was established in 1975 and was responsible for accreditation of perfusion schools as well as graduates. Recognising the conflict of interest in certifying graduates from schools it accredited the ABCP eventually ceased accrediting schools. Currently the ABCP serves as the certifying and recertifying body of perfusionists whilst the accreditation of perfusion schools is handled by the Accreditation Committee – Perfusion Education (AC-PE) (Toomasian *et al.* 2003: 261-263).

The AC-PE has prepared a curriculum which serves as a guideline for perfusion programme directors to include it in their respective cardiovascular perfusion programmes across the USA.

The following is a brief outline of what the curriculum consists of:

2.3.3.1 Summary of the AC-PE curriculum

a) Cardiovascular Anatomy

- Mediastinum Cardiovascular Anatomy
- Heart
- Cardiac Arteries, Veins, and Microcirculation
- Conduction System
- Major Arteries, Veins and Branches
- Developmental and Cardiac Embryology
- Vascular Embryology

b) Pathology and Surgical Repair

- Adult Cardiac Valvular Pathology and Surgical Repair
- Adult Coronary Artery Pathology
- Perfusion Techniques for Aortic Aneurysm Dissections: Thoracic and
- Thoracoabdominal
- Congestive Heart Failure
- Congenital Heart Defects: Left to Right Shunts
- Congenital Heart Defects: Cyanotic Anomalies
- Congenital Heart Defects: Obstructive Anomalies
- Congenital Heart Defects: Miscellaneous Anomalies

c) Physiology

- Cardiovascular Physiology
- Cardiovascular Hemodynamics
- Renal Physiology
- Ventilation, Oxygenation, Respiration
- Myocardial Physiology
- Hematology

- Coagulation Management

d) Pharmacology

- Pharmacodynamics and Pharmacokinetics
- Pharmacology of Anesthetic Agents
- Anti-arrhythmic Pharmacology
- Inotropic and Vasopressor Pharmacology
- Vasodilators
- Pharmacological Treatment of Congestive Heart Failure (CHF)
- Antimicrobial Agents/Antibiotics
- Anticoagulants
- Heparin Induced Thrombocytopenia (HIT)
- Antithrombin III Deficiency
- Chemotherapeutic, Immunosuppressive and Diabetic Agents

e) Physics

f) Chemistry

g) Mathematics

h) Immunology

- Immunology of Blood Contact with Artificial Materials
- Immunology of Reperfusion Injury

Cardiopulmonary Bypass

a) Extracorporeal Circuit Components for Cardiopulmonary Bypass

- Perfusion Circuits
- Tubing
- Pumps
- Extracorporeal Filters
- Oxygenators
- Heat Exchangers
- Reservoirs
- Hemoconcentrators/Ultrafilters/Dialysis

b) Cardiopulmonary Bypass Techniques

- Conduct of Cardiopulmonary Bypass
- CPB Cannulation and Monitoring

c) Adequacy of Perfusion

d) Myocardial Preservation

- Cardioplegia Administration Techniques
- Cardioplegia Solutions

e) Systemic Hypothermia

f) Blood Conservation Techniques

- Standards for Perioperative Autologous Blood Collection and Administration
- Hemodilution
- Intraoperative Autotransfusion
- High Volume Autologous Platelet Concentration
- Low Volume Autologous Platelet Concentration Systems
- Hemoconcentration
- Pharmacological Interventions

g) Special Considerations in Perfusion

- Malignant Hyperthermia
- Perfusion of the Pregnant Patient
- Sickle Cell and Other Blood Disorders

h) Catastrophe Management

i) Adjunctive Techniques

- Assisted Venous Drainage
- Selective Cerebral Perfusion

j) Patient Monitoring

k) Organ Transplantation

- Heart Transplantation: Donor Recipient Considerations

- Lung and Heart-Lung Transplantation
- Liver Transplantation – Perfusion Support

Mechanical Assist

a) Extracorporeal Life Support Techniques

- ECMO
- Cardio Pulmonary Support (CPS)
- Intra-Aortic Balloon Pumping (IABP)
- Ventricular Assist Devices

Principles of Laboratory Analysis

a) Overview - Laboratory Analysis

b) Laboratory Analysis – Special Chemistry

c) Laboratory Analysis – Blood Chemistry

d) Laboratory Analysis – Coagulation

Biomedical Engineering

a) Biomedical Instrumentation

b) Biophysical Transport Phenomenon

c) Biomedical Electrical Safety

d) Medical and Diagnostic Imaging Technology

Safety

a) Blood/Fluid Exposure

b) Patient Safety

Continuous Quality Assurance

a) Continuous Quality Improvement (CQI) for the Perfusionist

Ethics

a) Medical Ethics

History

a) Historical Development of Extracorporeal Technology

Research

a) Introduction to Research Methods

Business Practices

a) Business Practice Regulatory Agencies

Emergency Preparedness

(AC-PE 2004)

The ABCP (USA) only certifies graduates from accredited programmes. For certification with ABCP a two part written examination needs to be completed. Part 1 is the Perfusion Basic Science Examination (PBSE) and part 2 is the Clinical Application in Perfusion Examination (CAPE).

To be eligible for the PBSE, the candidate is required to have graduated from an accredited programme, completed 75 clinical cases as a student and provide a letter from their training institution indicating satisfactory clinical competency. Eligibility for the CAPE requires, in addition to the criteria for PBSE, that the graduate is employed and documentation proving that the candidate has completed 50 clinical cases after graduation (Toomasian *et al.* 2003: 259-260).

2.4 COMPARISON OF VARIOUS TRAINING AND EDUCATION PROGRAMMES

All the various programmes listed above have comparable content in that they all have similar subjects/modules with slight variations within certain subjects/modules. All provide basic science subjects such as anatomy, physiology, chemistry and physics and also cover pharmacology and perfusion specific content such as CPB/extra corporeal circulation etc. The AC-PE (USA) curriculum consists of a few more subjects such as Organ Transplantation, Special Considerations in Perfusion and Medical Ethics. In SA only one training unit (Groote Schuur & Red Cross) offer cardiac transplantation hence students who are trained at that unit are competent in organ transplant perfusion and those who train at other units are incompetent at organ transplant perfusion.

The EBCP, AC-PE and the SA curricula also contain a research subject as part of their curricula whilst the ABCP (Australia) does not have it as part of their curriculum. The SA and Italian curricula require that a research thesis/dissertation is handed in and presented in order to obtain qualification. There is no indication from ABCP (Australia and USA) and the EBCP that a research dissertation/thesis is a requisite for certification with those boards.

The ANPeC, ABCP (USA) and CUT (SA) requires that a set minimum number of clinical CPB cases are performed to be eligible to write the final qualification/certification examination. The EBCP and the Australian board do not indicate that a set number of clinical CPB cases are a requisite for their certification examinations.

All the perfusion programmes discussed above seem to be using the didactic training method in some way or the other with the exception of the SA training programmes which have moved onto using the WIL method in line with the Outcomes Based Education (OBE) system used throughout the SA education system.

A **didactic method** is a teaching method and a theory of teaching that follows a consistent scientific approach or educational style to engage the student's mind. Didactics is, in a wider sense, a theory and practical application of teaching and learning. The theory of didactic learning methods focuses on the baseline knowledge students possess and seeks to improve upon and convey new information. Didactics also refers to the foundation or starting point in a lesson plan, where the overall goal is knowledge. A teacher or educator, as an authority figure, acts as both a guide and a resource for students. This method is archaic, and educational institutions are moving away from this method of teaching and learning.

The term **Work Integrated Learning (WIL)** describes an approach to career-focused education that includes classroom-based and workplace-based forms of learning that are appropriate for attaining a professional qualification (CHE 2011:4).

WIL prepares students and allows them to learn in the workplace. It further offers graduates the opportunity to apply theoretical knowledge in the practical environment.

The many advantages of WIL include:

- Academic benefits, such as improved general academic performance, promotion of interdisciplinary thinking, and increased motivation to learn;
- Personal benefits, such as heightened communication skills, teamwork, leadership and cooperation,

- Career benefits, for example, career clarification, professional identity, increased employment opportunities and salaries, development of positive work values and ethics; and
- Skills development, including increased competence and increased technical knowledge and skills (CHE 2011:6).

The Council on Higher Education (CHE), in its 2011 guide on WIL, explains that a profession is made up of three fields:

1) Academic, which provides the scientific basis,
2) Educational, which provides the programme, assessment, and pedagogic practices, and
3) Professional, which is the work environment (CHE 2011:8).

Each discipline has an important role to play in producing a responsible citizen.

In developing an educational programme such as the one for cardiovascular perfusion, curricular alignment is necessary to achieve the intended outcomes of the programme. In WIL all three fields (academic, educational and professional) have to be aligned in such a way that, although there is "re-contextualisation" of the fields, each field retains purpose. Therefore, it is necessary that academics, workplace representatives and students are engaged in the design, implementation and evaluation of a programme (CHE 2011:9-14).

2.5 Outcomes-Based Education (OBE)

The description of the outcomes and essential content of the cardiovascular perfusion programme is based on the principles of the more popular outcomes-based-education (OBE) approach, where the "programme should be defined by the outcomes to be obtained by students"

Making use of outcomes-based education means programme design starts the from the end, moving to the start, enabling teachers in medical education to focus on 'what the students will do rather than what the staff do' (Prideaux 2003:269) or as Tyler explains, *Learning takes place through the active behaviour of the student: it is what he does that he learns, not what the teacher does*. (as quoted by Biggs & Tang 2007: Introductory page).

This makes sense because, by determining what the student needs to know, the educator is enabled to equip students with the exact knowledge that is required. Hence by describing the outcomes of the cardiovascular perfusion programme we will be able to determine what the student needs to know and by describing the essential content the educator will be enabled to teach the exact knowledge.

OBE is a student-centred learning method that focuses on measuring student performance (the "outcome"). OBE differs from traditional education, which focuses primarily on the resources that are available to the student, called inputs. The outcomes have less to do with memorization of knowledge and information and more to do with how students demonstrate that knowledge as a result of their learning experiences while seeking that knowledge (Mokhaba 2004:29-30).

OBE includes the principles of assessment. Assessment, as a fundamental part of training, has to be centred on “deep, active learning” and include “high order cognitive skills” and, therefore, form a central part of the training programme and module plan. In compiling an educational programme, the designer should determine which methods and modus operandi will be used for assessment, and which assessment criteria will be used to assess students from “successful to even unsuccessful performance”. Furthermore, the processes and assignments used for assessment should be reliable, practicable and valid. The assessment system should be transparent, fair and realistic, with a “wide range of approaches” (Geyser 2004:92).

The assessment process answers questions such as the following: *Why do we assess? What do we assess? Who assesses? When do we assess? and How do we assess?* (Geyser 2004:105).

Although the assessment methods in the different SA curricula do answer the questions posed by Geyser in the above paragraph to a certain extent, there is still much room for improvement as the methods and types are different at all 3 universities of technology as explained in Section 2.2.2. The revised HEQSF policy and the alignment of the clinical technology programme to the policy together with the standardisation of the cardiovascular perfusion practice programme and the uniform examination that this study seeks to achieve will greatly enhance the standard of the qualification of Clinical Technology (Cardiovascular Perfusion) in line with the outcomes based education goals.

Describing the outcomes in terms of this study will include the identification of crucial elements needed to keep pace with advancing technology and the incorporation thereof into the programme.

These steps can be summarised as follows:

Identify elements that must be changed, removed or added;
Describe the outcomes and content of the perfusion programme.
An important prerequisite for a programme to succeed is that it must be current and must contain elements appropriate for its educational aim. The "sabre toothed programme" described by Prideaux (2003:268) is based on the "fable of the cave dwellers who continued teaching about hunting the sabre toothed tiger long after it became extinct."

This study aims to describe outcomes and essential content of a cardiovascular perfusion programme that are current with respect to changes in the clinical field of cardiovascular perfusion. As part of health science education the programme should therefore achieve a symbiosis with health services and communities in which the students will serve, thus the values that underlie the programme should enhance health service provision. To ensure that the programme maintains its usefulness, it must be responsive to the changing patient health status of today, increasing scope of practice and values and expectations in education.

2.6 CONCLUSION

In this chapter the theoretical perspectives of the study were provided. The SA and international curricula and training programmes were compared and discussed together with how the field of perfusion has evolved to what it is today.

In the next chapter, Chapter 3, titled ***Research Design and Methods,*** a thorough description of the design and methods used for the study will be discussed. An explanation of how validity, reliability, trustworthiness and rigour of the study was ensured will also be provided.

CHAPTER 3

RESEARCH DESIGN AND METHODS

3.1. INTRODUCTION

In this chapter the research design and research methodology of the study will be discussed. The theoretical perspectives of the research design are provided first, followed by a description of the methods used in this study, namely, the literature study, questionnaire survey, Delphi survey and the pilot studies. The survey population, sample selection, data collection and analysis of both empirical methods are described. The chapter ends with an explanation of the way validity, reliability, trustworthiness and rigour of the study was ensured as applicable to the study.

3.2. THEORETICAL PERSPECTIVES ON THE RESEARCH DESIGN

Theory building, strategy of enquiry and types of design will be discussed.

3.2.1. Theory building

Theory building refers to the relationship between the theoretical part of the study and the empirical aspects of the study. In the theoretical part the research concepts are identified and the relationship and interaction between these concepts are specified to create a theoretical framework. The literature study and document analysis form the basis of the theoretical framework, as discussed in Chapter 2. The empirical part of the study, consists of the questionnaire, the Delphi and the findings and analysis thereof.

3.2.2. Strategy of inquiry and research approach

Research methods in education and social sciences are divided into two main types:

- Quantitative, and
- Qualitative.

Quantitative research is a formal, objective, systematic process in which numerical data are used to obtain information about the world.

This research method is used:

- *To describe variables;*
- *To examine relationships among variables;*
- *To determine cause-and-effect interactions between variables.* (Burns & Grove 2005:23).

The specific nature of quantitative data lies in the fact that numerical data is used to obtain information, hence a mathematics-based method needs to be applied to analyse the numerical data (Sagepub 2010:Online).

When a quantitative method is used, the inquiry should be objective and therefore the researcher is seen to be completely detached from the phenomenon being researched. In other words, the researcher does not try to influence the outcomes of the research with his/her attitude, feelings and experiences. Influencing outcomes will allow bias to creep into the research, which is regarded as poor scientific technique.

Qualitative methods are associated with non-numerical data collection. Instead of statistical analysis of data this method draws on a subjective/inductive process of inquiry. When using the qualitative method, the researcher becomes part of the phenomenon being studied and analysis of data is interpretive, as it is based on words, feelings, perceptions, and experiences. Qualitative data lacks generalisability and it is more difficult to reproduce results.

Table 3.1 presents the main differences between qualitative and quantitative research methods, as suggested by Van der Stoep, Scott and Johnson (2009).

Table 3.1: Qualitative and quantitative research (Van der Stoep *et al* 2009)

Characteristic	Quantitative research	Qualitative research
Type of data	Phenomena are described numerically	Phenomena are described in a narrative fashion
Analysis	Descriptive and inferential statistics	Identification of major schemes
Scope of inquiry	Specific questions or hypotheses	Broad, thematic concerns
Primary advantage	Large sample, statistical validity, reflects the population accurately	Rich, in-depth, narrative description of sample
Primary disadvantage	Superficial understanding of participants' thoughts and feelings	Small sample, not generalisable to the population at large
Type of data	Phenomena are described numerically	Phenomena are described in a narrative fashion
Analysis	Descriptive and inferential statistics	Identification of major schemes

Other researchers (Ivankova, Creswell & Plano Clark in Maree 2010:257) explain how to conduct mixed methods research, which is a relatively new type of approach compared to qualitative and quantitative approaches. This type of research makes use of both quantitative and qualitative methods for obtaining data. Generally, a research design will be termed as mixed methods if the qualitative and the quantitative data are more or less equal in weight.

3.2.3 Research design

This study uses a descriptive, exploratory study design that employed mainly a quantitative methodology with some qualitative elements; the latter was achieved by using a questionnaire survey and the Delphi survey to address the study's objectives and aims. Because the researcher wants to describe the outcomes and essential content of a cardiovascular perfusion programme it is important that various documents are analysed and participants from relevant institutions are questioned to explore what is being offered at different institutions and what the gaps are.

In this research study, after considering the research question, the objectives of the study and the method of data collection, i.e. questionnaire survey and Delphi survey, the researcher decided that a quantitative method with qualitative elements was best suited to acquire the data required.

The questionnaires for both the questionnaire survey and the Delphi consisted of closed-ended (specific) questions, which provided numerical data. In cases where more information regarding a particular criterion was needed, open-ended questions were used to obtain an in-depth understanding of the matter. The qualitative elements added value to the quantitative aspects of the study.

Since the majority of the data is quantitative in nature and a limited amount of data involved qualitative comments, it would not be technically correct to call this mixed-methods research; it should rather be called a quantitative study with qualitative elements.

3.2.4 Description of the methods

3.2.4.1 *Literature study and document analysis*

The aim of a literature study is to conceptualise and contextualise a problem against related theory and research, while ensuring that the researcher is sufficiently knowledgeable about the subject of study (Singleton & Straits 1999:544). In this study, a literature review and analysis of documents of the Department of Education, Higher Education Qualifications Framework, Higher Education Quality Committee (HEQC), CHE, SAQA, CUT, DUT TUT and perfusion programmes in the USA, Europe and Australia were carried out. The literature review and the document analysis had the specific aim of describing the history and the current status of the outcomes and content of existing cardiovascular perfusion programmes. This information provided the necessary background and context to the stated problem. It also formed the basis for the development of the questionnaire and some statements in the Delphi survey.

Through document analysis of international perfusion programmes the researcher was able to identify factors that relate to the role and competences of a cardiovascular perfusionist, and the outcomes and essential content described for cardiovascular perfusion programmes internationally.

3.2.4.2 *The questionnaire survey*

To obtain the necessary information on current practices, to determine the validity and adequacy of the current outcomes and essential content of cardiovascular perfusion programmes and to obtain Delphi statements for the Delphi survey, a questionnaire survey was considered adequate for this research. Quantitative data was thus collected by means of a self-compiled, semi-structured questionnaire using the online survey-management system, EvaSys.

Other methods, such as interviews and nominal group techniques, were also considered but not chosen, as it would not have been practicable to gather the target population in one place. Members of the target population are scattered far and wide, and their clinical commitments would make it impossible to gather them in one place. Costs involved in travelling to interview each member of the target population was also deemed prohibitive.

Taking into account the above-mentioned reasons, the fact that most of the questions that needed to be answered were specific, and because the intention was not to gather information on thoughts, feelings and perceptions of the target population, an interview or nominal group technique was not considered to be ideal; instead, a questionnaire survey and a Delphi survey were considered to be most appropriate for the data that had to be gathered.

According to McMillan and Schumacher (2001:34) questionnaires, as a quantitative method of data collection, are especially useful for gaining information on the nature of the needs of a specific target population.

Questionnaires have the further advantage that they allow respondents to remain anonymous. The questionnaires can be distributed and returned in ways that make the respondents feel confident that their identities are secure.

The purpose of the questionnaire in this survey was to determine the validity, adequacy and current practices and status of the outcomes and essential content of the cardiovascular perfusion programmes, and to obtain statements for the Delphi survey.

Initially, the researcher and his supervisor were of the opinion that the questionnaire survey

alone would be sufficient to achieve the goals, the objectives and the aims of the study (cf. 1.4.1; 1.4.2; 1.4.3). The questionnaire, at that stage, was supposed to be distributed to all perfusionists, cardiothoracic surgeons and cardiac anaesthetists. It was then suggested by the protocol evaluation committee that the study should use two data-gathering methods.

a) Questionnaire survey

This survey was distributed to all perfusionists who are involved in training and/or lecturing of students to determine current practices and perceptions of educationists/lecturers and trainers of cardiovascular perfusion students regarding the outcomes and essential content of cardiovascular perfusion programmes, and to provide statements for the Delphi survey.

The evaluation committee members were informed that the survey population will be very small, around six or seven, because only seven institutions (cf. 3.3.1.3) train perfusionists. The evaluation committee decided that that number would be adequate to reach the objectives of the questionnaire survey. Nevertheless, the researcher endeavoured to find more members who fitted the description of the survey population, and identified 14 perfusionists to whom the questionnaire was sent.

b) Delphi survey

The Delphi survey was distributed to the panel of experts described in Section 3.3.2, so that they could describe the outcomes and essential content of a cardiovascular perfusion programme.

The questionnaire was compiled in English as all participants were known to understand and converse in English and the language of instruction for cardiovascular perfusion programmes offered at all institutions is English. Questionnaires were circulated electronically using the EvaSys survey-management system (cf. 3.2.4.3), with a return date specified. The questionnaire survey was conducted over four months. An information document explaining the research study and requesting participation in the questionnaire survey was sent to the participants a week prior to the distribution of the questionnaire.
The questionnaire was distributed on 11 April 2014. A weekly reminder for the participants to complete the survey was sent by the EvaSys system for the first three weeks of the

survey and daily reminders from the fourth week till the end of the survey. The initial time frame for the questionnaire survey was one month, but due to the slow response rate of the participants and a change in workplace by the researcher, the time was extended until a favourable number of responses had been received. Participants who had not responded by end of the third week were sent daily email reminders by the EvaSys system. Calls were made and text messages using WhatsApp were sent to the participants to request them to complete the questionnaire. At the end of the four months the researcher, in consultation with his supervisors, decided to conclude the survey as no more responses were expected. Thus the survey was closed on 21 July 2014.

In compiling the questionnaire the researcher constantly worked to minimise any aspect that could impact negatively on the results of the study, by keeping questions as simple as possible. The first statement on the questionnaire informed the participants that, by completing the questionnaire, they were giving informed consent. Questions were arranged in such a way that the survey did not appear cluttered.

The questionnaire survey was a quantitative study consisting mainly of closed-ended questions that required participants to choose from the options essential, useful, or not needed.

There were a few open-ended questions, and space was provided under each unit of the questionnaire for participants to give further opinions on matters that the researcher excluded from the questionnaire.

Participants were provided with the researcher's contact details for clarification and information purposes. Further discussion on the questionnaire survey is available in Chapter 4 (cf. 4.2).

3.2.4.3 *EvaSys survey-management system*

EvaSys is an internet-based survey-management system used by more than 500 institutions worldwide. It provides flexibility in survey methods and strong functions for reporting and analysis. Applications include module evaluations, event evaluations, alumni surveys, employee surveys, independent surveys and the Delphi survey. EvaSys can be used to create questionnaires, distribute questionnaires and analyse the results. It also captures data automatically.

EvaSys is able to send automatic reminders to participants to complete the questionnaires within a time frame set by the researcher. It also has a temporarily save option, so that participants can complete the questionnaire at times that suit them–participants do not need to complete the questionnaire in one sitting. EvaSys has an added benefit in that it guarantees confidentiality and anonymity, if needed (Meintjies 2013: Information session).

3.2.4.4 *The Delphi survey*

The Delphi survey was used in this study to describe the outcomes and essential content and to determine their relevance, effectiveness and importance in a cardiovascular perfusion programme.

The Delphi survey refers to the process of achieving consensus of opinion among a panel of experts in a given field. It consists of a structured group interaction process that is conducted in rounds of opinion collection and feedback. Once consensus of opinion or stability of data has been achieved the process is concluded (Skulmoski, Hartman & Krahn 2007).

Olaf Helmer and Norman Dalkey of RAND Corporation developed the original Delphi method in the 1950s for a US-sponsored military project. The initial aim was to develop a tool to forecast future events and their probable effects on society using questionnaires with controlled-opinion feedback (Helmer-Hirschburg 1964). There are two types of Delphi methods, namely, the *classical Delphi* and the *typical Delphi*.

a) *Classical Delphi*

Skulmoski *et al.* (2007) quote Rowe and Wright (1999), who characterised the classical Delphi method by four key features:

- Anonymity of Delphi participants: The participants are allowed to express their opinions freely, without undue social pressure to conform by other members of the group.
- Iteration: The participants refine their judgements or opinions after receiving feedback on the work of the group of participants from one round to the next.
- Controlled feedback: The participants receive feedback regarding their fellow participants' perspectives, giving each individual participant the opportunity to change or clarify his/her views and judgements.
- Statistical aggregation of group response: Quantitative analysis and interpretation of data takes place.

b) *Typical Delphi*

Skulmoski *et al.* (2007) explain their use of the typical Delphi process as follows:

- Develop the research question;
- Design the research; and
- Select the research sample: Selecting the appropriate experts is the Delphi process' most critical part, as the Delphi output is based on their expert judgements.

According to Skulmoski *et al.* (2007) there are four requirements for expertise:

- Do the participants have adequate knowledge and experience regarding the questions contained in the questionnaire?
- Do the participants' capacity and willingness allow them to participate?
- Do the participants have sufficient time to participate in the Delphi survey? and
- Are there efficient communicative skills at play?

The process then proceeds as follows:

- Develop round one of the Delphi survey: This is where the broad, initial "brainstorm" question is developed to ensure that the participants understand the question, thereby avoiding inappropriate answers and frustration.
- Delphi pilot study: This could be done to test and adjust the Delphi questionnaire to foresee procedural problems and facilitate comprehensive improvement.
- Release and analyse round one of the questionnaire: The participants receive, answer and return their questionnaires to the researcher, who then analyses the answers according to the research paradigm. This might include the use of reality maps in order to better approximate the collective intelligence on the topic.
- Develop round two of the questionnaire. Round-one answers form the foundation of round two's questions.
- Release and analyse round two of the questionnaire: Feedback is given to participants, who are provided the opportunity to verify that round one indeed reflects their opinions. Participants have the opportunity to change or expand their round-one responses once the other participants' answers have been shared with them.
- Further rounds continue until stability of the data or consensus of opinion has been achieved.

The Delphi method that was used in this study was the typical method following the steps given above. The research participants were experts who fulfilled the criteria explained in Step 3 above. The Delphi survey was a quantitative study consisting mainly of closed-ended questions that required participants to choose from the following options, i.e., essential, useful, or not needed. There were a few open-ended questions, as well as space provided under each unit of the questionnaire for participants to give further opinions on matters that the researcher might have excluded from the Delphi questionnaire.

The Delphi survey began in November 2014 and ceased once stability and consensus regarding all statements had been achieved. Consensus and stability was achieved at the end of the second round of the Delphi survey. The Delphi questionnaire was distributed via the EvaSys survey-management system (cf. 3.2.4.3), which also analysed the response data. The first round of the Delphi took place over nine weeks, starting on 7 November 2014 and concluding on 16 January 2015. The second round of the Delphi was conducted

from 2 February 2015 until 23 February 2015. Stability and consensus was deemed to have been achieved by the end of the second round and the research was concluded. An information document explaining the research as well as the Delphi survey was sent to participants prior to them receiving the Delphi questionnaires.

Stability has been described as the natural tendency for opinions of experts to centralise (Linstone & Turoff 1979:277). In this study, stability was declared when movement of the opinion of the group stagnated, which occurred in the second round of the Delphi.

Consensus was declared when 80% of the participants' votes fell within the same bracket on the scale. Dajauni, Sincoff and Talley (1979:83) state that consensus is assumed to have been achieved when a certain percentage of responses fall within a prescribed range for the value being estimated. Therefore, the aim of the Delphi survey was to reach a level of consensus among the expert panel members on a specific statement. According to Larson and Wissman (2000:46), consensus has been reached when 80% of the participants indicate a similar value (to a specific item) as their choice.

The complete details of the Delphi survey of this study is explained in Section 3.3.2, The Delphi Survey.

3.3 SAMPLE SELECTION

3.3.1 The questionnaire survey (Appendix C)

3.3.1.1 *Target population*

The target population of the questionnaire survey consisted of cardiovascular perfusionists who are involved in training and supervision and/or involved in lecturing cardiovascular perfusion students in SA. The target population involved 14 members.

3.3.1.2 *Survey population and sample size*

The survey population of the questionnaire survey consisted of all HPCSA-registered cardiovascular perfusionists (excluding managers/heads of perfusion departments) who are/were involved in training and supervision and/or involved in lecturing cardiovascular perfusion students in SA at the time of conducting the survey, and who completed the survey questionnaire (see Section 3.3.1.3. for description). The number of participants included all the available participants who met the criteria above. The questionnaire was distributed to 14 participants, and 10 participants completed the survey, hence, the participant's population size was 10.

3.3.1.3 *Sample description*

All HPCSA-registered cardiovascular perfusionists (excluding managers/heads of perfusion departments) who completed the survey questionnaire, are/were involved in training and supervision and/or lecturing cardiovascular perfusion students in SA and are currently employed or were employed in the past 10 years by the CUT, the DUT or one of the following seven academic hospitals that currently train perfusion students in SA, namely,

- Charlotte Maxheke Hospital (Johannesburg)
- Chief Albert Luthuli Academic Hospital (Durban)
- George Mukhari Hospital (GaRankuwa)
- Groote Schuur Hospital and Red Cross Children's Hospital (Cape Town)
- Steve Biko Academic Hospital (Pretoria)
- Tygerberg Hospital (Cape Town)

- Universitas Academic Hospital (Bloemfontein)

3.3.1.4 *Pilot study*

To determine the correctness of the structure and the amount of time needed to complete the questionnaire, to ensure the clarity of the questionnaire content, and to remove any bias, a pilot study was carried out. Prior to carrying out the pilot survey, a test questionnaire was sent by the EvaSys administrator to the researcher and his promoters using the EvaSys system to iron out any irregularities that might have crept in the electronic format of the questionnaire. A few minor errors were noted, e.g. numbering of questions and spelling errors. The errors were rectified and a second test questionnaire was sent to the researcher and his promoters. There were no errors identified in the second test questionnaire and the questionnaire was deemed appropriate to be distributed as a pilot.

The pilot study was carried out by sending an electronic questionnaire (EvaSys) to two qualified perfusionists who are currently involved or used to be involved in the training and lecturing of perfusion students in the last 10 years. The pilot study questionnaire was sent on 19 February 2014 and, upon request of the pilot study participants, they were given two weeks to complete the questionnaire. The pilot study was concluded on 4 March 2014 as both the pilot study participants had completed the questionnaire by this date. The pilot study was a success and no amendments to the questionnaire were necessary. The feedback from the participants was also very positive and they acknowledged that the questionnaire was easy to understand and simple to complete. They also believed that there was no bias in the questionnaire. It was ascertained that the questionnaire would take approximately 30 minutes to complete. The researcher and his promoter decided not to include the results of the pilot survey in the main survey. They felt that the sample size of 10 was adequate.

3.3.1.5 *Data collection*

An information document (Appendix A) explaining the research study and requesting participation in the questionnaire survey was sent to the participants a week prior to the distribution of the questionnaires. The questionnaires containing the explanation of the study as well as consent request was distributed to the relevant study population using the EvaSys electronic survey-management system. The completed questionnaires were collected by the EvaSys survey-management system.

3.3.1.6 *Data analysis*

The data (Appendix C) was analysed automatically by the EvaSys survey-management system. There was no need of the services of a biostatistician as the EvaSys system is capable of analysing all data. Frequencies, percentiles and histograms were generated by EvaSys. The collected data was integrated, summarised and displayed in graphical form.

3.3.2 The Delphi survey (Appendix F and I)

3.3.2.1 *Target population*

The target population of the Delphi survey consisted of a panel of experts from the field of cardiovascular perfusion, cardiac surgery and cardiac anaesthesiology who are/were involved in training and supervision and/or involved in lecturing cardiovascular perfusion students in SA or abroad.

3.3.2.2 *Survey population and sample size*

The survey population of the Delphi survey consisted of experts registered with their relevant registration bodies in their respective countries from the field of cardiovascular perfusion, cardiac surgery, and cardiac anaesthesia and who are involved in training, supervision and/or involved in lecturing/education of cardiovascular perfusion students in SA or abroad. International panellists did not complete the questionnaire. The population size was 18. The sample is made up of all the participants who responded to the Delphi survey, which numbered eight.

3.3.2.3 *Sample description*

All the experts fulfilled the following criteria:

- They possessed adequate knowledge and experience regarding the questions contained in the questionnaire;
- They were able and willing to participate in the Delphi;
- They had sufficient time to participate in the Delphi survey;
- There were efficient communicative skills at play;
- They were registered with their relevant registration bodies in their respective countries in the fields of cardiovascular perfusion, cardiac surgery or cardiac anaesthesia;
- They possessed more than 5 years' postgraduate experience in their fields; and
- They are/were involved in training, supervision and/or lecturing/education of cardiovascular perfusion students in SA or abroad, and they completed the Delphi survey (Skulmoski *et al.* 2007).

The experts from the field of cardiovascular perfusion in SA were managers/heads of cardiovascular perfusion at the following academic hospitals that provide training of perfusion students:

- Charlotte Maxheke Hospital (Johannesburg)
- Chief Albert Luthuli Academic Hospital (Durban)
- George Mukhari Hospital (GaRankuwa)
- Groote Schuur Hospital (Cape Town)
- Red Cross Children's Hospital (Cape Town)
- Steve Biko Academic Hospital (Pretoria)
- Tygerberg Hospital (Cape Town)
- Universitas Academic Hospital (Bloemfontein)

The experts from the field of cardiothoracic surgery and cardiac anaesthesia in SA were heads of departments of cardiothoracic surgery and cardiac anaesthesia at the following academic institutions:

- Medical University of South Africa
- University of Cape Town
- University of the Free State
- University of KwaZulu-Natal
- University of Pretoria
- University of Stellenbosch
- University of Witwatersrand

The international panel consisted of the general secretary and chairman of the academic committee of the EBCP, the chairman of EACTS and three other cardiac surgeons who are internationally recognised as experts in their fields.

3.3.2.4 *Pilot study*

To determine the correctness of the structure and the time needed to complete the Delphi questionnaire, the clarity of the Delphi questionnaire content, and to remove any bias, a pilot study was carried out. The pilot study was carried out by sending an electronic questionnaire (EvaSys) to one qualified perfusionist who had, the last 10 years, held the position of manager/head of perfusion, and who was a specialist (not part of the research team) at the Department of Cardiothoracic Surgery at Universitas Academic Hospital. The questionnaire remained unchanged but the researcher and his promoter decided not to include the results of the pilot study in the analysis of the final data of the main study.

3.3.2.5 *Data collection*

An information document explaining the research study and requesting participation in the Delphi survey was sent to the participants a week prior to the distribution of the Delphi questionnaire. The questionnaire containing the explanation of the study as well as consent request was distributed to the relevant study population using the EvaSys electronic survey-management system. The completed questionnaires were collected by the EvaSys survey-management system (Appendix F and I).

3.3.2.6 *Data analysis*

The data was analysed automatically by the EvaSys survey-management system. There was no need of the services of a biostatistician as the EvaSys system is capable of analysing all data. The results are reported separately for each round in the discussion of the measuring instrument, which details the topics dealt with in the different sections of the Delphi survey and provides an analysis of the responses for each round.

The findings of each round ended with a summative discussion of the round's findings (Appendix G and H). In this study, consensus was defined as having been reached when 80% of the participants indicated a similar value (to a specific item) as their choice. Statements on which consensus had been reached were deemed essential components to be considered when describing the outcomes and essential content of a cardiovascular perfusion programme. Statements on which no consensus was achieved, but for which stability was reached, will be tabulated. Finally, an overall discussion of the results is provided, with derived conclusions and recommendations, which will form the basis of the outcomes and essential content of a cardiovascular perfusion programme.

The information that emerged from the literature review and document analysis and the results of the Delphi survey will be used to describe the outcomes and essential content of a cardiovascular perfusion programme.

3.4 ETHICAL CONSIDERATIONS

3.4.1 Ethical approval

Approval to carry out the research was obtained from the Ethics Committee of the Faculty of Health Sciences, UFS. Since no invasive procedures were performed permission from hospital managers was not necessary. However, permission was sought from hospital managers, since the majority of participants were employed by hospitals (Appendix B). Permission was also sought from the dean of the faculty of health and environmental sciences of the CUT and the dean of the faculty of health sciences of the DUT, and the schools of medicine of the universities listed in Section 3.3.2.3 to permit their employees to participate in the study (Appendix C).

3.4.2 Informed consent (Appendix D)

Participation in the study was completely voluntary and did not involve any cost to the participants. There was no remuneration whatsoever in cash or kind nor were there any risks involved by participating in the study. Participants were free to withdraw from the study as and when they wished without explanation and without the fear of being prejudiced.

An overview of the study was provided to the target population. The target population was informed via email that they would be receiving the EvaSys-based questionnaire at least a week before they received the actual EvaSys-based questionnaire.

The first statement of the questionnaire in the questionnaire survey as well as the Delphi survey informed participants that completing the questionnaire would be regarded as informed consent. Thus, a separate informed consent document was not necessary. A written guarantee of anonymity of participants and confidentiality of information was provided to the questionnaire survey participants and a written guarantee of confidentiality of information was provided to the Delphi panellists. The process of Delphi does not allow for anonymity of participants because the researcher has to know which of the Delphi panel members answered the Delphi statements.

3.4.3 Privacy policy

The EvaSys survey-management system guarantees to provide anonymity and confidentiality as it automatically sends out reminders, hence neither the researcher nor any other person is aware of who has answered the questions of the questionnaire survey and who has not. In the questionnaire survey anonymity and confidentiality was guaranteed. The Delphi survey process demands that the researcher is aware of who answered the questionnaire so anonymity was not guaranteed. However confidentiality of information was guaranteed.

3.5 VALIDITY, RELIABILITY AND RIGOUR

3.5.1 Validity

"Validity establishes whether the results obtained meet all of the requirements of the scientific research method" (Shuttleworth 2008:Online). In other words, does the tool measure what it is supposed to measure in order for the researcher to obtain truthful results? The most common categories of validation are **face, content, criterion and construct validity**.

Face validity considers the face value of the measuring instrument. For this method of validation, no quantitative methods are needed. Researchers look at the questionnaire as a whole and its individual items and ask themselves, "Does it seem to measure what it should?" Face validation, in a sense, is a form of common sense applied to a questionnaire's purpose. It is useful because it reduces the possibility of encountering resistance from respondents (Delport & Roestenburg 2011:173-174).

Content validity is achieved by observing all the specific items on the questionnaire to determine whether the questionnaire addresses the topic overall. This type of validation is often the most important validation in developing new questionnaires. Typically, researchers create a list of all that the questionnaire is meant to measure and check the items on the questionnaire against this list. This enables researchers to ensure that every item corresponds to a desired measurement and that everything that should be measured is actually measured. Delport and Roestenburg (2011:173) cite Rubin and Babbie (2001), who suggest that content validity is established on the basis of judgements, that is, a judgement of whether the measuring instrument covers the entire concept made by the researchers and other experts. The main difference between face validation and content validation is that any individual can use face validation to validate a questionnaire, whereas content validation is performed by experts.

Criterion validity provides an objective evidence of validity. It compares scores of an instrument with other criteria known to measure the same concept. In other words, criterion validity can be established when there are other questionnaires or similar measures that investigate the same aspect of interest as the questionnaire in development. If the creators find that a questionnaire's responses correlate with that of another measurement,

then they can confirm concurrent validity (Delport & Roestenburg 2011:174).

Construct validity relates to the degree to which an instrument measures the characteristic being investigated, that is the extent to which the conceptual definitions match the operational definitions (The Free Dictionary:Online). The construct being measured should adequately represent the theoretical context (Delport & Roestenburg 2011:174-175).

To ensure face validity of this study the researcher consulted various perfusion programmes and followed new developments in cardiac surgery and perfusion by attending congresses and reviewing literature and using the information gained from this to develop the contents of the questionnaire. Content validity was ensured by a thorough study of the questionnaire by the researcher and his promoters, who are experts in the field of education, cardiac surgery and perfusion. The evaluation process and the ethical committee's approval further ensures content validity of the questionnaire. Delport and Roestenburg (2011:173) state that, "content and face validity may be established prior to data collection, while criterion and construct validity are established once the instrument has been used to collect data". Prior to conducting the pilot a test questionnaire was distributed electronically via the EvaSys system to the researcher and his promoters. This ensured face and construct validity by enabling the researcher and his promoters to view the questionnaire in the electronic format on the EvaSys system.

Using a pilot study and well-structured questionnaires compiled with the aid of the EvaSys survey-management system for the questionnaire survey and the Delphi survey, and using experts in this field who were selected using predefined criteria, from variety of backgrounds and different institutions throughout SA, contributed much to ensuring the validity of this study. Hasson, Keeny and McKenna (2000:1013) quote Goodman, *Making use of participants who are experts in their field and who have an interest in the subject area, may help increase the validity of the Delphi.*

By making use of the questionnaire survey results to develop the Delphi statements also ensured criterion and construct validity, because this enabled the researcher to compare the results of the successive rounds of the Delphi with each other as well as to the questionnaire survey.

3.5.2 Reliability

The ability to generate the same results under similar conditions repeatedly with the same experiment is known as reliability (Shuttleworth 2008). Delport and Roestenburg (2011:177) cite Neuman and Kreuger (2003) and Salkind (2006), who suggest that reliability of measures can be increased by the procedures such as the following: eliminating unclear items, standardising instructions and conditions, maintaining consistent scoring procedures and using pilot studies.

To ensure that this study is reliable a pilot study was carried out to eliminate bias and unreliable elements from the questionnaires of both the questionnaire survey and the Delphi survey. Ensuring well-constructed questionnaires by using the EvaSys survey-management system and the help of an EvaSys expert, implementing strict criteria for selecting the sample population for both the surveys, and putting measures in place to ensure high response and completion rates further enhanced the reliability of the results.

The EvaSys survey-management system automatically reminded participants to complete the questionnaire and the researcher also reminded and encouraged participants to complete the questionnaire which enhanced the response rate, thereby increasing the reliability of the study.

Using the questionnaire survey results to develop the Delphi statements also ensured reliability, as these statements were standardised and were clear and unambiguous. Scoring procedures were also consistent, as data was analysed and managed by the EvaSys system.

3.5.3 Rigour

The rigour of the study was ensured by the steps listed in Section 3.2.4.4 (b). To avoid repetition the process is not repeated here.

3.6 CONCLUSION

Chapter 3 provided the theoretical perspectives of the research design, explanations of qualitative and quantitative research designs, the types of Delphi, methods used to conduct the study and the procedures that were followed, the ethical aspects related to the study as well as how reliability, validity, and rigour was ensured.

In the next chapter, Chapter 4, entitled ***Results, analysis, interpretation and the discussion of the findings of the questionnaire survey***, will be presented in the form of graphs, and will be discussed accordingly.

CHAPTER 4

RESULTS, ANALYSIS, INTERPRETATION AND THE DISCUSSION OF THE FINDINGS OF THE QUESTIONNAIRE SURVEY

4.1 INTRODUCTION

In Chapter 3 the methodology used in the research project and the theoretical aspects thereof were discussed. In this chapter the results obtained from the questionnaire survey are presented in line with the objectives stated in Chapter 1 (cf. 1.4.3), using graphs, followed by a discussion of the data obtained from each graph. The results of the open-ended questions (qualitative data) included for certain questions in the questionnaire will also be discussed. That will be followed by a short summary and conclusion of the chapter. The processes of literature review and questionnaire survey were used to collect the data.

4.2 THE SURVEY PROCESS AND FEEDBACK

The purpose of the questionnaire in this survey is to determine the adequacy and validity of current outcomes and essential content of the cardiovascular perfusion programmes in SA and to obtain statements for the Delphi survey.

The reasons for choosing the questionnaire survey as the method of collecting the data, the explanation of the format and time frame of the survey are explained in Chapter 3 (cf. 3.2.4.2; cf. 3.3.1).

The researcher obtained permission from the relevant institutions to conduct the study amongst their employees. The consent request document had a clause stating that, if the researcher did not receive any response by 28 March 2014, the non-response would be regarded as consent. The number of participants is limited as there are not many perfusionists who meet the required inclusion criteria (cf. 3.3.1.2).

Prior to conducting the survey, pilot study questionnaires were completed by two qualified perfusionists who are currently involved or were involved in training and lecturing perfusion students within the last 10 years. No corrections or amendments were needed to be made

to the questionnaire (cf. 3.3.1.4).

The email addresses of participants were obtained either by phone calls to the head of perfusion at each institution where the participants were employed, or by consulting the websites of the relevant universities of technology at which participants were employed.

A week before the questionnaires were distributed an information document explaining the research study and requesting participation in the questionnaire survey was sent to the target population. The information document informed participants when and how they would receive the questionnaire. The information document also contained the contact details of the researcher, in case the participants needed clarification or wished to comment.

The dates and method of distribution of the questionnaire were discussed in Chapter 3 (cf. 3.2.4.2). The questionnaire was sent to 14 participants who had been identified in SA. The initial time frame of the survey was four weeks, but by the end of three weeks very little response had been received, even though reminders had been sent to the participants (cf. 3.3.1.4). Telephone calls to participants at one institution revealed that the email addresses were work addresses and the employer had restricted links and websites that employees could access; therefore the participants could not access the link to the questionnaire from their work email addresses. Private email addresses were then obtained and the link to the EvaSys questionnaire was sent to participants' private email addresses.

The survey time frame was then extended to provide participants more time to complete and submit the questionnaires online. The response rate was quite slow and reminders were constantly made via email by EvaSys, and via "Whatsapp" messages and telephone calls by the researcher. The researcher also made calls to the head of perfusion at each hospital to request that the relevant participants under the head's management complete and submit the questionnaire. By 21 July 2014 the survey was closed as the researcher and the supervisors were of the opinion that no more responses would be forthcoming. A total of 10 responses (71.4% of the 14) had been received.

4.3 DEMOGRAPHIC INFORMATION

In this section the participants' demographic information is interpreted and displayed in graphs. Information regarding the participants' ages and genders, the years they obtained their qualifications and were employed, and type and institution of qualification(s) and employment was recorded.

4.3.1 Age of participants

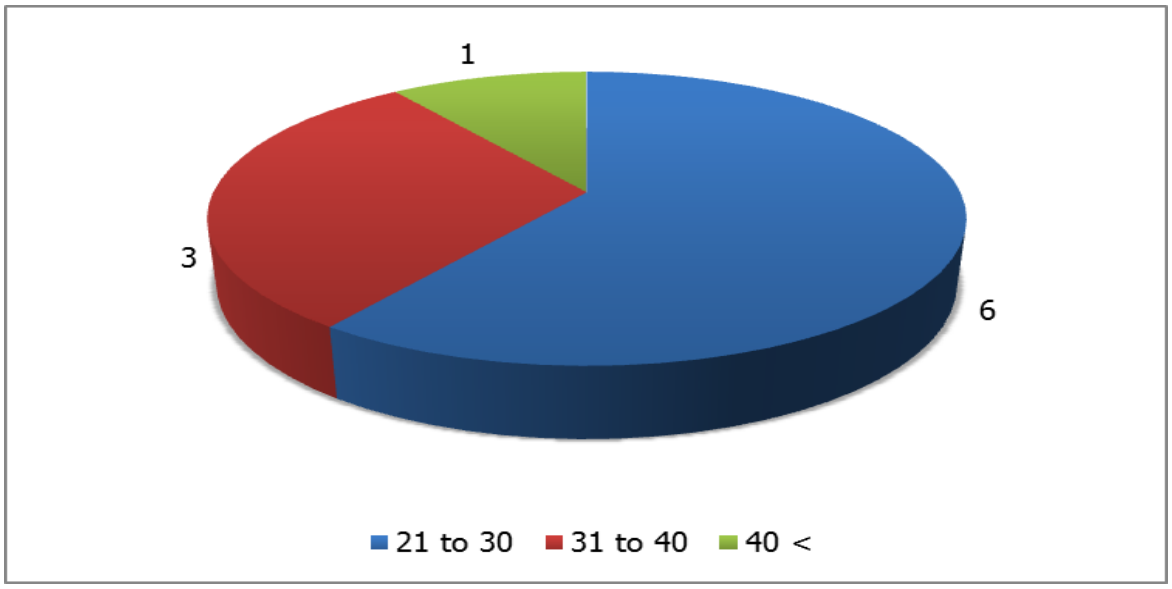

Figure 4.1: Age distribution of participants (n=10)

The average age of respondents was 31.7 years, with a median of 29. The ages of respondents ranged from 25 years to 47 years at the time of completion of the survey. Two were aged 25, one aged 27, two aged 28, one 29, one 32, one 37, one 39 and one 47 years of age. The largest number of respondents were in the age group 21 to 30 years of age (60%), followed by the age group 31 to 40 years of age (30%); 10% of the respondents were in the older than 40 years age group.

4.3.2 Gender

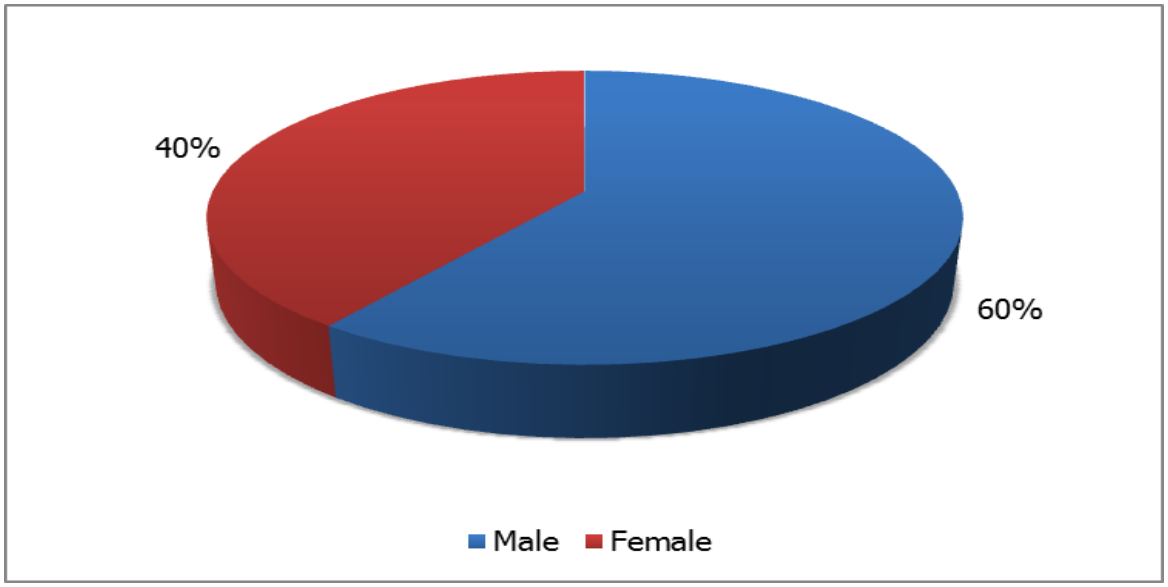

Figure 4.2: Gender distribution of participants (n=10)

The gender profile comprised 60% male and 40% female respondents.

4.3.3 Institutions that awarded B.-Tech. qualifications

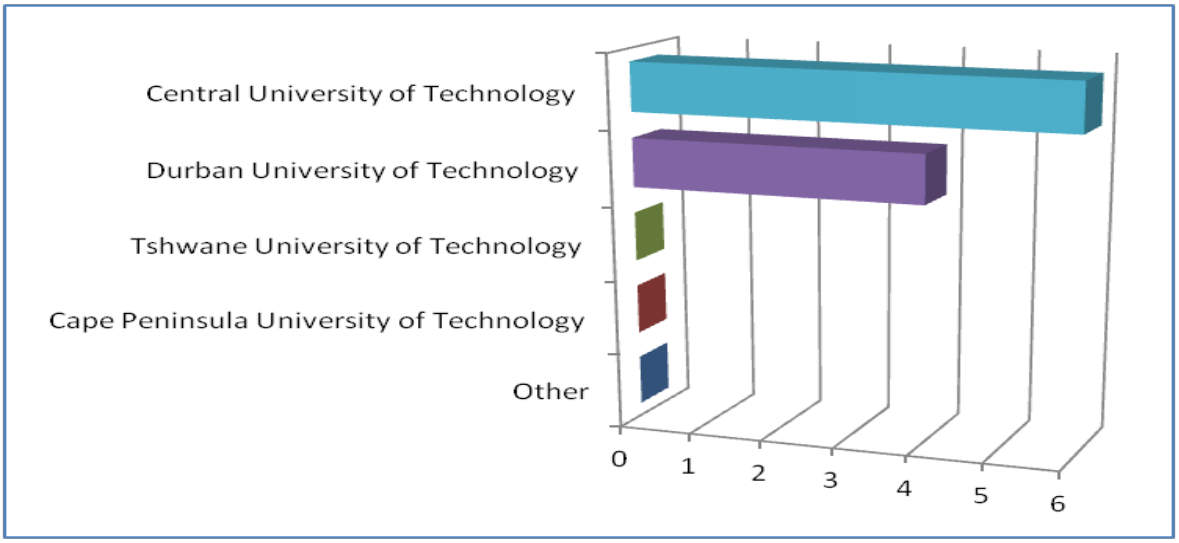

Figure 4.3: Institutions awarding B.-Tech. qualifications (n=10)

All the respondents had obtained their qualification at South African universities of technology. All qualifications were obtained from Central University of Technology (60%) and Durban University of Technology (40%).

4.3.4 Year of obtaining B.-Tech. qualification

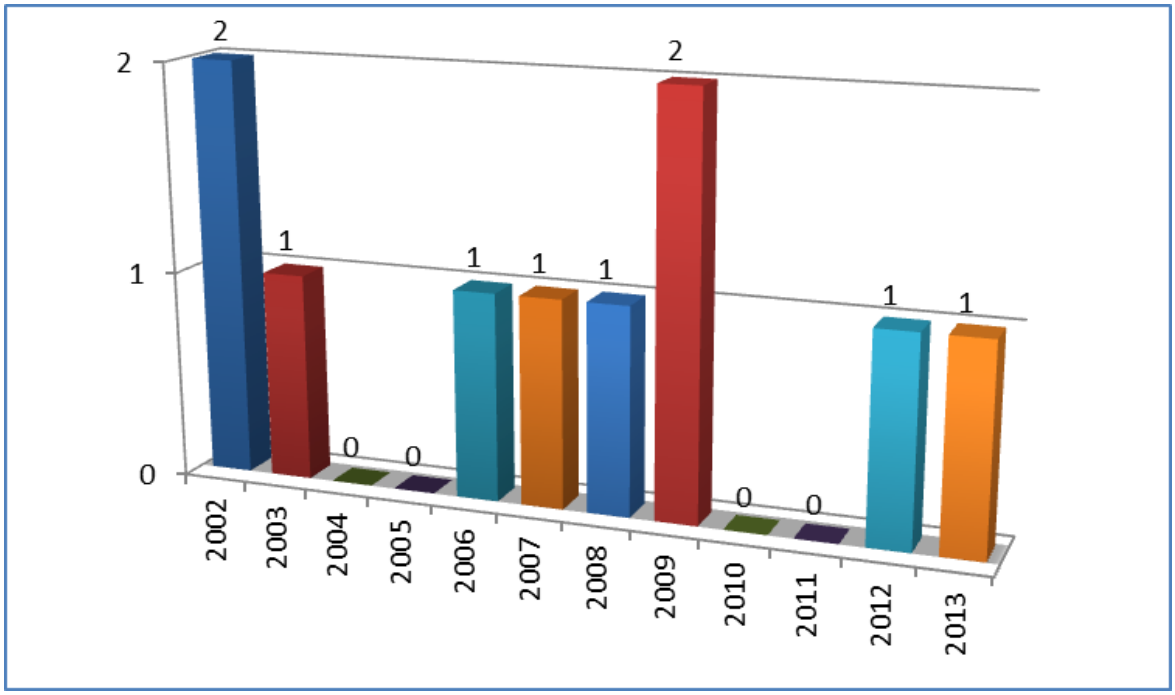

Figure 4.4: Years in which participants attained B.-Tech. or equivalent qualifications (n=10)

The earliest year of qualification of the 10 respondents was 2002, and the most recent qualification was completed in 2013. Of the 10 respondents, two respondents qualified in 2002 and two in 2009, whilst one participant qualified in 2003, one in 2006, one in 2007, one in 2008, one in 2012 and one in 2013.

4.3.5 Postgraduate qualifications

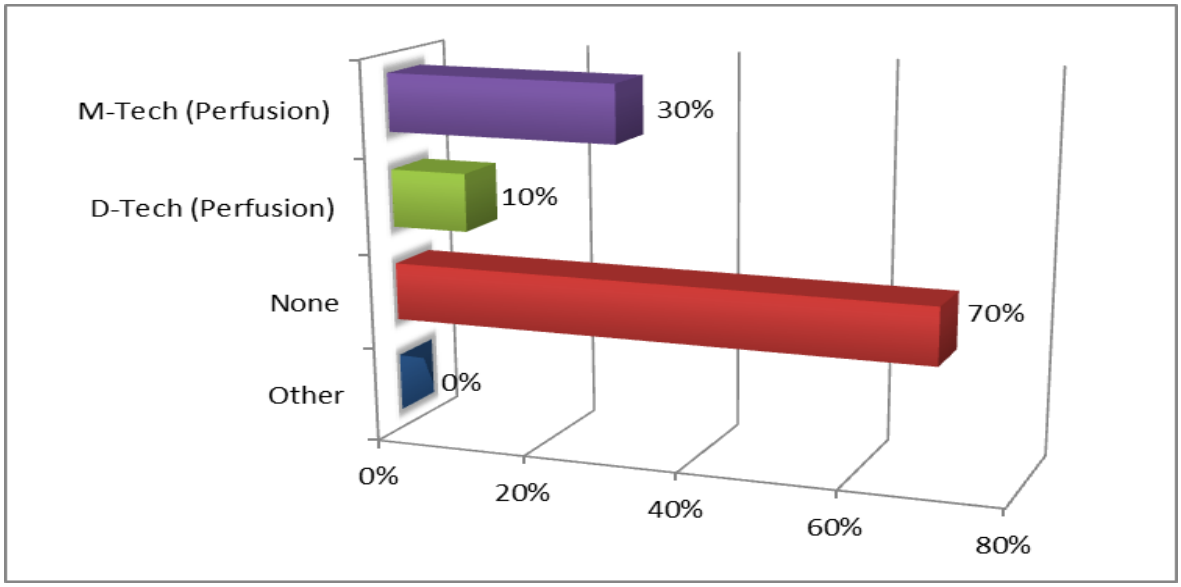

Figure 4.5: Postgraduate qualifications completed (n=10)

The majority of the respondents (70%) do not have postgraduate qualifications, whilst 30% possess M.-Tech. Clinical Technology (Perfusion) degrees and 10%, one respondent, possesses a D.-Tech. Clinical Technology (Perfusion) qualification. None of the respondents have postgraduate qualifications in any other field.

4.3.6 Place of employment

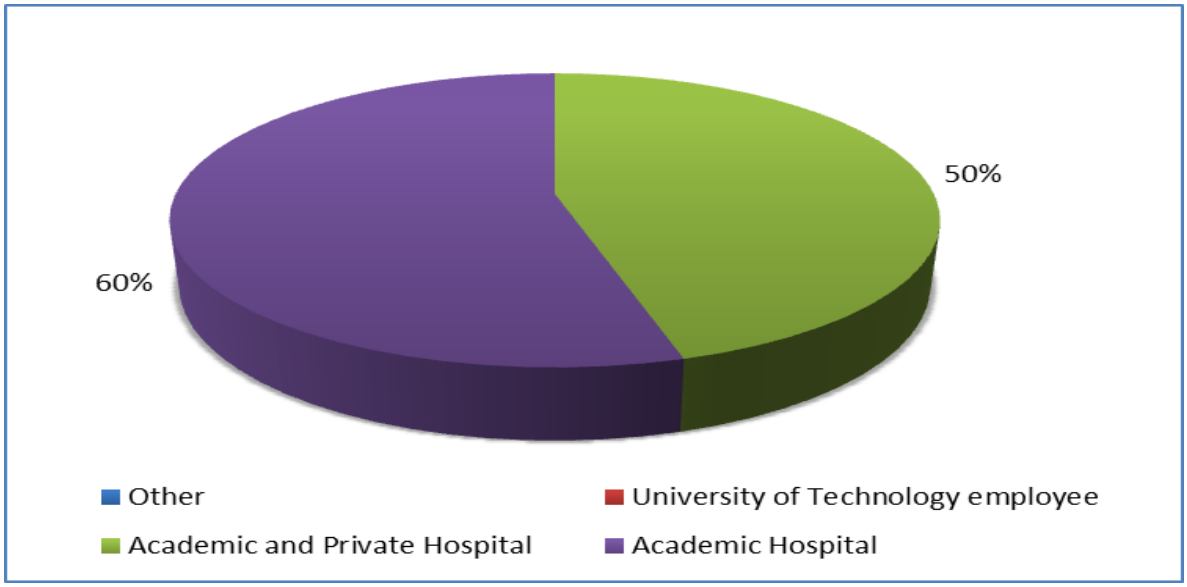

Figure 4.6: Place of current employment (n=10)

This question determined where the participants worked, whether they were employed by an academic (public) hospital, a private hospital, a university of technology, any other place or a combination of any of the places mentioned.

The EvaSys survey results chart indicates that 50% of the respondents worked only at an academic hospital, and 60% worked at both academic and private hospitals. The 10% excess that is obtained here is due to one of the respondents ticking both the options, i.e. 1. Academic hospital and 2. Academic and private hospital. We can deduce that 50% of the respondents work only in an academic hospital setting and 50% work in academic as well as the private settings. None of the respondents indicated that they were employed by a university of technology or by any other employer.

Many of the hospitals permit healthcare professionals, which include perfusionists, to work outside public service, termed remunerative work outside public service (RWOPS), hence 50% of the respondents are able to work in the public and the private sector.

4.3.7 Type of employment

To ascertain the type (full time/part time) of employment at the participant's place of employment (cf. 4.3.6) the participants were asked to choose between full time, part time and not applicable in all the categories mentioned below.

4.3.7.1 *Type of employment at academic hospital*

All the respondents (100%) indicated that they were full-time employees of an academic hospital. The following figure indicates this finding.

4.3.7.2 *Type of employment at private hospital*

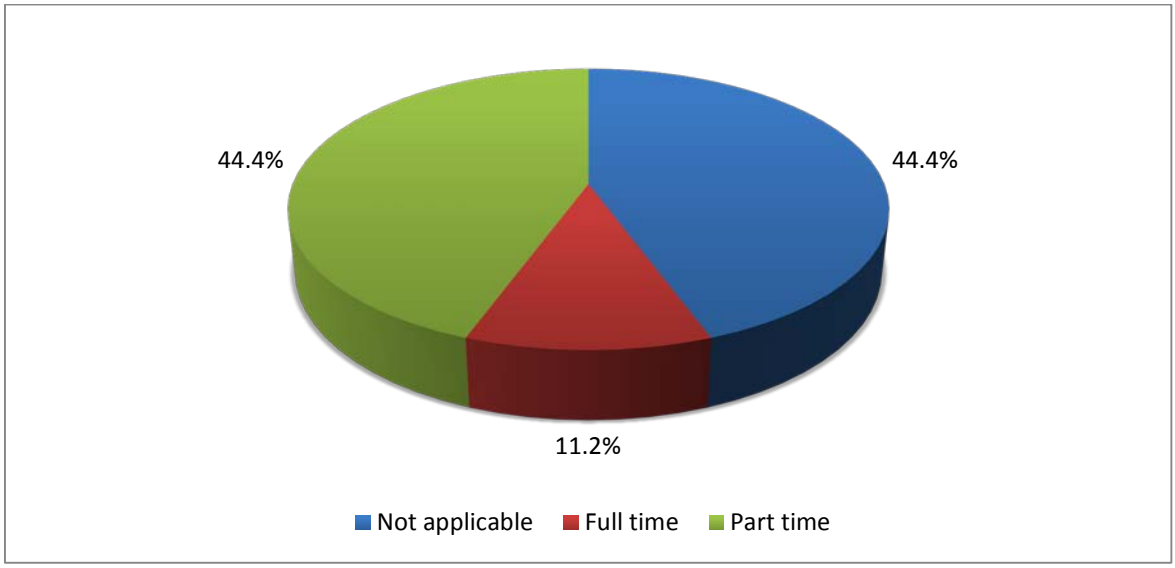

Figure 4.7: Type of employment at private hospital (n=9)

One respondent abstained from answering this question for unknown reasons. Of the remaining respondents 44.4% indicated that they were working part time at a private hospital, 11.1% indicated that they were employed full time at a private hospital and 44.4% answered not applicable.

It can be ascertained that the 44.4% who answered not applicable were from the 50% (cf. 4.3.6) who indicated that they worked only at academic hospitals. Regarding the 11.1% who indicated that they worked full time at private hospitals: knowing that 100% of the respondents were full-time employees at academic hospitals (cf. 4.3.7.1), we can ascertain that the 11.1% who indicated that they work full time at private hospitals regard themselves as having two full-time jobs.

4.3.7.3 *Type of employment at university of technology*

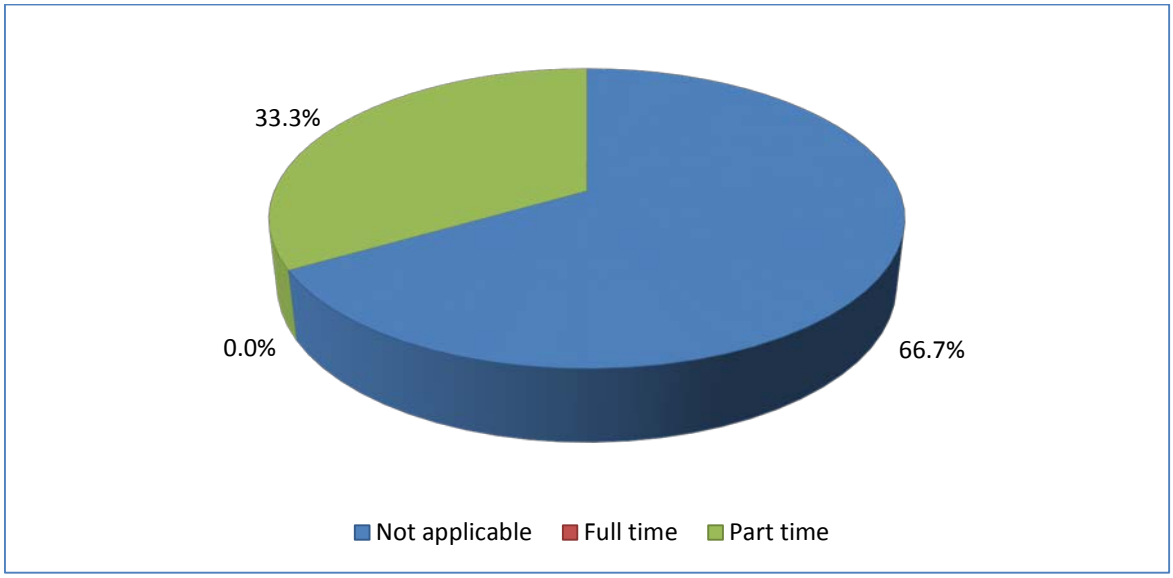

Figure 4.8: Type of employment at university of technology

One respondent abstained from answering this question. Of the remaining respondents 33.3% indicated that they were employed on a part-time basis by a university of technology, and 66.7% indicated that the question was not applicable to them, meaning they are not employees of a university of technology.

The indication by 33.3% of the respondents that they are part-time employees does not correlate with the question regarding place of employment (cf. 4.3.6), as none of the respondents indicated in that question that they were employed by a university of technology. It could be that the respondents overlooked their choice of employment at a university of technology or, because none of them are full-time employees at a university of technology they did not deem it significant to state that they were employed by a university of technology. From the researcher's own experience part-time employment at a university of technology entails lecturing for only one hour per week, hardly enough time to consider as employment.

4.4 VALIDITY AND ADEQUACY OF CURRENT OUTCOMES

In this section the validity and adequacy of the current outcomes of cardiovascular perfusion programmes will be determined and the statements that should form part of the Delphi statements will be identified. This section contained both open-ended and closed-ended

questions. For the closed-ended questions participants had to choose between "yes", "no", and "unsure", whilst the open-ended questions asked for either a motivation for the choice made by participants in the closed-ended question, or an opinion or facts regarding certain matters.

The responses for the open-ended questions, are reproduced as given by the respondents; no changes to the spelling, grammar or any other matter have been made throughout the document.

4.4.1 Modification of the current exit-level outcomes

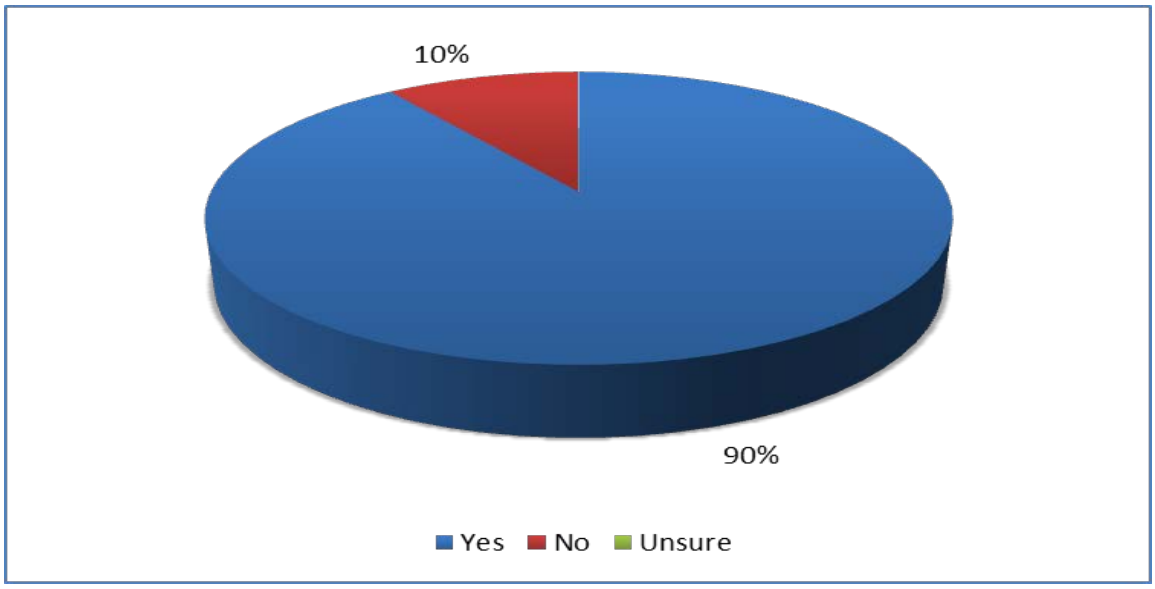

Figure 4.9: Is there a need to modify the current exit-level outcomes? (n=10)

Participants were asked whether there was a need to modify the current exit-level outcomes of the perfusion programme to prepare perfusion graduates better to meet new expectations. An emphatic 90% of the respondents indicated that there was a need to modify the current exit-level outcomes, and 10% of the respondents indicated that there was no need for change.

An open-ended question asking for a motivation for their choice revealed interesting opinions. The points are given verbatim below:

- *"I think there should be a more streamlined approach with regard to theoretical and practical training amongst the various institutions, as this shall prepare better the*

newly qualified for work in any of the various institutions."

- *"Paediatric requirements need to be looked at. There are few academic hospitals doing regular paediatric cases. With Adults ECMO needs to be looked at as well as other LVAD support devices not used frequently at accredited training institutions. A weekend congress/learning/wetlab session should be held for fourth years to give them some exposure. MiniCPB and centrifugal pump bypass can also be included in such a week/weekend."*
- *"Students need better exposure to other perfusion practices."*
- *"The volume of academic work that is expected of students cannot be accomplished within a year for those exiting at diploma level. Further the allocation of complicated cases cannot be covered within a year resulting in inadequately trained 'perfusionists'."*
- *"There is no standard practice and training amongst universities and hospitals.*
- *"To keep up to date with new developments."*
- *"Yes definitely. To make sure that the standard among the graduates is at the same level. According to the uniform outcomes the preparation and evaluation of the students could be compared between different units."*
- *"I think SA should have programmes like abroad which are strictly perfusion from 1st year."*
- *"If the exit is a btech, this will motivate the graduates to further studies like mtech & dtech"*
- *"They can graduate but must remain in the training for two years more as juniors"*

4.4.2 Description of the current exit-level outcomes

Participants were asked to indicate the current exit-level outcomes described by the institution their students are part of. The following responses were received:

- *"At the moment universities have different curriculums reason why i dont knw? But Dut focuses on the academic side (research) and rely on the student competent and where training takes place. So when these factors have problems that when you get an incompetent Perfusionist pumping cases."*
- *"120 Cases of which 20 or more must be children. With 2 years full time practical training."*
- *"120 adults and 20 kids. B.Tech research. CUT"*

- *"4 years of two are practical training"*
- *"Central University of Technology."*
- *"completion of a B. Tech Degree"*
- *"Diploma - Supervised Practice"*
- *"B Tech - Independant Practice"*
- *"I was left to sort things out for myself. I qualified in 2006 from the Durban Institute of Technology and didn't have correspondence with them apart from course material."*
- *"The outcomes is met by practicals throughout the year and the student need to do 100 Adult CPB and 20 children. Central University of Technology"*
- *"ndip , tut"*

The above answers provided by the participants are not actually exit level outcomes of cardiovascular perfusion but rather specific requirements for qualification. This is due to a possibility of participants who are supervisors or lecturers of students not being aware of the current outcomes. It is also possible that the relevant universities of technology may have not provided the participants and lecturers with the outcomes that need to be achieved which could be due to exit level outcomes specific to cardiovascular perfusion not being described. We can gauge from the above answers that every institution has its own requirements, determined mainly by the training institution (hospital) and not the institution (university of technology) awarding the qualification. There are no uniform outcomes that have been stated that need to be achieved by the students in order to qualify.

4.4.3 Adequacy of current exit-level outcomes

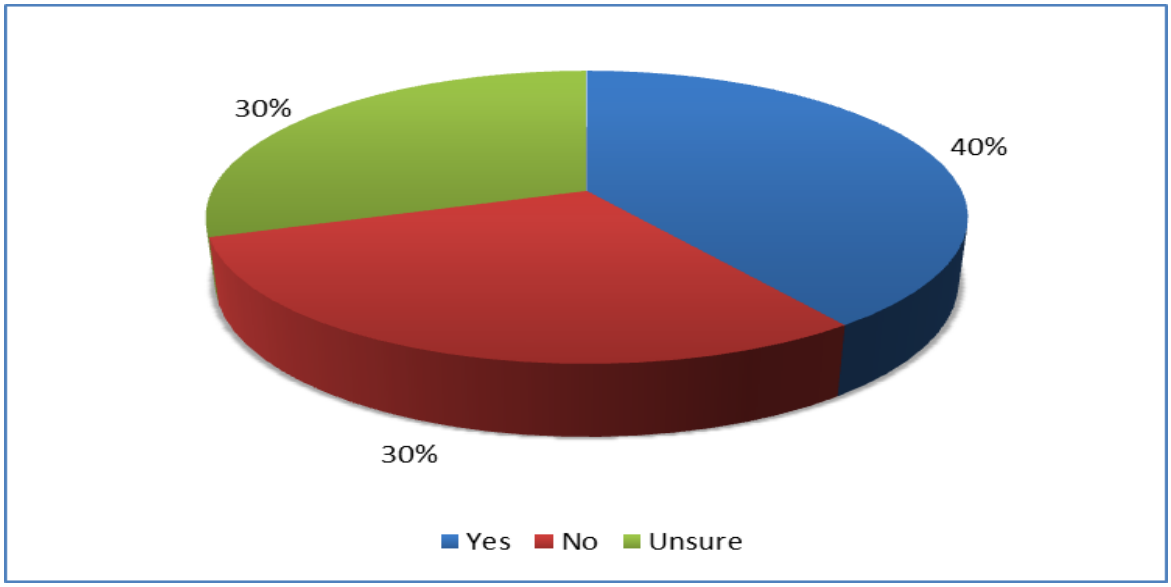

Figure 4.10: Do the current exit-level outcomes of perfusion education adequately prepare the perfusionist? (n=10)

Participants were asked whether the current exit-level outcomes of perfusion adequately prepare the perfusionist for the expectations of modern practice. Forty per cent of the respondents were of the opinion that the current exit-level outcomes were adequate to prepare the perfusionist, while 30% stated that the outcomes were not adequate and another 30% of respondents were unsure whether the exit-level outcomes were adequate or not.

To motivate the answers, the following remarks were made:

- *"It depends where the perfusionist works once they are qualified."*
- *"Its a fine line because it is entirely dependent on the training facility. Some are prepared well enough and others are prepped just enough to manage the profession."*
- *"Think the practical training must be extended to 3 years."*
- *"Those exiting at B Tech level have a better grounding and understanding of perfusion practice because they have covered the fundamentals in the 1st year. The number of cases covered in the B Tech level (provided students are placed in a busy unit) increases the confidence of junior perfusionists and exposes them to a variety of cases."*

- *"atleast three years practical training can be enough"*
- *"the trainees come in underequipped"*
- *"throughout the training program the students are tested. the requirements is well in range and to fulfill the requirements the students are exposed to a large margin of different cases."*

4.4.4 Competency of newly qualified perfusionists

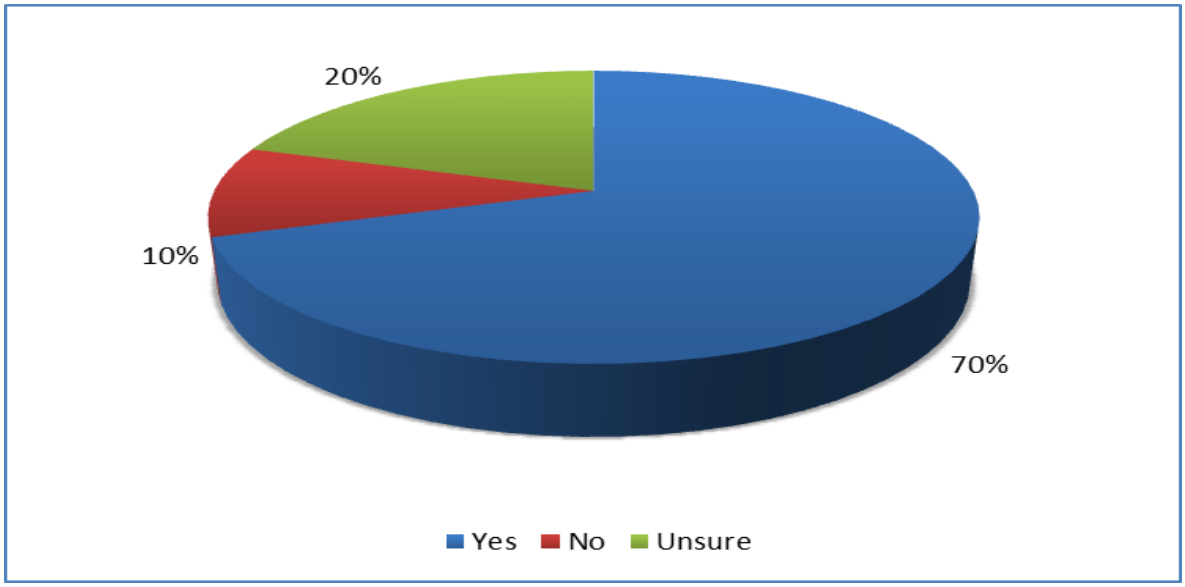

Figure 4.11: Are the newly qualified B.-Tech. perfusionists competent to fulfil the tasks? (n=10)

The next question asked whether the newly qualified B.-Tech. perfusionists employed at their hospitals were competent to fulfil the tasks required of them. Seventy per cent of the respondents indicated that the newly qualified perfusionists were competent whilst 10% indicated that they were not, and 20% of the respondents were unsure about the competency of the newly qualified perfusionists.

Participants were asked: If you answered "No", then please indicate in which tasks do you find them incompetent? The following responses were received:

- *"I was the last BTech to qualify in 2006 and still remain at my institution. We had a student just complete his BTech in 2009 and then leave our institution."*
- *"we haven't taken any newly btech perfusionists, we take them as students & train them"*

Participants who were unsure were asked to explain why they were unsure:

"None of the students have qualified yet."

4.4.5 Change in exit-level outcomes to improve competencies

The participants were then asked whether a change in exit-level outcomes would improve the scope of competencies of the graduates.

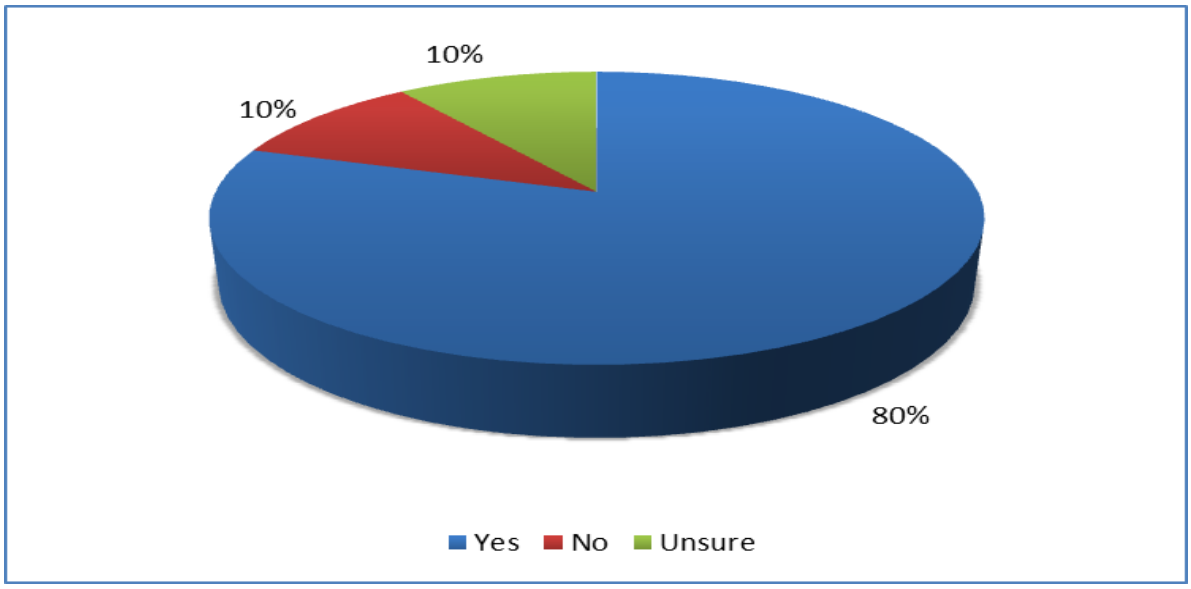

Figure 4.12: Would a change in exit-level outcomes improve the scope of competencies of graduates? (n=10)

Eighty per cent of the respondents responded with "yes", indicating that they believe that a change in the exit-level outcomes will improve competencies. Ten per cent of the respondents indicated that it would not improve and another 10% were unsure whether a change in exit-level outcomes would improve competencies or not.

4.4.6 Standardised curriculum

The participants were asked whether they believed that there should be a standardised curriculum to be used by all institutions.

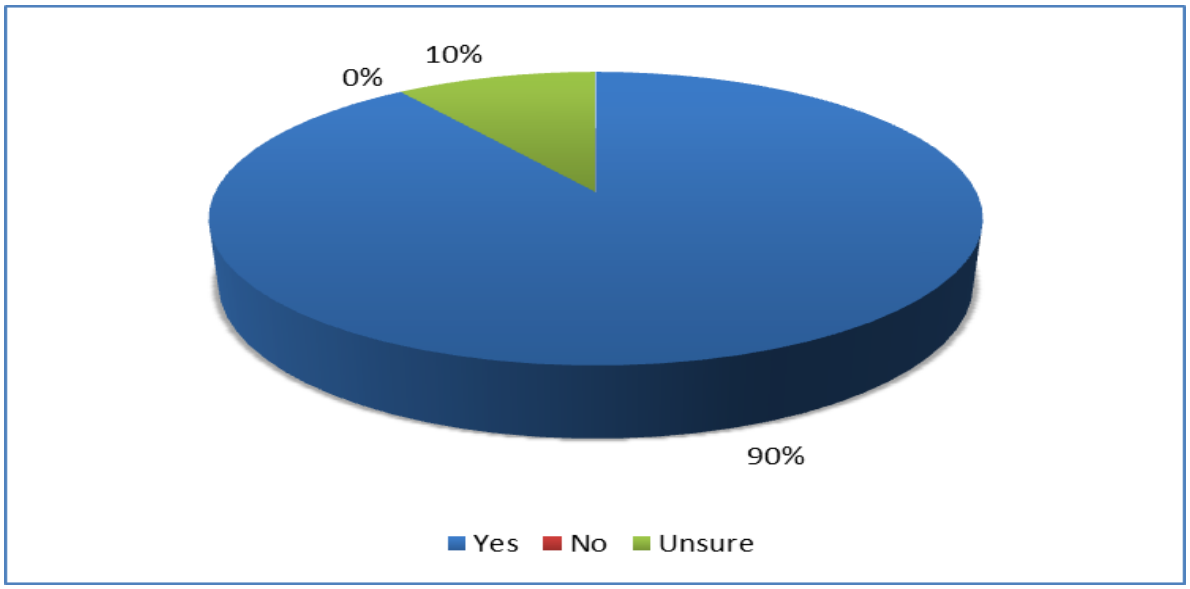

Figure 4.13: Should a standardised curriculum be used by all institutions? (n=10)

Ninety per cent of respondents indicated that a standardised curriculum should be used by all institutions and 10% were not sure if that should be the case.

4.4.7 Single exit exam

The respondents (100%) were unanimous that a single exit exam should be a requirement for assessing that all outcomes have been fulfilled.

4.4.8 Format of the exit exam

Participants were asked how the exit exam should be conducted.

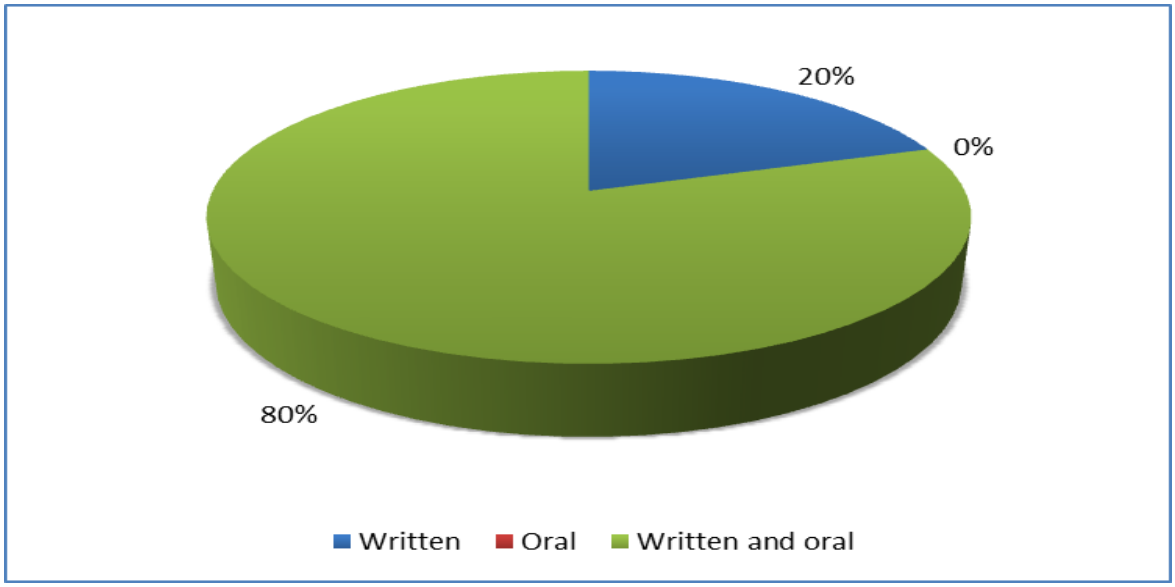

Figure 4.14: How should the single exit exam be conducted? (n=10)

Eighty per cent of respondents indicated that the exit exam should be both in written and oral form, whilst 20% indicated that it should be only in written form. None of the respondents indicated that an oral exam only would be sufficient.

4.4.9 Conducting the exam

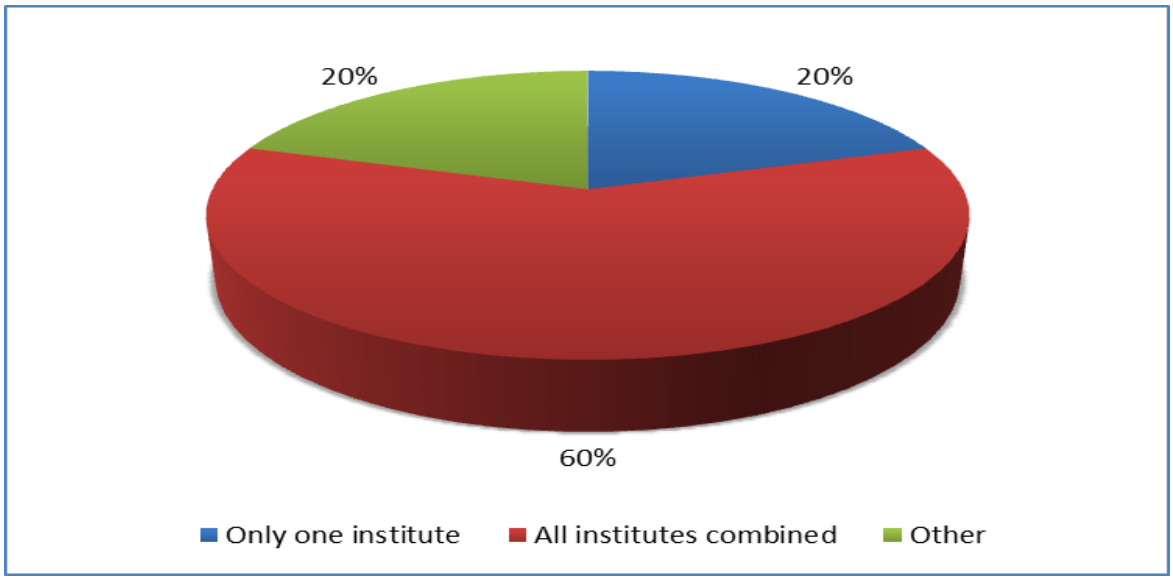

Figure 4.15: Who should conduct the exit exam? (n=10)

Participants were asked to indicate who should conduct the exit exam. The favoured choice of 60% of respondents was "all institutions combined". Twenty per cent indicated that only one institution should conduct the exam and 20% selected "other" as their choice.

Respondents who answered that another body/institution should conduct the exams were asked to clarify their answers:

- *"Exams should be conducted by a College of Cardiovascular Perfusion that is accredited by all Institutes to ensure that those qualifying meet all requirements and are legible for registration with HPCSA."*
- *"The training institution."*

4.4.10 Discussion

In this section the researcher wanted to determine if the current outcomes of the cardiovascular perfusion programmes in SA were valid and adequate and which statements together with the literature study should form part of the Delphi statements.

As far as the validity of the current outcomes of the cardiovascular perfusion programmes are concerned, the majority of the respondents indicated that the current outcomes are still valid and newly qualified graduates are competent to do the job required of them. However, their answers also indicate that the outcomes are not totally adequate and outcomes should be modified to improve competencies. Respondents also voiced concerns regarding the lack of uniformity of the curriculum and indicated that a standardised curriculum with a single exit exam would produce highly competent perfusionists who will be able to provide perfusion services at any hospital.

The researcher and his promoter were of the opinion that all the closed-ended and open-ended questions asked in this section of the questionnaire should form part of the Delphi survey as the questions proved to be quite appropriate. The few suggestions that were given by respondents in the open-ended questions were incorporated in the Delphi statements, as they were deemed to be quite valid and appropriate for the Delphi.

4.5 QUESTIONS PERTAINING TO OUTCOMES AND ESSENTIAL CONTENT

In this section the researcher wanted to gain an understanding of the perceptions of the participants regarding the outcomes and essential content of the perfusion programme, i.e. whether the participants believe that the outcomes and content indicated are "**essential", "useful"** or **"not needed".** Participants were also given the opportunity to propose their own outcomes and content under each section and were asked to indicate whether they believed that a proposition was essential or useful.

4.5.1 Clinical Practice

4.5.1.1 *Outcomes*

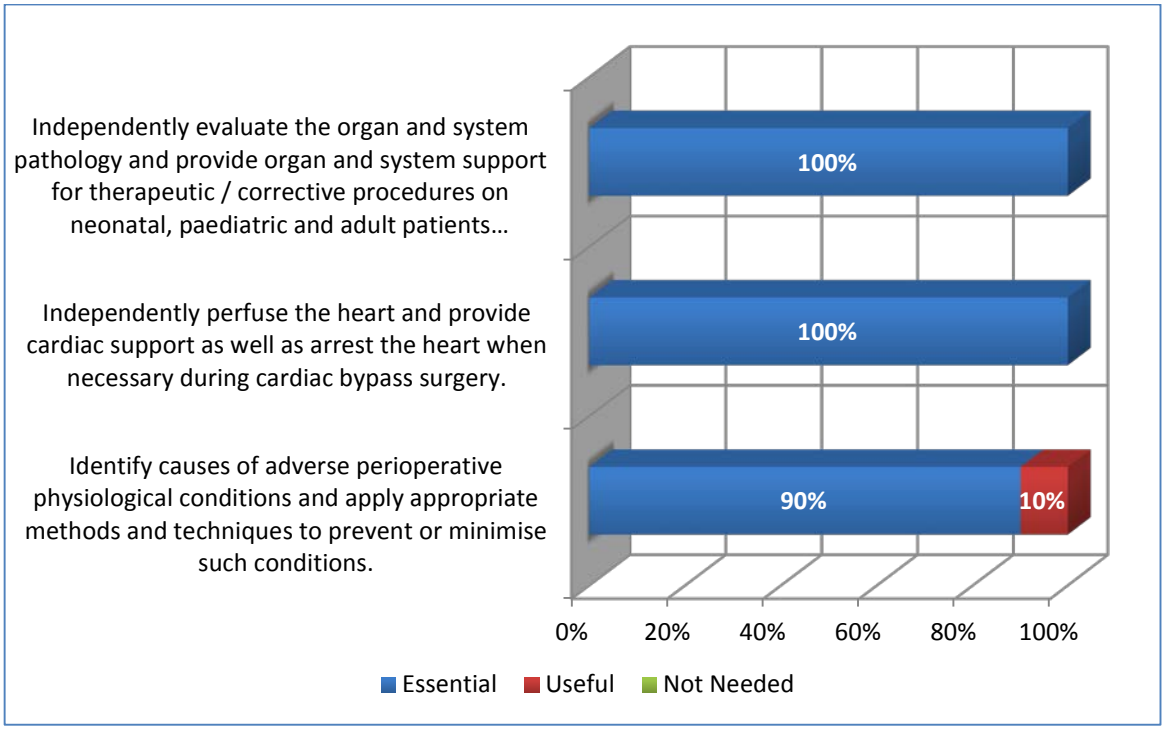

Figure 4.16: Whether the listed clinical practice outcomes are essential in a perfusion programme (n=10)

Participants were asked to state any other outcome that should be included in clinical practice and indicate whether it was "**essential"** or **"useful"**. One respondent had an input and stated: *"Basic Mechanical trouble shooting. Pharmacological knowledge"*

The respondent did not indicate whether the outcome stated was essential or useful. Basic mechanical troubleshooting will be part of perfusion technology (cf. 4.5.3), and

pharmacological knowledge will fall under pharmacology (cf. 4.5.2). Regarding the outcomes for clinical practice, the respondents were unanimous in agreeing that the first two outcomes were essential; for the third outcome 10% stated that it was useful and 90% that it was essential (Fig. 4.16). None of the respondents indicated that it was not needed.

4.5.1.2 *Content*

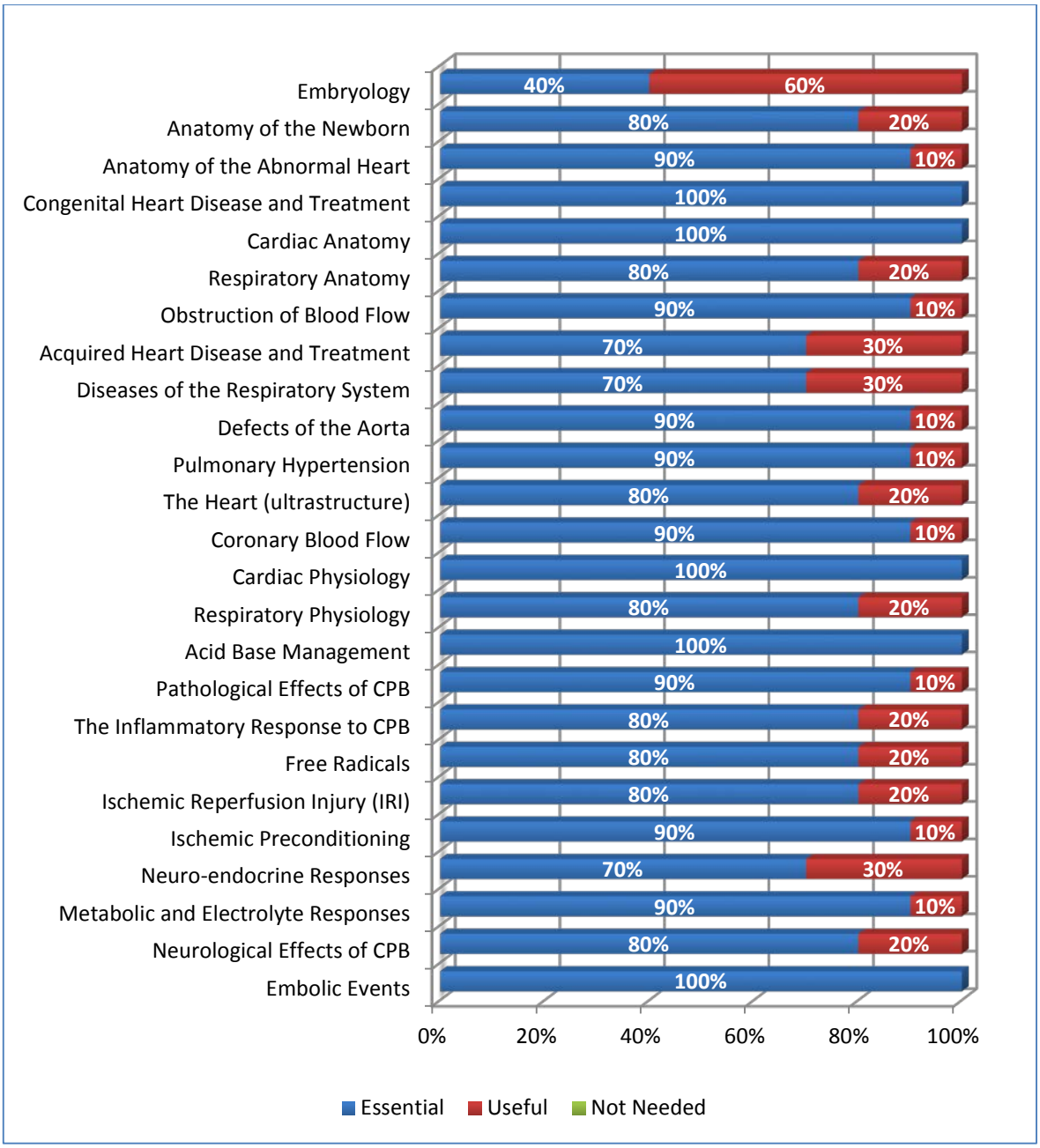

Figure 4.17: Are the listed clinical practice content topics essential in a perfusion programme? (n=10)

Participants were asked to suggest any other content that should be included in clinical practice and to indicate whether it was essential or useful. One respondent stated: *"essential–hypothermia, coagulation cascade, cardiac electrophysiology".*

Hypothermia is included under perfusion technology (cf. 4.5.3.2). Coagulation cascade forms part of blood management (cf. 4.5.4.2), while electrophysiology is part of haemodynamic monitoring (cf. 4.5.5.2).

The majority of the respondents indicated that all the content topics listed were essential while a few felt that the topics were useful; the exception is embryology, where the majority (60%) indicated that it was useful and 40% indicated that it was essential. For three of the content topics there was a unanimous indication that they were essential. No respondent indicated that any of the content topics listed were not needed.

4.5.2 Pharmacology

4.5.2.1 *Outcomes*

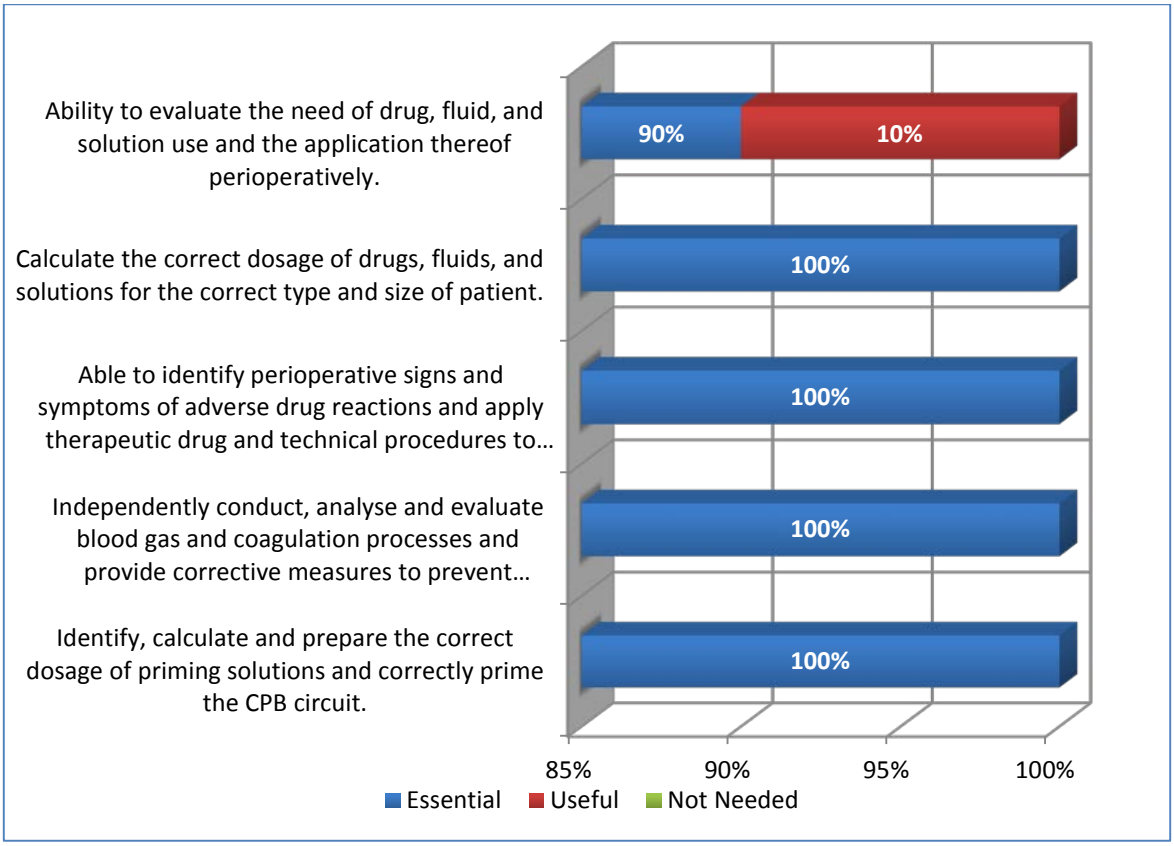

Figure 4.18: Whether the listed pharmacology outcomes are essential in a perfusion programme (n=10)

Participants were asked to suggest any other outcomes that should be included in pharmacology and indicate whether the outcomes were essential or useful. One respondent had an input and stated: *"essential- in-depth understamdinng of pharmacokintics, distribution, half-lives, action of all drugs used on the pump".*

Pharmacokinetics, distribution half lives, etc., all fall under pharmacological concepts listed in Fig. 4.19 below. However, *"Action of all drugs used on the pump"* would fall under clinical pharmacology (Fig. 4.19), and the researcher decided that for the Delphi survey *"Action of all drugs used on the pump"* will be listed emphatically as "common drugs used in cardiac surgery", forming part of the contents of pharmacology.

Respondents were unanimous that the outcomes listed for pharmacology were all essential, except for one outcome, where 90% indicated that it was essential and 10% indicated that it was useful.

4.5.2.2 *Content*

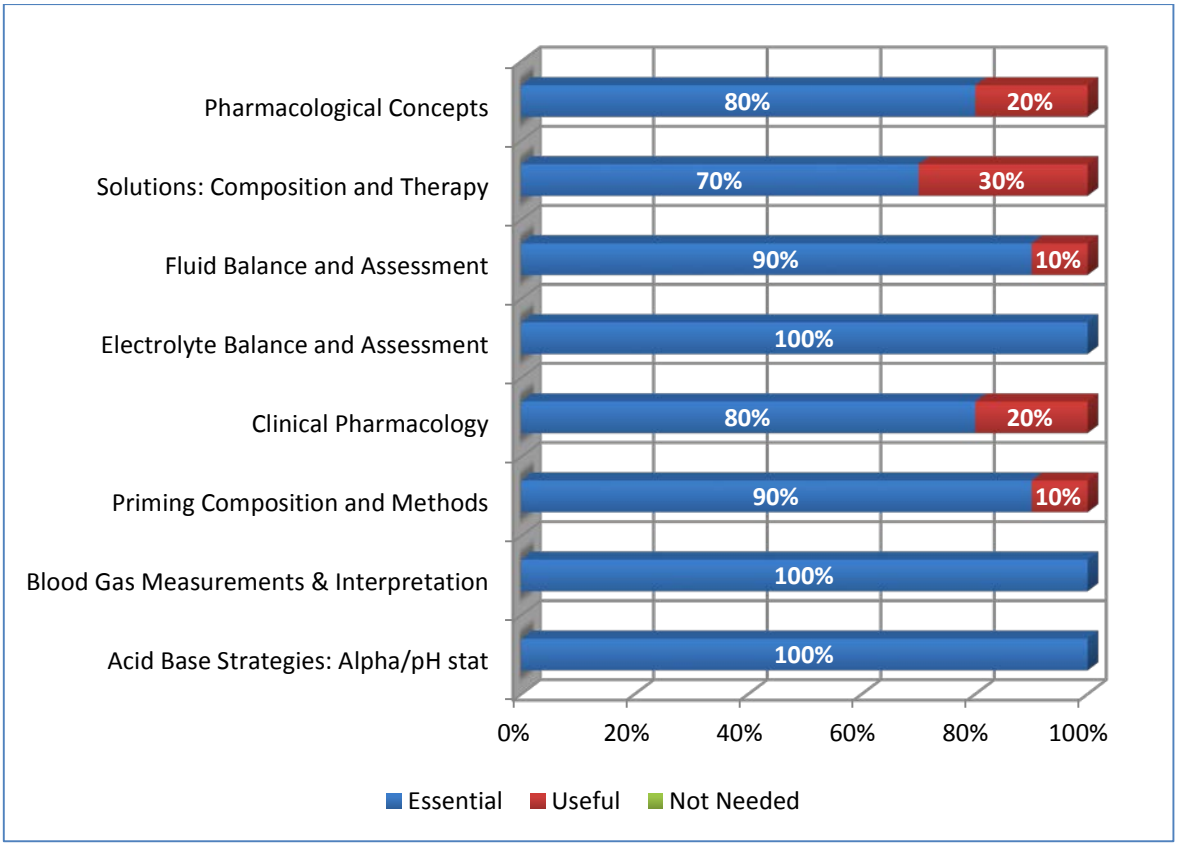

Figure 4.19: Are the listed pharmacology content items essential for a perfusion programme? (n=10)

No respondents had any further input regarding pharmacology content.

For three of the listed content items, respondents were unanimous that they were essential while, for the rest of the contents, 70% or more felt that they were essential and 30% or less felt that they were useful. No one indicated that any one of them was not needed.

4.5.3 Perfusion Technology

4.5.3.1 *Outcomes*

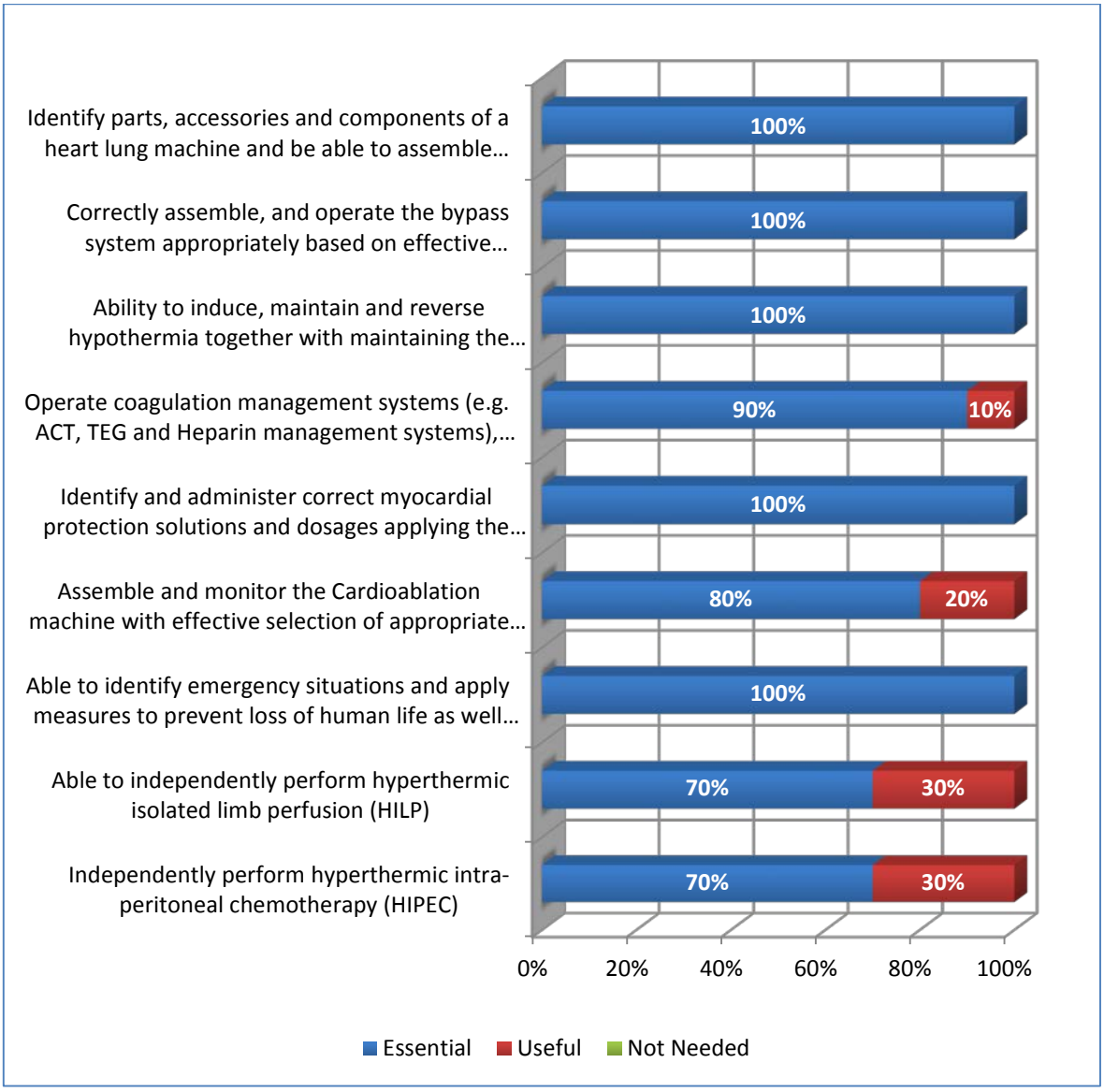

Figure 4.20: Whether the listed perfusion technology outcomes are essential in a perfusion programme (n=10)

Participants were asked to suggest any other outcomes that should be included in perfusion

technology and indicate whether it was essential or useful. One respondent had an input and stated: *"essential--- ecmo".*

ECMO is listed in the contents of mechanical circulatory support (cf. 4.5.6.2; Fig. 4.27).

Regarding the outcomes for perfusion technology, for three of the nine listed outcomes, respondents were unanimous that these outcomes were essential; for the remaining four outcomes, 70% or more felt stated they were essential and 30% or less indicated that they were useful. None of the outcomes were indicated as not needed.

4.5.3.2 *Content*

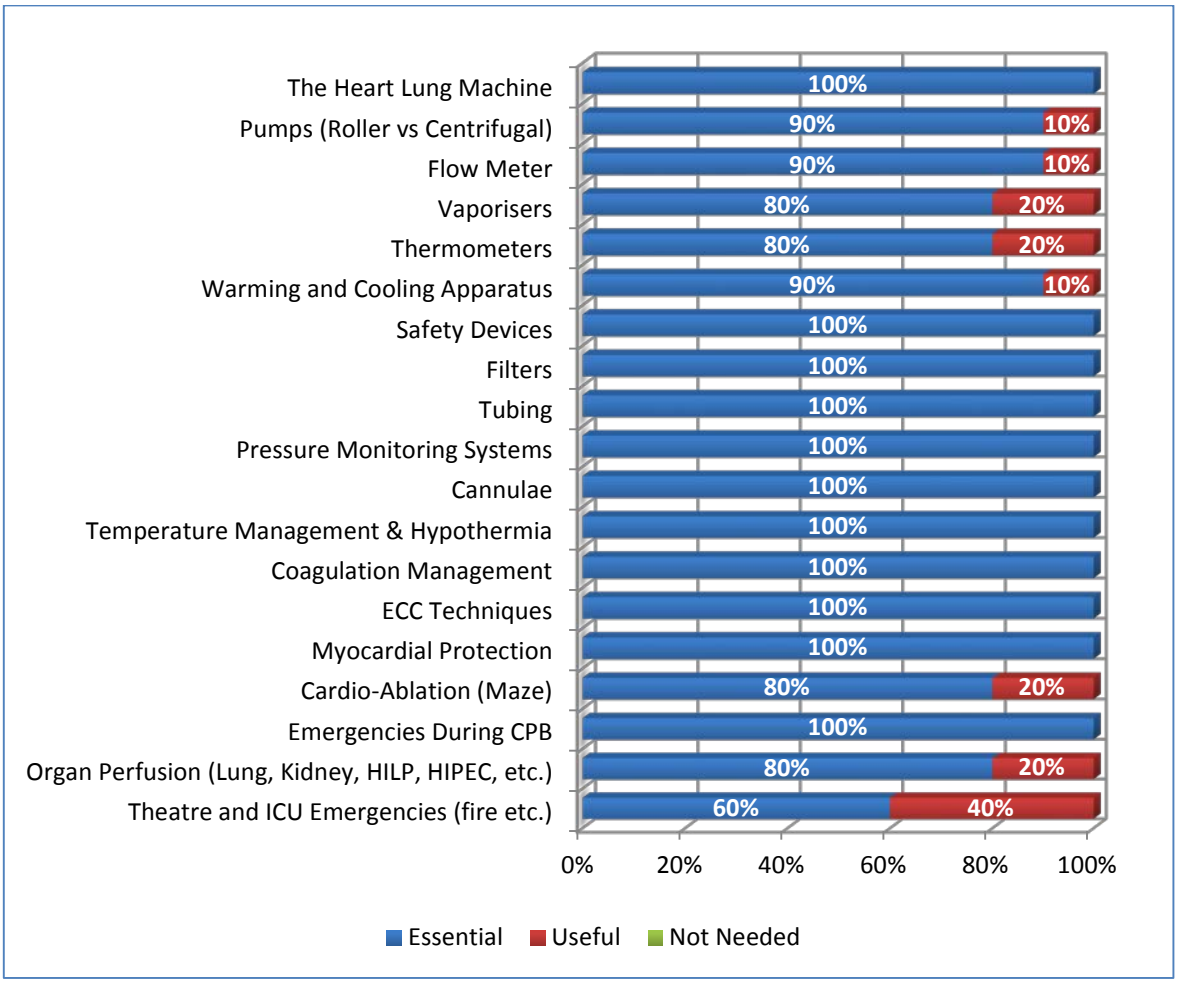

Figure 4.21: Are the listed perfusion technology content topics essential for a perfusion programme? (n=10)

Participants were asked to suggest any other content topics that should be included in perfusion technology and indicate whether it was essential or useful. One respondent had an input and stated: *"essential---total circ arrest".* This suggestion had been noted and was added to the Delphi questionnaire.

Respondents were unanimous about 11 of the 19 essential content topics listed (Fig. 4.21), indicating that these topics were essential. For one of the 19 (Theatre and ICU emergencies) 60% indicated it was essential and 40% indicated that it was useful. For the remainder of the contents 80% or more of the respondents indicated that the topics were essential and 20% or less indicated that they were useful. No one indicated that any of the content topics were not needed.

4.5.4 Blood Management

4.5.4.1 *Outcomes*

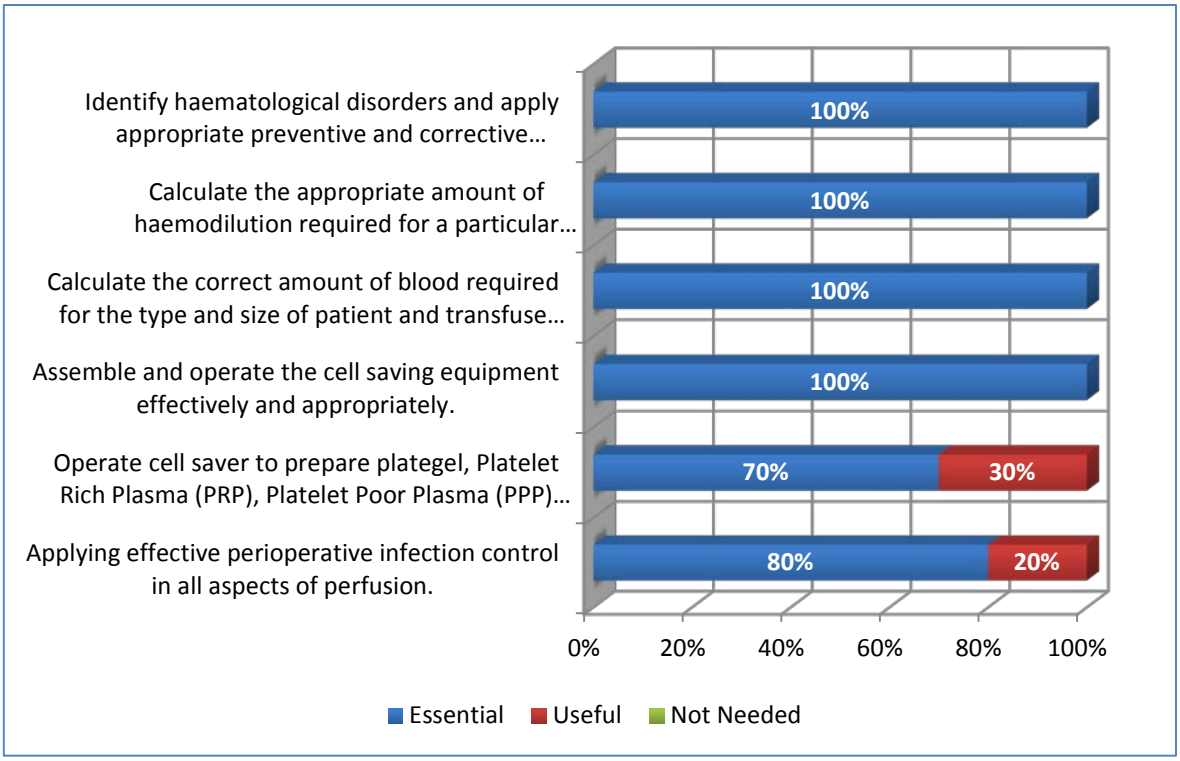

Figure 4.22: Whether the listed blood management outcomes are essential in a perfusion programme (n=10)

There were no further inputs from respondents regarding outcomes for blood management. For four of six listed outcomes of blood management, respondents were unanimous that

they were essential. For one of the outcomes 70% indicated that it was essential while 30% indicated that it was useful. For the remaining outcome 80% indicated it was essential and 20% indicated it was useful. None of the respondents indicated that any of the outcomes were not needed.

4.5.4.2 *Content*

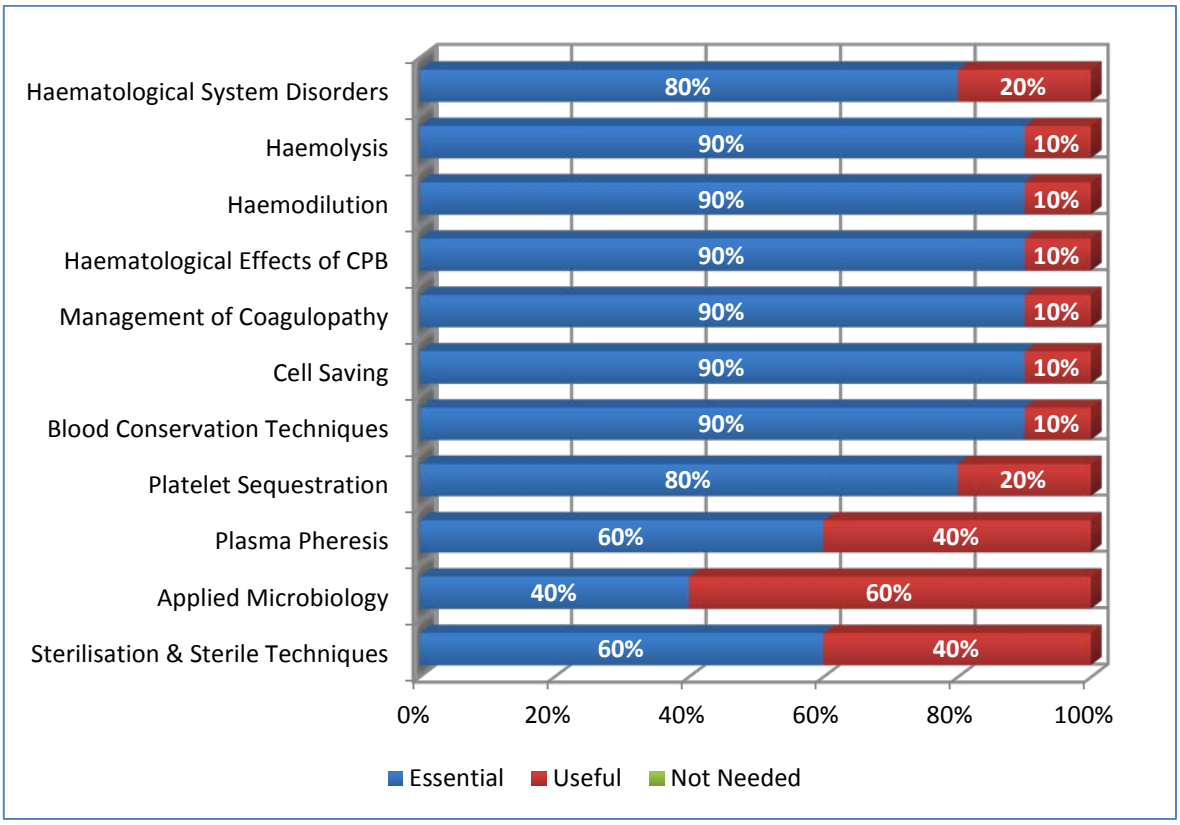

Figure 4.23: Are the listed blood management content topics essential for a perfusion programme? (n=10)

There were no further inputs from respondents regarding content for blood management.

For six of 11 of the content topics listed, 90% of the respondents indicated that the topics were essential and 10 indicated they were useful. For two of the content topics 60% indicated they were essential and 40% indicated they were useful. For one of the content topics (Applied Microbiology) 40% indicated it was essential and 60% indicated it was useful. For two of the content topics 80% indicated they were essential and 20% indicated that they were useful. No respondent indicated that any of the listed content topics were not needed.

4.5.5 Haemodynamic Monitoring and Related Technologies

4.5.5.1 *Outcomes*

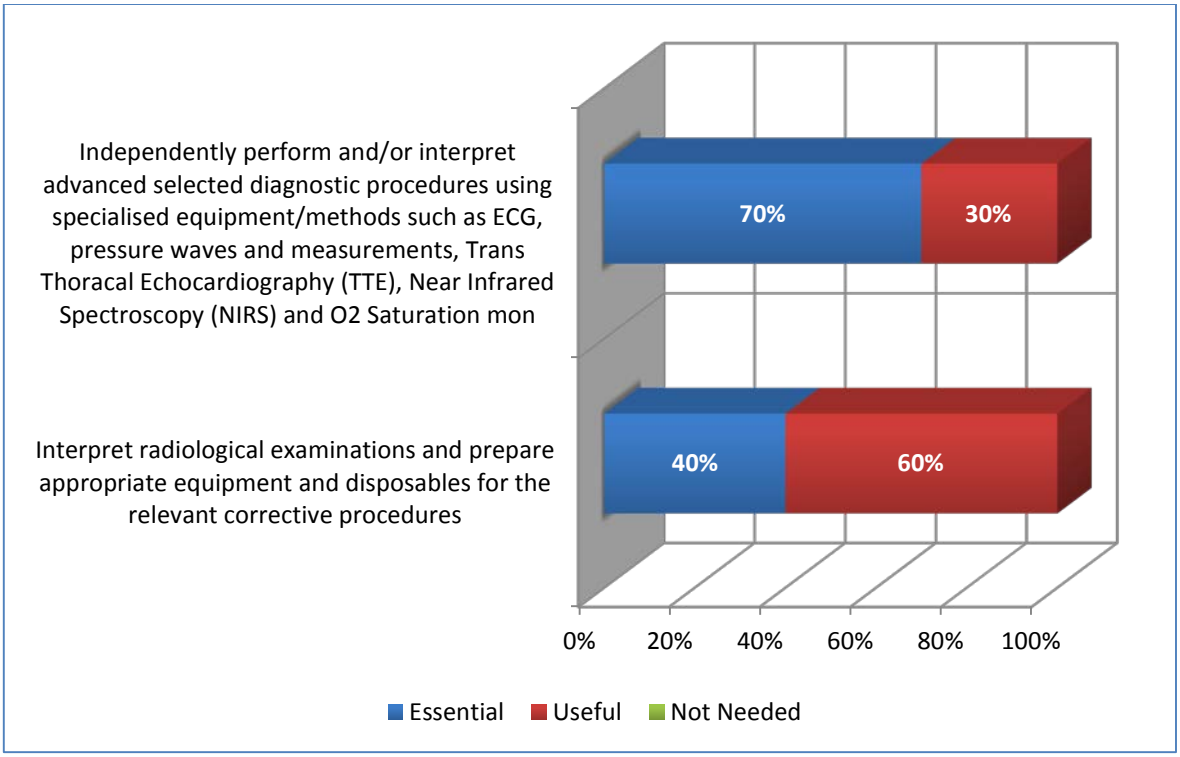

Figure 4.24: Whether the listed haemodynamic monitoring and related technologies outcomes are essential in a perfusion programme (n=10)

There were no further inputs from respondents regarding outcomes for haemodynamic monitoring and related technologies.

There were two outcomes listed for haemodynamic monitoring and related technologies. For the one outcome 70% of the respondents indicated that the outcome was essential and 30% indicated it was useful. For the other outcome, 40% indicated it was essential and 60% indicated it was useful. No one indicated that any one of them was not needed.

4.5.5.2 *Content*

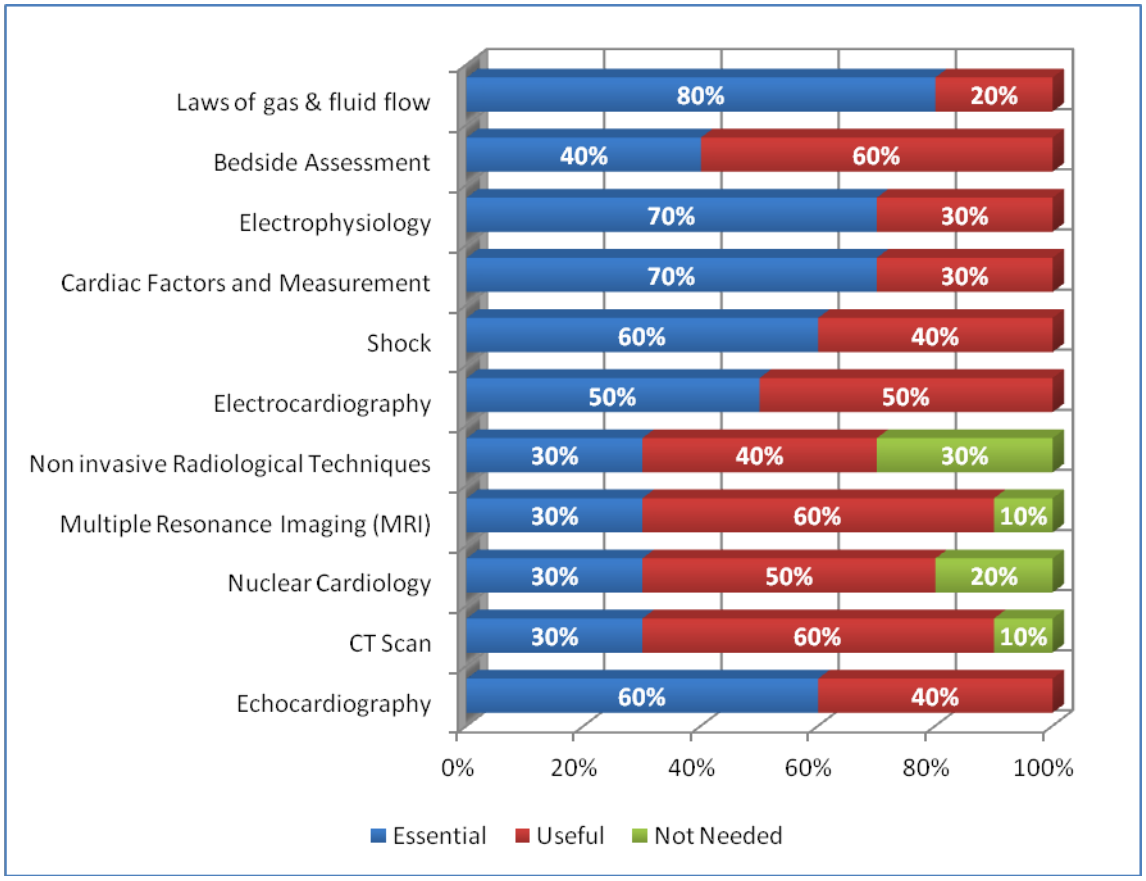

Figure 4.25: Are the listed haemodynamic monitoring and related technologies content topics essential for a perfusion programme? (n=10)

There were no further inputs from respondents regarding contents for haemodynamic monitoring and related technologies.

This section of the questionnaire gathered the greatest variety of reactions. For five of the 11 listed content topics 60% or more of the respondents indicated that the topics were essential, 40% or less indicated that they were useful, and no one indicated they were not needed. For one of the content topics (electrocardiography) there was a 50/50 split between essential and useful while, for another (bedside assessment), 40% of respondents indicated the topic was essential and 60% indicated it was useful; none indicated not needed. For four of the content topics there were split indications between essential, useful and not needed:

For non-invasive radiological techniques 30% of respondents indicated it was essential, 40% indicated useful and 30% of the respondents indicated not needed. For MRI 30%

indicated essential, 60% indicated useful and 10% indicated not needed. For nuclear cardiology 30% indicated essential, 50% indicated useful and 20% indicated not needed. For computer topography (CT) scan 30% indicated essential, 60% indicated useful and 10% indicated not needed.

4.5.6 Mechanical Circulatory Support

4.5.6.1 *Outcomes*

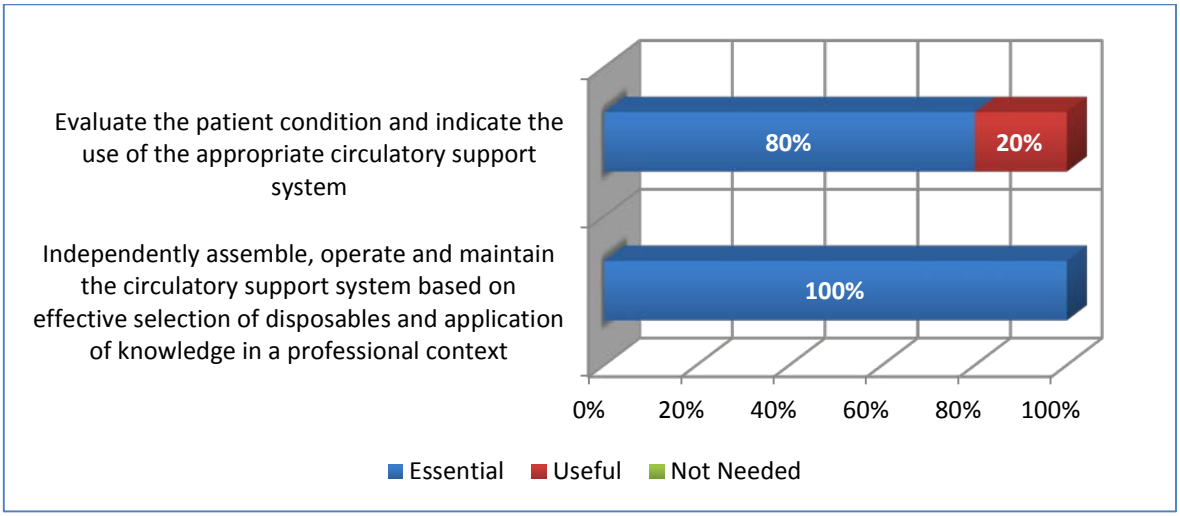

Figure 4.26: Whether the listed mechanical circulatory support outcomes are essential in a perfusion programme (n=10)

One respondent stated that,

"Appropriate timing & duration of support should form part of the outcomes for mechanical circulatory support".

"Appropriate timing & duration of support" should actually form part of the contents under each support device and not part of outcomes or essential content, because each device has its own timing and duration for which it is used.

For one of the two listed outcomes 80% of respondents indicated it was essential and 20% indicated it was useful while, for the remaining outcome, respondents were unanimous that it was essential. There was no indication for any of the two that they were not needed.

4.5.6.2 *Content*

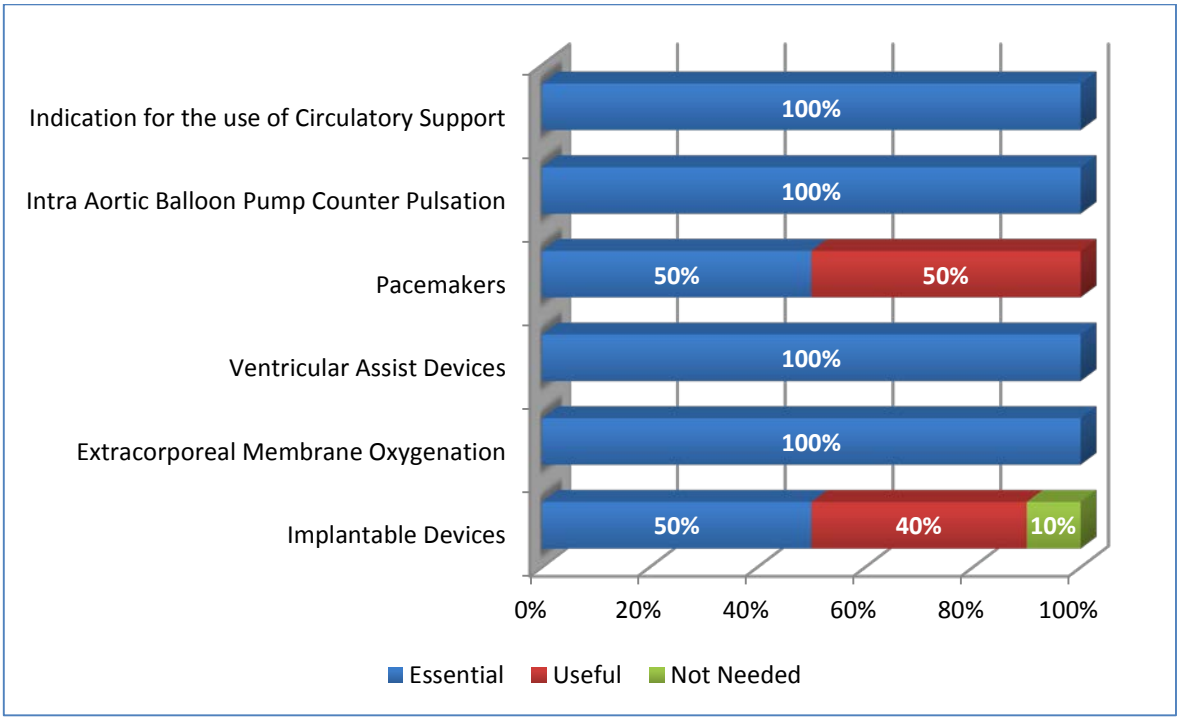

Figure 4.27: Are the listed mechanical circulatory support content topics essential for a perfusion programme? (n=10)

There were no further inputs from respondents regarding content for mechanical circulatory support.

Four of the six content items listed solicited a unanimous response of essential. For one of the content items (Pacemakers) 50% of respondents indicated it was essential and 50% indicated it was useful. For the remaining item (Implantable Devices), 50% indicated it was essential, 40% indicated it was useful and 10% indicated it was not needed.

4.5.7 Comments

Participants were given the opportunity to comment, and only one comment was received:

"i think it will be good as diff acad institutions to meet & try to come up with a uniform curric, so that any graduate perfusionist can fit anywhere & to improve the standard of clinical practice & academic mind"

4.5.8 Discussion

The objective of this section was obtain statements for the Delphi survey related to the outcomes and essential content perfusion programme. The researcher and his promoter agreed that if there is an indication from more than 50% of the respondents that any particular content was not needed then it will not form part of the Delphi statements. Having carefully studied answers to each question the researcher concluded that all the questions posed in this section will form part of the Delphi statements, because no question elicited an indication that it was not needed from 50% or more of the respondents. The researcher also decided that suggestions and comments that were received from the respondents would also be added to the Delphi statements for the Delphi survey.

4.6 SUMMARY OF RESULTS FROM THE QUESTIONNAIRE SURVEY

In this chapter the results of the questionnaire survey were presented, discussed, interpreted and analysed. The purpose of the questionnaire in this survey was to determine current practices and perceptions of educationists/lecturers and trainers of cardiovascular perfusion students in relation to the outcomes and essential content of the cardiovascular perfusion programme and to provide statements for the Delphi survey.

After a successful pilot study, which required no amendments, an information document explaining the survey was distributed to 14 identified perfusionists; this was followed by the actual online questionnaire. The questionnaire survey was conducted over four months, at the end of which 71% of the target population originally identified had responded.

The questionnaire consisted of three main components:

- Demographic information;
- Validity and adequacy of current outcomes; and
- Questions pertaining to outcomes and essential content.

In the demographic information section, information regarding the participants' ages and genders, the years of graduation, types of qualification, institutions awarding the qualification(s) and employment was recorded. The respondents ranged in age from 25 to 47 years old. Sixty per cent of the respondents were in the age group 21 to 30 years old,

30% were in the 31 to 40 year age group and 10% were older than 40 years old.

Sixty per cent of the respondents were male and 40% female. All the respondents had qualified in SA, and all of them from the DUT and the CUT. The earliest B.-Tech. qualification of a respondent was awarded in 2002 and the latest was in 2013. Seventy per cent of the respondents had no postgraduate qualifications whilst 30% had M.-Tech. degrees and one (10%) had a D.-Tech. degree. As far as employment was concerned, 100% of the respondents were employed full time at an academic hospital; 50% of them also worked in the private setting. Further, 33.3% of the respondents indicated that they were employed by a university of technology on a part-time basis.

In the section dealing with the validity and adequacy of current outcomes participants had to choose a "Yes", "No" or "Unsure" answer and motivate their choice where required. Ninety per cent of respondents indicated that there was a need to modify the outcomes of perfusion programmes, giving various reasons to motivate their answers. Participants were asked to indicate the exit-level outcomes of the programmes described by their particular institutions. The answers varied greatly, indicating that there was no uniform outcomes among the institutions. Forty per cent of respondents indicated that the current exit-level outcomes prepared students adequately for work, whilst 30% indicated it did not and 30% were unsure. Seventy per cent indicated that newly qualified perfusionists were competent, 20% were unsure and 10% indicated that the newly qualified perfusionists were not competent. Eighty per cent of respondents indicated that a change in exit-level outcomes will improve competence 10% indicated it would not 10% were unsure. Ninety per cent of respondents indicated that all institutions should use a standardised curriculum, but 10% were unsure whether they supported this idea.

All the respondents indicated that a single exit exam should be set; 60% indicated it should be conducted in a written and oral form and 20% indicated it should only be in the written form. Furthermore, 60% of respondents indicated that all institutions combined should conduct the exams, whilst 20% indicated that one institution should conduct it and 20% indicated that another body, like a college of perfusion or the training institution itself, should conduct the exam.

The last section contained questions pertaining to outcomes and essential content of the perfusion programme. This section was divided into six subsections, namely, clinical practice, pharmacology, perfusion technology, blood management, haemodynamic monitoring and related technologies, and mechanical circulatory support.

For clinical practice, respondents were unanimously in favour of two of three listed outcomes, indicating that they were essential. For the third outcome, 90% of the respondents indicated it was essential and 10% indicated that it was useful. For all the essential content topics listed, the majority of the respondents (70% and more) indicated they were essential and 30% or less indicated they were useful, with the exception of embryology, where 40% indicated it was essential and 60% indicated it was useful. No one indicated that any of the outcomes or essential contents were not necessary.

For four of five outcomes listed under pharmacology, 100% of the respondents indicated they were essential and for the remainder, 90% indicated it was essential and 10% indicated it was useful. For all the content items, the majority of the respondents (70% and more) indicated they were essential while 30% or less indicated they were useful. None of the respondents indicated that any of the outcomes and contents were not needed.

Five of the nine listed outcomes of perfusion technology received a 100% consensus statement that they were essential while, for the remaining four, 70% and more indicated they were essential and 30% and less indicated they were useful. The majority of the respondents (> 60%) indicated that the content topics were essential and 40% and less indicated they were useful. None of the respondents indicated that any of the outcomes or content topics were not needed.

The majority of the respondents indicated that the outcomes listed for blood management were essential while a minority of them indicated that a few of the outcomes were useful. For all the content items listed, 60% of respondents and more indicated they were essential and 40% and less indicated they were useful, except for applied microbiology, for which 40% indicated it was essential and 60% indicated it was useful. None of the respondents indicated that any of the outcomes or contents were not needed.

Two outcomes were stated for haemodynamic monitoring and related technologies. One was indicated as essential by 70% of the respondents and useful by 30%, while the other

was indicated as essential by 40% and useful by 60% of respondents. For five of 11 content topics listed, 60% and more of the respondents indicated they were essential and 40% and less indicated they were useful. For one topic there was 50/50 split between essential and useful, and for another one 40% of respondents indicated it was essential and 60% indicated it was useful. For the remaining four content topics, 30% of respondents indicated they were essential, 40% to 60% indicated they were useful and 10% to 30% indicated that they were not needed.

One of the two outcomes listed for mechanical circulatory support had a 100% consensus that it was essential while for the other outcome, 80% of respondents indicated it was essential and 20% indicated it was useful. For four of six content topics listed, 100% of the respondents indicated that they were essential. For one (pacemakers) 50% indicated it was essential and 50% indicated it was useful. For the remaining one (implantable devices) 50% indicated it was essential, 40% useful and 10% indicated it was not needed.

Having carefully studied each question and its responses, the researchers decided that all the statements under validity and adequacy of current outcomes, and questions pertaining to outcomes and essential content of a perfusion programme will form part of the Delphi statements, because there was no overwhelming indication from respondents that any of the outcomes or content items should not form part of the Delphi survey. In addition, the suggestions given by respondents will be added to the statements of the Delphi survey.

4.7 CONCLUSION

In Chapter 4, the survey process that was used was discussed. The demographic information and the results of the questionnaire survey were presented in the form of graphs, and analysed, interpreted and discussed accordingly followed by a summary of the results of the questionnaire survey.

In the next chapter, Chapter 5, ***Results and the Discussion of the Findings of the Delphi Survey,*** the results of the different rounds of the Delphi survey will be presented in the form of graphs and will be analysed, interpreted, and discussed accordingly.

CHAPTER 5

RESULTS, ANALYSIS, INTERPRETATION AND DISCUSSION OF THE FINDINGS OF THE DELPHI TECHNIQUE SURVEY

5.1 INTRODUCTION

In Chapter 4 the results of the questionnaire survey were presented in the form of graphs, and were analysed, interpreted and discussed. In this chapter the results obtained from rounds one and two of the Delphi survey are presented in graphs, in line with the aim (cf. 1.4.2) and objectives (cf. 1.4.3) stated in Chapter 1, followed by a discussion of the data. The responses to the open-ended questions (qualitative data) included in the Delphi will also be discussed. That will be followed by a short summary and conclusion of the chapter. The process used to collect the data consisted of two rounds of the Delphi technique survey. Stability was reached after round two as no changes occurred in the answers of the respondents.

5.2 THE DELPHI SURVEY PROCESS AND FEEDBACK

The purpose of the Delphi technique in this study was to achieve consensus regarding the outcomes and essential content, and to determine its relevance, effectiveness and importance in a cardiovascular perfusion programme.

The reasons for choosing the Delphi as the method of collecting the data, the explanation of the format, and the time frame of the Delphi survey process is explained in detail in Chapter 3 (cf. 3.2.4.2; 3.2.4.4; 3.3.2).

The researcher obtained consent from the relevant institutions to conduct the study among their employees. Consent was obtained by sending letters of request for consent (Appendices C and E) to the relevant institutions via email. Prior to conducting the Delphi, a pilot study of the Delphi was completed. No corrections or amendments to the Delphi questionnaire were necessary (cf. 3.3.2.4).

The Delphi questionnaires were divided into three parts:

1. Biographical information;
2. Questions pertaining to adequacy and validity of current outcomes of a cardiovascular perfusion programme; and
3. Questions pertaining to outcomes and essential content of a future cardiovascular perfusion programme.

The first round of the Delphi questionnaire was distributed to 18 experts identified by preselected criteria (cf. 3.3.2.2; 3.3.2.3). Of these experts, 44.4% responded. The Delphi survey started in November 2014 and ended on 23 February 2015 (cf. 3.2.4.4).

The idea of the Delphi is to obtain consensus about a statement. Consensus is deemed to have been achieved when 80% or more of the respondents agree on the same point (Larson & Wissman 2000:46). For the outcomes and essential content of the programme, 80% was regarded as appropriate and deemed fit. The statements on which consensus was reached in the first round were excluded from the second round (cf. 3.3.2.6). Stability was achieved in the second round.

N.B The researcher made no changes to language, spelling, grammar, sentence construction, etc. of the comments/responses given by the respondents in both rounds of the Delphi.

5.3 ROUND ONE OF THE DELPHI TECHNIQUE SURVEY

5.3.1 Biographical information

5.3.1.1 *Age*

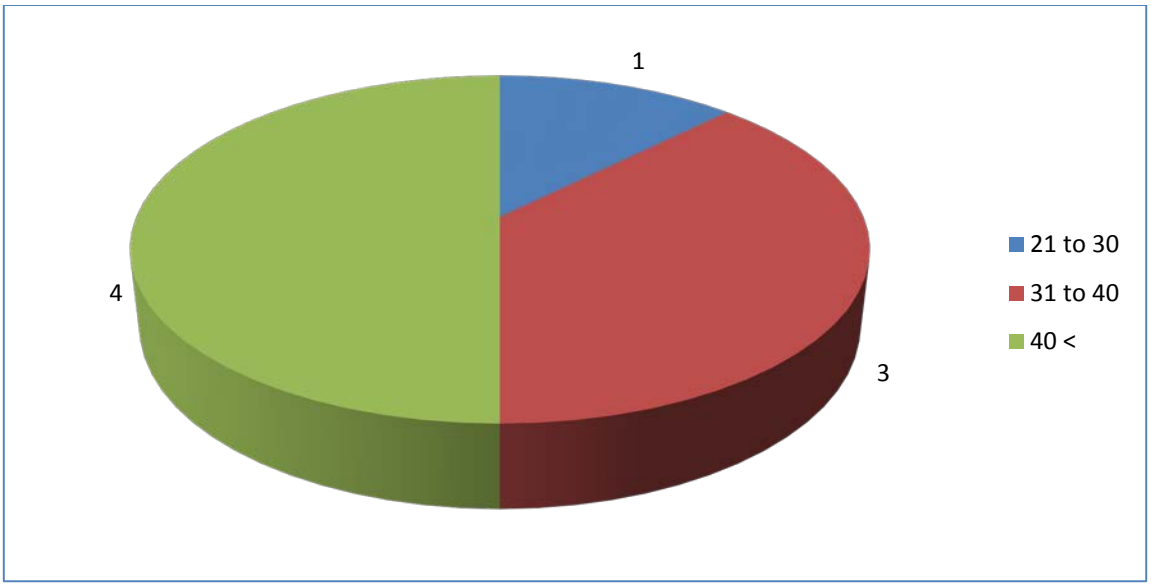

Figure 5.1: Age distribution for round 1 of the Delphi survey (n=8)

The age distribution of the respondents was as follows: One respondent was in the age group 21 and 30 years, three respondents were in the 31 to 40 year age group, and four respondents were in the above 40 years age group.

5.3.1.2 *Gender*

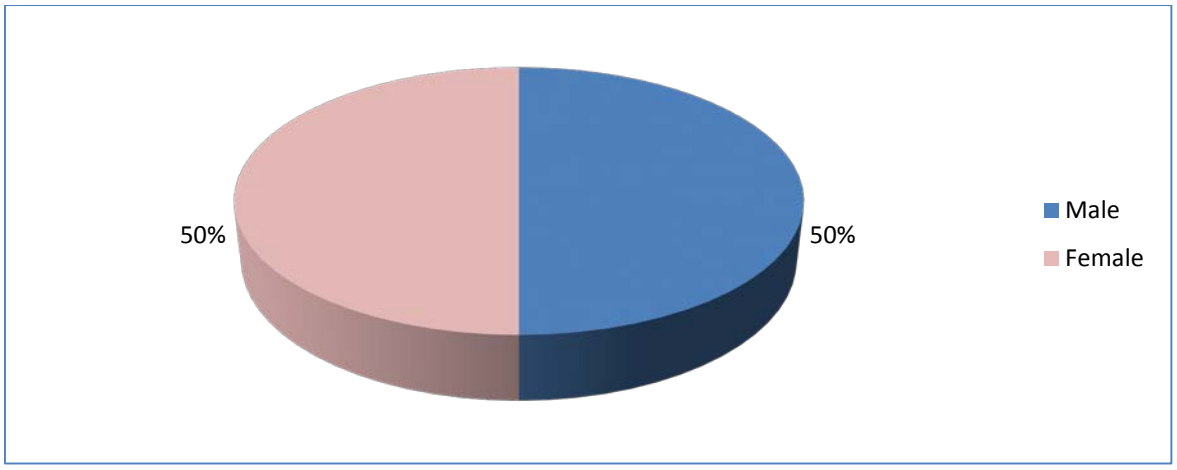

Figure 5.2: Gender distribution for round 1 of the Delphi survey (n=8)

The respondents represented both genders equally; 50% were male and 50% were female.

5.3.1.3 *Qualifications*

The question was open ended and asked participants about their educational qualifications.

Four of the participants have B.-Tech. degrees in Clinical Technology (Cardiovascular Perfusion). One has an M.Med. (Anaesthesiology) Fellow of College of Anaesthesiology (FCA) (SA) qualification, one has M.Med. (Cardiothoracic Surgery) degree and also a Certificate in Critical Care, one has M.Med. (Thoracic Surgery) and one has Fellow of College of Surgery (FCS) (SA) (Cardiothoracic Surgery) qualification.

Four of the respondents have cardiovascular perfusion qualifications, three are specialists in cardiothoracic surgery and one was a specialist in anaesthesiology.

5.3.1.4 *Institution awarding qualification(s)*

Participants were asked to indicate the institution from which they obtained their qualifications.

One respondent qualified at University of Witwatersrand, one at CUT and TUT, one at CUT, one at MEDUNSA (now University of Limpopo), one at ML Sultan Technikon (now DUT), one at TUT and two at UFS.

5.3.1.5 *Job designation*

The following answers were received from the Delphi panellists in response to a question about their job designations: *Assistant director perfusion [head of perfusion], chief perfusionist (supervisory assistant director), deputy director clinical technologist (perfusion), head of Clinical Unit Cardiothoracic Anaesthesiology, head of Department Cardiothoracic Surgery, head of Adult Cardio-Thoracic Surgery Department, head of Unit Thoracic Surgery, and senior perfusionist.*

5.3.1.6 *Current place of employment*

Respondents were employed at the following places at the time of the survey: Dr. George Mukhari Hospital/University of Limpopo complex, Dr. George Mukhari Academic Hospital, Gauteng, Groote Schuur and Red Cross War Memorial Children's Hospitals, Steve Biko Academic Hospital and as locum at other hospitals, Universitas Academic Hospital, Bloemfontein, Universitas Hospital and University of the Free State.

5.3.2 Questions pertaining to the adequacy and validity of current outcomes of a cardiovascular perfusion programme

In this section the validity and adequacy of the current outcomes of the cardiovascular perfusion programme were investigated. This section contained both open-ended and closed questions. For the closed questions participants had to choose between "yes", "no", and "unsure", whilst the open-ended questions asked for either a motivation for a choice made by participants in the closed question, or that participants provide their opinions or facts regarding certain issues.

5.3.2.1 *Current exit-level outcomes*

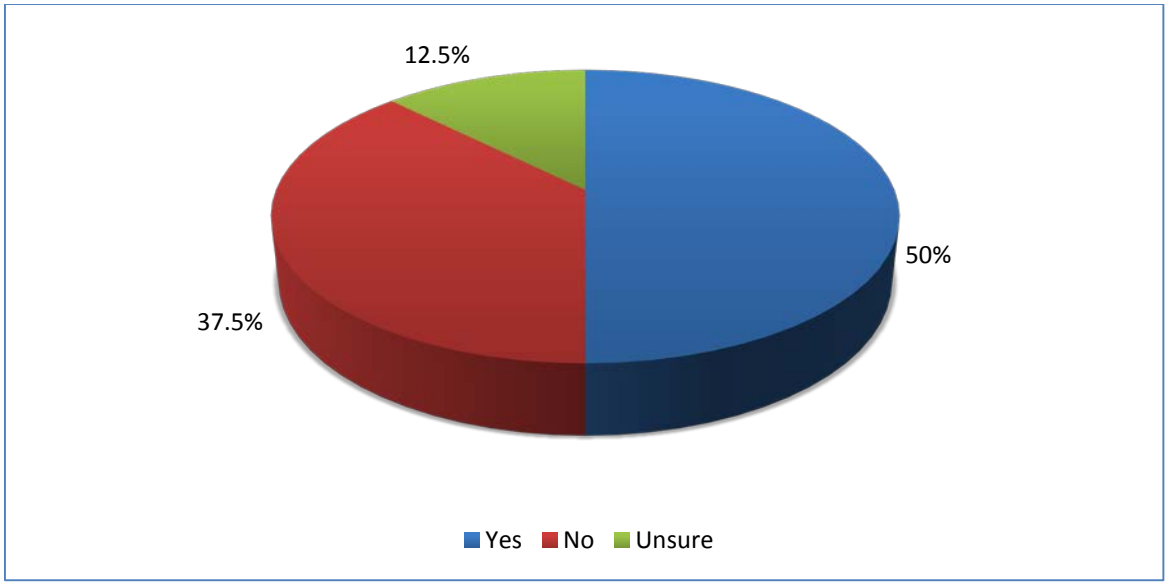

Figure 5.3: Do the current exit-level outcomes of perfusion adequately prepare the perfusionist? (n=8)

Of the respondents, 50% indicated that the current exit-level outcomes of the perfusion programme adequately prepare the perfusionist, whilst 37.5% indicated it did not and 12.5% were unsure. There was no consensus reached on this statement in the first round.

Participants were asked to motivate their choices. The following responses were received:

- *"Have a good mixture of the SA cardiovascular disease burden"*
- *"I am concerned that a National Diploma may be obtained after about 10 months' training in 3rd year. There is no way that all theory and practical training can be ADEQUATELY covered in this time period."*
- *"I've seen the trainees perform during their first year as qualified perfusionists."*
- *"More often students qualify with less cases than required, not yet competent to perform their duties fully. Some even still need supervision years after qualifying."*
- *"NEED 1 YEAR"*
- *"That's why I modify curriculum to include more physiology and other organ systems, pharmacology and new technology"*
- *"Training consists of academic development, research and practical experience. All training goals achieved"*
- *"We have started to add on additional assist device theory and practicals."*

5.3.2.2 *Description of the current exit-level outcomes*

The question that followed was:

What current exit-level outcomes have been described by a university of technology for your students/trainees to fulfil in order to graduate? (Please indicate the name of a university of technology).

These were the responses:

- *"50 cases adult cardiopulmonary bypass (CPB) cases and 25 paediatric CPB cases"*
- *"B Tech in Clinical technology.(perfusion), 3 year course, completion of research project in 3rd year, and final subject clinical perfusion, 100 cases = 80 adult and 20 paeds"*
- *"CUT (central university of technology)"*

- *"DURBAN"*
- *"I am appalled that for CUT, 3rd year students will pass and get their diploma even if failing the CPB practical, as it counts for only 10% of the final mark! This is the 'actual end point' they are being examined on! DUT, I feel, doesn't cover the theory of Perfusion sufficiently (when comparing the syllabi of the 2 universities) but they do agree that should the 3rd year student not pass the CPB prac, they may not graduate."*
- *"Not specified"*
- *"Pass all subjects, pass all practicals, minimum required adult cases, pediatric cases, assist devices simulations if no patients."*
- *"Tut has a portfolio system with comprehensive practical log books, and changes to the research aspect with abstracts and case studies ecs. The practical aspect counts for 30% of their end result, with a fail in practical resulting in a year fail."*

5.3.2.3 *Competency of newly qualified perfusionists*

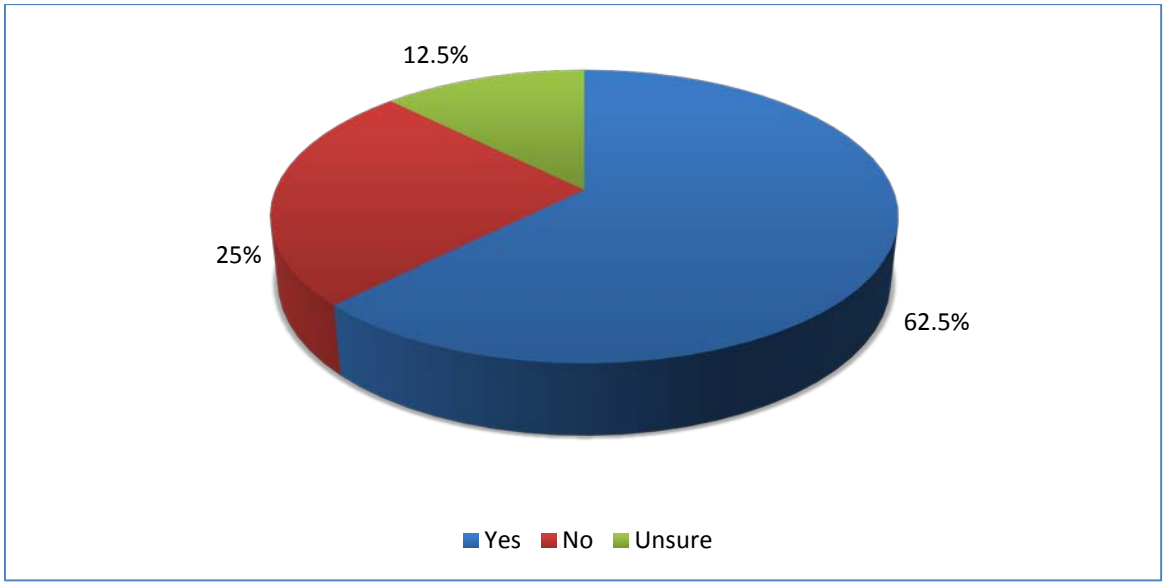

Figure 5.4: Are the newly qualified B.Tech. perfusionists employed at your hospital competent enough? (n=8)

In response to the above question 62.5% of the experts indicated that the newly qualified perfusionists were competent enough to carry out their tasks; 25% indicated they were not and 12.5% were not sure if the newly qualified perfusionists were competent. Consensus was not reached on this statement.

Participants were asked to indicate the tasks for which the newly qualified perfusionists lacked competency. The following responses were received:

- *"CAN NOT TRANSLATE THEORY KNOWLEDGE TO PRACTICLE SIDE"*
- *"If they are not competent to the task, they are not passed"*
- *"Paediatric perfusion, and other variety of complicated cpb cases, e.g. pulmonary embolectomy, partial bypass, etc."*
- *"Yes - BTech students (i.e. completed two years training in the unit) are competent to conduct both adult and paediatric CPB cases unsupervised by the end of their 4th year."*

Participants who were unsure were asked to indicate why they were unsure. This was the response: "If the newly qualified has not done high risk aneurysms they will still need to be assisted by a senior qualified for which we have made provision for."

5.3.2.4 *Should the current exit-level outcomes be modified?*

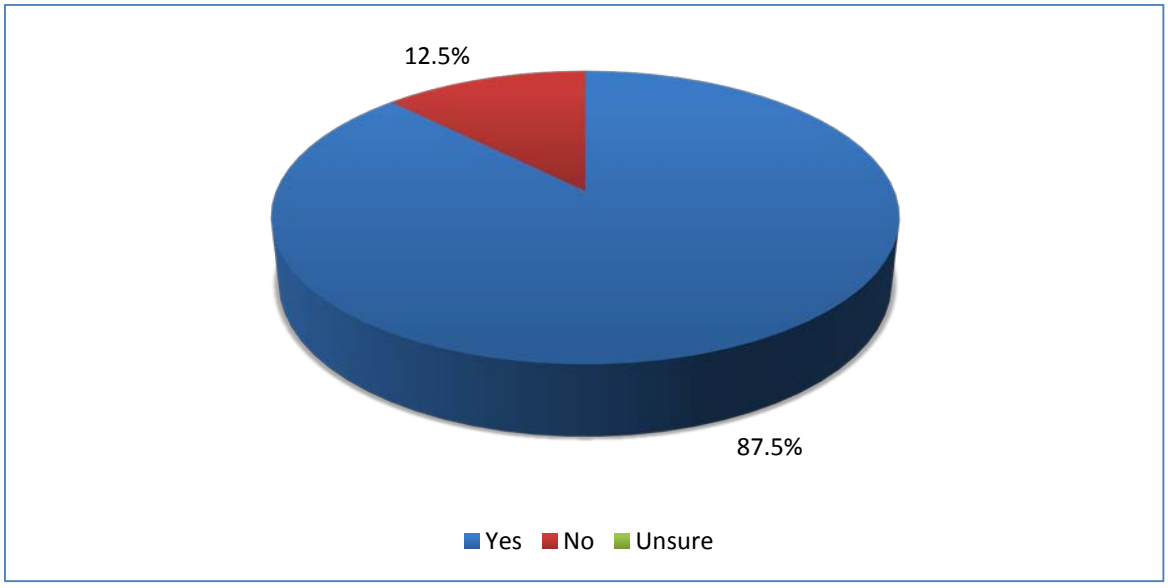

Figure 5.5: Is there a need to modify the current exit-level outcomes? (n=8)

The percentage of respondents who indicated that there is a need to modify the current exit-level outcomes was 87.5, and only 12.5% indicated that there is no need to modify it. There is consensus on this statement and this indicates that the current exit-level outcomes need modification.

5.3.2.5 *Change in exit-level outcomes to improve competencies*

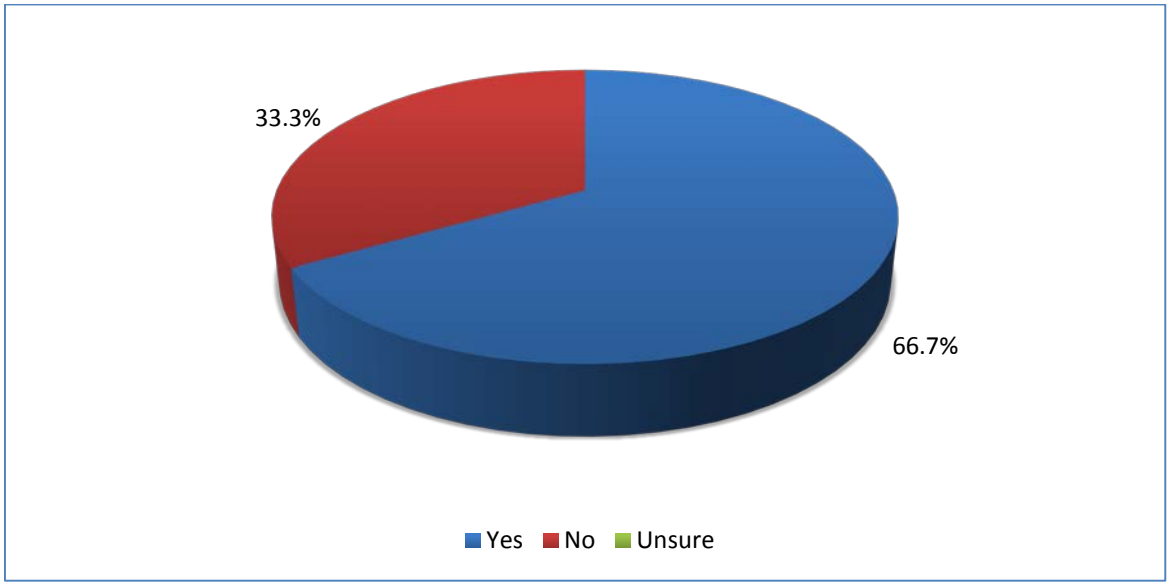

Figure 5.6: Would a change in exit-level outcomes improve the scope of competencies of the perfusionist graduate? (n=8)

Of the respondents 66.75% indicated that a change in the exit-level outcomes will improve competencies and 33.3% indicated that it will not. Since consensus was not reached on this statement it was restated in the second round of the Delphi.

5.3.2.6 *Standardised curriculum*

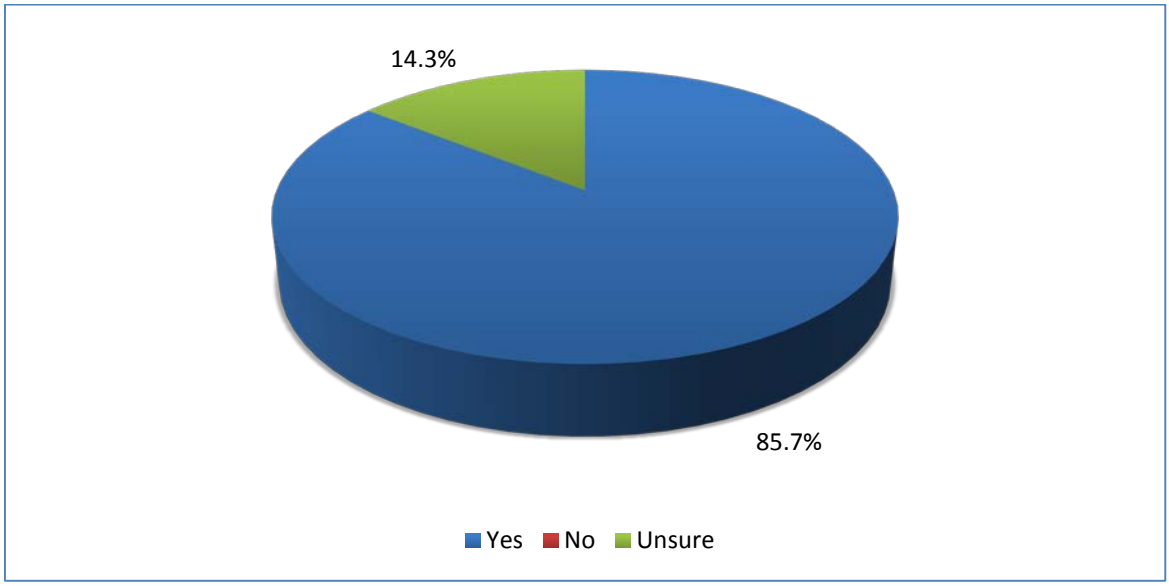

Figure 5.7: Should a standardised curriculum be used by all institutions? (n=8)

There was a consensus of opinion among 85.7% of respondents that a standardised curriculum should be used by all institutions. A further 14.3% of the respondents were unsure and none of them indicated that there should not be a standardised curriculum.

5.3.2.7 *Single exit exam*

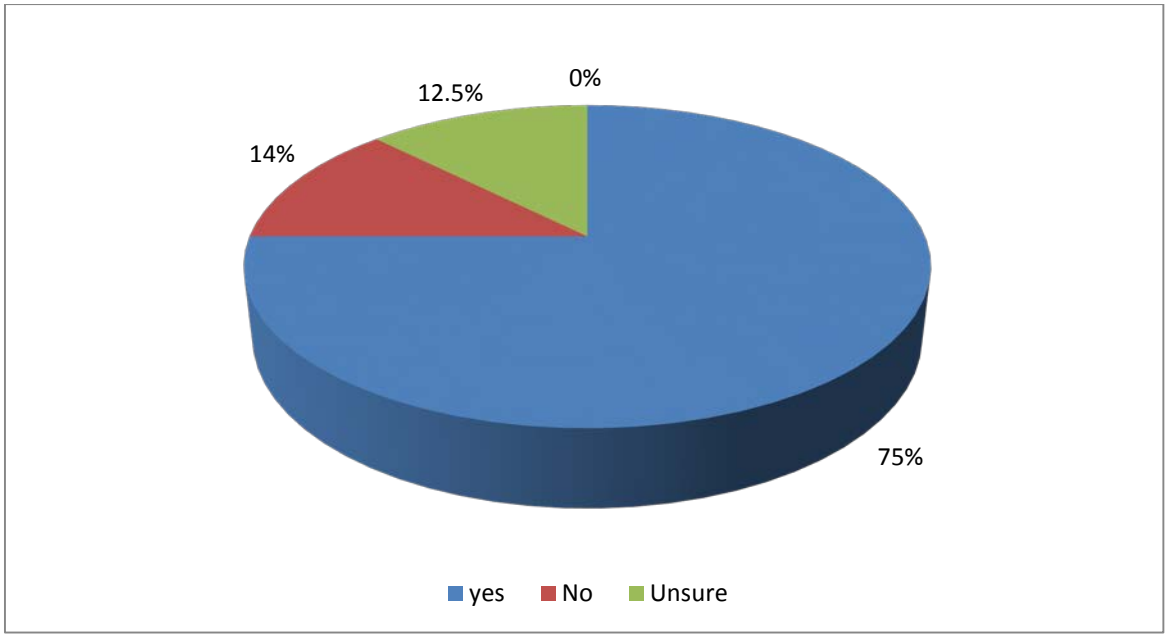

Figure 5.8: Should a single exit exam be a requirement for graduation/certification in order to assess whether all outcomes have been fulfilled? (n=8)

Consensus was not reached on this statement in this round and this question was restated in round two because, in round one, only 75% of the respondents indicated that a single exit exam should be a requirement to assess whether all outcomes have been met, whilst 12.5% of the respondents were unsure and 12.5% indicated that it should not be a requirement.

All the respondents who agreed that a single exit exam should be conducted also agreed unanimously that the exam should be conducted via both a written and oral format (n=5).

5.3.2.8 *Examining authority*

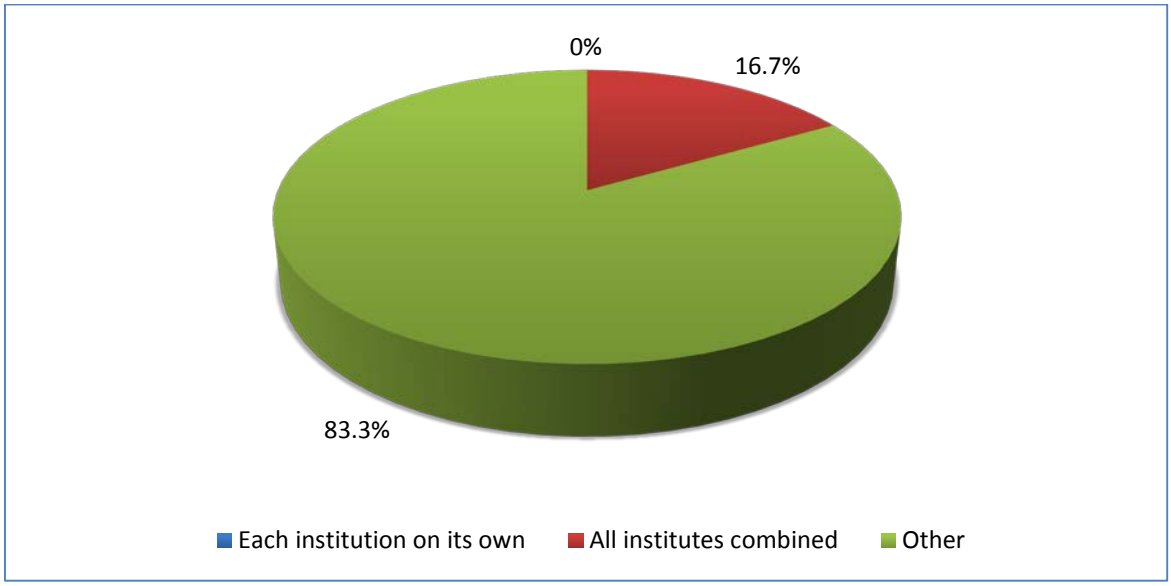

Figure 5.9: Who should conduct the exit exam? (n=6)

Respondents who had indicated that a single exit exam should be a requirement for graduation (cf. 3.5.2.7) were asked to suggest who should be the examining authority. Only 16.7% suggested that all institutions combined should conduct the exams, no one indicated that each institution should conduct the exam on its own, and there was consensus among 83.3% of respondents that “other” should conduct the exam.

Participants were asked to specify what they meant by “other”. These were the responses received:

- *"All institutes should work together to ensure quality but the exam should be conducted in the unit where the student resides."*
- *"As with the Colleges of medicine, a single exit examination should be the standard, to ensure a homogenous level of knowledge and competence. The examiners should be part a a central core of examiners from the training units."*
- *"I think collaboration between the institutions AS WELL as the training unit should be made for setting of written and oral exit exams."*
- *"I would suggest a practical examination on a simulation lab together with theory and oral exams."*
- *"ONE LOCAL, ONE OTHER TEACHING INSTITUTE AND PRIVATE PERFUSIONIST,AND A CARDIO-THORACIC SURGEON"*
- *"Via the perfusionists accredatation body involving all institutions"*

5.3.2.9 *College of perfusion*

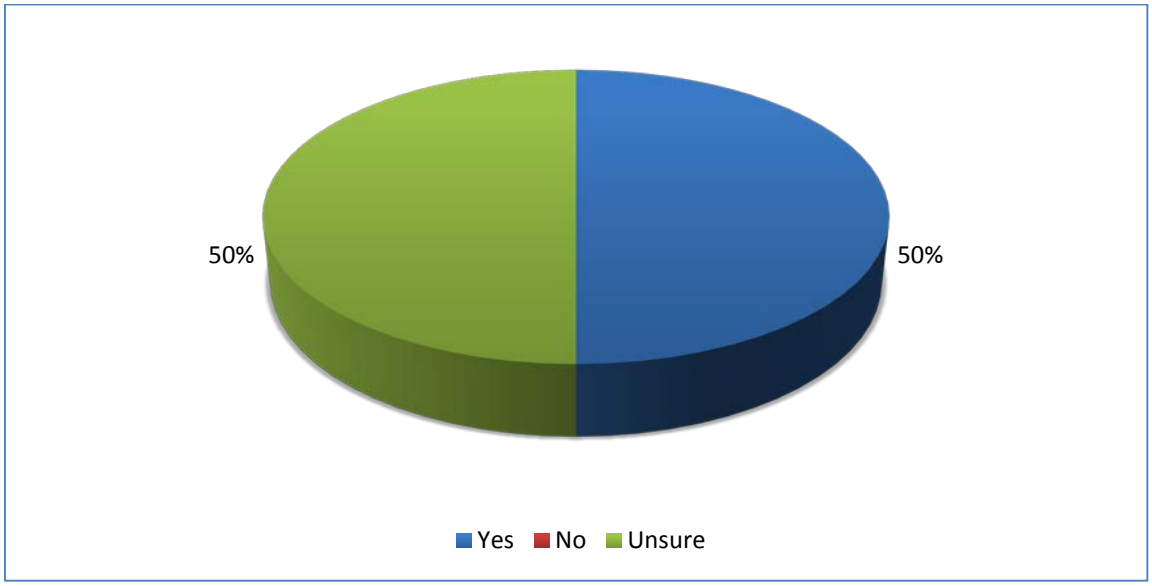

Figure 5.10: Should a college of perfusion be established to assess the competency of and certify perfusionists? (n=8)

Of the respondents 50% indicated that a college of perfusion should be formed and 50% were unsure about it. Since no consensus was reached on this statement it was restated in the second round of the questionnaire.

Participants were required to motivate their answers. These were the motivations:

- *"A college of perfusion would come in handy in the far future but as the industry is so small and specialized it is currently better to align with a known professional entity like to where we are moving to now in 2016, BSc etc."*
- *"For the same reasons as in 3.15." (cf. 5.3.2.8)*
- *"I'm unsure - well conducted exam at each institution will provide an fair and valid examination"*
- *"It assists with standardisation"*
- *"Our profession would be recognised, and this would ensure that students are adequately trained and certified."*
- *"THERE MUST BE THESIS ATTACHED TO EXAMS"*
- *"The possibility for a perfusion school has been proposed previously."*
- *"Yes and no. I don't necessarily think a college should be formed, but a BODY at least to assess the competency would be valuable."*

5.3.2.10 *Should qualifications be based on time or competency?*

- *"BOTH -- NEED 50 CASES ASSISTED AND 50 DONE (ADULT 50 TO 55 CASES, PAEDIATRICS 25 TO 30 CASES). 5 TO 10 CIRCULATORY ARREST."*
- *"Both (2 Counts)"*
- *"Both. Certain goals regarding competency must be coupled to a time frame."*
- *"Combination of both"*
- *"Definitely competency-based ... however, there should be a minimum time period stipulated."*
- *"competency based"*
- *"time"*

Participants were required to give reasons for their answers above (cf. 5.3.2.10). Below are the reasons they gave:

- *"Competency need to be measured and one of the measurements need to be time, not forgetting other monitoring and evaluation tools that should be used."*
- *"Some student have the ability to develop over time when others develop at a faster rate and is competent before the time based. outcomes must be reached where the slower developers take longer to develop ..."*
- *"Some students learn practically faster than their colleagues, and hence competency-based is more appropriate. Having a time-based training period only can be frustrating as it may not apply to all candidates."*
- *"Time means amount of cases the student has exposure to. It is a bit of a numbers game. If the unit does enough cases a year and the student himself does 200 of them that is good exposure. The types of patients are important too. Doing 200 low risk mvr cannot be compared to doing 1 switch. The longer the student is there, the more likely he is to experience a wide variety of complex hearts, being competent when he qualifies."*
- *"WORKED IN BOTH GOVERNMENT TEACHING & PRIVATE INSTITUTIONS."*
- *"We need competent perfusionists, not people who spend years working but not improving on their skill. We are sitting with that problem today."*
- *"time- if it is competency based very little students will finish in the allotted time"*

5.3.2.11 *Adequacy of time to achieve competency*

The next question was as follows:

Currently perfusionists go through theoretical instruction for their first two years of study as clinical technologists. They then go through another two years of full-time practical training as well as part-time theoretical instruction. In your expert opinion, is this time frame adequate for a graduate to achieve competency?

The following answers were given:

- *"More than enough to acquire a degree."*
- *"5 YEARS"*
- *"I think the "time frame" is enough, but I don't think the ND should be awarded after one year for PRACTICE. I think it can be awarded for theory, but that unsupervised practice only be permitted after a minimum of TWO years practical training."*
- *"No"*
- *"Unsure"*
- *"Yes"*
- *"no"*
- *"yes"*

Participants were required to motivate their opinions given in response to question above (cf. 5.3.2.11). These are the responses:

- *"(see above)"*
- *"DUE TO NUMBER OF CASES ARE GETTING DOWN."*
- *"Depending on the unit number of patients versus the perfusionists and surgeons allowing those students to do certain cases."*
- *"More theoretical instruction is needed to better prepare students for practical training. 3years of theory instruction would be recommended. For the final exam, a written and oral exam is needed to test for competency."*
- *"Most degrees are obtainable in three to four years. perfusion should not be any different."*

- *''That is why all students at this unit do 5 years total. Not 4. Its inadequate''*
- *''its been proven over time''*

5.3.2.12 *Suggestions for improving perfusion curriculum*

The next question was:

Please provide any other suggestions with regard to improvement of the perfusion curriculum.

These were the suggestions:

- *''A national standard text book, examination and curriculum must be emforced.''*
- *''Definitely a need for simulations in SA. Think it will definitely relax a student and teach them to concentrate on keeping the patient perfused before really going into OR.''*
- *''I think the universities should liase with the training units - those on the ground an in current practice have a lot of valuable insight in terms of syllabus content, order of topics to be covered etc.''*
- *''Increased wet lab training''*
- *''Joint establishment of the training institutions to establish a competency framework for perfusionists''*
- *''PARTLY INVOLVED IN HOMOGRAFT/WET LAB.''*
- *''refer to 3.21'' (cf. 5.3.2.11)*

5.3.3 Questions pertaining to outcomes and essential content

In this section participants were required to indicate which of the listed outcomes and essential content of a cardiovascular perfusion programme were ''essential'', ''useful'', or ''not needed''. At the end of each section participants were also given the opportunity to add any outcomes or content they believed should be included, and they were asked to indicate whether it was ''necessary'' or ''useful''.

5.3.3.1 Clinical Practice

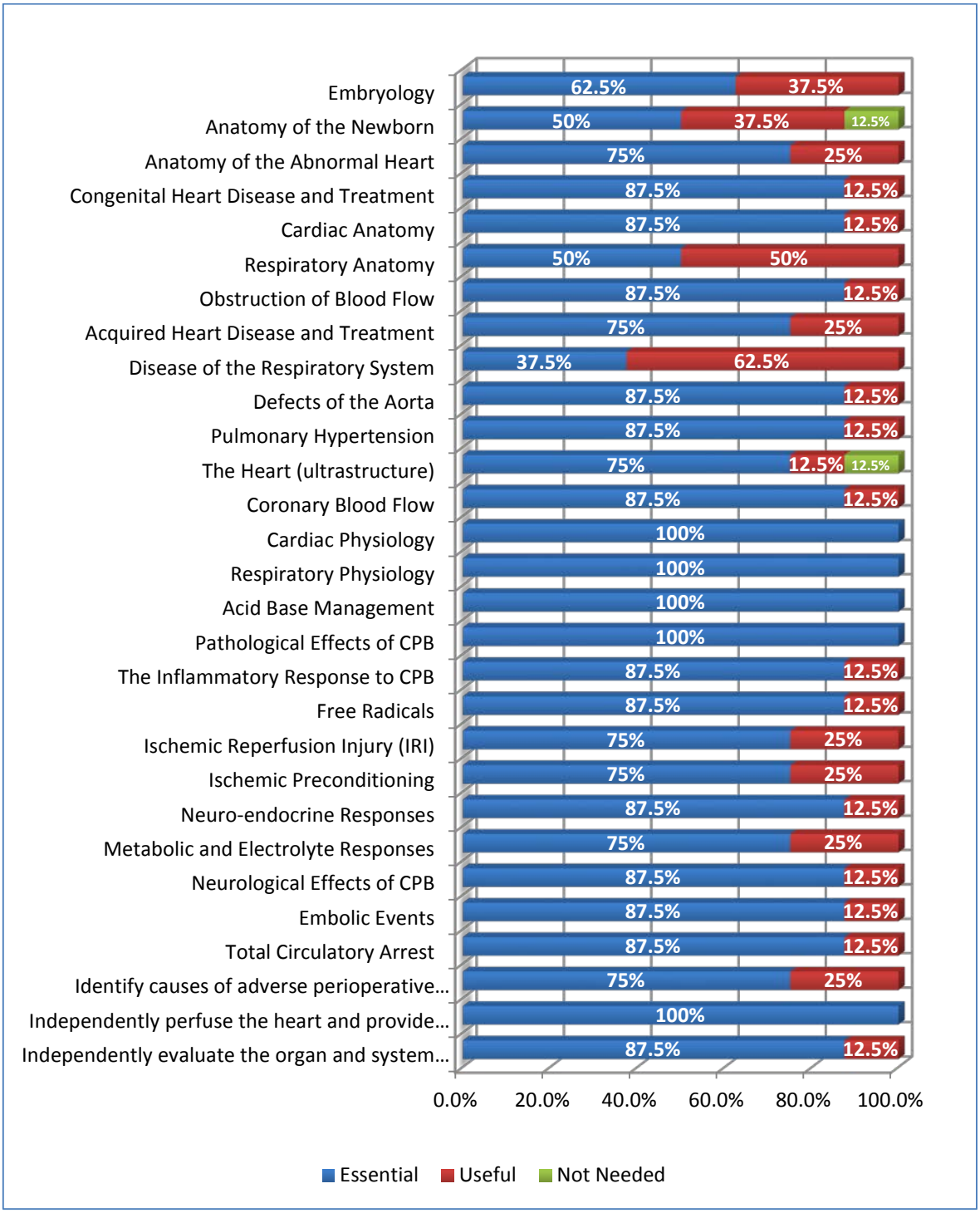

Figure 5.11: Are listed clinical practice outcomes and content topics essential for a perfusion programme? (n=8)

There were 26 content topics listed under clinical practice. Four of the content topics evoked unanimous consensus that they were essential, 12 of the content topics had 87.5%

consensus that they were essential. Consensus was not achieved for the remaining 10 topics and, therefore, these topics formed part of the second round of the Delphi survey.

Of the three outcomes listed (the last three statements in Fig. 5.11), there was consensus that two are essential, for one of the two there was a 100% consensus, and the other received 87.5% of the votes. For the remaining outcome consensus was not reached, 75% of the respondents indicated it was essential and 25% were unsure. Therefore, that outcome formed part of the second round of the Delphi survey.

Participants were asked:

Please state any other outcomes or contents that should be included in clinical practice and indicate whether it is essential or useful.

These are the responses:

- *"All other organ pathology and how it interacts within cpb. Neurological activity monitoring during dhca to ensure neuro activity suppression."*
- *"Haemodynamic monitoring,"*
- *"PATIENTS MUST BE FOLLOWED UP FOR 48 HOURS."*
- *"Physics of Perfusion, essential"*
- *"Troubleshooting - essential"*

5.3.3.2 *Pharmacology*

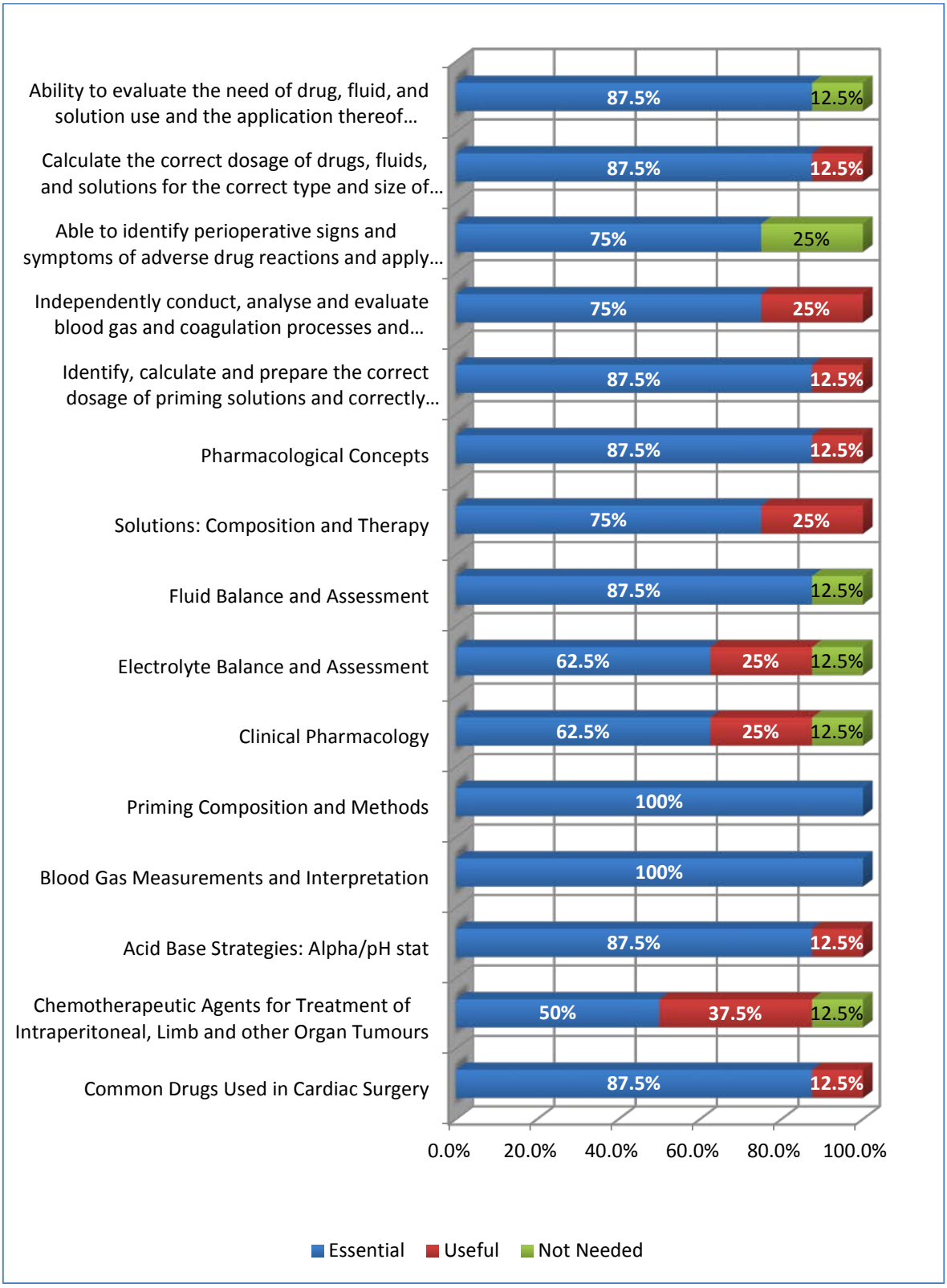

Figure 5.12: Are the listed pharmacology outcomes and content topics essential for a perfusion programme? (n=8)

There was consensus of opinion for three out of five outcomes listed under pharmacology – for these items 87.5% of the votes stated that they were essential. The remaining two items received 75% of the votes, which is not enough for consensus, hence they were restated in the second round of the Delphi survey.

There were 10 content topics listed under pharmacology. There was 100% consensus that two of the content topics were essential, while there was 87.5% consensus for four others. There was no consensus on the remaining four content topics, hence they were restated in the second round of the Delphi survey.

There was no additional input from participants regarding any other outcomes or contents under pharmacology.

5.3.3.3 *Perfusion Technology*

There are eight outcomes under perfusion technology. There was 100% consensus that they were essential on six of the eight and 87.5% consensus on one. Consensus was not reached on one of the outcomes, which was therefore restated in the second round of the Delphi survey. Of the 21 stated content topics under perfusion technology, there was a 100% consensus that they were essential on six content topics and 87.5% consensus on 12 of the content topics. There was no consensus on the remaining three content topics and therefore they had to be stated again in the second round of the Delphi survey.

Participants were asked to suggest any other outcomes or contents that should be included in perfusion technology and to indicate whether it would be essential or useful. Only one participant responded thus: *"Functioning of assist devices ecmos, vads, iabps".*

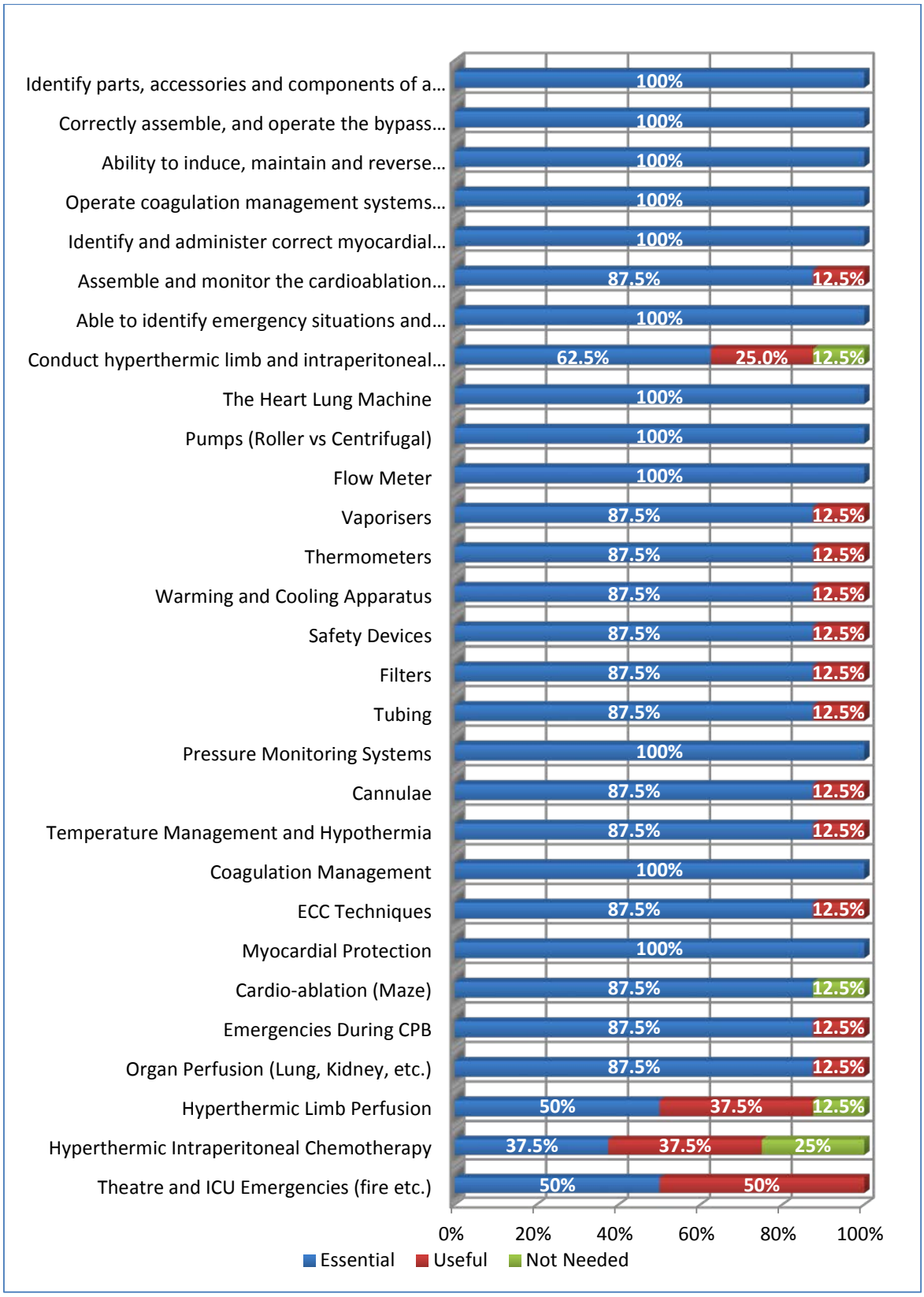

Figure 5.13: Are the listed perfusion technology outcomes and content topics essential for a perfusion programme? (n=8)

5.3.3.4 *Blood Management*

The following figure reflects the responses of the participants.

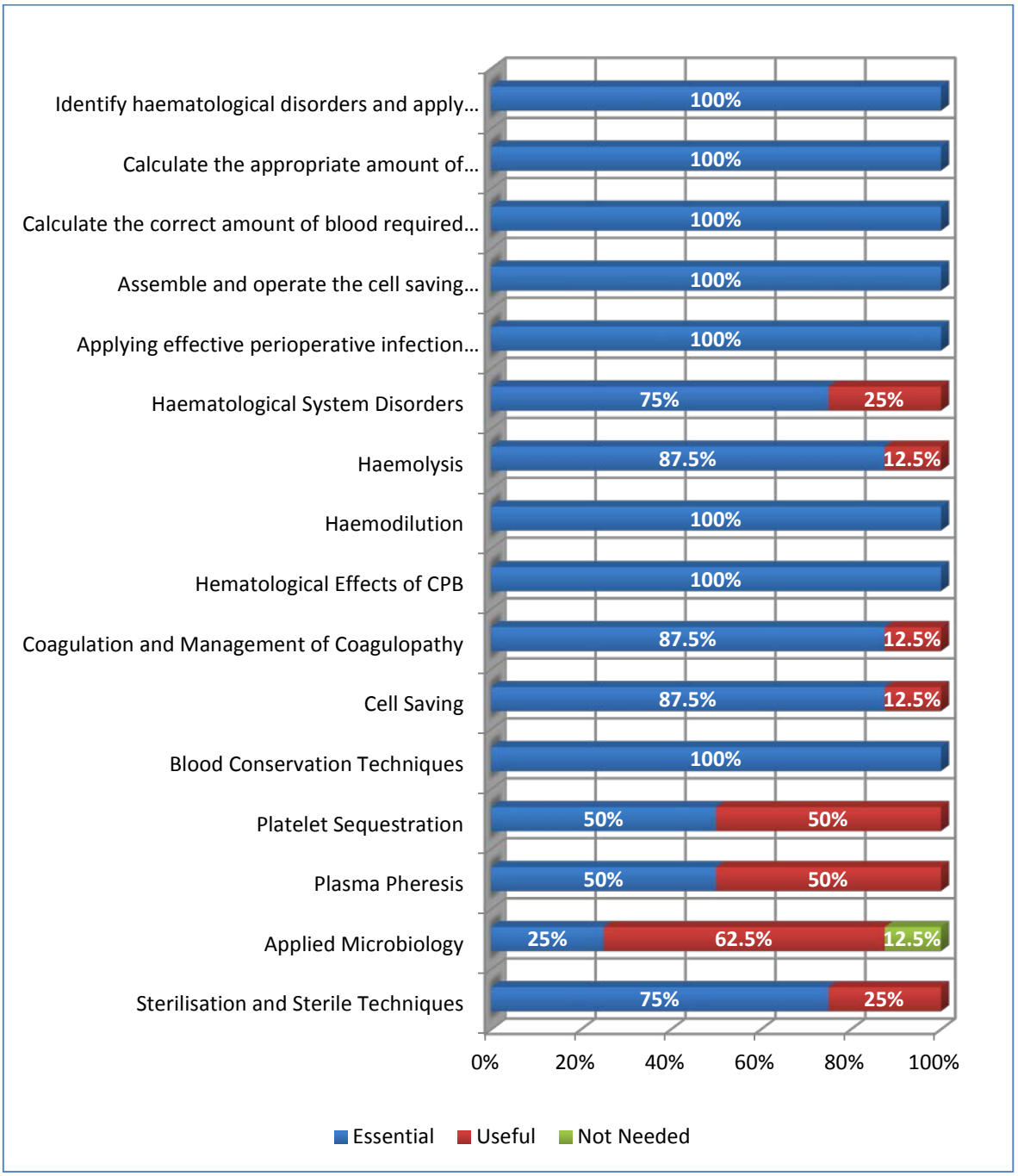

Figure 5.14: Whether the listed blood management outcomes and content topics are essential for a perfusion programme (n=8)

There was a 100% consensus on all five of the stated outcomes under blood management that they were essential. There were 11 content topics stated under blood management. There was 100% consensus on three of the content topics and 87.5% consensus on three

others that they were essential. There was no consensus reached on five of the stated content topics hence they were restated in the second round of the Delphi. Participants were asked to state any other outcomes or contents that should be included in blood management and indicate whether it is essential or useful. One participant responded: *"TEG PFA Tests"*

5.3.3.5 *Haemodynamic Monitoring and Related Technologies*

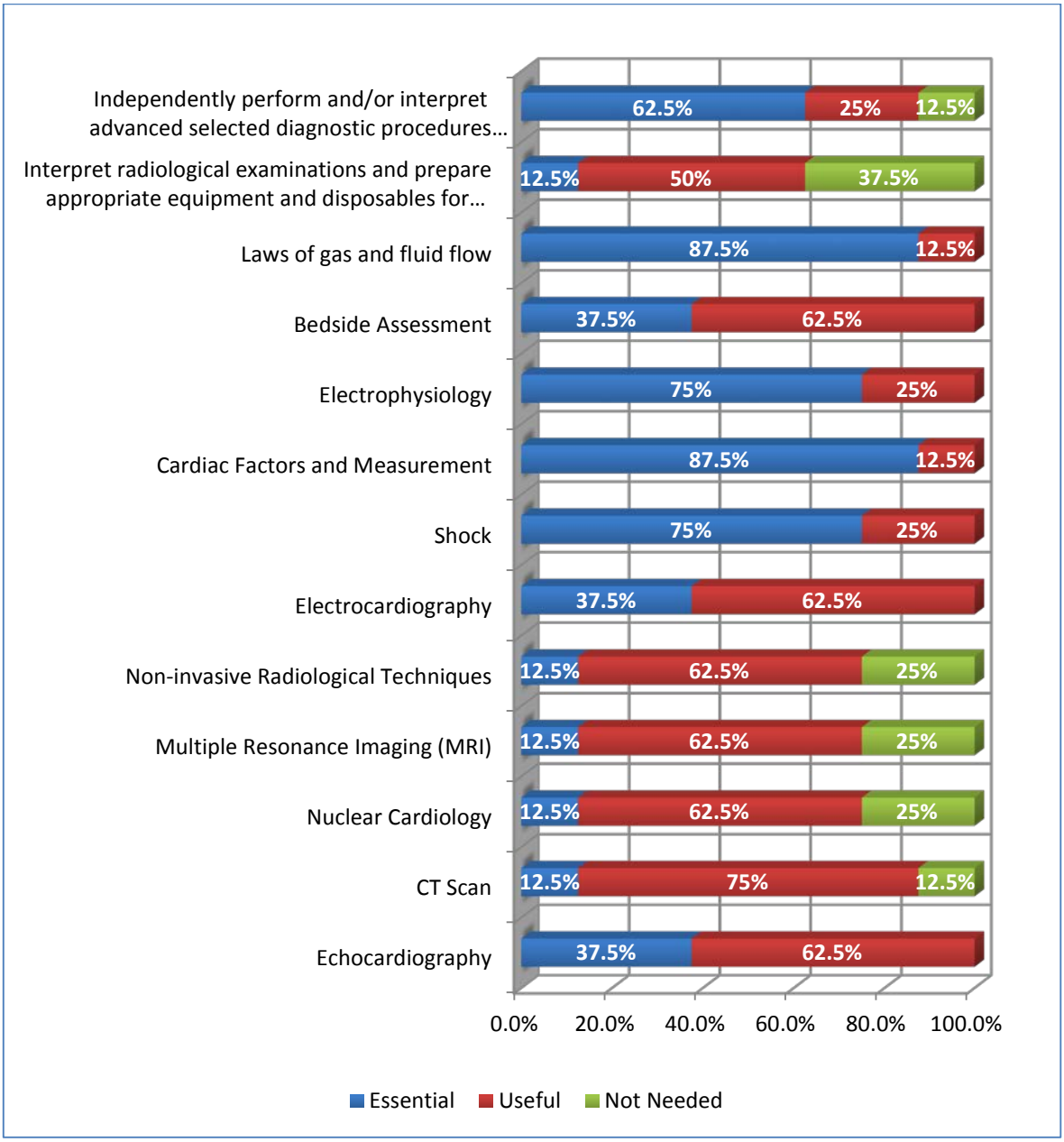

Figure 5.15: Are the outcomes and content topics for the listed haemodynamic monitoring and related technologies essential in a perfusion programme? (n=8)

There were two outcomes given under haemodynamic monitoring and related technologies and both were restated in the second round of the Delphi because consensus was not reached on any of them. Of the 11 content topics stated, 87.5% consensus about their essential nature was reached on only two of them. There was no consensus reached on the remaining nine topics, which were restated in round two of the Delphi. Participants did not suggest further outcomes or content topics for haemodynamic monitoring and related technologies.

5.3.3.6 Mechanical Circulatory Support

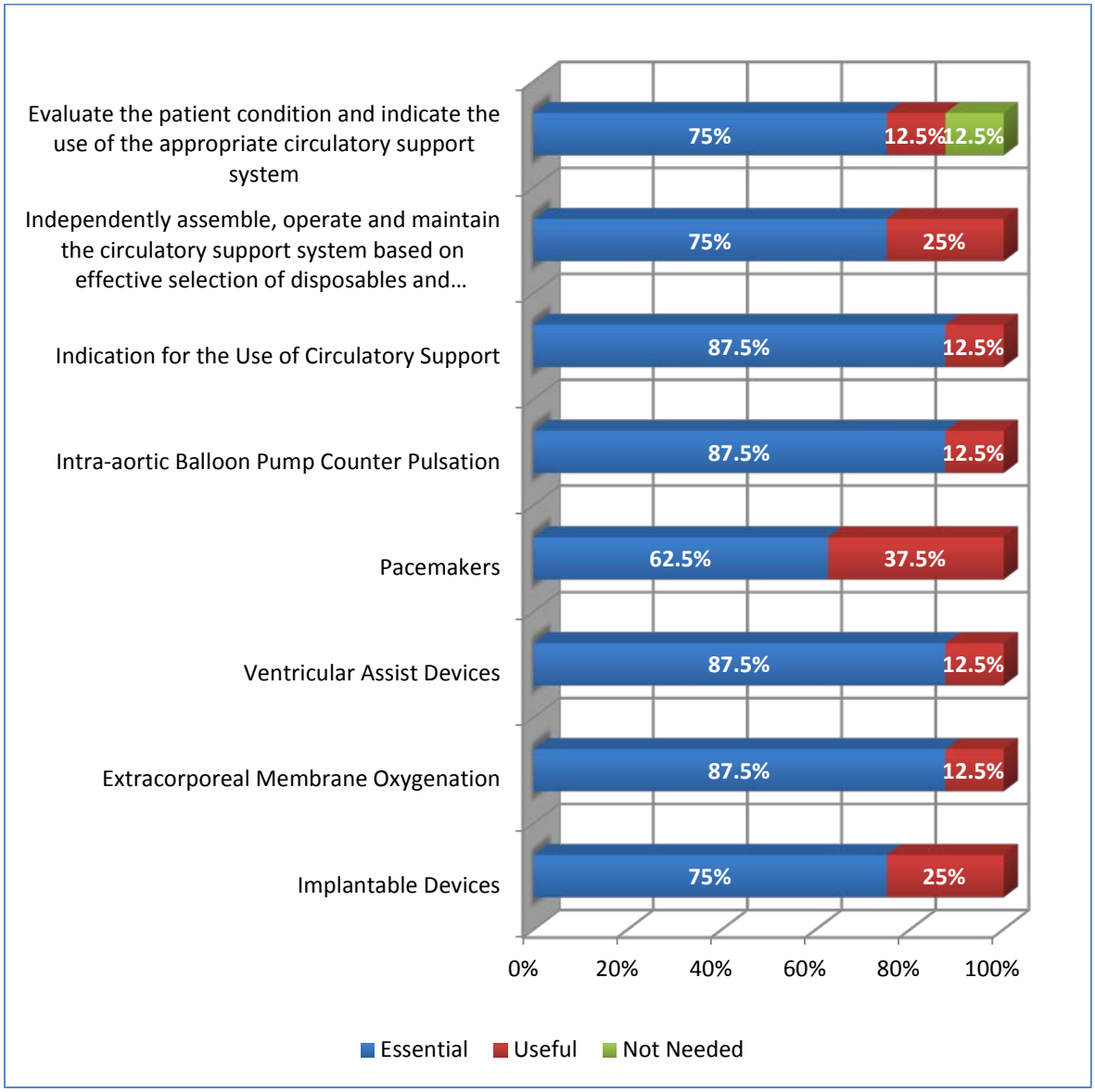

Figure 5.16: Are the listed mechanical circulatory support outcomes and content topics essential in a perfusion programme? (n=8)

There were three outcomes stated under mechanical circulatory support, and 87.5% consensus was reached on the essential nature of one outcome. Since there was no consensus on the remaining two items – only 75% of participants indicated they were essential – these items were restated in the next round of the Delphi.

There was 87.5% consensus that three out of the five stated content topics were essential, so the remaining two content topics were restated in the second round of the Delphi because consensus had not been reached about them being essential.

Participants provided no further input regarding outcomes and content for mechanical circulatory support.

Participants were given an opportunity to make comments at the end of the questionnaire. Only one participant commented: *"MUST EXPOSE TO HEART AND LUNG TRANSPLANT."*

At the end of the first round of the Delphi survey, feedback regarding the results of the first round of the Delphi and comments given by participants was sent to all the respondents. The researcher also provided clarification, where required on certain answers and comments, to the respondents. (Appendix G).

5.4 ROUND TWO OF THE DELPHI TECHNIQUE SURVEY

The second round of Delphi was only sent to the participants who responded in the first round of the Delphi survey. An information document (Appendix H) explaining the process was sent to the participants prior to sending out the round two questionnaire. Round two of the Delphi survey began on 2 February 2015 and ended on 23 February 2015. The response rate in round two was 100%.

Round two of the questionnaire consisted only of statements on which consensus **had not been reached** during round one (cf. 3.3.2.6). Consensus had been predefined as the state where 80% of the participants vote on a specific item with the same value on the three-point scale (Larson & Wissman 2000:46). Participants were given the opportunity to reconsider their opinions on the statements on which consensus had not been reached, taking into account the anonymous feedback that had been provided by their fellow participants and clarifications that were made by the researcher. Sections and statements

in the second-round questionnaire were numbered in the same way as in the first round questionnaire, so as to obtain consensus on the same questions.

5.4.1 Biographical information

The participants of round two of the questionnaire were the same respondents of round one of the questionnaire. The researcher, therefore, did not deem it necessary to gather the biographical information obtained in round one again. The only biographical information that was needed was the names of the respondents, so as to ensure the same participants who responded in round one were the ones responding in round two. The names were also used by the researcher to ascertain which participant/s responded and who did not, enabling the researcher to contact the non-respondents to obtain the reasons for their failure to respond.

5.4.2 Questions pertaining to the adequacy and validity of current outcomes of a cardiovascular perfusion programme

5.4.2.1 *Current exit-level outcomes*

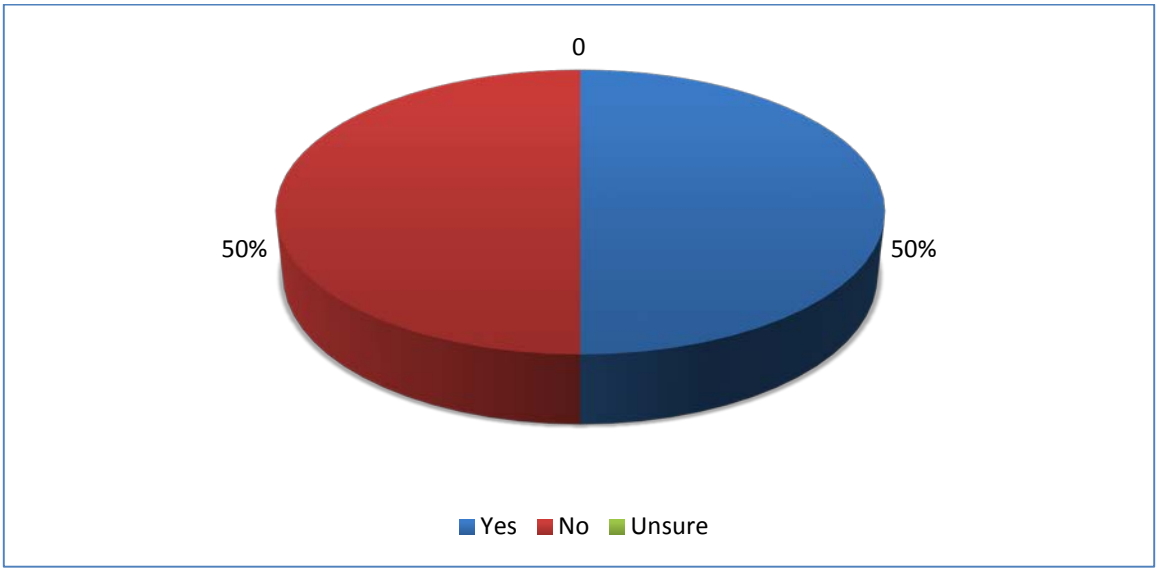

Figure 5.17: Do the current exit-level outcomes of perfusion adequately prepare the perfusionist for the expectations of modern practice? (n=8)

Half the participants agreed that the current exit-level outcomes prepare the perfusionist adequately. The same number of participants had also indicated “yes” in the first round.

Half the participants indicated that the current exit-level outcomes do not prepare the perfusionist adequately. In the first round 37.5% of respondents had indicated “no” and 12.5% had been “unsure”. A number of respondents who had been “unsure” in the first round changed their opinions to “no” in the second round.

To motivate their choices, participants gave the following reasons:

- *''A board exam would be beneficial.''*
- *''In Bloemfontein we train perfusionists to perform research, give lectures and participate in animal studies. They are well rounded and exposed to all the different aspects of cardiothoracic surgery. They are sought in all the other units, even abroad.''*
- *''Need more in depth physiology and trouble-shooting abilities''*
- *''Not a long enough time-frame for some students; also the fact that a ND can be obtained without actually passing a practical for conducting CPB is inappropriate.''*
- *''They are exposed to variety of patient mix and they use different technologies in their training''*
- *''We ensure our students exit as competent Perfusionists at all levels.''*
- *''Yes it does, in our institution the perfusionist is adequately trained in the allocated time- they will never have the necessary experience.''*
- *''needs more exposure for practical cases done in pediatric/ ecmo''*

Analysing the responses given in the second round the researcher and his supervisors were of the opinion that the participants’ opinions will not change in a next round and no consensus was possible on this statement, hence saturation is regarded to have been reached on this statement.

5.4.2.2 *Changing exit-level outcomes to improve competencies*

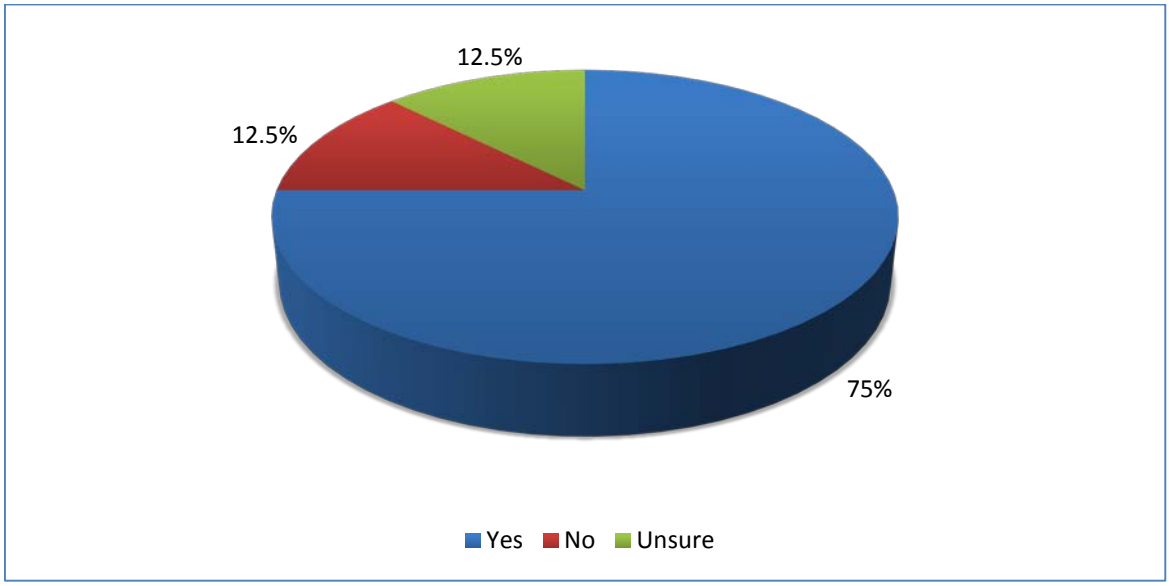

Figure 5.18: Would a change in exit-level outcomes improve the scope of competencies of the perfusionist graduate? (n=8)

Participants indicating a change in exit-level outcomes would improve the scope of competencies of graduates increased from 66.7% in the first round to 75% in the second round. A further 12.5% were unsure – a change from 0% in the first round – and 12.5% indicated "no", changing the exit-level outcomes would not change the competencies, a decline from 33.3% in the first round. Once again, no consensus was reached in this round. The researcher and supervisor decided that saturation had been reached in this round for this statement.

5.4.2.3 *Formation of a college*

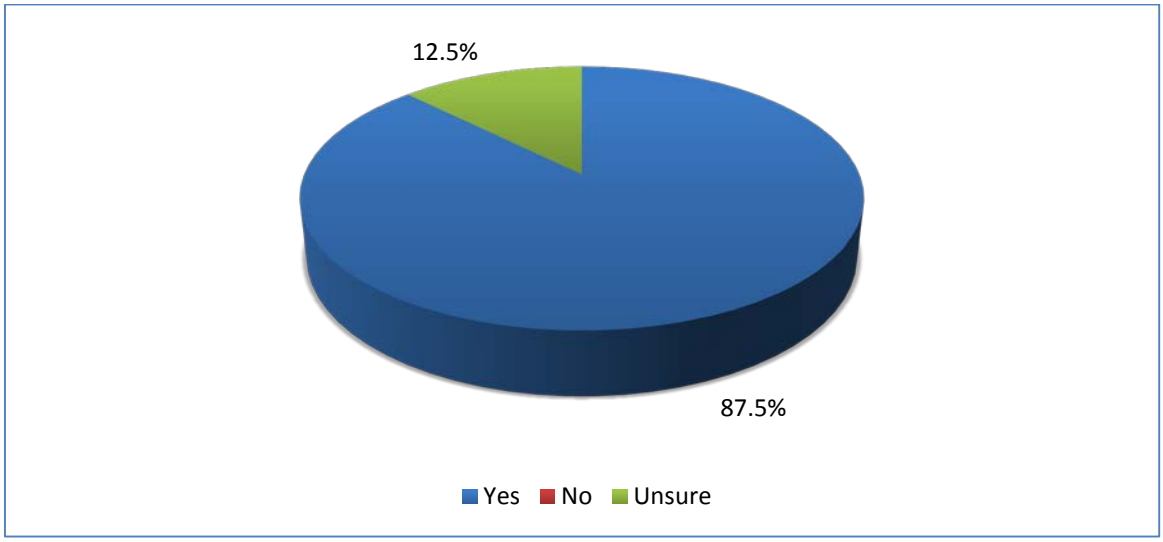

Figure 5.19: Should a college of perfusion be formed to assess the competency of and certify perfusionists? (n=8)

In the first round 50% of participants had indicated that a college should be formed, and 50% had been unsure. From the motivations for their choices given in the first round, researchers deduced that participants interpreted the term college in different ways. In the second round the researcher defined what was meant by college of perfusion, that is, a body of perfusionists similar to the colleges of medicine, which would be in charge of a single exit examination, setting standards and accreditation, ensuring a homogenous level of knowledge and competence. A college would differ from a school of perfusion.

In the second round there was consensus among 87.5% of participants who indicated that a college of perfusion should be formed; 12.5% of the participants were unsure.

Participants gave the following motivations for their choices in the question above:

- *"need s body of C/T Surgeon & perfusionist committee with proper programme"*
- *"Better knowledge of each others training and a common curriculum might be the answer."*
- *"Having more than one technikon allows for different standards in the output of students. The depth of knowledge and level outcomes are not equal for all perfusion institutions."*

- *"The professional body will ensure affiliation internationally possible in order for students and qualifieds to be part of an additional exchange program."*
- *"There is currently no minimal standard that is adhered to nationwide. Perfusionists should set the bar for themselves, based on international standards."*
- *"This will ensure that every student passes with the required level of knowledge, and that each student is competent enough to practice."*
- *"Yes there must be a standard set to assure quality of the product."*
- *"it would standardize the methods of assessment."*

5.4.2.4 *Time spent on training*

The next question was:

Currently perfusionists go through theoretical instruction for their first two years of study as clinical technologists. They then go through another two years of full-time practical training as well as part-time theoretical instruction. In your expert opinion, is this time frame adequate for a graduate to achieve competency?

The following responses were given:

- *"Definitely, we should make sure that every institution appoint the correct number of students, so that they get the necessary practical/case exposure."*
- *"No"*
- *"Yes" (n=2)*
- *"Yes - however I think the ND should be awarded or theory only - one year of training is not sufficient to prepare students to conduct CPB cases under minimal supervsion."*
- *"Yes."*
- *"they must do 80 adult/20 pediatric cases = 20 ECMO"*
- *"yes"*

Participants had to motivate their opinions given above.

- *"If a cardiac surgery unit do 200 cases of which 50 is paediatrics they obviously can only train 1 perfusionist per year. If a unit do 750 cases of which 150 is children the*

can train a maximum of 2 perfusionist. The Capacity of every institution should be looked at. Maybe the perfusionist society should look at this."

- *"Its enough to prepare the students, as long as they also go through a board exam to seal their qualification."*
- *"Our students have to perform a minimum number of pump cases before qualifying. This includes paediatric and adult cases. The number far exceeds the national norm."*
- *"Students should only be allowed to conduct CPB cases in adults "unsupervised" from 6 months in the 4th year of training and in paediatric cases from 8-10 months in their 4th year as it is a specialised area within perfusion."*
- *"Time period is long enough to even abtain an undergraduate degree"*
- *"Yes most degrees are obtained within four year time frame."*
- *"they need more practical experience before they reach this speciality, putting in drips, pt transport, transducers ecs. but this should be dealt with from 2016 onwards. They need more exposure and patient counts in a practical setting. This increases experience and troubleshooting abilities. and mostly, an increased period of training does mean more pt exposure"*

5.4.2.5 *Suggestions for improving the perfusion programme*

Participants were asked to provide suggestions to improve the perfusion curriculum.

- *"More in depth studying of diseases that are more prevalent in our part of the world, compared to many first world countries, and relation to bypass. such as TB, HIV, rheumatic heart disease ecs and even obesity and bypass (not that its not prevalent in first world counties) Im simply saying that perfusion strategies for OUR patients should be included. We tend to study out of books from worldregions that do not face many of our challenges and therefor the in depth data is not as forthcoming."*
- *"Should be a common curriculum for all universities. Curriculum managers from all institution should meet annually."*
- *"Simulation definitely"*
- *"Simulations and wet labs"*
- *"We should look at international perfusion curriculums and match it with their, so that our level of training is of international standards"*

5.4.3 Questions pertaining to outcomes and essential content

5.4.3.1 *Clinical Practice*

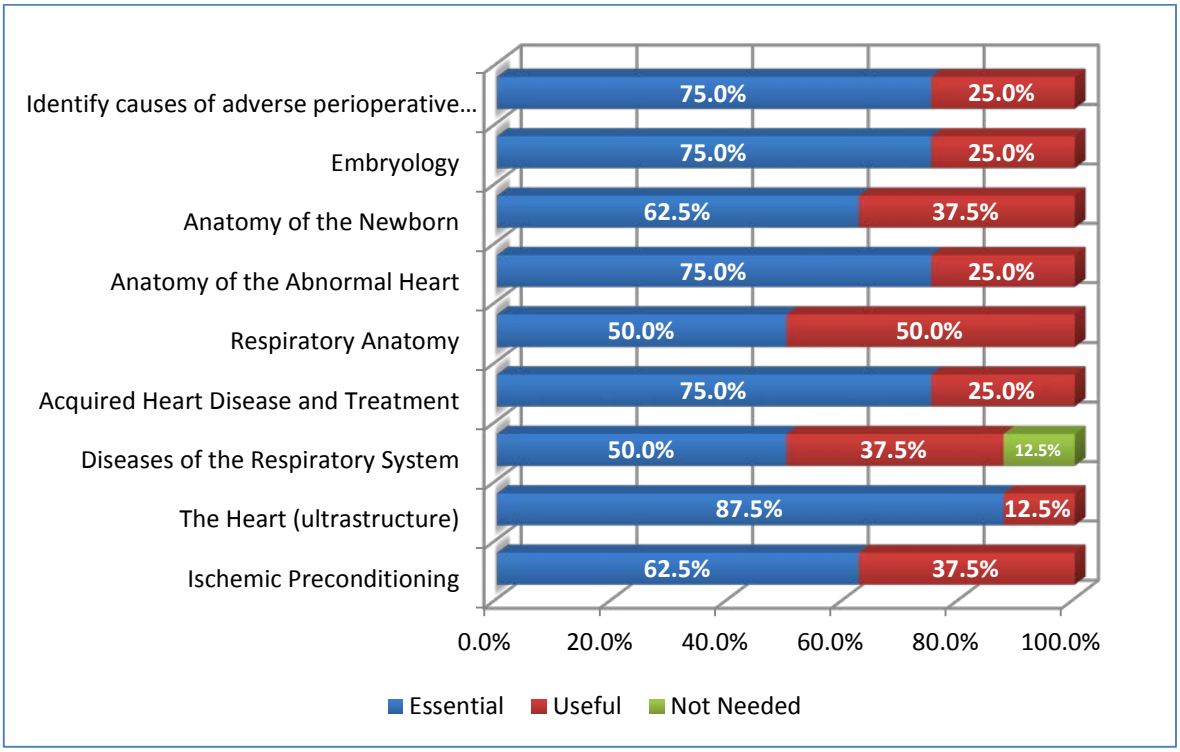

Figure 5.20: Are the listed clinical practice outcomes and content topics essential in a perfusion programme? (n=8)

There was no change in the opinions regarding the outcomes on which consensus had not been reached in the first round, hence the researchers decided that saturation had been reached.

In round two consensus was reached on only one of the content topics [The heart (ultrastructure)], with 87.5% of votes indicating that it is essential and 12.5% indicating it is useful. For the rest of the content topics there was no or little shift in opinions and no consensus was reached. Saturation was deemed to have been reached in the second round.

Participants had to state any other outcomes or contents that should be included in clinical practice, and they were asked to indicate whether it is essential or useful. Two participants responded:

- *"All organ systems to be covered thoroughly as Perfusion is about whole body perfusion."*

Researcher's comment: All organ systems are covered thoroughly in the first two years of the clinical technology course. Repeating it in the third and fourth years as an essential content item does not make sense. However, perfusion of the whole body would be covered under the various outcomes and essential contents stated under perfusion technology (Fig. 4.13).

- *"Aortic aneurysm surgery."*

Researcher's comment: In the first round of the Delphi survey consensus had been reached on the essential content "Defects of the Aorta". Aortic aneurysm surgery would fall under that essential content.

5.4.3.2 *Pharmacology*

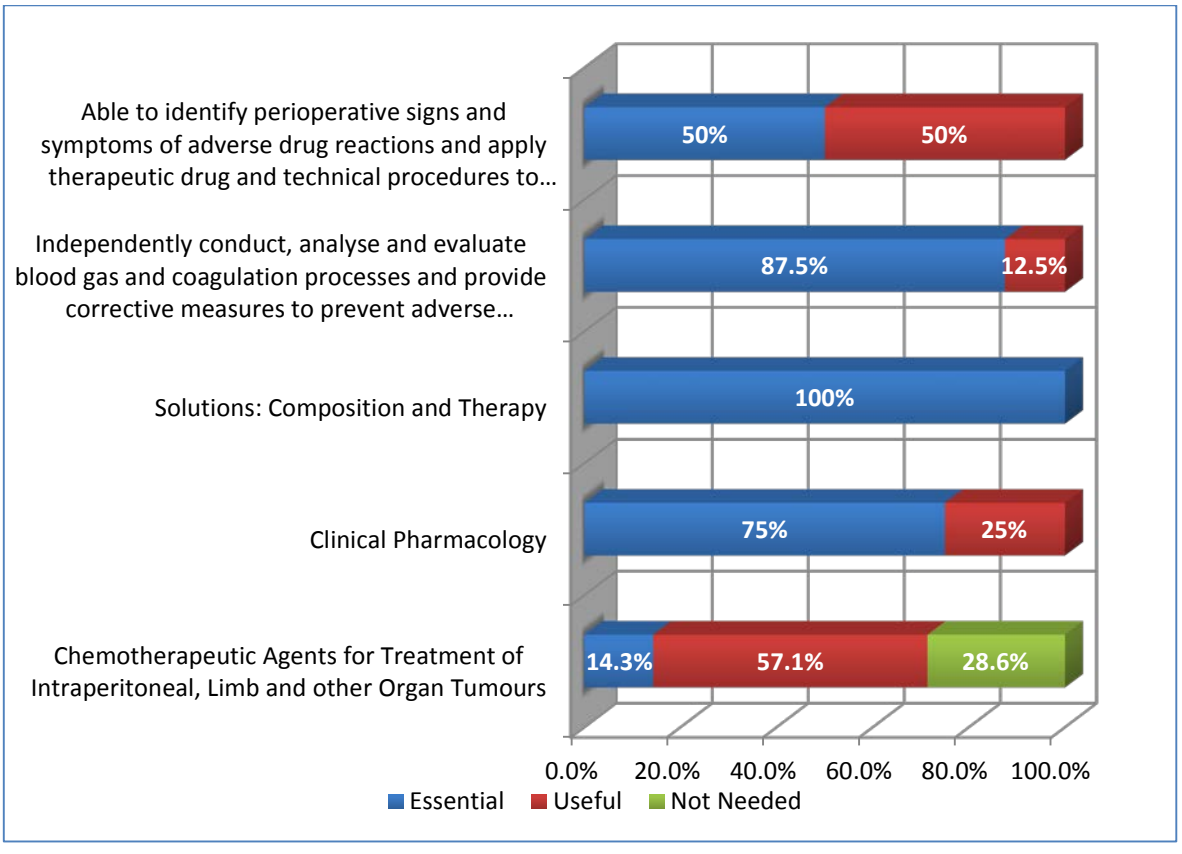

Figure 5.21: Are the listed pharmacology outcomes and content topics essential in a perfusion programme? (n=8)

The two outcomes for pharmacology on which consensus had not been reached in the first round were restated (i.e they formed part of the Delphi statements) in the second round.

In the second round, consensus was reached on one of the outcomes, "Independently conduct, analyse …" (Fig. 5.21). On the remaining outcome, half the participants indicated it was necessary and half indicated it was useful. There was no significant change from the first round, so saturation was deemed to have been reached.

For the contents on which consensus had not been reached in the first round, there was a 100% consensus on one of the content topics, “Solutions: Composition and Therapy” (Fig. 5.21), in the second round. There was no consensus on the rest of the contents and researchers decided that the opinions would not change significantly, and they therefore declared that saturation had been reached.

Participants were asked to suggest any other outcomes or contents that should be included in clinical practice, and to indicate whether it is essential or useful.

Only one participant responded:

- *"Heart failure therapy- essential, CAD medical management - essential, Emergency ACLS- essential"*

Heart failure therapy in a perfusion context would fall under “mechanical circulatory support” (cf. 5.3.3.6). Medical management of coronary artery disease (CAD) is the function of a cardiologist, who is a medical doctor, not the function of a perfusionist. Emergency advanced cardiac life support (ACLS) cannot be essential content for a perfusion programme, but is essential content for an emergency care technician. At best, it is useful content for a perfusionist.

5.4.3.3 *Perfusion Technology*

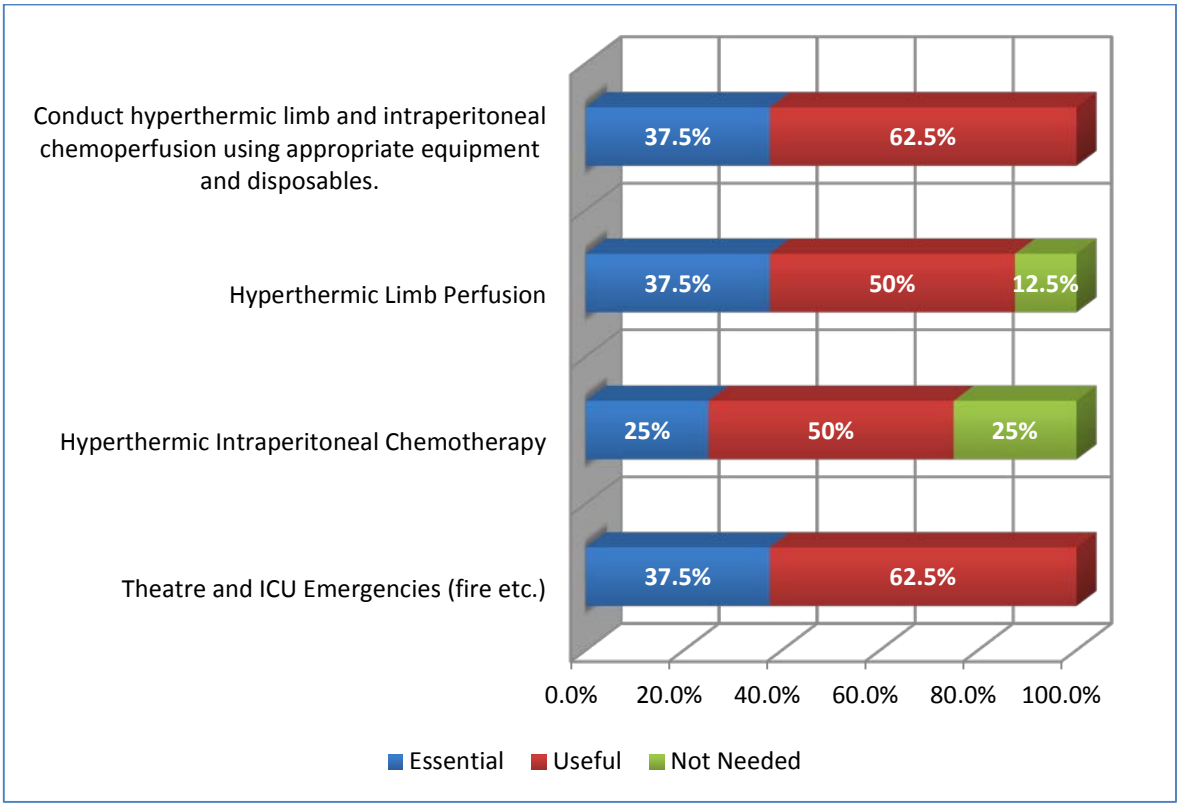

Figure 5.22: Are the listed perfusion technology outcomes and content topics essential in a perfusion programme? (n=8)

There was no consensus on any of the statements under perfusion technology and the researchers declared that saturation had been reached and that significant changes in opinions were not expected in further rounds.

Participants were asked to suggest any other outcomes or contents that should be included in clinical practice, and to indicate whether it is essential or useful.

Two participants responded:

- *"Defibrillator functioning and usage"*
- *"VADs and Extracorporeal life support- essential"*

Researcher's comment:

Defibrillator function and usage will fall under the content, “Emergencies during CPB” (Fig. 5.13) and “Shock” (Fig. 5.15). VADs and extracorporeal life support fall under mechanical circulatory support (cf. 5.3.3.6).

5.4.3.4 *Blood Management*

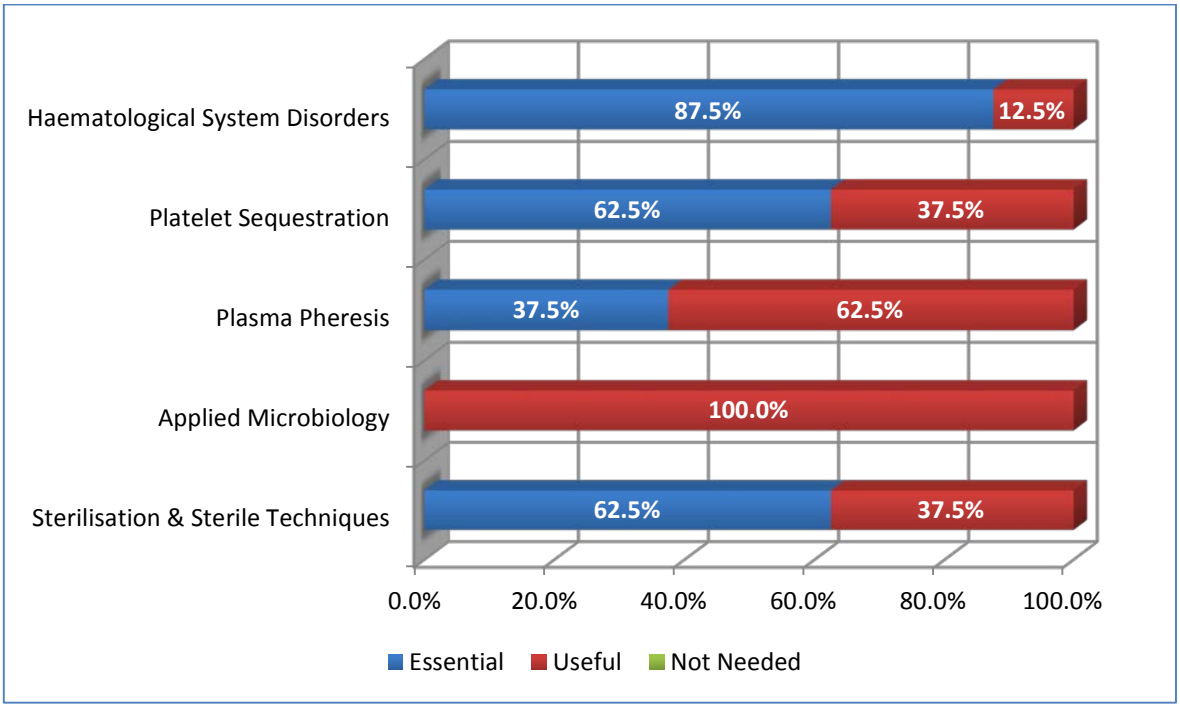

Figure 5.23: Are the listed blood management content topics essential in a perfusion programme? (n=8)

In round one of the Delphi survey, consensus had been reached on all the outcomes stated, so no outcomes were restated in the second round. Five content topics were restated in the second round. Consensus was reached on two of the statements, namely,

1) "Haematologic System Disorders", for which 87.5% of participants indicated it was essential and 12.5% indicated it was useful; and
2) "Applied Microbiology", for which 100% of the participants indicated it was useful.

For the remaining three content topics consensus was not reached and the researcher and his supervisor concluded that opinions would not change significantly, therefore saturation was deemed to have been reached.

There were no further inputs for outcomes and contents from participants for blood management.

5.4.3.5 *Haemodynamic Monitoring and Related Technologies*

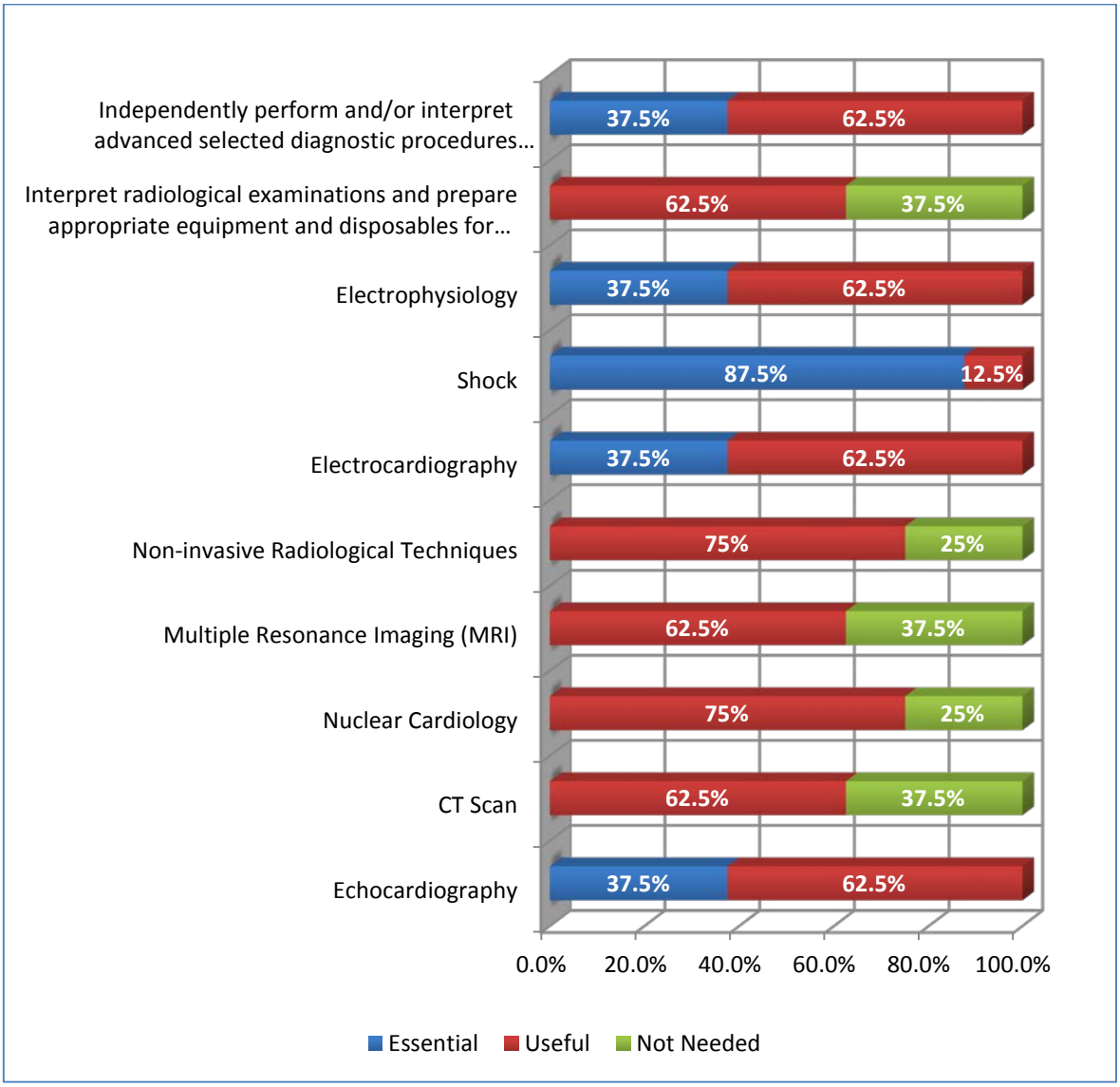

Figure 5.24: Are the listed haemodynamic monitoring and related technologies outcomes and content topics essential in a perfusion programme? (n=8)

Consensus was reached on only one of the contents, “Shock” (Fig. 5.24), with 87.5% of participants indicating it is essential and 12.5% indicating it is useful. There was no consensus reached for the rest of the outcomes and content topics; the researchers concluded that opinions would remain mostly stable and declared that saturation had been reached.

5.4.3.6 *Mechanical Circulatory Support*

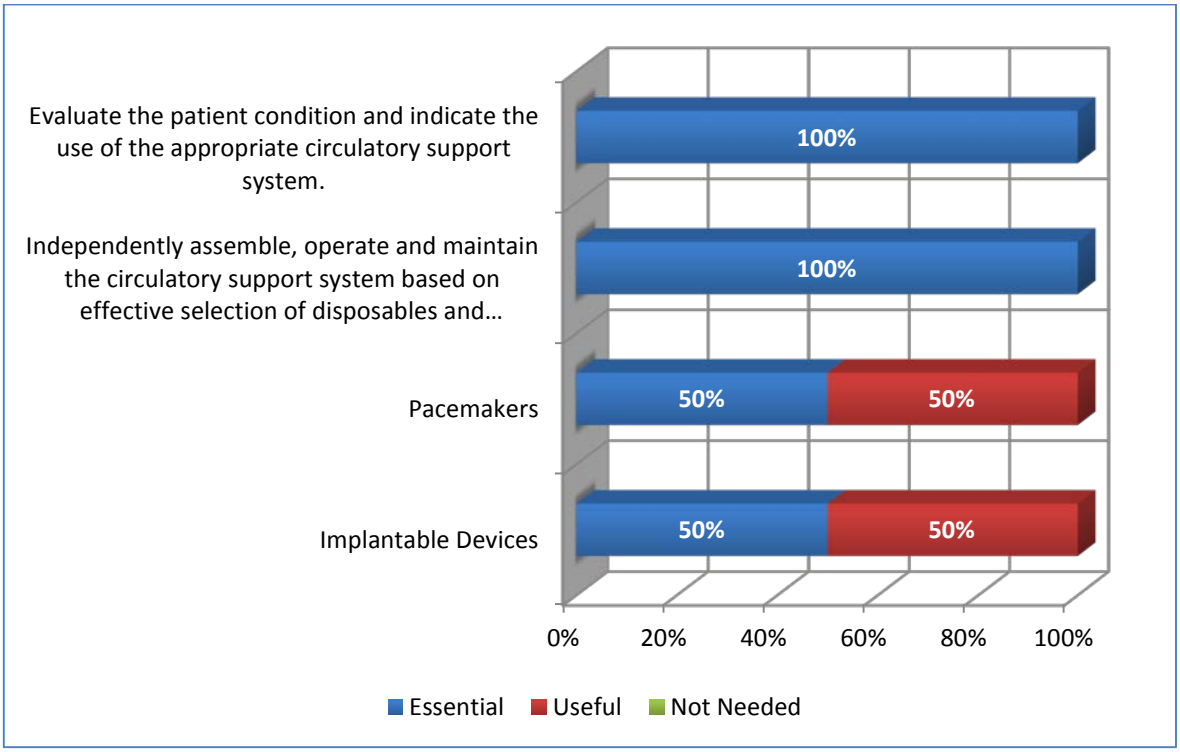

Figure 5.25: Are the listed mechanical circulatory support outcomes and content topics essential in a perfusion programme? (n=8)

There was a 100% consensus on both the outcomes stated in the second round, while there was a 50% split between “essential” and ‘useful” for both of the content topics stated in the second round. No further change in opinions was expected and saturation was declared.

Participants were asked to suggest any other outcomes or contents that should be included in clinical practice, and to indicate whether it is essential or useful.

Only one participant stated:

- *''ECMO and VAD-Useful''*

Researcher's comment: ECMO and VAD were stated in the first round of Delphi and consensus had been reached that both were essential contents.

5.5 CONCLUSION

In this chapter, the results of the Delphi technique survey were summarised and presented in graphs. The response rate for the Delphi technique survey's first round was 44.4%, and 100% for the second round.

The Delphi questionnaires were divided into three parts:

- Biographical Information;
- Questions pertaining to adequacy and validity of current outcomes of a cardiovascular perfusion programme; and
- Questions pertaining to outcomes and essential content of a future cardiovascular perfusion programme.

The first round of the Delphi results revealed that the majority of participants were older than 40 years old, the next largest group was in the 31 to 40 years of age, and only one participant being from the 21 to 30 years of age group. The gender profile had 50% male and 50% female participants. The majority of the respondents were perfusionists occupying head positions in their respective perfusion departments. An anaesthetist and cardiothoracic surgeons were the other respondents of the Delphi questionnaires.

Out of the nine statements pertaining to the adequacy and validity of current educational outcomes, consensus was reached on four of the statements and the remainder were restated in the second round of the Delphi.

With regard to the outcomes and essential content of a future programme, consensus was reached on 18 of the 26 outcomes stated, and of 84 content topics stated, consensus was reached on 47 topics. The outcomes and contents for which no consensus could be reached were restated in the second round.

With the exception of participants' names, the biographical details were not asked again in the second round, as this information had already been obtained in the first round.

There was consensus on one of the statements pertaining to validity and adequacy of current outcomes, and no consensus on the remaining statements, with saturation being reached in the second round.

With regard to the outcomes and essential content of a future programme, out of the eight outcomes stated in the second round, consensus was reached on three of the outcomes. Out of the 29 content topics stated in the second round, there was consensus on four statements that were considered essential, and consensus on one statement that it was considered useful. Saturation was achieved on the second round of the Delphi technique survey.

In this chapter the results and the discussion of the findings of the Delphi survey were presented in the form of graphs, and analysed, interpreted and discussed accordingly.

The next chapter is Chapter 6, ***Description of outcomes and essential content for a cardiovascular perfusion practice programme*.** This chapter will present the outcomes and essential content of a cardiovascular perfusion programme derived from this research study.

CHAPTER 6

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PRACTICE PROGRAMME

6.1 INTRODUCTION

In chapter 5 the results obtained from round one and two of the Delphi survey were presented in line with the aim (cf. 1.4.2) and objectives (cf. 1.4.3) stated in chapter 1 using graphs followed by a discussion regarding the data. The results of the open ended questions (qualitative data) included for certain questions in the Delphi were also discussed. In this chapter the description of outcomes and essential content derived from the research study is presented.

The faces of South Africa's health and education systems are undergoing major transformation. The post-apartheid exposure to the rest of the world, the democratic dispensation bringing equality of all races and policies allowing the previously disadvantaged population to gain a firm foothold in the economic and social development of SA and urbanisation has brought about new challenges in dealing with health care and education related issues in SA.

Cardiovascular perfusion which is an important component of cardiac surgery is no stranger to the challenges referred to in the above paragraph. The changes in disease profiles of patients, changes in surgical indications and advancing technology has made it apparent that perfusion education and training just like all other health care disciplines should be adapted to fulfil the needs of society.

The HPCSA document titled "*Education and Training of Doctors in SA"* states that the faculties of health sciences need to educate competent, knowledgeable, skilful and caring health care professionals conforming to modern medical standards who can adapt to change and will have lifelong learning attitudes (HPCSA 1991:1-9).

Cardiovascular perfusion having started as a non-professional career in 1950s has moved on to becoming a professional qualification today with programmes offered by universities of Technology in SA. However, since its offering as a qualification in 1981 onwards, there

has not been a proper description of outcomes and contents of the programme, with graduates displaying varying degrees of competencies and skills which are not adequate for current and future practice.

This study has been a formal attempt to scientifically describe the outcomes and essential contents of a Cardiovascular Perfusion practice programme so as to add value to the profession and produce graduates who are able to address and overcome the challenges with the qualities described in Chapter 1 (cf. 1.1;1.2;1.3) and the HPCSA document stated above.

According to the Higher Education Qualifications Sub Framework,

the HEQSF incorporates a nested approach to qualifications design. Within a nested approach to standards development, qualification specification requires a movement from generic to specific outcomes. The most generic standards are found in the level descriptors [cf. 6.2.1]. *The most specific standards are found in the programmes that lead to qualifications. Specific standards always meet the requirements of the generic standards within which they are nested or framed. Within this broader context, the focus of the HEQSF is on qualification type descriptors - the second layer of a nested approach. Within the nested approach, the outer layer provides the context for qualification specification. The National Qualifications Framework (NQF) level and its level descriptor form the outer and most generic layer in terms of the knowledge and skills that learners are required to acquire, integrate and demonstrate (applied competence) at each level of cognitive complexity on the HEQSF* (CHE 2013:13).

It further states,

Level descriptors and qualification descriptors are expressed in terms of learning outcomes. The design of programmes makes assumptions about the volume of learning that is likely to be necessary to achieve the intended outcomes (CHE 2013:15).

The level descriptors are the outermost layer of qualification specification. At each level they describe the generic nature of learning achievements and their complexity. Level descriptors are thus broad qualitative statements against which more specific learning outcomes can be compared and located (CHE 2013:18).

Taking cognisance of the nested approach of the HEQSF and applying it in the context of a cardiovascular perfusion programme the elements are briefly explained below and placed in the context of requirements of criteria for the qualification.

6.2 QUALIFICATION TYPES, DESIGNATORS AND QUALIFIERS

Level descriptors describe the generic nature of learning achievements and their level of complexity of knowledge and skill. They do not distinguish between different purposes of qualifications which is done by qualification types, designators and qualifiers. Level descriptors are expressed in terms of NQF levels. There are 10 NQF levels, levels 5 to 10 are occupied by higher education qualifications. Levels 5-7 are for undergraduate qualifications and level 8-10 for post graduate qualifications (the exception being professional Bachelor's degree which is at level 8 but is regarded as an undergraduate qualification) (CHE 2013:14-18).

6.2.1 Qualification types

Qualification type is the first name given to a qualification. The HEQSF describes 11 higher education qualification types that are pegged onto 6 NQF levels. Each qualification type is expected to meet the level of competence described by the level descriptor it is pegged onto.

Level descriptors are expressed in terms of learning outcomes. In order to achieve those outcomes certain volume of study is required. The HEQSF measures this volume of study required for a qualification as credits quantified as notional study hours. 1 credit is equal to 10 notional study hours and it represents all the learning activities the student engaged in including contact time, self-study, WIL, assignments, projects and examinations in order to achieve the outcomes for the particular type of qualification (CHE 2013:16).

The following table represents the qualification types with their relevant NQF levels

Table 6.1 Qualification types, their NQF levels and credits (Adapted from CHE 2013: 6; 27-41)

NQF LEVEL	QUALIFICATION TYPES	Minimum Total Credits
	Post Graduate	
10	Doctoral Degree Doctoral Degree (Professional)	360
9	Master's Degree Master's Degree (Professional)	180
8	Bachelor Honours Degree Postgraduate Diploma	120
	Undergraduate	
8	Bachelor's Degree (Professional)	480
7	Bachelor's Degree Advanced Diploma	360
6	Diploma Advanced Certificate	240
5	Higher Certificate	120

6.2.2 Designators

A designator is the second name given to a qualification. It is the next layer of qualification specialisation nested within the qualification type. For example, a Bachelor of *Commerce (BCom)* degree is a designator of the generic bachelor's degree in the commerce field. Such designators apply only to degrees (bachelors, masters and doctors) and not to certificates or diplomas. A degree designator describes a generic field of study, professions and disciplines and is stated in the qualification nomenclature and described through statements of desired educational training and outcomes and their associated assessment criteria. A designator meets the generic specifications laid down for the qualification type of which it is a variant. For example, a Bachelor of *Commerce (BCom)* complies with the generic requirements for a Bachelor's Degree**.**

6.2.3 Qualifier

The third name given to a qualification is known as the qualifier and forms the last and most specific layer of the qualification specialisation nested in the qualification type. Unlike the designator a qualifier is used with all qualification types and not limited to degrees and is used to indicate specialisation. For example a Bachelor of Engineering *in Electronics BEng (Electronics))* indicates that the person holds a Bachelor of Engineering degree with specialisation in *Electronics.* For qualification types which do not have a designator the qualifier is stated immediately after the qualification type. E.g. Post Graduate Diploma in Drama (PG DIP (Drama)). Bachelor degrees may have a second qualifier which qualifies the first qualifier indicating further specialisation within the first qualifier. For example a Bachelor of Science in Engineering *in Electronics BScEng (Electronics))* indicates that the person holds a Bachelor of Science degree specialising in engineering and further specialisation in electronics (CHE 2013:14-19)..

6.3 CARDIOVASCULAR PERFUSION IN THE CONTEXT OF THE NESTED APPROACH

The context of cardiovascular perfusion specification within the nested approach will be explained in terms of the re-registered qualification Bachelor: Clinical Technology and not in terms of the current qualifications ND: Clinical Technology and B.-Tech.: Clinical Technology offered by the universities of technology. The qualification was re-registered as per the SAQA decision, after consultation with the Quality Councils, to re-register all qualifications and part qualifications on the National Qualifications Framework that meet the criteria for re-registration (HPCSA 2013.Online) as is required by the revised HEQSF policy explained in Chapter 2 (cf. 2.2.3).

Qualification Type: Bachelor's degree
Designator: Clinical Technology
Qualifier: Cardiovascular Perfusion
NQF exit level 8
Minimum total credits: 480
Minimum total credits at level 8: 120
(HPCSA 2013.Online; CHE 2013:32)

6.3.1 Purpose and characteristics of a Bachelor's Degree

The HEQSF Green Book explains the purpose and characteristics of a Bachelor Degree thus.

Bachelor's Degree are of two types, namely general and professionally-oriented Bachelor's Degrees. Both types of degrees may be structured as a 360-credit qualification with an exit at level 7 or as a 480-credit qualification with an exit at level 8 on the NQF. It is also possible to structure a 480-credit Bachelor's degree with an exit at NQF level 7 (CHE 2013:32).

The Bachelor: Clinical Technology (Cardiovascular Perfusion) qualification is structured as a 480 credit qualification with an exit level 8 on the NQF which is professionally oriented.

The HEQSF explains further. "

The 480-credit Bachelor's Degree at NQF level 8 has both a higher volume of learning and a greater cognitive demand than the 360-credit degree at Level 7 and should prepare students to be able to undertake Master's level study by providing them with research capacity in the methodology and research techniques of the discipline.

The primary purpose of both the general and the professional Bachelor's Degree is to provide a well- rounded, broad education that equips graduates with the knowledge base, theory and methodology of disciplines and fields of study, and to enable them to demonstrate initiative and responsibility in an academic or professional context. Both the 360 and 480-credit Bachelor's Degrees may require students to undertake research in a manner that is appropriate to the discipline or field of study in order to prepare them for postgraduate study (CHE 2013:32).

The Bachelor: Clinical Technology (Cardiovascular Perfusion) requires students to carry out a research study and prepare a dissertation within the Cardiovascular Perfusion discipline.

The general Bachelor's Degree espouses general principles and theory to prepare students for entry into general employment or for a postgraduate programme such as the general Master's degree. The professional Bachelor's Degree espouses general principles and theory in conjunction with procedural knowledge in order to prepare students for

professional training, post-graduate studies or professional practice in a wide range of careers. The Bachelor: Clinical Technology (Cardiovascular Perfusion) is more in line with the professional Bachelor's Degree as it provides students with a thorough grounding in the knowledge, theory, principles and skills of the Cardiovascular Perfusion profession and the ability to apply these in a clinical setting. The professional degree programme as is the case with Clinical Technology in any specialist category contains a component of WIL. For Cardiovascular Perfusion WIL has to be compulsorily carried out under the supervision of a graduated Clinical Technologist in the specialist field of Cardiovascular Perfusion. Some professionally-oriented Bachelor's Degree programmes are designed in consultation with a professional body and recognised by a professional body as a requirement for a licence to practice that profession"(CHE 2013:32).

The Bachelor: Clinical Technology qualification is designed in consultation with the board of Radiography and Clinical Technology and requires graduates to register with the HPCSA to practice the profession in that category (HPCSA 2013:Online). However due to an absence of any professional body overseeing the specialist category of Cardiovascular Perfusion there is no standardised education and training programme for it and there is an urgent need for a body to ensure standardisation of the programmes, accreditation, certification and the improvement and maintenance of standards as revealed by this study. This body could also be consulted for future design of the programmes.

6.3.2 Designator and qualifier

As explained in 6.2.2, Bachelor's Degree designators are specific and indicate only broad and generic areas of study, disciplines or professions. The designator Clinical Technology indicates the general area of study of the field. Students are expected to complete their studies in the specialist category Cardiovascular Perfusion (Qualifier) to obtain the qualification at the NQF exit level 8.

6.3.3 Minimum admission requirements

The HEQSF (2013) states.

The minimum entry requirement is the National Senior Certificate or the National Certificate (Vocational) with appropriate subject combinations and levels of achievement, as defined in the Minister's policies: Minimum Admission Requirements for Higher Certificate, Diploma and Bachelor's Degree Programmes Requiring a National Senior Certificate, Government Gazette, Vol 751, No 32131 of 11 July 2008, and Minimum Admission Requirements for Higher Certificate, Diploma and Bachelor's Degree Programmes requiring a National Certificate (Vocational), published in the Government Gazette, Vol. 533, No. 32743, November 2009. Alternatively, a Higher Certificate or an Advanced Certificate or Diploma in a cognate field may satisfy the minimum admission requirements (HEQSF 2013:33).

The admission requirement for the qualification under discussion comply with the policies stated above. Access is open to learners in possession of a NSC, a SC or equivalent NQF Level 4 qualification (HPCSA 2013:Online).

The subjects required for admission for both SC and NSC are discussed in Chapter 2 (cf. 2.2.1)

It is assumed that learners are competent in:

- Mathematics at NQF Level 4.
- Life Sciences at NQF Level 4.
- Physical Science at NQF Level 4.
- Communication at NQF Level 4.
- Life Orientation at NQF level 4.

(HPCSA 2013:Online).

Progression

This Level 8 Bachelor's Degree qualification with 480 credits of the meets the minimum requirement for vertical progression and admission to a Master's Degree. Entry would be into Master: Clinical Technology (Cardiovascular Perfusion).

The qualification Bachelor: Clinical Technology within the context of the nested approach is thus:

The *level descriptor* (cf. 6.4.3) which describes the generic nature of learning achievements and their level of complexity of knowledge and skill within which is nested the *qualification type* (Bachelor) which indicates broad area of the level of education achieved. The *designator* (Clinical Technology) is then nested within the qualification type and indicates a broad area of a specific study within which is nested the *qualifier* (Cardiovascular Perfusion) which indicates a specific area of specialisation. Each nomenclature from qualification type to qualifier have to meet certain outcomes and specifications. In this context, the learning outcomes and specifications for a *Bachelor: Clinical Technology (Cardiovascular Perfusion)* meet the learning demands and specifications laid down for a *Bachelor: Clinical Technology* (cf. 6.4.1) within which the more specialised learning outcomes related to the field of *Cardiovascular Perfusion* (obtained from this research study) are located.

6.4 OUTCOMES OF A CARDIOVASCULAR PERFUSION PRACTICE PROGRAMME

Before giving the specific outcomes of the Cardiovascular Perfusion Practice Programme as formulated from this research, it would be more appropriate to indicate the critical cross field outcomes and learning outcomes of Clinical Technology and the level descriptors for a Bachelor's degree at exit level 8 within which the specific outcomes of Cardiovascular Perfusion have to be nested.

6.4.1 Exit level learning outcomes of Clinical Technology

1. Perform and monitor safety, health, environmental and quality assurance procedures in the clinical environment to ensure professional service and safety of all.
2. Apply scientific and technological knowledge for the management of the patient during clinical procedures in either Cardiology, Cardiovascular Perfusion, Critical Care, Nephrology, Neurology, Pulmonology or Reproductive Biology.
3. Perform therapeutic, corrective procedures and organ system support on patients using specialized health technology to facilitate the management of the patient.
4. Apply management principles and concepts in the health establishment to ensure professional, legal and ethical service delivery.

5. Demonstrate communication and interpersonal skills in a clinical environment.
6. Plan, design, and conduct research in a specific clinical science specialisation relating to a particular context of practice and application to the benefit of the patient.
7. Apply business performance management practices.
8. Design and implement experiential learning in the workplace.
(HPCSA 2013:Online).

6.4.2 Critical Cross-Field Outcomes of Clinical Technology:

- Identify and solve problems in the field of clinical technology in which responses display that responsible decisions using critical and creative thinking have been made.
- Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.
- Contribute to the full personal development of each learner:
  Reflect on and explore a variety of strategies to learn more effectively.
  Participate as a responsible citizen in the life of local, national and global communities.
  Be culturally and aesthetically sensitive across arrange of social contexts.
  Explore education and career opportunities.
- Organise and manage oneself and one's activities responsibly and effectively.
- Collect, analyse organize and critically evaluate information in Critical Care, Cardiology, Cardiovascular Perfusion, Nephrology, Neurology, Pulmonology or Reproductive Biology on a regional, national and international level.
- Communicate effectively in the learning and health care environment by using technology and associated accessories for transfer and sharing of information among healthcare workers and other stakeholders so as to deliver quality patient care and facilitate management processes.
- Demonstrate an understanding of clinical therapy principles by recognizing that problem solving contexts do not exist in isolation.
- Work effectively in collaboration with other health care professionals as members of a team. (HPCSA 2013.Online).

6.4.3 Level descriptors at exit level 08

Scope of knowledge:

A learner is able to demonstrate:

- Knowledge of and engagement in an area at the forefront of cardiovascular perfusion.
- An understanding of the theories, research methodologies, methods and techniques relevant to cardiovascular perfusion and an understanding of how to apply this knowledge in a particular context.

Knowledge literacy:

- An ability to interrogate multiple sources of knowledge in an area of specialisation, and to evaluate knowledge and processes of knowledge production.

Method and Procedure:

- An understanding of the complexities and uncertainties of selecting, applying or transferring appropriate standard procedures, processes or techniques to unfamiliar problems in cardiovascular perfusion.

Problem solving:

- An ability to use a range of specialised skills to identify, analyse and address complex and/or abstract problems drawing systematically on the body of knowledge and methods appropriate to cardiovascular perfusion.

Ethics and professional practice:

- An ability to identify and address ethical issues based on critical reflection on the suitability of different ethical value systems to specific contexts.

Accessing, processing and managing information:

- An ability to critically review information gathering, evaluation and management processes in specialised contexts in order to develop creative responses to problems and issues.

Producing and communicating information:

- An ability to present and communicate academic, professional or occupational ideas and texts effectively to a range of audiences, offering creative insights, rigorous interpretations and solutions to problems and issues appropriate to the context.

Context and systems:

- An ability to operate effectively within a system, or manage the system based on an understanding of the roles and relationships between elements within the system.

Management of learning:

- An ability to apply in a self-critical manner learning strategies which effectively address own and others' professional and ongoing learning needs.

Accountability:

- An ability to take full responsibility for own work, decision making and use of resources, and full accountability for the decisions and actions of others where appropriate

  (SAQA, 2011:Online).

6.4.4 Specific outcomes of a Cardiovascular Perfusion practice programme

The following table represents the outcomes for cardiovascular perfusion on which consensus was achieved that it was essential and on which consensus was not achieved in the research study. The percentage of respondents who indicated that the outcome was essential on which consensus was not reached will also be indicated for future reference.

Consensus was deemed to have been achieved when at least 80% of the respondents agreed upon a statement. Outcomes on which consensus was achieved that those were essential will be included in the programme and items on which no consensus was achieved will not be included in the programme.

Table 6.2: Essential outcomes for a cardiovascular perfusion practice programme. (N.B Non-essential are stated for future reference purposes)

Outcomes	Consensus (Essential)	No consensus (Not essential) not included
1. Clinical Practice		
1.1. Independently evaluate the organ and systems pathology and provide organ and system support for therapeutic/corrective procedures on neonatal, paediatric and adult patients correctly and ethically using specialised equipment (heart lung machine , cell saver etc.) appropriately based on effective selection of disposables and application of knowledge in a professional context and provide counselling where necessary.	X	
1.2. Independently perfuse the heart and provide cardiac support as well as arrest the heart when necessary during cardiac bypass surgery.	X	
1.3. Identify causes of adverse perioperative physiological conditions and applying appropriate methods and techniques to prevent or minimise such conditions.		X 75% essential. 25% useful.
2. Pharmacology		
2.1. Ability to evaluate the need of drug, fluid, and solution use and the application thereof perioperatively.	X	
2.2. Calculate the correct dosage of drugs, fluids, and solutions for the correct type and size of patient.	X	
2.3. Able to identify perioperative signs and symptoms of adverse drug reactions and apply therapeutic drug and technical procedures to reverse or decrease the adverse effects.		X 50% Essential. 50% useful.
2.4. Independently conduct, analyse and evaluate blood gas and coagulation processes and provide corrective measures to prevent adverse physiological events perioperatively.	X	

2.5. Identify, calculate and prepare the correct dosage of priming solutions and correctly prime the CPB circuit.	X	

3. Perfusion Technology		
3.1. Identify parts, accessories and components of a heart lung machine and able to assemble them correctly.	X	
3.2. Correctly assemble, and operate the bypass system appropriately based on effective selection of disposables and application of knowledge in a professional context.	X	
3.3. Ability to induce, maintain and reverse hypothermia together with maintaining the organ and systems within physiologically acceptable limits.	X	
3.4. Operate coagulation management systems (e.g. ACT, TEG and Heparin management systems), interpret results and apply proper corrective measures.	X	
3.5. Identify and administer correct myocardial protection solutions and dosages applying the most appropriate strategies.	X	
3.6. Assemble and monitor the cardio-ablation machine with effective selection of appropriate disposables.	X	
3.7. Able to identify emergency situations and apply measures to prevent loss of human life as well as assets.	X	
3.8. Conduct hyperthermic limb and intraperitoneal chemoperfusion using appropriate equipment and disposables.		X 37.5%Essential. 62.5% useful

4. Blood Management		
4.1. Identify haematological disorders and apply appropriate preventive and corrective measures perioperatively.	X	
4.2. Calculate the appropriate amount of haemodilution required for a particular procedure and administer correct solution dose.	X	

4.3. Calculate the correct amount of blood required for the type and size of patient and transfuse using the safest methods.	X	
4.4. Assemble and operate the cell saving equipment effectively and appropriately	X	
4.6. Applying effective perioperative infection control in all aspects of perfusion.	X	

5. Haemodynamic Monitoring and Related Technologies		
5.1. Independently perform and/or interpret advanced selected diagnostic procedures using specialised equipment/methods such as ECG, pressure waves and measurements, trans thoracic echocardiography (TTE), near infrared spectroscopy (NIRS) and Oxygen (O_2) saturation monitors.		X 37.5% essential. 62.5% useful
5.2. Interpret radiological examinations and prepare appropriate equipment and disposables for the relevant corrective procedures.		X 62.5% useful. 37.5% not needed

6. Mechanical Circulatory Support		
6.1. Evaluate the patient condition and indicate the use of the appropriate circulatory support system.	X	
6.2. Independently assemble, operate and maintain the circulatory support system based on effective selection of disposables and application of knowledge in a professional context.	X	

6.5 ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PRACTICE PROGRAMME

The following table represents the contents for Cardiovascular Perfusion on which consensus was achieved that it was essential and on which consensus was not achieved in the research study. The percentage of respondents who indicated that the content was essential on which consensus was not reached will also be indicated for future reference.

Consensus was deemed to have been achieved when at least 80% of the respondents agreed upon a statement. The items on which consensus was reached will be included as

essential content in the cardiovascular perfusion programme. Items on which no consensus has been reached will not be included in the programme but are mentioned for reference purposes.

Table 6.3: Essential content for a cardiovascular perfusion practice programme.

(N.B Non-essential are stated for future reference purposes)

Contents	Consensus (Essential) Included in programme	No Consensus (Not Essential). Not included
1. Clinical Practice.		
1.1. Embryology		X 75% essential; 25% useful
1.2. Anatomy of the Newborn.		X 62.5% essential; 37.5% useful
1.3. Anatomy of the Abnormal Heart		X 75% essential; 25% useful
1.4. Congenital Heart Disease and Treatment.	X	
1.5. Cardiac Anatomy.	X	
1.6. Respiratory Anatomy.		X 50% essential; 50% useful
1.7. Obstruction of Blood Flow.	X	
1.8. Acquired Heart Disease and Treatment.		X 75% essential; 25% useful
1.9. Diseases of the Respiratory system.		X 50% essential; 37.5% useful
1.10. Defects of the Aorta.	X	
1.11. Pulmonary Hypertension.	X	
1.12. The Heart (ultra structure).	X	
1.13. Coronary Blood Flow.	X	
1.14. Cardiac Physiology.	X	
1.15. Respiratory Physiology.	X	
1.16. Acid Base Management.	X	
1.17. Pathological Effects of CPB.	X	
1.18. The Inflammatory Response to CPB.	X	
1.19. Free Radicals.	X	
1.21. Ischemic Preconditioning.		X 62.5% essential; 37.5% useful
1.22. Neuro-endocrine Responses.	X	
1.24. Neurological Effects of CPB.	X	
1.25. Embolic Events.	X	
1.26. Total Circulatory Arrest	X	

2. Pharmacology		
2.1. Pharmacological Concepts.	X	
2.2. Solutions: Composition and Therapy.	X	
2.3. Fluid Balance and Assessment.	X	
2.4. Electrolyte Balance and Assessment.		X
2.5. Clinical Pharmacology.		X 75% essential; 25% useful

2.6. Priming Composition and Methods.	X	
2.7. Blood Gas Measurements and Interpretation.	X	
2.8. Acid Base Strategies.	X	
2.9. Chemotherapeutic Agents for Treatment of Intra-peritoneal, Limb and other Organ Tumours.		X 14.3%essential; 57.1% useful
2.10. Common Drugs Used in Cardiac Surgery	X	

3. Perfusion Technology		
3.1. The Heart Lung Machine.	X	
3.2. Pumps (Roller vs Centrifugal).	X	
3.3. Flow Meter.	X	
3.4. Vaporisers.	X	
3.5. Thermometers.	X	
3.6. Warming and Cooling Apparatus.	X	
3.7. Safety Devices.	X	
3.8. Filters.	X	
3.9. Tubing.	X	
3.10. Pressure Monitoring Systems.	X	
3.11. Cannulae.	X	
3.12. Temperature Management and Hypothermia.	X	
3.13. Coagulation Management.	X	
3.14. ECC Techniques.	X	
3.15. Myocardial Protection.	X	
3.16. Cardio-Ablation (Maze).	X	
3.17. Emergencies During CPB.	X	
3.18. Organ Perfusion (Lung, Kidney, etc.).	X	
3.19.Hyperthermic Limb Perfusion		X 37.5% essential; 50% useful
3.20. Hyperthermic Intra-peritoneal Chemotherapy		X 25% essential; 50% useful
3.21. Theatre and ICU Emergencies (fire etc.).		X 37.5% essential;62.5% useful

4 Blood Management		
4.1. Haematological System Disorders.	X	
4.2. Haemolysis.	X	
4.3. Haemodilution.	X	
4.4. Hematologic Effects of CPB.	X	
4.5. Coagulation and Management of Coagulopathy.	X	
4.6. Cell Saving.	X	
4.7. Blood Conservation Techniques.	X	

4.8. Platelet Sequestration.		X 67.5% essential; 32.5% useful
4.9. Plasma Pheresis.		X 37.5% essential; 67.5% useful
4.10. Applied Microbiology.		X 100% Useful
4.11. Sterilization and Sterile Techniques.		X 62.5% essential; 37.5% useful

5. Haemodynamic Monitoring and Related Technologies		
5.1. Laws of gas and fluid flow.	X	
5.2. Bedside Assessment.		X
5.3. Electrophysiology.		X 37.5% essential; 62.5% useful
5.4. Cardiac Factors and Measurement.	X	
5.5. Shock.	X	
5.6. Electrocardiography.		X 37.5% essential;62.5% useful
5.7. Non-invasive Radiological Techniques.		X 0% essential; 75% useful
5.8. Multiple Resonance Imaging (MRI).		X 0% essential; 62.5% useful
5.9. Nuclear Cardiology.		0% essential; 75% useful
5.10. CT Scan.		X 0% essential; 62.5% useful
5.11. Echocardiography.		X 37.5% essential; 62.5% useful

6.Mechanical Circulatory Support		
6.1. Indication for the Use of Circulatory Support.	X	
6.2. Intra Aortic Balloon Pump Counter Pulsation.	X	
6.3. Pacemakers.		X 50% essential; 50% useful
6.4. Ventricular Assist Devices.	X	
6.5. Extracorporeal Membrane Oxygenation.	X	
6.6. Implantable Devices.		X 50% essential; 50% useful

6.6 CONCLUSION

In this chapter an explanation of the critical cross field outcomes of clinical technology and the level descriptors of a Bachelor's degree at exit level 08 within the nested approach was presented followed by the specific outcomes and essential content for a cardiovascular perfusion practice programme in a tabular format as derived from the study.

The next chapter, Chapter 7, ***Conclusions and recommendations,*** will state the conclusion of the dissertation and make recommendations for future study.

CHAPTER 7

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

In chapter 6 an explanation of the critical cross field outcomes of clinical technology and the level descriptors of a Bachelor's degree at exit level 08 was presented, followed by the specific outcomes and essential content for a cardiovascular perfusion practice programme in a tabular format as derived from the study.

In this chapter the conclusions of the dissertation, recommendations and limitations for the study are presented. The overview of the study is given first followed by the conclusions drawn from the study, a brief discussion of the limitations of the study, the contribution to knowledge and the study's significance. Lastly the recommendations for future study and concluding remarks are made.

7.2 OVERVIEW OF THE STUDY

The findings of the research served to attain the aim of the study which was to describe the outcomes and essential content of a cardiovascular perfusion practice programme. In Chapter 1 the orientation to the study was given, a brief background to the research problem and the research question was stated. The aims, objectives, and methods employed to achieve them were discussed briefly. The demarcation of the field and the scope of the study, its value and significance, and the implementation of the findings were also explained. In Chapter 2 the theoretical perspectives of the study were provided. South African and international curricula were analysed and discussed. In Chapter 3 the description of the design of the study and the methods implemented to collect data for the empirical part of the study were explained. In Chapter 4 the results of the questionnaire survey were presented and analysed and the interpretation of the findings were explained. In Chapter 5 the results of both rounds of the Delphi were presented and analysed and the interpretation of the findings were explained.

In Chapter 6 the HEQSF's nested approach of qualification design is presented and an explanation of how cardiovascular perfusion fits within that context is given. The outcomes and essential content of a cardiovascular perfusion practice programme as derived from this study was presented.

This chapter concludes this dissertation. In Chapter 1 (cf. 1.3) the reasons that led to the formulation of the research question and the outline of the research question were presented. Three main objectives were pursued in order to obtain answers to the research question and achieve the aims of the study. In Section 7.2.1 the research question is reviewed together with the four objectives and the findings of the research study.

7.2.1 Research question and objectives

The research question was -***what should the outcomes and essential contents of a perfusion practice programme in South Africa include?*** The following three objectives were pursued to answer the research question:

a) *To determine the current outcomes and essential programme content of the current cardiovascular perfusion practice programmes.*

This objective was pursued and achieved by carrying out a literature study of available articles on perfusion education and training and by carrying out document analysis of local and international perfusion programmes and curricula. The current outcomes and essential content derived from the literature study and document analysis were presented and discussed in Chapter 2

b) *To determine the adequacy and validity of the current outcomes and programme content of the cardiovascular perfusion practice programmes and obtain statements for the Delphi survey.*

The above-mentioned objective was pursued and achieved by means of a questionnaire survey (Appendix C) sent out to all HPCSA registered and B.-Tech. qualified perfusionists involved in education and training of perfusion students in SA.

The questionnaire survey revealed that although the current outcomes and content were valid they were not adequate to prepare perfusionists for current and future practice. All the Delphi statements for the Delphi survey were derived from the questionnaire survey. The complete discussion and details of the results of the questionnaire survey were presented in Chapter 4.

c) To determine the required outcomes and essential content of a cardiovascular perfusion practice programme.

This objective was pursued and achieved by means of a Delphi survey involving experts from the fields of perfusion, cardiac surgery and cardiac anaesthesia. Saturation had been reached in round two of the survey. Consensus was reached on most of the statements. The statements on which consensus had been reached that they were essential formed part of the required outcomes and essential content of a cardiovascular perfusion programme. A detailed explanation of the Delphi and its results have been given in Chapter 5 and the outcomes and essential content that needs to be included in the perfusion programme were presented in Chapter 6.

7.3 CONCLUSION

This research is based on the hypothesis that the current outcomes and essential content of the perfusion programmes presented in SA are either not described or are inadequate in producing graduates who are able to provide the skills required of a perfusionist by current and future cardiovascular surgery and other perfusion-related healthcare needs. This shortcoming necessitated the description of outcomes and essential content for a cardiovascular perfusion practice programme, which was the aim of the research.

A combination of methods was used to generate and analyse empirical data using the EvaSys survey-management system. The results were interpreted and presented in Chapters 4 and 5.

The first set of empirical data was generated from the questionnaire survey- the purpose of which is explained in Section 7.2.1.2 and in Chapter 4. The results revealed that the outcomes and the essential content of the various cardiovascular perfusion programmes varied greatly. Although the outcomes and content were valid and did produce competent

perfusionists, the outcomes and content were not adequate and therefore there was a need to modify them to improve the competence and skills of new graduates. The results further revealed that there was a need for a standardised curriculum and a single exit examination which should be conducted in both oral and written formats - this will contribute to producing graduates who are able to successfully apply their skills at any hospital in SA.

The results also indicated that all the statements should form part of the Delphi questionnaire and the suggestions given by respondents were also included as statements in the Delphi questionnaire.

The second set of the empirical data was generated from the Delphi survey employed to obtain consensus on statements to determine the required outcomes and essential content of the cardiovascular perfusion practice programme. Saturation was reached in the second round of the Delphi. Consensus was reached that these outcomes were essential for 20 of the 25 outcomes. Of the 86 content topics stated there was consensus on 56 topics that they were essential. The 20 outcomes and the 56 content topics on which consensus was reached are included in the cardiovascular perfusion practice programme that is presented in Chapter 6. Secondary to the outcomes and essential content the research also revealed a need for a perfusionist body/college to oversee the standardisation of curricula, to conduct examinations and manage accreditation of perfusionists.

7.4 LIMITATIONS OF THE STUDY

The following limitations were recognised by the researcher in the study:

a) Non adherence to time limit set for both questionnaire survey and the Delphi by participants. Although participants were informed before and during the distribution of the questionnaire and the Delphi through various communication sources about the time limits within which responses should be given, participants did not respond within the time limits stipulated. This forced the researcher to extend the time limits until adequate responses had been received or no more responses were expected. The heavy workload in clinical fields may have contributed to respondents' delay in responding.

b) Change in the EvaSys administrator. A new EvaSys administrator at the UFS did not help matters either as the new administrator had to be oriented about the research study. The previous administrator had been involved from the beginning of the study and had been well aware of what needed to be achieved. This caused a slight delay as problems crept in with regard to the way the Delphi should be conducted, because the new administrator was not fully aware about how a Delphi is conducted.

c) During the course of the research the researcher accepted a new position. Consequently, much of his time was absorbed by relocation to another town and getting acquainted with a new workplace. The move away from his promoters meant the frequent contact sessions the researcher had enjoyed whilst in Bloemfontein were no longer possible. The decrease in the contact sessions led to communication breakdowns. Communication with the co-promoter was essential because he is acquainted with many cardiac surgeons who were participants in the Delphi survey. His request that they complete the Delphi would have increased the response rate.

d) Lower than expected response rates. The response rates for both the questionnaire survey and the Delphi were lower than expected. The researcher knows that participants were very busy with various commitments. Numerous notifications using different modes of communication were used to remind participants to complete the questionnaire survey or the Delph, but only one participants indicated that he/she was unable or unwilling to respond. The researcher believes that travelling to the various centres where participants were based and personally encouraging them to complete the questionnaire survey or the Delphi would have increased response rates and made it possible to obtain responses within the stipulated timeframe, but due to financial and time constraints and vast distances, the researcher was not able to travel to respondents.

e) Conducting a questionnaire survey and a Delphi instead of a Delphi only. Using two different methods of gathering data may not be a limitation in itself, but in hindsight, the researcher is of the opinion that a Delphi alone, consisting of participants used in both the questionnaire survey and the Delphi survey, would have yielded stronger results and would perhaps have enabled the research to be conducted in a shorter

time. The supervisors, however, were convinced that, because there were a limited number of participants, the two methods served as a justification in itself.

f) The lack of recent available literature on the research topic especially related to perfusion education and training in SA or even the rest of Africa also posed a challenge as information was difficult to obtain and the researcher had to rely heavily on personal communication to obtain information.

7.5 CONTRIBUTION TO KNOWLEDGE

The researcher is of the opinion that the research made a contribution to new knowledge by describing outcomes and essential content that are either not or inadequately described in the current programmes offered by the various institutions. The programme presented in Chapter 6 can be used by all the institutions to enhance their curricula and, as the results provide a standardised, uniform curriculum, can be used by all the institutions to produce graduates who will be highly skilled and competent perfusionists, able to provide the services that are required at present and in the future. The programme outcomes and content described through this research can be applicable internationally as well.

In addition to the above, the research also provided:

- A clear understanding of the changing environment of cardiac surgery and perfusion science and the way the changes impact on the role of cardiovascular perfusionists in the South African context in particular;
- A comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice; and
- A complete set of outcomes that can form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion.

7.6 RECOMMENDATIONS

Through this study the outcomes and essential content of a cardiovascular perfusion programme have been described. The research proved that many outcomes that are not described by the current curricula and content that is not part of the current curricula are essential. Furthermore, the research indicated a need for a standardised curriculum to be used by all institutions in SA. The way forward is to approach the various universities of technology and present to them the programme that has been formulated, and request them to adopt it as their programmes. Prior to adoption, though, various bodies, such as SAQA, CHE and HPCSA, need to be approached and due process needs to be followed to approve the programme.

This research was by no means a complete study of all aspects of perfusion education. Training of perfusionists is a major part of perfusion education. Investigations into the different training institutions, their methods of training, types of cases covered in training, population served, number of cases performed to justify competence, demography of patients, etc. need to be made in order to ascertain if training is at an adequate level. Once this has been ascertained, investigations into development and standardisation of training programmes can be carried out through further research. The description of outcomes and essential content is only the first step in developing competent perfusionists who are able to provide the required skills.

The role of the level of training received is as important as the outcomes and contents. In fact, the training will determine whether the outcomes are met by students. Students at institutions that adopt a standardised curriculum but provide non-standardised, haphazard training, will not achieve competence. Therefore, further research should be carried out regarding training programmes, to achieve conformity with the outcomes and essential content described in this research. After implementing the programme comprising the outcomes and essential content, further research can be undertaken to determine whether further adjustments for the programme are required. The investigation into the above mentioned further research recommendations will, God willing, be carried out at doctoral and postdoctoral levels.

This research can form the basis of similar research that can be carried out in other fields of clinical technology, viz. cardiology technology, nephrology technology, pulmonology

technology, critical care technology, reproductive biology technology and neurophysiology technology. Other healthcare-education and training-related research can also benefit from this research.

7.7 CONCLUDING REMARK

We know that, if the heart suffers any damage, the effects will be felt by the whole body and, if not treated properly, multi-organ disease becomes highly possible. Cardiovascular perfusion, being the heart of cardiac surgery, needs to constantly develop to remain healthy or else it will deteriorate and cause damage to entire spectrum of cardiac and other related surgeries.

Surely in the body is a piece of flesh, if it is healthy the entire body will be healthy, and if it becomes unhealthy the entire body will become unhealthy. Behold! it is the heart. (Prophet Muhammad (Peace and salutations be upon him)).

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APPENDICES

APPENDIX A: Letter of request and information document to potential participants to participate in the questionnaire survey

Information Document

Dear Colleague,

Request to participate in the Magister study titled:

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

I am in the process of writing a dissertation to obtain the Magister degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State. The title of my research is DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

My supervisors are

Study leader

Dr. J. Bezuidenhout, Senior Lecturer:
Division Health Sciences Education
Office of the Dean, Faculty of Health Sciences
University of the Free State
Tel: +27 (0)51 405 3095
Email: bezuidj@ufs.ac.za

Co-Study leader

Prof. Francis Smit
Department of Cardiothoracic Surgery
Faculty of Health Sciences
University of the Free State
Tel:+27(0)514053861
Email:smitfe@ufs.ac.za

As indicated by the title, the **purpose** of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme.

The **problem** that will be addressed is that current outcomes and essential content of a cardiovascular perfusion programme are inadequate for producing graduates who can immediately provide the wide range of skills required by modern and future cardiovascular surgery. This hypothesis necessitates the description of the outcomes and content of a perfusion programme that expands the scope of practice of the cardiovascular perfusionist, develops the profession of cardiovascular perfusion, creates opportunities for a fulfilling career for its practitioners and provides a highly professional patient service.

The aim of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme.

In order to achieve this aim the following objectives will be pursued:

1. To determine the current outcomes of a current cardiovascular perfusion programme.
2. To determine the current essential programme content of a cardiovascular perfusion programme.
3. To determine the required outcomes and essential content of a cardiovascular perfusion programme; and
4. Using the results from above to describe appropriate and relevant outcomes and programme content to achieve the aims of the study.

The research is a descriptive design consisting of a quantitative study with qualitative elements. The methods that will be used are an electronic questionnaire survey and the Delphi technique using the online EvaSys survey-management system. The questionnaire survey will first be conducted to derive the Delphi statements. Once the questionnaire survey has been completed and the Delphi statements derived, the Delphi process will be conducted to achieve the aims of the study.

The questionnaire and the Delphi statements designed by the research team using the Evasys survey-management system will be used in this study. The questionnaire which **you will be receiving soon** and the Delphi statements (freely available on completion of questionnaire survey) will be put through a pilot phase to iron out any bias and inefficacies.

The value of the study can be listed as follows:

- Gaining a clear understanding of the changing environment of cardiac surgery and perfusion science and how this impacts the role of cardiovascular perfusionists in the South African context in particular;
- Compiling a comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice;

- Developing a complete set of outcomes that will form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion;
- Developing essential programme content for the graduate degree in the field of perfusion;
- Enhancing the curricula of cardiovascular perfusion programmes greatly;
- Possibly standardising the programme of cardiovascular perfusion programmes, at least in South Africa; and
- Possibly providing invaluable information and content for new cardiovascular perfusion programmes internationally.

The significance of the study lies in the fact that, although this study will be focused on the cardiovascular perfusion programmes in South Africa, the outcomes and essential programme content that will be described or many of its components will be applicable internationally.

The findings of this study will be used directly in the enhancement and reform of the programme of Cardiovascular Perfusion at the CUT.

The **findings** of this study will be made public to the School of Medicine, the University of the Free State, the Schools of Health Technology, Central University of Technology, Durban University of Technology, Tshwane University of Technology and other educationalists in Higher Education through paper presentations at conferences and seminars and by the publishing of articles in applicable journals.

I therefore kindly request you to participate in the questionnaire survey.

You will receive an electronic questionnaire by email 11 April 2014 through the EvaSys survey-management system. The completed questionnaire should be returned by no later than 9 May 2014. The system will automatically send you reminder emails to complete the questionnaire. Once you have completed the questionnaire and submitted it, the reminder emails will cease.

N.B. The system **does** have a temporary save function. Therefore you can temporarily save your questionnaire and complete it at the appropriate time.

The system guarantees anonymity and confidentiality so neither the researchers nor any third party will know your details or answers to a particular question.
Should you have any specific questions, my contact details are as follows:

Telephone number: 051 4053879
Cellular phone: 0836860404
Email address: z.a.musa786@gmail.com
Postal address: 04 Bloem Plaza, Maitland Street, Bloemfontein 9301

There is no compensation for or risks involved in participating in this study. As your participation in the study is voluntary, you may also withdraw from this study at any given time, without any penalty.

Note: Submission of the completed questionnaire will be regarded as consent.

For any complaints/problems you can contact **the Ethics Committee of the Faculty of Health Sciences, University of the Free State,** telephone number (051) 4052812
Thank you for taking the time to read this communication and I sincerely hope that you will be willing to contribute to this project.

Yours sincerely

Mr. Zainul AAbideen Musa
Department of Cardiothoracic Surgery and Health Professions Education
University of the Free State
Bloemfontein (Ecufs no. 07/2014) Registered Project.

APPENDIX B: Letter of request for consent to hospital managers to allow the distribution of the questionnaire survey to the relevant employees of the hospital

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The Hospital CEO/Manager
(Name of Hospital)
Private Bag X
City and code

Dear Sir/Madam

Request for consent to conduct a Magister study with the title:

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

I currently occupy the position of Senior Clinical Technologist: Perfusion, under the Department of Cardiothoracic Surgery, Universitas Academic Hospital and Lecturer in the Department of Clinical Technology at the Central University of Technology. For the past five years I have been involved in teaching, training and learning within this Department.

I am in the process of writing a dissertation to obtain the Magister degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 2010153092). The title of my research is DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

My supervisors are

Study leader
Dr. J. Bezuidenhout, Senior Lecturer:
Division Health Sciences Education
Office of the Dean, Faculty of Health Sciences
University of the Free State
Tel: +27 (0)51 405 3095

Co-Study leader
Prof. Francis Smit
Department of Cardiothoracic Surgery
Faculty of Health Sciences
University of the Free State

Email: bezuidj@ufs.ac.za Tel: +27(0)514053861
Email:smitfe@ufs.ac.za

As indicated by the title, the **purpose** of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme.

The **problem** that will be addressed is that current outcomes and essential content of a cardiovascular perfusion programme are inadequate for producing graduates who can immediately provide the wide range of skills required by modern and future cardiovascular surgery. This hypothesis necessitates the description of the outcomes and content of a perfusion programme that expands the scope of practice of the cardiovascular perfusionist, develops the profession of cardiovascular perfusion, creates opportunities for a fulfilling career for its practitioners and provides a highly professional patient service.

The aim of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme. This will address the requirements of modern and future cardiovascular perfusion practice.

In order to achieve this aim the following objectives will be pursued:

1. To determine the current outcomes of a current cardiovascular perfusion programme.
2. To determine the current essential programme content of a cardiovascular perfusion programme.
3. To determine the required outcomes and essential content of a cardiovascular perfusion programme; and
4. Using the results from above to describe appropriate and relevant outcomes and programme content to achieve the aims of the study.

The research is a descriptive design consisting of a quantitative study with qualitative elements. The methods that will be used are an electronic questionnaire survey and the Delphi technique using the online EvaSys survey-management system. The questionnaire survey will first be conducted to derive the Delphi statements. Once the questionnaire survey has been completed and the Delphi statements derived, the Delphi process will be conducted to achieve the aims of the study.

The questionnaire and the Delphi statements designed by the research team using the EvaSys survey-management system will be used in this study. The questionnaire (freely available) and the Delphi statements (freely available on completion of questionnaire survey) will both be put through a pilot phase to iron out any bias and inefficacies.

The value of the study can be listed as follows:

- Gaining a clear understanding of the changing environment of cardiac surgery and perfusion science and how this impacts the role of cardiovascular perfusionists in the South African context in particular;
- Compiling a comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice;
- Developing a complete set of outcomes that will form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion;
- Developing essential programme content for the graduate degree in the field of perfusion;
- Enhancing the curricula of cardiovascular perfusion programmes greatly;
- Possibly standardising the programme of cardiovascular perfusion programmes, at least in South Africa; and
- Possibly providing invaluable information and content for new cardiovascular perfusion programmes internationally.

The significance of the study lies in the fact that, although this study will be focused on the cardiovascular perfusion programmes in South Africa, the outcomes and essential programme content that will be described or many of its components will be applicable internationally.

The findings of this study will be used directly in the enhancement and reform of the programme of Cardiovascular Perfusion at the CUT.

The **findings** of this study will be made public to the School of Medicine, the University of the Free State, the Schools of Health Technology, Central University of Technology, Durban University of Technology, Tshwane University of Technology and other educationists in

higher education through paper presentations at conferences and seminars and by the publishing of articles in applicable journals.

I therefore kindly request your consent to distribute the questionnaire to the relevant target population within your hospital to execute the study.

No response by 28 March 2014 from your side by would be regarded as consent.

Should you have any specific questions, my contact details are as follows:

Telephone number: 051 4053879
Cellular phone: 0836860404
Email address: z.a.musa786@gmail.com
Postal address: 4 Bloem Plaza, Maitland Street, Bloemfontein 9301

Thank you for taking the time to read this communication; I sincerely hope that you will consent to this project.

Yours sincerely

Mr. Zainul Abideen Musa
Department of Cardiothoracic Surgery and Health Professions Education
University of the Free State
Bloemfontein
(Ecufs no. 07/2014)
Registered Project

APPENDIX C: The questionnaire survey. Questions and responses of participants

APPENDIX D: Letter of request and information document to potential participants to participate in the Delphi

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Information Document

Dear Participant,

Request to participate in the Magister study titled:

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

I am in the process of writing a dissertation to obtain the Magister degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State. The title of my research is DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

My supervisor is
Dr. Johan Bezuidenhout
Health Professions Education
Faculty of Health Sciences
University of the Free State

My co-supervisor is
Prof F.E Smit
HoD Cardiothoracic Surgery
Faculty of Health Sciences
University of the Free State

As indicated by the title, the **purpose** of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme.

The **problem** that will be addressed is that current outcomes and essential content of a cardiovascular perfusion programme are inadequate for producing graduates who can immediately provide the wide range of skills required by modern and future cardiovascular surgery. This hypothesis necessitates the description of the outcomes and content of a

perfusion programme that expands the scope of practice of the cardiovascular perfusionist, develops the profession of cardiovascular perfusion, creates opportunities for a fulfilling career for its practitioners and provides a highly professional patient service.

The aim of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme.

In order to achieve this aim the following objectives will be pursued:

1 To determine the current outcomes of a current cardiovascular perfusion programme.
2 To determine the current essential programme content of a cardiovascular perfusion programme.
3 To determine the required outcomes and essential content of a cardiovascular perfusion programme; and
4 Using the results from above to describe appropriate and relevant outcomes and programme content to achieve the aims of the study.

The research is a descriptive design consisting of a quantitative study with qualitative elements. The methods that will be used are an electronic questionnaire survey and the Delphi technique using the online EvaSys survey-management system. The questionnaire survey (sent out to qualified perfusionists involved in education and training of Perfusionists) has been conducted to derive the Delphi statements.

The questionnaire and the Delphi statements designed by the research team using the Evasys survey-management system are being used in this study. The questionnaire survey has been completed and the Delphi statements have been derived.

The Delphi questionnaire was developed after a thorough literature study, document analysis and a questionnaire survey was conducted. Various criteria and contents were identified and are listed under various subheadings which will form the basis of describing the outcomes and essential content of a Cardiovascular Perfusion programme.

The value of the study can be listed as follows:

- Gaining a clear understanding of the changing environment of cardiac surgery and perfusion science and how this impacts the role of cardiovascular perfusionists in the South African context in particular;
- Compiling a comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice;
- Developing a complete set of outcomes that will form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion;
- Developing essential programme content for the graduate degree in the field of perfusion;
- Enhancing the curricula of cardiovascular perfusion programmes greatly;
- Possibly standardising the programme of cardiovascular perfusion programmes, at least in South Africa; and
- Possibly providing invaluable information and content for new cardiovascular perfusion programmes internationally.

The significance of the study lies in the fact that, although this study will be focused on the cardiovascular perfusion programmes in South Africa, the outcomes and essential programme content that will be described or many of its components will be applicable internationally.

The findings of this study will be used directly in the enhancement and reform of the programme of Cardiovascular Perfusion at the CUT.

The **findings** of this study will be made public to the School of Medicine, the University of the Free State, the Schools of Health Technology, Central University of Technology, Durban University of Technology, Tshwane University of Technology and other educationalists in Higher Education through paper presentations at conferences and seminars and by the publishing of articles in applicable journals.

I therefore kindly request you to participate in the Delphi Pilot Process.

Your participation will be regarded as consent.

The Delphi statements provides you the opportunity to express your expert opinion on the relative importance of each criterion. The Delphi will go through a few rounds (maximum

three) to attain consensus of opinion among experts or saturation is reached on a statement.

You will receive the first round of the electronic questionnaire by email by 24 October 2014. You will have until 9 November to complete the questionnaire. The questionnaires will be sent electronically via the UFS EvaSys survey-management system. The system will automatically send you reminder emails to complete the questionnaire. Once you have completed the questionnaire and submitted it, the reminder emails will cease. Feedback after the end of each round will be given to all the participants.

N.B. The system does have a temporary save function. Therefore you can temporarily save your questionnaire and complete it at the appropriate time.

The system guarantees quasy anonymity and complete confidentiality so only the researchers will know your details or answers to a particular question. Please note that you keep all information pertaining to this research and questionnaire strictly confidential to prevent contamination of the process.

Should you have any specific questions, my contact details are as follows:

Telephone number: 015 2975858
Cellular phone: 0836860404
Email address: z.a.musa786@gmail.com
Postal address: Dept. Cardiothoracic Surgery, Private bag X9316, Polokwane 0700

There is no compensation for or risks involved in participating in this study. As your participation in the study is voluntary, you may also withdraw from this study at any given time, without any penalty.

For any complaints/problems you can contact **the Ethics Committee of the Faculty of Health Sciences, University of the Free State,** telephone number (051) 4052812
Thank you for taking the time to read this communication and I sincerely hope that you will be willing to contribute to this project.

Yours sincerely

Mr. Zainul Abideen Musa
Department of Cardiothoracic Surgery and Health Professions Education
University of the Free State
Bloemfontein (Ecufs no. 07/2014) Registered Project.

APPENDIX E: Letter of request for consent to Dean/Deputy Dean of the Faculty of Health Sciences to allow the distribution of the Delphi to the relevant employees of the Faculty

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To: Dean/Deputy Dean of the Faculty of Health Sciences
Name of university
City

Dear Sir/Madam

Request for permission to conduct a Magister study with the title:

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

I currently occupy the position of Senior Clinical Technologist: Perfusion, under the Department of Cardiothoracic Surgery, Universitas Academic Hospital and Lecturer in the Department of Clinical Technology at the Central University of Technology. For the past six years I have been involved in teaching, training and learning within this Department.

I am in the process of writing a dissertation to obtain the Magister degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 2010153092). The title of my research is DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

My supervisors are

Dr. Johan Bezuidenhout
Health Professions Education
Faculty of Health Sciences
University of the Free State

Prof F.E Smit
HoD Cardiothoracic Surgery
Faculty of Health Sciences
University of the Free State

As indicated by the title, the **purpose** of the study is to describe the outcomes and essential content for a cardiovascular perfusion practice programme.

The **problem** that will be addressed is that current outcomes and essential content of a cardiovascular perfusion programme are inadequate for producing graduates who can immediately provide the wide range of skills required by modern and future cardiovascular surgery. This hypothesis necessitates the description of the outcomes and content of a perfusion programme that expands the scope of practice of the cardiovascular perfusionist, develops the profession of cardiovascular perfusion, creates opportunities for a fulfilling career for its practitioners and provides a highly professional patient service.

The aim of the study is to describe the outcomes and essential content for a cardiovascular perfusion programme. This will address the requirements of modern and future cardiovascular perfusion practice.

In order to achieve this aim the following objectives will be pursued:

1. To determine the current outcomes of a current cardiovascular perfusion programme.
2. To determine the current essential programme content of a cardiovascular perfusion programme.
3. To determine the required outcomes and essential content of a cardiovascular perfusion programme; and
4. Using the results from above to describe appropriate and relevant outcomes and programme content to achieve the aims of the study.

The research is a descriptive design consisting of a quantitative study with qualitative elements. The methods that will be used are an electronic questionnaire survey and the Delphi technique using the online EvaSys survey-management system. The questionnaire survey will first be conducted to derive the Delphi statements. Once the questionnaire survey has been completed and the Delphi statements derived, the Delphi process will be conducted to achieve the aims of the study.

The questionnaire and the Delphi statements designed by the research team using the Evasys survey-management system will be used in this study. The questionnaire (freely

available) and the Delphi statements (freely available on completion of questionnaire survey) will both be put through a pilot phase to iron out any bias and inefficacies.

The value of the study can be listed as follows:

- Gaining a clear understanding of the changing environment of cardiac surgery and perfusion science and how this impacts the role of cardiovascular perfusionists in the South African context in particular;
- Compiling a comprehensive and clear description of the role and competences of the cardiovascular perfusionist involved in the cardiovascular perfusion practice;
- Developing a complete set of outcomes that will form the foundation for a postgraduate specialist study within the field of cardiovascular perfusion;
- Developing essential programme content for the graduate degree in the field of perfusion;
- Enhancing the curricula of cardiovascular perfusion programmes greatly;
- Possibly standardising the programme of cardiovascular perfusion programmes, at least in South Africa; and
- Possibly providing invaluable information and content for new cardiovascular perfusion programmes internationally.

The significance of the study lies in the fact that, although this study will be focused on the cardiovascular perfusion programmes in South Africa, the outcomes and essential programme content that will be described or many of its components will be applicable internationally.

The findings of this study will be used directly in the enhancement and reform of the programme of Cardiovascular Perfusion at the CUT.

The **findings** of this study will be made public to the School of Medicine, the University of the Free State, the Schools of Health Technology, Central University of Technology, Durban University of Technology, Tshwane University of Technology and other educationists in higher education through paper presentations at conferences and seminars and by the publishing of articles in applicable journals.

I therefore kindly request your consent to distribute the Delphi questionnaire to the relevant target population within your Faculty to execute the study.

Should you have any specific questions, my contact details are as follows:

Telephone number: 015 2975858
Cellular phone: 0836860404
Email address: z.a.musa786@gmail.com
Postal address: 4 Bloem Plaza, Maitland Street, Bloemfontein 9301

The research study has been approved by the ethics committee of the University of the Free State, ethics number ECUFS 07/2014. For any complaints/problems you can contact **the Ethics Committee of the Faculty of Health Sciences, University of the Free State,** telephone number (051) 4052812

Thank you for taking the time to read this communication; I sincerely hope that you will be willing to contribute to this project by granting consent.

No response from your side by 24 August 2014 will be regarded as consent.

Yours sincerely

Mr. Zainul Abideen Musa
Department of Cardiothoracic Surgery and Health Professions Education
University of the Free State
Bloemfontein
Ethics Approved: (Ecufs no. 07/2014)
Registered Project

APPENDIX F: Delphi round 1 questionnaire and responses of participants

APPENDIX G: Letter of thanks and feedback to round one participants of the Delphi with results of the first round

DESCRIPTION OF THE OUTCOMES AND ESSENTIAL CONTENT FOR A CARDIOVASCULAR PERFUSION PROGRAMME.

Dear Delphi Participant,

Thank you once again for your participation and giving your valuable time in the first round of the Delphi process. Your continued participation is essential and invaluable as it will be the means of the improvement of the cardiovascular perfusion programme in South Africa.

Attached you will find the results of the first round of the Delphi process. I am sending you this feedback with the sole purpose of providing you with the results and information regarding the first round. **You do not need to do anything with it.**

According to Larson and Wissman (2000:46), consensus is reached when 80% of the participants indicate a similar value (to a specific item) as their choice. Dajauni, Sincoff and Talley (1979:83) state that consensus is assumed to have been achieved when a certain percentage of responses fall within a prescribed range for the value being estimated. Therefore, the aim of the Delphi process is to reach a level of consensus among the expert panel members (You) on a specific statement. Consensus was declared when 80% of the participants' votes fell within the same bracket on the scale.

In the attached feedback you will note that a scale with results on each question is provided and comments by other participants have been included. Clarification has been given on certain answers where required indicated in bold as '' comment Z. Musa'' in bold.

After Round one, out of 119 closed questions (statements), consensus was reached on 75 (63%) statements. These statements will be removed from round two, and only the remaining statements will be left for your consideration. The second round questionnaire will reach you by 27/01/2015.

Please keep the attached feedback next to you when you complete the second round.

Kind Regards

Zainul Abideen Musa

Researcher University of the Free State

APPENDIX H: Letter and information document to Delphi panel round two

DESCRIPTION OF OUTCOMES AND ESSENTIAL CONTENT OF A CARDIOVASCULAR PERFUSION PROGRAMME.

Dear Delphi Participant,

Thank you once again for your participation in the Delphi process and for the feedback given during round 1 of the survey.

Purpose of the round two questionnaire

In round two of the questionnaire you are provided with all the statements on which consensus was **not reached** during round one. Consensus was pre-defined as the state where 80% of the participants vote on a specific item with the same value on the three point scale. All the questions on which consensus was reached, have been removed from this questionnaire as explained in the feedback letter sent to you on 22/01/2015.
In the second round of the Delphi process you are given the opportunity to reconsider your opinion on the statements on which consensus was not reached, taking into account the anonymous feedback that was provided by your fellow participants and clarifications that were made by the researcher. All sections and statements are numbered in the same way as in the first round.

Instructions for completing the second round

As mentioned above, the round two questionnaire only contains the statements on which there was no consensus reached in round one. During this (second) round you are allowed to change your opinion if you want to and you can make new comments in the space provided.
Please use the following scale (provided) again:

1. Essential = **Must definitely be included.**
2. Useful = **Can be included.**
3. Not Needed = **Must definitely be excluded.**

The questionnaire in the second round should take approximately 15 minutes to complete. Please answer all questions. Please contact me if there are any questions or uncertainties. Your response remains anonymous and your confidentiality is guaranteed and will only be known to the researchers.

The second round questionnaire is also based on the Evasys Survey Management System as the first round. You will receive a link from the system through which you can access the questionnaire online. You will have fourteen working days to complete the questionnaire. As in the first round you will receive automatic reminders to complete the questionnaire. Once you complete and submit the questionnaire the reminders will cease. Please submit the questionnaire by 16 February 2015. Analysis can only be done once all questionnaires are received back, so your cooperation with regards to the deadline is greatly appreciated.

N.B Please keep the results feedback form of round one in front of you while completing the second round. The statements in this questionnaire do not follow a respective sequence but are rather numbered the same as it was in the first round e.g. question 3.9 in round one is still question 3.9 in round two even thou questions 3.3 to 3.8 have been removed. This is to ensure that we can get consensus on the same question.

Thanks once again for your time and the tremendous effort put into this exercise.

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APPENDIX I: Delphi round 2 questionnaire and responses of participants