

**SOUTH AFRICAN PHYSIOTHERAPISTS' PERCEPTIONS
OF AND INVOLVEMENT WITH
NON-INVASIVE POSITIVE PRESSURE VENTILATION
THERAPY IN THE MANAGEMENT OF PATIENTS
FOLLOWING CORONARY ARTERY BYPASS GRAFT
SURGERY**

Komal Soni

A Research Report submitted to the Faculty of Health Sciences, The University of the Witwatersrand, Johannesburg, in (partial) fulfilment of the requirements for the degree of MSc Physiotherapy.

DECLARATION

I Komal Soni declare that this Research Report is my own, unaided work. It is being submitted for MSc Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Komal Soni

Name of candidate


Signature of candidate

____ 14th ____ day of ____ February _____ 2025 _____ in ____ Johannesburg _____

ABSTRACT

Background

Pulmonary dysfunctions after coronary artery bypass graft (CABG) surgery are a common complication that can occur after the procedure. Therefore, the main aim of physiotherapy is to decrease the incidence of pulmonary complications after CABG surgery. Non-invasive positive pressure ventilation (NPPV) is a treatment technique that can be used by physiotherapists to encourage opening of the airways and prevent them from collapsing once the air is expelled. There is, however, varied evidence regarding the efficacy of NPPV to treat pulmonary complications after CABG surgery, with further limited evidence regarding physiotherapists involvement in the use of NPPV, particularly in South Africa. The aim of this study was to provide rich descriptions of physiotherapists' current perceptions of and involvement in the use of NPPV techniques to treat patients after CABG surgery in South Africa.

Method

A descriptive qualitative study using a semi-structured interview schedule was conducted. The interviews were done online via Zoom or Microsoft Teams. Physiotherapists involved in the treatment of patients after CABG surgery were contacted in the private and public sectors of South Africa. Only physiotherapists with two or more years of experience, excluding their community service year, were included in the study. An inductive approach was adopted for data analysis.

Results

Eleven participants were included in the study. There were seven participants who made use of NPPV techniques, whilst the other four did not make use of this technique at all. The use of NPPV techniques by participants included CPAP, BiPAP, HFNO, and IPPB. The administration and choice of NPPV was directed by the treating physician or surgeon of the patient. Lack of multidisciplinary involvement, resources and staff competency of NPPV apparatus were deemed as barriers to the use of NPPV therapy. Sufficient space in the cardiothoracic ICU and receiving support from the nursing staff allowed for a more efficient administration of NPPV therapy and was thus reported as enablers.

Conclusion

Findings suggest that use of NPPV in physiotherapy patient management after CABG is more common in the private sector than the public sector of South Africa. There were more barriers to use of the technique as opposed to enablers. This study contributes to the limited body of knowledge of physiotherapy management of patients after CABG surgery in South Africa.

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LIST OF ABBREVIATIONS

ARDS	- Acute Respiratory Distress Syndrome
CABG	- Coronary Artery Bypass Graft Surgery
CAD	- Coronary Artery Disease
CPAP	- Continuous Positive Airway Pressure
CPB	- Cardiopulmonary Bypass
BiPAP	- Bilevel Positive Airway Pressure
DBE	- Deep Breathing Exercises
ECMO	- extracorporeal membrane oxygenation
HFNO	- High-Flow Nasal Oxygen Therapy
IABP	- Intra-Aortic Balloon Pump
ICU	- Intensive Care Unit
IPPB	- Intermittent Positive Pressure Breathing
MDT	- Multidisciplinary Team
NPPV	- Non-Invasive Positive Pressure Ventilation
SOB	- Shortness of Breath

DEFINITIONS

Non-invasive positive pressure ventilation therapy is a form of respiratory support given to patients without inserting an artificial airway (Peñuelas et al., 2007). The oxygen is delivered to the patient via a mask or nasal interface which is connected to the device that delivers positive pressure to the patient. This form of oxygen therapy can be used for patients with respiratory failure, congestive heart failure and chronic obstructive pulmonary disease. Furthermore, NPPV can also be used as a treatment modality for patients post extubation who still experience respiratory dysfunction (Ferreira et al., 2012; Peñuelas et al., 2007).

CHAPTER 1

1 INTRODUCTION

1.1 BACKGROUND

Coronary artery bypass graft (CABG) surgery is one of the treatment interventions used for advanced coronary artery disease (CAD) (Dimeling and Bakaeen, 2021). Although technology and surgical procedures continue to advance, there is still a high incidence of pulmonary complications after surgery (Tanner and Colvin, 2020). An international multicenter prospective study revealed that 55% of patients presented with pulmonary complications after CABG surgery, with pulmonary effusions being the most prevalent complication seen in 33% of patients postoperatively, and atelectasis was observed in 16% of patients after CABG surgery (Fischer et al., 2022). This results in a longer hospital stay and increased morbidity and mortality rates for patients (Pieczkoski et al., 2017). The complications can include pneumonia, respiratory failure, atelectasis and pulmonary oedema.

Some of the reasons for these complications can be due to the location of the procedure (e.g. the thoracic region) and the median sternotomy incision (Naveed et al., 2017). The median sternotomy incision causes significant trauma to the chest wall, as the sternum is cut down the centre, where the two margins of the bone are separated in order for the surgeon to gain access to the heart (Ragnarsdóttir et al., 2004). After the procedure, the sternum is wired back together (Alexander and Smith, 2016). The disruption to the sternum and bony anatomy of the chest cavity, can contribute to decreased static compliance of the chest wall and subsequently alter the breathing mechanics of the patient postoperatively (Ramos et al., 2024). This contributes to dysfunction of the respiratory muscles and thus reduces overall ventilation effectiveness of the patient (Naveed et al., 2017). These post-operative changes to the respiratory system can impair gaseous exchange and thus leave patients more susceptible to respiratory failure (Badenes et al., 2015; Ramos et al., 2024).

Other reasons for impaired respiratory function include placing the patient on cardiopulmonary bypass during the CABG operation which results in a systemic inflammatory response as well as postoperative pain, causing shallow breathing patterns (Naveed et al., 2017). Additionally, patients can be subject to a period of immobility after the CABG procedure, thus increasing the time spent in supine and thus reducing the ventilation efficiency of the lungs (Fischer et al., 2022). This can contribute to respiratory compromise such as atelectasis, respiratory infections including bronchitis and pneumonia, pulmonary oedema, pleural effusions and hypoxemia (Sweity et al., 2021).

Montrief et al. (2018) reports that patients post CABG surgery have an increased susceptibility to developing pneumonia due to postoperative pain in the chest wall that can inhibit their ability to move. Furthermore, patients post CABG surgery are initially on mechanical ventilation, although for a short period of time in most patients, this can also inherently increase patients' risk of pneumonia (Montrief et al., 2018). Although patients are generally intubated for a short period of time post CABG surgery, the likelihood of patients developing ventilator-associated pneumonia can increase by up to 3% per day of intubation (Wang et al., 2022). The risk of pneumonia is dependent on the severity of patients' condition postoperatively, co-morbidities as well as the actual pathogen causing the infection (Montrief et al., 2018). Interestingly, Ailawadi et al. (2017) explained that post-operative pneumonia is one of the most common infections to occur after CABG surgery, however it may not necessarily present in the early post-operative stages. Patients after CABG surgery can present with a pneumonia even up to five days after the procedure which can be as a result of the lack of intensive respiratory care patients receive during the first few days in ICU (Ailawadi et al., 2017). Atelectasis is one of the most frequent complications after cardiac surgery (Hasan et al., 2015). This can be due to the length of time of the surgery and the use of anaesthesia which results in increased lung compliance, diaphragm dysfunction and ultimately, impaired gaseous exchange in the lung tissue (Hasan et al., 2015). This is supported by previous reports from Westerdahl et al. (2000) and Polastri et al. (2016) that patients commonly present with reduced lung volumes and decreased ventilation post cardiac surgery.

Another common postoperative complication is pain. Pain is often present at the sternal incision site, in the leg at the harvest site of arteries or veins and at the insertion site of the chest drain into the chest wall (Hong et al., 2020). As a result, patients are hesitant to cough, move or comply with deep breathing exercises (Ribeiro et al., 2020; Westerdahl et al., 2000). Thus, pain can be a major limiting factor for patients' participation in postoperative physiotherapy management.

Physiotherapy is vital after CABG surgery in order to improve patient outcomes (Westerdahl and Olsén, 2011). The main aim of physiotherapy after CABG surgery is to decrease the incidence of pulmonary complications (Filbay, et al., 2012). Secondary to this, the focus is to reduce patients' pain and to improve their mobility, function and overall quality of life following CABG surgery (Filbay et al., 2012). Physiotherapy interventions used to achieve these aims can include early out-of-bed mobilisation, positioning for ventilation-perfusion matching, the active cycle of breathing technique or deep breathing exercises, incentive spirometry, positive expiratory pressure therapy and supported coughing (Derakhtanjani et al., 2019; Westerdahl et al., 2000).

Another technique that physiotherapists use to treat and prevent patients' pulmonary complications after CABG surgery is the use of non-invasive positive pressure ventilation (NPPV) therapy. Non-invasive positive pressure ventilation is a form of oxygen therapy delivered to patients at a predetermined pressure without the use of an artificial airway. This helps to open the airways and subsequently prevent them from collapsing once the air is expelled (Gong and Abdulghari, 2022). It reduces the patient's work of breathing as there is less pressure within the alveoli that the patient needs to overcome to initiate a breath (Gong and Abdulghari, 2022). The oxygen from the NPPV device can be delivered through continuous positive airway pressure (CPAP), bi-level positive airway pressure (BiPAP), high-flow nasal oxygen therapy (HFNO) or intermittent positive pressure breathing (IPPB) (Ferreira et al., 2012; Polastri et al., 2016).

In a systematic review and meta-analysis by Pieczkoski et al. (2017), the authors aimed to evaluate the effectiveness of NPPV compared to conventional post-operative physiotherapy. The authors found that use of NPPV as a treatment technique showed an improvement in patients' oxygen levels post operatively (Pieczkoski et al., 2017). These findings are encouraging as patients can present with atelectasis and subsequent hypoxemia after cardiac surgery (Pieczkoski et al., 2017). This is largely because the positive pressure delivered to the patient assists in opening and subsequently improving recruitment of alveoli during ventilation (Pieczkoski et al., 2017). This is particularly useful as patients may have difficulty in effective spontaneous ventilation after cardiac surgery because of pain, anaesthesia and time on mechanical ventilation (Pieczkoski et al., 2017). These factors can alter the functional residual capacity of the lungs and thus ultimately impair gaseous exchange (Pieczkoski et al., 2017).

Conventional physiotherapy interventions have been widely documented as an important strategy in preventing and managing post-operative pulmonary complications that patients develop following CABG surgery. However, there is varied evidence and an overall lack of literature, especially in South Africa, regarding use of NPPV techniques as a physiotherapy treatment, and physiotherapists' perceptions on its use for patients after CABG surgery. The documented potential benefits of NPPV after CABG surgery thus warrant a need to further explore the use of this treatment modality within the South African context, in addition to physiotherapists' perceptions of NPPV use.

1.2 **PROBLEM STATEMENT**

Roos and Van Aswegen (2011) conducted an observational cross-sectional study to report on South African physiotherapists' current involvement and subsequent treatment

approaches for patients with CAD. Sixty-eight percent of physiotherapists reported being involved in treating patients with CAD (Roos and Van Aswegen, 2011). Only a few physiotherapists reported not treating patients with CAD at all due to time, space and equipment constraints (Roos and Van Aswegen, 2011).

Roos and Van Aswegen (2011) found that deep breathing exercises (DBE) was the most frequently used treatment technique by physiotherapists, closely followed by manual techniques, active cycle of breathing technique, postural drainage, incentive spirometry and the blow bottle. Similarly, Filbay, et al. (2012) conducted a survey in Australia and New Zealand and found varied physiotherapy protocols in place with the main influence on their treatment choice being clinical experience as opposed to evidence-based practice. In addition, a randomised clinical trial by Derakhtanjani, et al. (2019) concluded that there was limited data on preferred physiotherapy treatments for patients after CABG surgery.

In a narrative review, Polastri, et al. (2016) concluded that IPPB is beneficial in treating patients with reduced lung volumes, however a major limitation of their study was the small sample of studies included in the review. This is a common occurrence in other studies as well. Furthermore, Roos and van Aswegen (2011) reported that IPPB was not a commonly used treatment modality by physiotherapists in South Africa. Zhu, et al. (2013) also expressed that there is limited data on the use of NPPV to treat respiratory failure in patients after cardiac surgery.

However, in the study by Roos and Van Aswegen (2011), specific use of NPPV techniques by South African physiotherapists for patients after cardiac surgery was not the focus point. Although there is well established data on respiratory complications post CABG surgery, there is conflicting data regarding which mode of treatment is beneficial. Thus, determining use of this treatment technique by South African physiotherapists cannot truly be concluded. The study by Roos and Van Aswegen (2011) is the only known study in South Africa that examined physiotherapy treatment approaches for patients with CAD or post cardiac surgery. Additionally, there are no known South African studies that document the use of NPPV techniques for patients following CABG surgery, thus the need to expand the available evidence with the present study.

1.3 **AIM**

The aim of this study was to provide rich descriptions of physiotherapists' current perceptions of and involvement in the use of NPPV techniques as treatment for patients after CABG surgery in South Africa.

1.3.1 Objectives

- To explore physiotherapists' current involvement in the use of NPPV techniques to treat patients post CABG surgery in South Africa
- To explore physiotherapists' current perceptions of barriers to the use of NPPV techniques in their postoperative patient management following CABG surgery
- To explore physiotherapists' current perceptions of enablers to the use of NPPV techniques in their postoperative patient management following CABG surgery

1.4 SIGNIFICANCE

There is limited evidence on physiotherapy management practices for patients following CABG surgery in South Africa, and the existing evidence shows that there are varying approaches to treatment. Roos and Van Aswegen (2011) showed that the most common treatment techniques used by physiotherapists in patient management in South Africa post CABG surgery were DBE's, manual techniques, the active cycle of breathing technique, and incentive spirometry. The least commonly used intervention was IPPB. As mentioned earlier, IPPB is a form of NPPV. It is not known how physiotherapists in South Africa perceive and use NPPV techniques as part of their management of patients after CABG surgery. Exploration of this topic may lead to future discussions among South African physiotherapy clinicians on which treatment approaches to include in the development of local clinical practice guidelines for the management of patients after CABG surgery. This study provides a foundation for future research on the effectiveness of NPPV to minimise the incidence of postoperative pulmonary complications in patients after CABG surgery.

1.5 TYPE OF STUDY

A descriptive qualitative study using a semi-structured interview schedule was conducted.

CHAPTER 2

2. LITERATURE REVIEW

2.1 INTRODUCTION

Coronary artery bypass graft surgery is one of the most common cardiac surgical procedures performed worldwide (Adelborg et al., 2017). It is well documented that physiotherapy is an important factor in the management of patients in ICU's globally (Hanekom et al., 2015; Lottering and Van Aswegen, 2016). As a result, physiotherapists working in the cardiothoracic ICU need to be familiar with the CABG procedure and the subsequent post-operative effects on patients after CABG surgery. Thus, in this chapter, the following topics will be explored: the risk factors for developing CAD and the management thereof; the process of CABG surgery along with the frequency of this procedure in the South African setting; the post-operative complications after CABG surgery with specific focus on respiratory dysfunctions; conventional physiotherapy practices to treat patients after CABG surgery, and lastly the use of NPPV as a treatment technique for patients following CABG surgery, including the current practices of physiotherapists in South Africa with specific relation to use of NPPV techniques. This information will aid in providing a more in-depth take into the current literature available and how all these factors could play a role in physiotherapists' perceptions of and involvement in treating patients after CABG surgery, as well as their choice of treatment modalities.

2.2 SEARCH STRATEGY

A search for the available literature was conducted using the following key databases: EBSCOHost; Pubmed; PEDro; Google Scholar; SCOPUS and SABINET African Journals. The key words used to identify relevant articles for this literature review were: coronary artery disease or CAD; non-invasive positive pressure ventilation or NPPV or NIV; cardiac surgery; coronary artery bypass graft surgery or CABG surgery; physiotherapy; rehabilitation; chest physiotherapy; post-operative complications; respiratory complications or respiratory dysfunctions or pulmonary complications. As a result of the limited data published in more recent years regarding cardiac surgery and use of NPPV techniques, the time frame for each database was set to include publications from 2000 to 2024. This allowed for the inclusion of a larger number of relevant studies. All of the articles included in the literature review were written in English.

2.3 CORONARY ARTERY DISEASE - RISK FACTORS AND MANAGEMENT

Coronary artery disease is becoming increasingly prevalent in low and middle-income countries, including sub-Saharan Africa (Yuyun et al., 2020). This is associated with diets that have an increased calorie intake as well as a decrease in physical activity (Abdelatif et

al., 2021). The rise in prevalence of CAD subsequently poses an increased financial burden on the individual and their families due to the associated health care costs (Abdelatif et al., 2021).

The risk factors for developing CAD include smoking or tobacco use, obesity, type II diabetes mellitus, hypertension, inactive lifestyles as well as poor dietary habits (Abdelatif et al., 2021; Yuyun et al., 2020). There is a particularly high burden of disease related to diabetes mellitus in Africa, which can significantly contribute to patients developing severe cardiac disease that requires surgical intervention (Akintoye, et al. (2023). Furthermore, an overall mortality rate of patients in Africa after CABG surgery has shown to be four percent (Akintoye et al., 2023). This value proved to be higher than other studies which report lower values for Brazil, the United Kingdom, Canada and America (Akintoye et al., 2023). Some of the reasons for this could be due to Africa being a developing country with a subsequently lower socio-economic status contributing to poor post-operative outcomes; as well as a difference in operating techniques for CABG surgery in Africa compared to other countries (Akintoye et al., 2023).

Initially, CAD can be managed with conservative measures that include lifestyle modifications. This refers to incorporating regular activity and a balanced diet into a person's daily routine, as well as medication (e.g., statin therapy) to treat symptoms and prevent progression of the disease (Doenst et al., 2022b). The development of statins to treat patients with atherosclerotic changes has greatly improved over the years (Doenst et al., 2022a). Statin therapy has shown to result in better patient survival rates than those who did not use any medicinal therapy (Doenst et al., 2022a). Statins are thus an important adjunct to lifestyle modifications, when indicated, as they prevent platelet collection in the arteries (Doenst et al., 2022a).

Surgical intervention for patients with CAD is indicated for those who present with complex, multiple diseased coronary vessels with an increased risk of a myocardial infarction; as well as patients with diabetes mellitus or chronic kidney disease, as these pose an additional risk of developing a myocardial infarction (Doenst et al., 2022b). Coronary artery bypass graft surgery is therefore the main line of treatment for patients with severe CAD as the procedure facilitates an increase in blood flow through the coronary arteries (Doenst et al., 2022a). Subsequently, CABG surgery significantly reduces the likelihood of a myocardial infarction and thus potentially prolongs a person's life expectancy (Doenst et al., 2022a).

There are approximately 8400 CABG surgeries performed in South Africa per year in the private sector, as opposed to approximately 59 surgeries in the public sector per year (Manie et al., 2008; Ngcobo et al., 2020). Consequently, the economic burden of CABG surgery is

more prevalent in the private sector hospitals in South Africa as majority of CABG surgeries are performed in this sector, and it is also an expensive and specialised procedure (Manie et al., 2008).

2.4 **CORONARY ARTERY BYPASS GRAFT PROCEDURE**

Coronary artery bypass graft surgery is an open-heart procedure that involves entering the thorax through a median sternotomy incision (Alexander and Smith, 2016). The pericardial sac of the heart is opened, and the heart is arrested (Senst et al., 2022). The heart is then placed on cardiopulmonary bypass. This allows the surgeon to move the heart to identify which vessels are affected whilst maintaining perfusion and oxygenation to the heart for one to two hours (Alexander and Smith, 2016; Senst et al., 2022).

The vessels used for the grafting are assessed pre-operatively to ensure their durability. The commonly used graft vessels are the saphenous vein and less so, the left internal thoracic artery (Alexander and Smith, 2016). The saphenous vein is harvested from the patient's thigh through a series of small incisions. Once the vessel has been harvested, one end of the harvested vessel is connected at the distal end of a coronary vessel, away from the site of stenosis (Alexander and Smith, 2016). The other end of the graft vessel is then connected to the proximal ascending portion of the aorta which thus forms the new anastomosis (Alexander and Smith, 2016). Thereafter the patient is removed from the bypass machine and the sternum is fixed with wires (Alexander and Smith, 2016; Senst et al., 2022). The duration of uncomplicated CABG surgery is between three to four hours. There are pleural and mediastinal drains left in place for the first few post-operative days in the ICU (Alexander and Smith, 2016).

It is worth noting that some high-risk patients may still present with decreased cardiac output and cardiac function post CABG surgery or may need additional circulatory support whilst they await CABG surgery (Del Carmen et al., 2020; Parissis et al., 2016). It is typically patients with a history of myocardial infarcts; diminished left ventricular function; diabetes mellitus; peripheral vascular disease or left main coronary artery disease (Parissis et al., 2016). Such patients are temporarily placed on intra-aortic balloon pump (IABP) therapy. The aim of IABP is to decrease the work of the heart, particularly the left ventricle, by providing support to the cardiac vessels (Parissis et al., 2016). The IABP is a catheter with an inflatable balloon that is inserted percutaneously into the ascending aorta (Parissis et al., 2016). Helium gas is then pumped into the balloon via a console to inflate the balloon at the start of diastole. This results in blood volume displacement due to the decline in pressure resulting in an increase in blood flowing into the heart. The converse occurs with systole where contraction of the balloon increases blood pressure, thus forcing blood out of the heart (Parissis et al.,

2016). The device therefore assists by supporting circulation to the heart and peripheries as well as improving overall heart functionality (Del Carmen et al., 2020; Parissis et al., 2016). It is important to note that IABP therapy is prophylactic and temporary support given to high-risk patients in the ICU and is thus not considered a long-term treatment option for advanced CAD (Del Carmen et al., 2020).

2.5 POST-OPERATIVE COMPLICATIONS AFTER CABG SURGERY AND PHYSIOTHERAPY MANAGEMENT

It is evident that CABG surgery is an invasive and intricate procedure. Therefore, it is possible for post-operative complications to occur. Some commonly reported post-operative complications include cardiac arrhythmia, stroke, myocardial infarction, sternal wound infection, and renal dysfunction (Reiche et al., 2021). Cardiopulmonary bypass during CABG surgery can predispose patients to systemic inflammatory response syndrome and, in some cases, the development of acute respiratory distress syndrome with resultant pulmonary oedema and severe hypoxaemia (Szelkowski et al., 2015; Rong et al., 2016). Pulmonary reperfusion injury after termination of cardiopulmonary bypass and pulmonary hypertension have been reported in some cases (Tanner and Colvin, 2020).

The more frequently reported pulmonary complications that patients develop after CABG surgery include shortness of breath (SOB), lung volume loss and atelectasis, pneumonia, pleural effusion, and haemothorax (Szelkowski et al., 2015; Tanner and Colvin, 2020; Akintoye et al. 2023). These complications are directly related to increased length of hospital stay, hospital costs, and patient morbidity (Weissman, 2004). These pulmonary complications are discussed in more detail below. Older patients have a greater risk of developing pulmonary complications post-operatively as they experience pain at a different level compared to younger patients (Arends et al., 2022). They have a higher risk of adverse reactions to administered pain medication compared to younger patients in their post-operative care, due to impaired metabolism and excretion of the drugs (McKeown, 2015). Many older patients present with reduced muscle mass and low exercise endurance pre-operatively which may prolong their post-operative recovery of function as well as their ICU and overall hospital stay (Nardi et al., 2019; Sadeghi, 2023).

2.5.1 Shortness of Breath

Administration of anaesthetic medication during CABG surgery can significantly affect the function of the respiratory system. These drugs slow down cardiac function which directly affects the respiratory drive of the patient (Weissman, 2004). The functional residual capacity of the lungs can reduce by twenty percent during anaesthesia, which results in shallower

breathing patterns (Szelkowski et al., 2015; Weissman, 2004). The sternotomy incision and manipulation of the viscera, in addition to the administration of a cardioplegic solution during the operation, can result in phrenic nerve damage and subsequent diaphragm dysfunction (Moreno et al., 2011).

Significant blood loss during surgery can result in anaemia and subsequently increase the stress placed on a patient's heart due to an increased cardiac output (Wolmarans et al., 2021). As a result, patients may need blood transfusions as part of their post-operative care (Wolmarans et al., 2021). The reduced oxygen-carrying capacity of haemoglobin in the blood can contribute to sensations of SOB, until haemoglobin levels are restored (Lobel et al., 2015).

Pain and fear of movement are major contributors to patients' respiratory dysfunction post-operatively, resulting in shallow breathing, lower inspiratory volumes, and impaired gaseous exchange due to a ventilation-perfusion mismatch (Santo et al., 2022; Sweity et al., 2021). In the first few post-operative days, patients can experience intense pain at the site of the sternotomy incision, particularly during deep inspiration (Westerdahl, 2015) which encourages shallow rapid breathing and a sensation of SOB. Since pain can hinder patients' ability to mobilise, breathe and cough, proper pain management post-operatively is important to decrease patients' risk for developing respiratory complications (Öğüt and Sucu Dağ, 2019).

The aims of physiotherapy management of patients who present with SOB include restoration of a normal diaphragmatic breathing pattern and use of body positioning to improve ventilation-perfusion matching as well as to encourage relaxation and optimal movement of the diaphragm (Gosselink, 2004). Deep breathing exercises and active cycle of breathing technique is often used by South African physiotherapists as part of their in-hospital management of patients CAD (Roos and Van Aswegen, 2011).

2.5.2 Decreased Lung Volume and Atelectasis

The most prevalent pulmonary complication seen in patients after CABG surgery is lung volume loss and atelectasis (Szelkowski et al., 2015). Mechanical ventilation is known to preferentially ventilate the anterior lung regions, when a patient lies in supine (Zeng et al., 2022). These airways are stretched open to almost full capacity in the supine position, allowing for air to move freely in and out of these airways as opposed to the resistance to airflow encountered in the more posterior and lower lung segments (Mezidi and Guérin, 2018; Zeng et al., 2022). These posterior airways are partially compressed due to the weight of the body resting on them in the supine position. Patients are therefore at risk of developing some

degree of lung volume loss in the posterior and lower lung segments due to the prolonged time spent in supine in theatre during CABG surgery (Groenewald et al., 2007).

Patients often present with left lower lobe atelectasis, which can be attributed to compression and manipulation of the left lung during CABG surgery to allow for easier visualisation of the heart, as well as relaxation of the diaphragm muscle resulting in further compression of the lower lobes of the lungs during the CABG procedure (Neves et al., 2013). Post-operatively, patients can present with abdominal distension; poor cough efforts and low inspiratory volumes due to SOB and pain (Weissman, 2004). This contributes to the development of atelectasis (Tanner and Colvin, 2020; Weissman, 2004). Patients subsequently try to compensate by increasing their respiratory rate with shallower breathing patterns, which proves to be more detrimental as opposed to counter-acting the effects of atelectasis (Weissman, 2004).

Physiotherapy management therefore aims to facilitate deeper breathing through focused expansion of the patient's lateral basal lung segments to encourage larger lung volume changes (Ahmad, 2018). Deep breathing exercises are an easy to execute technique that requires no additional equipment (Renault et al. 2008). Slower and deeper breathing allow for improvements in static and dynamic lung compliance and assist with restoring normal lung volumes (Ahmad, 2018; Russo et al., 2017). Inhalation therapy with administration of bronchodilator medication may assist to resolve any bronchospasm, if present, and facilitate deeper breathing and larger lung volume changes (Wedzicha et al., 2012). Early out of bed activity is encouraged to facilitate greater lung volume changes and reverse any areas of atelectasis. Typically, early mobilisation of patients post-CABG surgery begins on the first day after the procedure and is either facilitated by a nurse or physiotherapist (Esmealy et al., 2023). Early mobility-focused protocols for patients post CABG surgery are commonly used by physiotherapists in Sweden (Westerdahl and Möller 2010). Deep breathing exercises, active cycle of breathing technique, transfer training, and graded mobilisation are frequently used by South African physiotherapists in their in-hospital management of patients with CAD (Roos and Van Aswegen, 2011). The use of IPPB therapy is, however, not common practice (Roos and Van Aswegen, 2011).

2.5.3 Post-Operative Pneumonia

Risk factors for post-operative pneumonia include patients that are mechanically ventilated for two or more days; patients that smoked pre-operatively, and those with a history of chronic obstructive pulmonary disease (Weissman, 2004). Furthermore, since the population of patients undergoing CABG surgery is becoming increasingly older with additional

comorbidities, as well as the development of antibiotic-resistant bacteria, this also leaves patients at risk for developing pneumonia after CABG surgery (Wang et al., 2021).

Intubation in theatre for mechanical ventilation during surgery, suppresses the function of the mucociliary escalator and is associated with retention of secretions and risk of pneumonia (van der Lee et al., 2021). Some patients may develop pharyngeal deficits, largely due to the trauma from prolonged mechanical ventilation during, and potentially after, the CABG procedure (Werle et al., 2016). As a result, patients can present with swallowing defects post-operatively which can cause aspirations, further increasing patients' risk for pneumonia (Weissman, 2004; Werle et al., 2016).

As mentioned earlier, most patients experience severe pain postoperatively which, if not managed well, inhibits their ability to cough and clear retained secretions from their airways. Infected secretions that are retained within the lungs increase the patient's risk for pneumonia (van der Lee et al., 2021).

The priority for physiotherapy management is to prevent the onset of post-operative pneumonia (Westerdahl, 2015). This is achieved through various manual chest therapy techniques, as appropriate, and the administration of mucolytic medication using nebuliser therapy to facilitate movement and clearance of retained secretions (Westerdahl, 2015; Afxonidis et al., 2021; Çirak et al., 2015). The patient is educated about the importance of coughing with support applied to the sternal incision to ensure an effective cough effort is made. Early exercise therapy and mobilisation out of bed is encouraged to facilitate greater lung volume changes to mobilise retained secretions from the peripheral to the central airways for effective clearance (Allahbakhshian et al., 2023). South African physiotherapists often use education about CABG precautions as well as the mechanical vibromat, manual chest therapy techniques, postural drainage, and suction in their in-hospital management of patients with CAD (Roos and Van Aswegen, 2011).

2.5.4 Pleural Effusion and Haemothorax

Another common pulmonary complication reported after CABG surgery is pleural effusion. Pleural effusion refers to a collection of fluid in the pleural space (Jany and Welte, 2019). In healthy undisturbed lungs, the parietal and visceral pleura produce pleural fluid which is then reabsorbed by the lymphatic vessels in the parietal pleura (Jany and Welte, 2019). These lymphatic vessels have a large reserve in order to maintain a fluid balance in the pleural space. Therefore, an effusion can occur if there is a disruption to the equilibrium between the two pleura, which can be caused by an increased production and subsequent reduced reabsorption of pleural fluid (Jany and Welte, 2019). Pleural effusion post CABG surgery is

associated with trauma during the surgery resulting in an inflammatory reaction of the pleura and mediastinum. This causes leaking of blood and inflammatory markers, such as neutrophils and leukocytes, into the pleural space (Tanner and Colvin, 2020; Weissman, 2004). Furthermore, because of the significant blood loss associated with the CABG procedure, some of the retained blood can pool in the pericardial and pleural spaces in addition to the inflammatory cells released, thus further leaving patients at risk for developing a haemothorax (Brookes et al., 2021; Tanner and Colvin, 2020).

Pleural effusions can put pressure onto and impede function of the diaphragm, thus leaving patients susceptible to respiratory dysfunction and atelectasis (Brookes et al., 2021). This can result in patients' presenting with altered respiratory biomechanics and subsequent dyspnoea (Brookes et al., 2021; Weissman, 2004). Most post-operative effusions are small and resolve spontaneously, however, some patients with larger effusions may require drainage thereof (Weissman, 2004). Pleural effusion and haemothorax are thus also associated with a lengthened hospital stay and a delay in recovery of patients' post-operative journey (Brookes et al., 2021).

The aim of physiotherapy patient management in the case of pleural effusion or haemothorax is to encourage deep breathing and coughing to assist with drainage of fluid out of the pleural spaces into the inserted intercostal drainage tube/s. Similarly, out-of-bed activity is encouraged to achieve the same goal, if the patient's condition is stable (Ribeiro et al., 2020; Afxonidis et al., 2021). Patients may experience pain in the leg at the site where the graft was harvested due to the invasion of muscles and nerves from the procedure (Parry et al., 2010). As a result, they may complain of pain during early mobility practices in the ICU that include standing and walking, moving into a chair and turning in bed, all of which can cause exhaustion and fear of activity (Öğüt and Sucu Dağ, 2019; Tüfekçi et al., 2022). Education about the benefits versus risks of early activity and mobilisation is an essential part of post-operative physiotherapy management of patients recovering from CABG surgery. South African physiotherapists educate patients with CAD about precautions to adhere to after CABG surgery. They also frequently use deep breathing exercises, active cycle of breathing technique, and graded mobilisation as part of their in-hospital patient management, with infrequent use of IPPB therapy (Roos and Van Aswegen, 2011). Whilst there are a variety of physiotherapy strategies used in the management of patients after CABG surgery (as described above), this study specially explores the use of NPPV techniques (including IPPB therapy) by South African physiotherapists. Thus, the focus of this technique as a treatment strategy in managing patients after CABG surgery is shared below.

2.6 NON-INVASIVE POSITIVE PRESSURE VENTILATION THERAPY AS A PHYSIOTHERAPY TREATMENT TECHNIQUE FOR PATIENTS AFTER CABG SURGERY

Non-invasive positive pressure therapy is a form of ventilation support for the patient, without the invasiveness of an artificial airway (Macintyre, 2019). Therefore, NPPV is a way to continue respiratory support for patients after extubation post CABG surgery (Gonçalves de Lima et al., 2024). Positive pressure is delivered to the patient through various interfaces, including a total face mask that covers the eyes, nose and mouth; a oro-nasal mask that covers the nose and mouth; a nasal mask which only covers the nose; mouthpieces which are held in place by the patient's lips; nasal prongs; or a helmet which covers the entire head (Popat and Jones, 2016).

Normal ventilation is driven by a pressure gradient created by the respiratory muscles. When the diaphragm contracts and the ribcage expands, this results in a decline in the alveolar pressure and thus allows for air to flow into the lungs (Pleil et al., 2021). Conversely as the diaphragm relaxes, the pressure in the lungs increase which results in air being exhaled back into the atmosphere (Pleil et al., 2021). This means that air flows from a high to a low pressure. Therefore, use of positive pressure created by NPPV techniques, assist to maintain alveolar expansion in the poorly ventilated areas of the lung, subsequently facilitating efficient gaseous exchange and thereby reducing hypoxemia in patients' post-operative recovery period (Gonçalves de Lima et al., 2024). The tidal volume of the patient is created either by a trigger from the patient or through a trigger from the NPPV machine (Macintyre, 2019).

Depending on the type of NPPV device used, positive pressure support can be delivered throughout the inspiratory and/or expiratory cycle of a breath (Popat and Jones, 2016). The different NPPV devices include CPAP which provides one level of continuous positive pressure throughout the inspiratory and expiratory cycle; BiPAP provides two varied levels of positive pressure with a higher pressure during inspiration and a lower pressure during expiration respectively; HFNO provides humidified oxygen at a high flow rate; and IPPB which provides a set positive pressure to the airways during inspiration only (Heuer and Hilse, 2021).

2.6.1 Positive Attributes to use of NPPV Techniques

Non-invasive positive pressure ventilation therapy can pose many positive effects on the respiratory system which thus aims to prevent and treat pulmonary complications after CABG surgery. One major effect of NPPV on the respiratory system is its ability to unload the respiratory muscles (Macintyre, 2019). The diaphragm is the main respiratory muscle used during inspiration (Macintyre, 2019). Compared to the peripheral muscles, the diaphragm

contains a higher concentration of type I muscle fibres which are fatigue-resistant (Macintyre, 2019). Furthermore, the diaphragm is densely populated with capillaries thus allowing for a more efficient diffusion of oxygen compared to peripheral muscles (Macintyre, 2019). It is therefore a strong, important muscle involved in respiration (Macintyre, 2019).

Consequently, it is understandable that a major contributing factor to post-operative pulmonary complications is diaphragm dysfunction and weakening after CABG surgery, especially in cases where a patient received prolonged mechanical ventilation (Laghlam et al., 2021). This is largely due to pain at the sternum; pain from insertion of pleural and mediastinal drains as well as potential injury to the phrenic nerve from the CABG surgical procedure (Laghlam et al., 2021). This means more energy is required during respiration which can result in patient fatigue and overloading of the diaphragm, further contributing to the development of muscle dysfunction (Macintyre, 2019). Since NPPV augments the breath of the patient, the patient effort required for a breath is reduced, thus offloading and reducing the work required from the diaphragm (Macintyre, 2019).

Another encouraging effect NPPV has on the respiratory system includes recruitment of alveoli and subsequent improvement in gaseous exchange (Macintyre, 2019). This is possible through use of positive pressure, which assists in opening of collapsed alveoli, providing a larger surface area for gas exchange, and thus improving the oxygenating capacity of the lungs (Gilliland and Brainard, 2015). As a result, patients show an increase in their tidal volumes, improving their overall ability to ventilate efficiently (Gilliland and Brainard, 2015). This further enhances the patient's functional residual capacity and thus improves compliance of the lungs (Gilliland and Brainard, 2015).

In addition to the obvious respiratory advantages, the interfaces used and set-up of NPPV devices provides several benefits in comparison to invasive mechanical ventilation. Since NPPV is used with the absence of an artificial airway, this helps to protect the patient's trachea and epiglottis from trauma caused by the intubation process, thereby reducing patients' risk of aspiration (Macintyre, 2019). Furthermore, the various interfaces allow patients to take breaks when eating, drinking and talking, thus improving patients' willingness to use and comfort during NPPV therapy (Gilliland and Brainard, 2015; Macintyre, 2019). Furthermore, the interfaces with the least coverage such as, the nasal mask and nasal prongs, limit feelings of claustrophobia and allow patients to communicate easily with an additional ease of clearing secretions (Gilliland and Brainard, 2015).

2.6.2 **Disadvantages Associated with use of NPPV Techniques**

However, a flawed characteristic in the design of the various NPPV masks is the risk of air leaks and increased dead space within the mask which may increase the patient's respiratory rate (Gilliland and Brainard, 2015; Macintyre, 2019). Additionally, the nasal mask poses a risk of oral air leaks (Gilliland and Brainard, 2015). As a result, NPPV cannot consistently deliver the same pressure and volume to the patient (Macintyre, 2019). This further impairs the trigger sensitivity, resulting in asynchrony between the patient and the NPPV device (Macintyre, 2019). Moreover, although the nasal masks provide more comfort and are perhaps less daunting for patients that are claustrophobic, they can cause an irritation to the nasal passages and rhinorrhoea (Gilliland and Brainard, 2015). Another, potential disadvantage to note is that despite the trachea being spared with use of NPPV, this limits suctioning of the airways and can thus impair pulmonary hygiene in patients struggling to clear secretions (Macintyre, 2019).

2.6.3 **Potential Clinical Indications for use of NPPV Techniques Post CABG Surgery**

Despite some flaws, it is clear NPPV therapy can be a valuable tool to provide sufficient respiratory support and oxygenation to patients after extubation (Gonçalves de Lima et al., 2024). It is thus justified to consider preventing failed extubation of patients after CABG surgery through the use of NPPV. In a six-month pilot survey conducted in Italy, De Santo et al. (2009) examined the safety and efficacy of implementing NPPV techniques after extubation failure on patients' lung function and post-operative outcomes. The authors found that use of NPPV in the first few days after extubation avoided reintubation in seventy-five percent of patients, with further improvements in their hypoxaemia (De Santo et al., 2009). However, whilst these results are promising, the authors point out that for patients that present with severe hypoxaemia, delaying reintubation by using NPPV techniques, can leave patients more susceptible to pulmonary complications (De Santo et al., 2009). Thus, patients need to be thoroughly screened in order to determine whether NPPV would be beneficial (De Santo et al., 2009). Similarly, in Switzerland, NPPV is a popular treatment choice by clinicians for acute cases in the ICU including extubation failure; as well as COPD exacerbations and post-operative respiratory failure (Salvadè et al., 2012).

Expanding further on clinical indications for the use of NPPV techniques, Gonçalves de Lima et al. (2024) conducted a systematic review in order to determine the potential indications to guide clinicians on the prescription of NPPV techniques for treatment after cardiac surgery. The authors found the main predictors to be an elevated body mass index; pneumonia; post-operative injury to the lungs and hypercapnia (Gonçalves de Lima et al., 2024). In terms of the type of NPPV device used, there was no general consensus among the studies reviewed. Furthermore, there was varied prescription of NPPV techniques in terms of the duration and

settings on the device. Thus, the authors found that each patient was given an individualised treatment program specific to their clinical presentation (Gonçalves de Lima et al., 2024).

After reviewing all the studies, the authors concluded that NPPV techniques could be used in three ways for patients after cardiac surgery: to prevent, improve and treat post-operative pulmonary complications (Gonçalves de Lima et al., 2024). However, the authors point out that patients presenting with bronchospasm; poor cough efforts; large amounts of secretions; heart failure; hypercapnia immediately after extubation and being mechanically ventilated for more than three days, present as a high-risk to failure of NPPV when used as a preventative measure for respiratory failure (Gonçalves de Lima et al., 2024). Thus, it is worth noting that NPPV therapy is generally not indicated as a standalone treatment for clearing secretions, but rather as a device to augment secretion clearance along with traditional physiotherapy techniques (Piper and Moran, 2006). This highlights the importance of screening patients in order to use the appropriate treatment technique based on their clinical presentation, so as to avoid unnecessary delays in curative measures.

In addition, Ampatzidou et al. (2019) conducted a retrospective cohort study in Greece to determine the factors that influence treatment of respiratory failure after cardiac surgery with use of NPPV techniques. The authors acknowledged that in more recent years, studies have indicated use of NPPV as a treatment option to treat acute respiratory failure after cardiac surgery. However, the results are varied amongst the literature with regards to its efficacy in treating ARDS (Ampatzidou et al., 2019). In their study, more than eighty percent of patients with ARDS were successfully treated using NPPV techniques after cardiac surgery (Ampatzidou et al., 2019). Conversely, factors such as old age; multiple comorbidities; recurrent post-operative complications and more frequently, chronic obstructive pulmonary disorder, were associated with factors contributing to NPPV failure (Ampatzidou et al., 2019).

Understandably, some clinical settings may still consider prophylactic use of NPPV for patients after CABG surgery in an effort to prevent post-operative pulmonary complications. Nasralla et al. (2018) found when NPPV was used prophylactically in the first five days after patients were extubated, they presented with improved tissue perfusion and preservation of pulmonary function following CABG surgery (Nasralla et al., 2018). However, Abrard et al. (2023) conducted a randomised controlled trial in Spain to test the efficacy of NPPV on preventing respiratory failure after cardiac surgery and found no difference in patient outcomes with use of prophylactic NPPV techniques. Furthermore, the frequency of post-operative pulmonary complications, length of stay in ICU, and in the hospital overall, was similar between the control and NPPV-treated group (Abrard et al., 2023). Similarly, Zhou et al. (2023) conducted a systematic review and meta-analysis to determine the efficacy of

NPPV immediately post-operatively on patients after cardiac surgery. The findings showed no significant improvement on the incidence of post-operative pulmonary complications with prophylactic use of NPPV techniques (Zhou et al., 2023). Furthermore, there was no effect shown on the reintubation or mortality rates of patients after cardiac surgery (Zhou et al., 2023). However, the authors found promising results for the use of prophylactic NPPV techniques on the incidence of atelectasis after cardiac surgery (Zhou et al., 2023).

2.6.4 Exploring Various NPPV Techniques

As previously discussed, a common respiratory complication after CABG surgery is atelectasis, which can impair gaseous exchange in the lungs due to the subsequent development of a pulmonary shunt (Fisher, 2021). Thus, since CPAP helps to maintain a higher pressure in the alveoli and airways during the entirety of the breathing cycle, it allows for re-expansion of collapsed alveoli and therefore an improvement in ventilation-perfusion matching of the lungs (Fisher, 2021). This NPPV technique also assists in unloading the respiratory muscles and thus reducing their work of breathing (Mirunalini et al., 2023). Continuous positive airway pressure can be delivered using a nasal or oro-nasal mask; or a helmet (Mirunalini et al., 2023).

Similarly, BiPAP has also shown benefits to patients' oxygenation capacity and their work of breathing (Hamid et al., 2020). Since BiPAP uses a higher inspiratory pressure as opposed to the expiratory pressures applied, this further helps to recruit more alveoli and subsequently improve compliance of the lungs (Hamid et al., 2020; Melton et al., 2019). Furthermore, BiPAP also improves patients' arterial oxygen partial pressure to fraction of inspired oxygen ratio (Hamid et al., 2020). It is thus understandable that BiPAP is another common treatment choice adopted by clinicians to treat respiratory failure after cardiac surgery (Melton et al., 2019).

Bilevel positive pressure ventilation therapy has shown improvements in patients' hypoxaemia and atelectasis post cardiac surgery but shows no conclusive evidence regarding its effect on preventing reintubation of patients (Melton et al., 2019). Similarly, two systematic reviews found BiPAP to have no significant effect on the incidence of reintubation of patients after cardiac surgery (da Conceição dos Santos et al., 2024; Wu et al., 2020). In a quasi-experimental study to examine the effects of BiPAP on respiratory and haemodynamic measures in patients post cardiac surgery in Pakistan, the results showed improvements in patients' respiratory parameters within fifteen minutes of treatment (Hamid et al., 2020). Subsequently, BiPAP showed a more rapid, marked improvement in patients' PaO₂ levels as compared to CPAP (Hamid et al., 2020). Bi-level positive pressure is also

well documented regarding the improvements shown in patients' tidal volumes, lung expansibility and reduced work of breathing post cardiac surgery (Liu et al., 2020).

Moreover, in a randomised control trial conducted in six ICUs throughout France, the authors compared the effects of BiPAP and HFNO on patients' respiratory parameters and concluded that no treatment was superior to another (Stéphan et al., 2015). However, the authors acknowledge that whilst BiPAP is a useful treatment tool, it can cause discomfort to the patient due to the mask interface used and requires a substantial amount of resources to implement properly (Stéphan et al., 2015). In this way, HFNO is more tolerated by patients due to its improved comfort, reduced desaturation episodes and patients are less likely to encounter displacement of the interface (Stéphan et al., 2015).

High-flow nasal oxygen therapy provides continuous warm, humidified oxygen at a high flow rate to the patient (Wang et al., 2023). This allows for a consistent concentration of oxygen to be delivered to the patient, with rates of up to eighty litres per minute with a low level of positive pressure throughout the breathing cycle (Wang et al., 2023). A major effect of HFNO is its ability to reduce the viscosity of sputum (Wang et al., 2023). Typically, after cardiac surgery, patients are hesitant to cough due to pain. This can result in an accumulation of secretions through the respiratory channels, with a subsequent increase in airway resistance (Wang et al., 2023). This increases work of breathing and subsequent patient fatigue, making it progressively difficult for patients to cough and clear their secretions (Wang et al., 2023). Thus, placing patients on HFNO can not only humidify the respiratory tract, but improve functioning of the cilia and the viscosity of the secretions, making it easier for patients to cough up sputum after cardiac surgery (Wang et al., 2023).

Furthermore, HFNO has shown to improve end expiratory lung volumes due to the continuous application of low levels of positive pressure, subsequently aiding in the recruitment and prevention of alveolar collapse (Corley et al., 2011). This contributes to improved functional residual capacities and lung compliance, which can also explain the reduction in respiratory rate of patients placed on HFNO (Corley et al., 2011).

Keeping in line with the other positive pressure devices discussed, IPPB exerts a similar effect on the respiratory system through use of positive pressure. Intermittent positive pressure breathing is a device that administers intermittent positive pressure during inspiration only. It is a passive ventilatory support and thus requires a low inspiratory effort from the patient (Romanini et al., 2007). This not only improves expansion of the lungs, but also of the thoracic cavity, with subsequent improvement in thoracic mobility (Romanini et al., 2007). It is thus understandable that IPPB shows a reduction in the respiratory muscle

workload during respiration, which further improves oxygenation levels in patients after CABG surgery (Polastri, et al., 2016). This is largely because patients require less effort to breathe, which means less energy expenditure and thus less oxygen utilisation from the respiratory muscles (Romanini et al., 2007). In addition, this aids in improving patients' overall tidal volumes following CABG surgery (Müller et al., 2006). Intermittent positive pressure breathing can therefore also assist patients in clearing secretions (Polastri et al., 2016).

However, for patients with respiratory failure, IPPB may not necessarily provide sufficient ventilatory support and thus the previously mentioned NPPV techniques may be the more appropriate treatment choice in that case (Denehy and Berney, 2001). Another limitation is that since IPPB is carried out through cycles of positive pressure delivered to the patient, the tidal volume generated can depend on the compliance of the lungs (Denehy and Berney, 2001). This can result in less compliant areas of the lung receiving a lesser volume of air (Denehy and Berney, 2001). In addition, patients also need to be awake and responsive in order to provide a seal their lips around the mouthpiece, as well as to trigger a breath when using the IPPB device (Denehy and Berney, 2001). Lastly, compressed gas is needed to administer the IPPB device, meaning clinicians need access to wall oxygen which limits use to specific clinical settings (Denehy and Berney, 2001).

Expanding further on use of the IPPB machine, it is operated solely by the physiotherapist, which allows for physiotherapists to easily manage the delivery of the device to patients whilst ensuring patients' comfort and is in turn, easy to use (Filbay et al., 2012). Similarly, Boeken, et al. (2010) found that nasal CPAP is also an easy to manage, cost-effective treatment technique that improves pulmonary function following CABG surgery.

Putting theory to practice, a systematic review by Ferreira, et al. (2012), reports on the available evidence with regards to using NPPV as a treatment for patients after CABG surgery. The authors found that the most commonly used NPPV modalities were CPAP, BiPAP and IPPB, with most studies reporting positive influences on patients' oxygenation, vital capacity and cough ability after CABG surgery (Ferreira et al., 2012). However, the studies used in the article were all based in Brazil and Europe and thus may not be a true reflection of global practices. In Brazil, NPPV techniques were also a common treatment choice by physiotherapists to manage patients after CABG surgery (Fiore et al., 2010). The most commonly used devices were CPAP and IPPB, as these devices were deemed by physiotherapists to be easy to use and more efficient than conventional breathing exercises (Fiore et al., 2010). In addition, Zhu, et al. (2013) conducted a randomized clinical trial in Beijing to test the efficacy and safety of NPPV to treat respiratory failure after cardiac surgery. However, a major limitation was the small sample size. Thus, although the results showed

positive influences on patients' clinical outcomes, the authors acknowledge the need for larger sample sizes as well as more randomised clinical trials to provide more insight into the need for NPPV after cardiac surgery as well as if the use of NPPV techniques is warranted to treat respiratory failure in certain patients after cardiac surgery (Zhu et al., 2013).

In the South African setting, Roos and Van Aswegen (2011) conducted a cross-sectional observational study to determine physiotherapy practices for treating patients with CAD. The authors found that the least commonly used device was IPPB (Roos and Van Aswegen, 2011). The reasons why physiotherapists did not use IPPB therapy in patient care were not explored by the authors. However, since post-operative pulmonary complications are still common after CABG surgery, use of IPPB therapy may still be warranted (Roos and Van Aswegen, 2011).

It is also worth noting that in a systematic review and meta-analysis by Akintoye, et al. (2023) examining the outcomes of patients after CABG surgery in Africa, the authors concluded that there is a limited amount of evidence reporting on outcomes after cardiac surgery, particularly in Africa. Some of the main reasons stated were the lack of resources and funding- a common occurrence in developing countries (Akintoye et al., 2023). Subsequently, this speaks to the lack of literature on physiotherapy treatment approaches, specifically on the use of NPPV techniques, for patients after CABG surgery in Africa, extending to the South African setting as well.

2.6.5 Global Reports of Physiotherapists' Involvement in NPPV Provisions

It is evident that use of the various NPPV devices requires a certain degree of skill to administer the technique correctly. Lockstone et al. (2020) conducted an observational single-centre study in Australia to determine the safety of NPPV therapy administered by physiotherapists for patients after abdominal surgery. The physiotherapists included in the study had a range of one to ten years of experience in treating this patient population. The included physiotherapists were further trained on the use of NPPV techniques by a senior ICU-trained physiotherapist. The authors concluded that NPPV techniques administered by physiotherapists within the first twenty-four hours after abdominal surgery was deemed safe with no specific reports of complications related to the delivery of the treatment technique (Lockstone et al., 2020). Thus, physiotherapists with specific training for use of NPPV devices, can be equipped with the necessary skills in order to safely administer NPPV techniques for patients (Lockstone et al., 2020).

However, it was deemed more feasible to administer NPPV therapy, particularly for high-risk patients after abdominal surgery, with a multidisciplinary approach (Lockstone et al., 2020).

This allowed for timeous and efficient administration of NPPV therapy, especially if the physiotherapy department was short-staffed (Lockstone et al., 2020). Although this patient population does not fit that of the present study, the results regarding physiotherapist-driven NPPV therapy for post-surgical patients in the ICU are promising and should encourage further exploration into provisions of NPPV for patients post CABG surgery.

Although this patient population does not fit that of the present study, the results regarding physiotherapist-driven NPPV therapy for post-surgical patients in the ICU are promising and should encourage further exploration into provisions of NPPV for patients post CABG surgery. Sørensen et al. (2013) share similar sentiments to the above study stating that since nurses in the ICU spend a great deal of time at the patient's bedside, they are, in addition to the physiotherapists, able to monitor the NPPV device in use and the patient's response to the treatment. With more exposure and adequate training, nurses could become more comfortable with the various NPPV devices, thus allowing for a collaborative approach to treatment (Sørensen et al., 2013).

In contrast, in a survey to determine the involvement of physiotherapists in the administration of NPPV techniques in the British Isles, physiotherapists were not involved in the delivery of NPPV techniques or in screening of patients to determine if they require use of this particular ventilation therapy (Moran et al., 2005). Instead, physiotherapists in these regions only treated patients who were already placed on NPPV therapy (Moran et al., 2005). The authors point out that since blood gases are typically conducted in order to determine whether patients require NPPV therapy, this is a specialised skill that most physiotherapists are not trained in. Thus, it may be justified for physiotherapists working in the ICU with exposure to use of NPPV therapy, to receive specialised training of the skills needed to not only safely administer NPPV techniques, but to also assess whether it is appropriate for specific patient populations (Moran et al., 2005).

Rosière et al. (2009) shared similar sentiments stating that patients should be assessed thoroughly in order to determine the most appropriate physiotherapy treatment modality, which aims to avoid wasting of resources and unfavourable patient outcomes. The authors aimed to develop local guidelines between physiotherapists and physicians in a hospital in Switzerland based on the available literature, with specific focus on use of NPPV therapy (Rosière et al., 2009). Specific to pulmonary complications, the authors recommended NPPV for patients with atelectasis, post-operative hypoxaemia and as prophylactic treatment in the post-operative recovery period (Rosière et al., 2009). The overall recommendations from the article state that physiotherapists or physicians working in the ICU can be equipped to administer NPPV techniques to patients in this clinical setting, warranting that they have the

necessary experience and skills to do so (Rosière et al., 2009). However, in the administration of NPPV outside of the ICU setting, physiotherapists are recommended to discuss the application with the ICU physician first (Rosière et al., 2009). Similarly, in a survey in India to understand the use of NPPV administered in the ICU, the authors reported that NPPV prescribed for patients in the ICU and wards was only directed by the treating physician (Chawla et al., 2008). However, the authors acknowledge the benefit of training healthcare professionals involved in the care of ICU patients in the administration of NPPV, in order to lessen the burden of physicians and improve quality of care (Chawla et al., 2008).

Lastly, the cross-sectional survey study by Roos and Van Aswegen (2011) is the only known study in the South African setting to mention physiotherapists use of NPPV devices, specifically IPPB, for patients with CAD. However, provision of IPPB by physiotherapists for their patients was not the focus of that study. Thus, it is not known to what extent South African physiotherapists are involved in administering all forms of NPPV therapy to patients after cardiac surgery.

2.7 QUALITATIVE RESEARCH

Sutton & Austin (2015) describe qualitative research as a way for the researcher to develop a deeper understanding of people and their behaviours; as opposed to quantitative research, which reports on the amount of people with specific behaviours. Thus, using a qualitative approach allowed the researcher to delve deeper into physiotherapists' treatment approaches as well as the reasoning behind their clinical choices in treating patients after CABG surgery. The aim was therefore to gather rich descriptions from participants which the researcher could analyse, learn and draw from.

An important part of conducting qualitative research involved the researcher engaging in reflexivity. Olmos-Vega et al. (2023) define reflexivity as 'continuous, collaborative, and multifaceted practices through which researchers self-consciously critique, appraise, and evaluate how their subjectivity and context influence the research processes' (Olmos-Vega et al., 2023: 242). Reflexivity is thus an ongoing process the researcher engaged in to improve the rigor of the research and evaluate all possible subjective influences on the research findings. The way in which the researcher achieved reflexivity is described in Chapter three.

Lastly, there were three assumptions the researcher had to account for in order to contribute to valuable qualitative research. The first is methodological assumptions, which referred to the researcher objectively recording the perceptions described by the participants, verbatim, independent of interpretations from the researcher (Bradshaw et al., 2017). Next was

ontological assumptions which accounted for the different realities as seen and described by each participant (Bradshaw et al., 2017). Lastly, epistemological assumptions accept that participants provided a subjective account to the issue in question, however there can be data to support or negate their interpretation (Bradshaw et al., 2017). These assumptions in relation to this study are described in more detail in Chapter three.

2.8 **CONCLUSION**

The recovery of patients after CABG surgery requires a multidisciplinary approach in order to efficiently manage the multiple bodily systems affected. Physiotherapy is an important element of postoperative patient care to prevent and address pulmonary function impairments and optimise patients' recovery of physical function. Existing evidence to support the various physiotherapy treatment strategies used to optimise patient recovery is scarce, especially in the context of South Africa. Existing evidence on the use of NPPV techniques to prevent post-operative pulmonary complications following CABG surgery, especially after extubation, is supportive of its beneficial effect on patient outcomes. There is however, no evidence that describes its use by physiotherapists as a patient care strategy in South African healthcare settings. It is not known whether physiotherapists use NPPV in patient care nor what factors influence its use, or not.

CHAPTER 3

3. METHODS

3.1 INTRODUCTION

The aim of this study was to provide information on physiotherapists' perceptions of as well as involvement in using NPPV for patients after CABG surgery in South African healthcare settings. Thus, this chapter details the qualitative approach adopted in order to collect the data as well as acknowledging the researcher's reflexivity prior to data collection. The research context, sampling strategy and ethical considerations for this study are also explained. Thereafter, the process of data collection through the use of semi-structured interviews is described along with the subsequent procedure of managing and analysing the research findings.

3.2 QUALITATIVE APPROACH AND RESEARCH PARADIGM

(Sutton and Austin, 2015) describe qualitative research as a way for researchers to 'develop an understanding of the meaning people ascribe to their experiences' (Sutton and Austin, 2015:226). Thus, qualitative research aims to describe the world from the participants' perspective to uncover the reasons for observed patterns of the explored topic (Busetto et al., 2020). For this study, a descriptive, exploratory, qualitative study with semi-structured interviews was used to gather rich, in-depth descriptions of physiotherapists perceptions of the use of NPPV in the care of patients following CABG surgery.

3.3 RESEARCHER CHARACTERISTICS AND REFLEXIVITY AND ASSUMPTIONS

As defined in Chapter two, reflexivity is an ongoing process whereby the researcher actively reflects on the relationship 'between their identity, context and research' (Olmos-Vega et al., 2023:242).

Thus, specific to this study, the researcher acknowledged sharing certain common traits with the participants. This referred to the researcher also being a qualified physiotherapist working in a cardiothoracic ICU, in addition to also having used NPPV techniques to treat patients post CABG surgery. The researcher declared these traits to the participants prior to the start of the interview in order to improve the rigor of the research as well as the readers' understanding of the data collected. In addition, some participants were previous colleagues of the researcher and thus it was important that the researcher listened to the participants' accounts objectively without using prior experiences to influence the truth.

In addition, there were three assumptions the researcher had to account for. The first was methodological assumptions where the aim of the researcher was to gather rich descriptions

about the perceptions of the physiotherapists' use of NPPV techniques on patients after CABG surgery. The researcher then had to interpret the data without straying too far from participants' literal descriptions. Next was ontological assumptions where the researcher had to take into account that the physiotherapists' perceptions regarding the use of NPPV techniques were all relative and will vary between each participant. Thus, once data was obtained, the aim was to understand and interpret each physiotherapists' account and the meaning they had given to the use of or not thereof of NPPV techniques specific to their setting. This was done through data analysis and engaging with the interview recordings and transcripts repetitively. Lastly, epistemological assumptions allowed the researcher to accept that each physiotherapist's subjective perception of using NPPV techniques for patients after CABG surgery will strengthen the data that already exists on this topic, as well as further strengthen the data and research to come. There was thus a relationship between the subjective and objective data gathered (Bradshaw et al., 2017).

3.4 RESEARCH CONTEXT

All interviews were conducted online via Zoom or Microsoft Teams. The interviews were conducted in English as this is the common language used by healthcare professionals to communicate with their patients. The interviews were conducted one-on-one between researcher and participant. The researcher then subsequently analysed, transcribed and interpreted the data thereafter. The researcher included more than one physiotherapist from a facility in Gauteng. The physiotherapists worked for separate practices thus there was no conflict of interest. The researcher did not provide personal responses to the interview questions. The first interview was observed by the researcher's supervisor to ensure that the researcher was equipped with the skills to efficiently carry out the rest of the interviews.

3.5 PARTICIPANTS

Physiotherapists treating patients after CABG surgery in private and public hospital intensive care units (ICU) in South Africa were invited to participate. Male and female qualified physiotherapists in all provinces across South Africa involved in the management of patients following CABG surgery in ICU's, were approached. All physiotherapists included had two or more years of experience working with patients after CABG surgery, excluding their community service year. The physiotherapist with the most experience at each facility was recruited for the interview.

3.6 SAMPLING STRATEGY

Initially, potential participants were identified using a purposive, homogenous sampling strategy. Campbell et al. (2020) states that this form of sampling allows the researcher to choose participants specific to the objectives of the study as opposed to random sampling.

This allows the researcher to include participants who have the most appropriate responses and ideas to the research questions of the study (Campbell et al., 2020).

The researcher first used the Department of Health website to identify all tertiary government hospitals across South Africa with cardiothoracic ICU's that treat patients following CABG surgery. The head of the physiotherapy department of each public facility was contacted to ask for permission to interview the physiotherapists involved in the care of these patients in cardiothoracic ICU (see Appendix A). Once potential participants from the different government facilities were identified for the study by the physiotherapy department heads, they were privately contacted by the researcher via email or WhatsApp to further screen their eligibility. Thereafter the participants who fit the inclusion criteria were sent an information sheet about the study as well as informed consent forms (see Appendix B, C1 and C2).

For private facilities, the head of administration for the South African Society of Physiotherapy (SASP) was contacted to obtain permission to contact the chairperson of the Cardiopulmonary Physiotherapy Rehabilitation Group (CPRG) in order to send an advertisement regarding the study to the group's members (see Appendix D). No access to the CPRG database was obtained due to the POPI Act. Thus, an advertisement was sent out to all members of the SASP CPRG group via email, with a brief description of the study and participant inclusion criteria. The members from the private sector who saw the advertisement and were willing to participate contacted the researcher directly via email or WhatsApp. Thereafter, the potential participants were further screened against the inclusion criteria by the researcher. If the potential participants were included, they were subsequently sent an information sheet and consent forms.

Thereafter, a snowball sampling technique was used to recruit more participants that fit the inclusion criteria from different provinces throughout South Africa. This was done by asking the potential participants from government and private facilities, who did not fit the inclusion criteria, to suggest other potential participants to the researcher to contact via email or WhatsApp.

3.6.1 Estimation of Data Saturation

The data calculation methods by Guest et al. (2020) were used to determine if data saturation has occurred. This calculation required the researcher to place a value for each new theme noted in each interview respectively, and to then plug the values into a specific equation developed by Guest et al. (2020).

Thus, in order to determine data saturation, the first five interviews were chosen with the number of emerging themes from each interview recorded respectively. The sum of all the

themes from the five interviews was thirty. This formed the base set, and thus the denominator of the equation. Thereafter, the sum of the themes that emerged for the next three consecutive interviews was calculated to be four. This value was divided by the base set denominator of thirty and then converted to a percentage which amounted to thirteen percent. Since the value was more than five percent, this meant that there were still new emerging themes which were significant in value, thus the calculation must continue using the next two consecutive interviews. The ninth and tenth interview calculation was three percent. Since this was less than five percent, data saturation was deemed to have been reached as there were no new significant themes noted. Guest et al. (2020) state that the lower the value from the calculation, the researcher is less likely to miss new important themes from subsequent interviews. This was confirmed after an additional eleventh interview was conducted and, despite not drawing any new themes, provided rich descriptions which the researcher deemed to be beneficial to include in the report.

This method was applied prospectively during data collection in order to determine whether more or less interviews are required for the research sample.

3.7 ETHICAL CONSIDERATIONS

Ethical clearance was granted from the University of the Witwatersrand Human Research Ethics (Medical) Committee (HREC) (certificate number: M220932) (see Appendix E). The TRREE Introduction to Research Ethics course was also completed and the relevant certificate was submitted to the HREC (see Appendix F). Permission to invite members of the SASP CPRG to participate in the study was obtained from the secretary of SASP. Permission from heads of the relevant physiotherapy departments in public sector hospitals that were eligible for the study was also obtained in order to contact the eligible potential participants for the interviews. Written consent for participation and audio recordings of each interview was obtained from all participants interviewed. The participants were informed that they may withdraw at any point during the interview without any consequences. All the information obtained from the interviews was only used for the purpose of this study. Each transcript and interview recording was allocated a number to ensure anonymity and no personal details of participants were shared in reporting the study findings. The transcripts and interview recordings will be saved for a period of two years should the results be published, otherwise these documents will be saved for six years if the findings remain unpublished, according to University policy.

3.8 PROCEDURE

3.8.1 Data Collection

Data collection took place from February 2023 to March 2024. The researcher contacted the identified potential participants and screened them against the inclusion criteria for the study. Those that qualified for participation were informed of the purpose of the study (see Appendix B) and their consent for participation and audio/video recording was obtained prior to the interview being conducted (see Appendices C1 and C2). The interview platform was Zoom or Microsoft Teams and the interviews were conducted in English. The interviews were conducted by the researcher using a semi-structured interview schedule (see Appendix G and H) to guide each interview.

Once the participant agreed to participate, the interview was conducted on a day and at a time that was agreed upon between the researcher and participant. Each participant was then sent a meeting reminder from Zoom or Microsoft Teams to allow them to join on the relevant date. Each participant was verbally informed of the recording of the interview prior to starting the actual interview questions, as well as a brief summary of the study. Each participant was also given a chance to introduce themselves and ask questions to clarify anything that was not clear pertaining to the study. The interviews ranged in duration from thirty to forty-five minutes.

The interview recordings were thereafter transcribed verbatim by the researcher. The first interview done by the researcher was observed by the researcher's supervisor, who is experienced in qualitative study designs. This was to ensure rigour of the interview process. The researcher's supervisor pointed out that the researcher should provide the participants with a summary of the discussions held at the end of each interview. This allows the participant to feel heard and to verify that the researcher captured an accurate understanding of the participants' responses. Furthermore, the researcher was asked to take note of participants' body language and non-verbal cues in addition to their verbal responses, to establish the overall essence of each interview. The researcher used this guidance for all future interviews to enhance and improve the interview process. The researcher also reflected on each interview after its conclusion to capture the essence of the interview.

3.8.2 Data Management

The recordings of the interviews and transcripts were stored on a password protected laptop, with an additional back-up on a password protected online drive. Only the researcher and supervisor had access to the data. The researcher rewatched each interview recording to familiarise themselves with the data prior to transcribing. After transcribing each interview verbatim, the researcher rewatched the interview recordings to ensure an accurate account

of the interview was transcribed. Furthermore, this also allowed the researcher to take note of participants' non-verbal communication during the interview.

The researcher adopted a grounded theory approach in preparation for data analysis. Chapman et al. (2015) explain that this is an inductive approach to generating hypotheses from the data as it allows the researcher to draw new conclusions and add to existing literature on the topic, without using the older data to influence the new research findings. Thus, the researcher first did a detailed search of the research pertaining to NPPV use as a physiotherapy treatment technique for patients after CABG surgery in order to familiarise themselves with the current and available data. This allowed the researcher to develop a broader understanding of the available literature as well as of the data collected specific to their study and subsequently compare the two. Furthermore, the researcher could then identify new themes and conclusions that emerged from the interviews conducted for this study (Chapman et al., 2015).

3.8.3 Data analysis

Ravindran (2019) refers to data analysis as 'meanings that people attach to their actions and responses' (Ravindran, 2019: 40). Data analysis is a complex, time-consuming process where the researcher is the primary instrument and is involved in deep emersion of the data and the participants responses (Ravindran, 2019).

Braun & Clarke (2006) outline a method for data analysis using a thematic approach. This method was applied for data analysis of this study. The authors report that this method of analysing the data 'minimally organises and describes your data set in rich detail' (Braun & Clarke 2006:6).



Figure 3.1: Braun and Clarke's (2006) **Thematic Analysis Steps**

3.8.3.1 Familiarisation of data

This first step of data analysis involved the researcher transcribing the interview recordings of each participant. The interview recordings were transcribed verbatim for each participant (as described in section 3.8.2 above). Once all the transcripts were complete, the researcher re-read each transcript to get a detailed understanding of the meaning attached to participants' responses. This further prompted the researcher to take notes of important thoughts and concepts that emerged from all the transcripts.

3.8.3.2 Generate initial codes

This phase allows the researcher to start the process of deeply engaging with the transcripts in order to make sense of what was found. Initial codes were generated based off the researcher's reflective journal and notes taken during the interviews; all the while keeping in line with the study objectives. Each of the three study objectives were highlighted a specific colour, after which the codes that emerged from the transcripts were then highlighted the same colour as the objective they related to.

3.8.3.3 Develop themes

In this next step, the researcher had to collate the codes under each objective into central themes. This is a vital step where a theme is what captures 'something important about the data in relation to the research question' ((Braun and Clarke, 2006:10). Furthermore, it is also a way of identifying patterns as well as similarities or differences that have developed from the initial codes generated (Braun and Clarke, 2006).

3.8.3.4 Review themes

This step as a way to refine the initial themes generated from the previous phase, so that they 'cohere together meaningfully' (Braun and Clarke, 2006:20).

Here the researcher re-read the codes under the broader themes to further refine them into more concise and specific themes. Themes that were similar were collated into one clearly identifiable theme. The researcher then further reviewed the codes under the newer themes in order to determine under which theme they were most suitable.

In addition, the researcher's supervisor followed the same process of thematic analysis, separate to that of the researcher. The researcher then compared their respective findings in order to further refine and review the themes identified. The researcher also made note of any additional themes with their subsequent codes that were not consistent between the two separate findings. The researcher then compared codes under the common themes between the researcher and the supervisor to further confirm whether the correct meaning to each theme was identified. The researcher then chose the most appropriate themes with the corresponding codes between the supervisor and researcher, and captured the data in the research report for the supervisor to review. The supervisor and researcher then met in-person to discuss the thematic findings. Once a consensus was reached, those themes were included in the research report.

3.8.3.5 Define themes

Once the researcher had collated and finalised the themes and codes between her and the supervisor, the researcher subsequently finalised the titles of each theme. The three themes were each given the respective title of each study objective. This allowed the researcher to understand and define the essence of each theme. Thereafter, the researcher was able to categorise each code under the appropriate theme.

3.8.3.6 Write the report

Once all the themes and codes were defined and given a clear title, the researcher was able to write up the results. Excerpts were quoted from participants' transcripts in the results to add depth to the reported data.

3.9 Trustworthiness

Bradshaw et al. (2017) state that researchers must document the ways in which the quality and rigor of the data collected as well as the analysis thereof is maintained. This refers to trustworthiness of the research. There are four criterion that were considered in order to ensure rigor of the research namely; credibility, transferability, dependability and confirmability. Each criterion is expanded further below.

3.9.1 Credibility

This refers to the accuracy of the data presented (Bradshaw et al., 2017). The researcher achieved this through re-reading and prolonged engagement with the interview recordings and transcripts also contributed to data credibility. The first three transcripts were sent back to the respective participants for verification of the accuracy of what was transcribed. It was important that the researcher maintained a good rapport with each participant in order for them to feel comfortable to share information in the interviews. Thus, the researcher took guidance from the supervisor after observation of the first interview to ensure the rest of the participants were approached in an appropriate manner in order to gain rich descriptions from the participants.

3.9.2 Transferability

This is the generalisation of the data and the ability to use the findings in another research setting (Bradshaw et al., 2017). This was achieved by providing necessary details of the study design and subsequent methods used to collect data. The details of this study are specific to that of South Africa. Thus, there is a possibility that this study can be replicated in a different context which would subsequently present different results. Transferability was achieved through purposive sampling followed by snowball sampling which thus enabled the researcher to recruit a homogenous set of participants that fit specific criteria. Furthermore,

a detailed description of the data retrieved from the interviews was reported on in the Results chapter.

3.9.3 Dependability

Dependability refers to the reliability of the study (Korstjens and Moser, 2018). In order to achieve this, a detailed and precise account of all research steps of the methodology and analysis were described by the researcher. Subsequently, this allowed the researcher to have an audit trail for the study.

3.9.4 Confirmability

Lastly, Korstjens & Moser (2018) describe this as ways in which the researcher maintains neutrality of the data collected. Thus, the findings should be an accurate account of each participant's perceptions without the researcher's influence or bias skewing the data (Bradshaw et al., 2017). Once the interviews were transcribed, the researcher rewatched the recorded interviews in order to confirm that a word-for-word account for each participant was transcribed. The transcriptions were also thus objective in nature. Furthermore, the researcher asked the first three participants to verify their respective transcripts and confirm if they felt that the transcripts were an accurate account of each respective interview.

3.10 SUMMARY

This chapter provides an in-depth description of the design of this study as well as the subsequent methodological steps used to gather and analyse the data. Ways in which the researcher maintained trustworthiness in respect to the data is also explained here. The next chapter will present the findings from the interviews.

CHAPTER 4

4. RESULTS

4.1 INTRODUCTION

This chapter provides a detailed description of the research findings that emerged from the participants' interviews, with the aim of meeting each of the study objectives.

As described in the thematic analysis in chapter three, each objective was broken down into specific codes that emerged from the participants' transcripts. Thus, initially a brief tabulated summary of the thematic findings is described (see Figure 4.1). Thereafter, a more detailed analysis of the research findings under each study objective is expanded on, with relevant quotes from participants to support each code.

4.2 PARTICIPANT DETAILS

Over sixty physiotherapists were contacted with regards to participating in this study. Only fifteen physiotherapists from this pool agreed to participate. From the fifteen potential participants, only those with the most experience was chosen from each facility and were included in the study after their consent was obtained. Nine participants were females (82%), and two were males (18%). Nine participants (82%) worked in private facilities, whilst only two worked in government facilities (18%) (see Figure 4.2, Figure 4.3, Figure 4.4). Seven participants (64%) had four or more, but less than 10 years of work experience managing patients recovering from CABG surgery. Only three participants (27%) had more than ten years of experience treating patients who underwent CABG surgery. Participants were from different provinces in South Africa including Kwa-Zulu Natal; Gauteng and the Western Cape (see Figure 4.5).

Table 4.1: Summary of Themes, Sub-Themes and Corresponding Codes Emerging from the Interviews

Theme	Sub-Theme	Corresponding Codes
Participants' current involvement in the use of NPPV to treat patients post CABG surgery	Types of NPPV	- IPPB - CPAP - BiPAP - HFNO
	Initiation of NPPV by specific health professionals	- Administered by treating physician/ cardiothoracic surgeon
	Reasons for not using NPPV in treatment	- Provides no additional therapeutic benefits - Not familiar with/never used NPPV therapy
South African physiotherapists' perceptions of barriers to the use of NPPV in their patient management post CABG surgery	MDT staff matters	- Staff competency - MDT staff perceptions - Workload
	Patient-related limitations	- Patient level of sedation - Post-operative pain - Patient comfort when using NPPV - Language barriers
	Environmental limitations	- Space limitations in the ICU - Lack of resources
	NPPV technique related limitations	- Lack of evidence-based prescription of IPPB - Lack of adequate undergraduate training of NPPV devices - Patient and facility costs of IPPB equipment - Portability of high-flow machine
South African physiotherapists' perceptions of enablers to the use of NPPV in their patient management post CABG surgery	MDT staff matters	- Training of MDT staff members on use of NPPV therapy - Good relationship between physiotherapists and nurses - Efficient multidisciplinary approach
	NPPV technique usage	- Pre-operative physiotherapy - Evidence-based practice - Physiotherapist competency with using NPPV
	Environmental factors	- Cardiothoracic ICU space - Access to NPPV resources

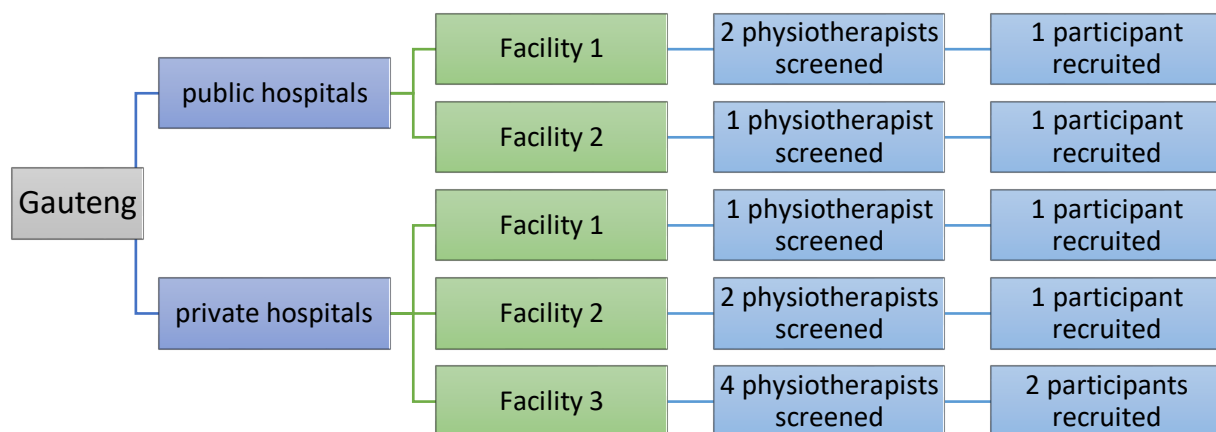


Figure 4.2 : Public and private facilities contacted in Gauteng with the resulting participants recruited from each facility

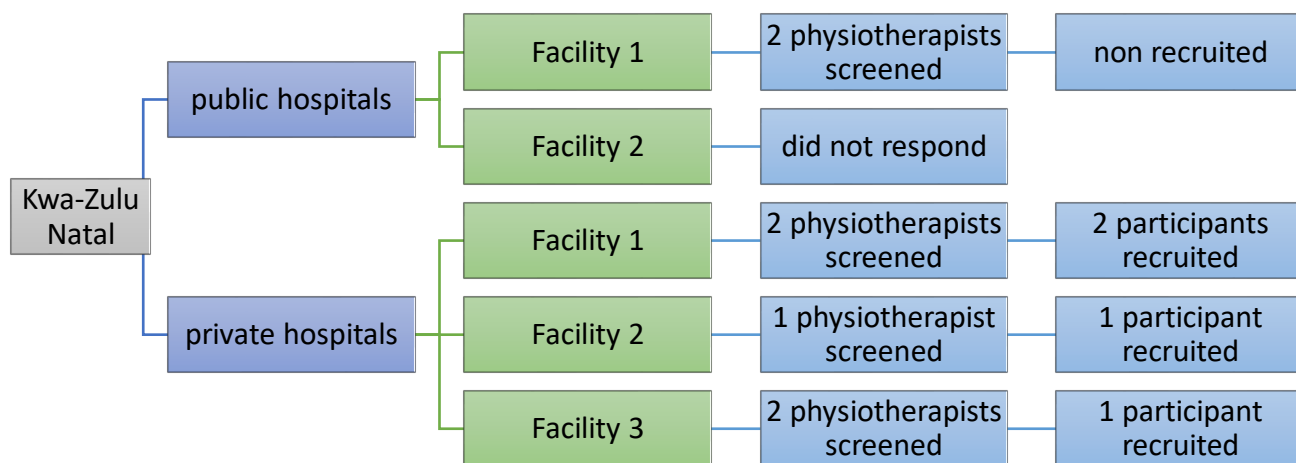


Figure 4.3: Public and private facilities contacted in Kwa-Zulu Natal with the resulting participants recruited from each facility

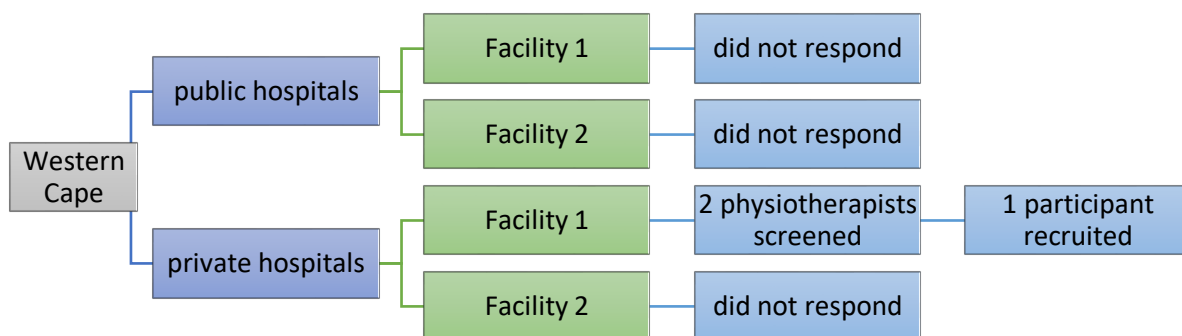


Figure 4.4 : Public and private facilities contacted in the Western Cape with the resulting participants recruited from each facility

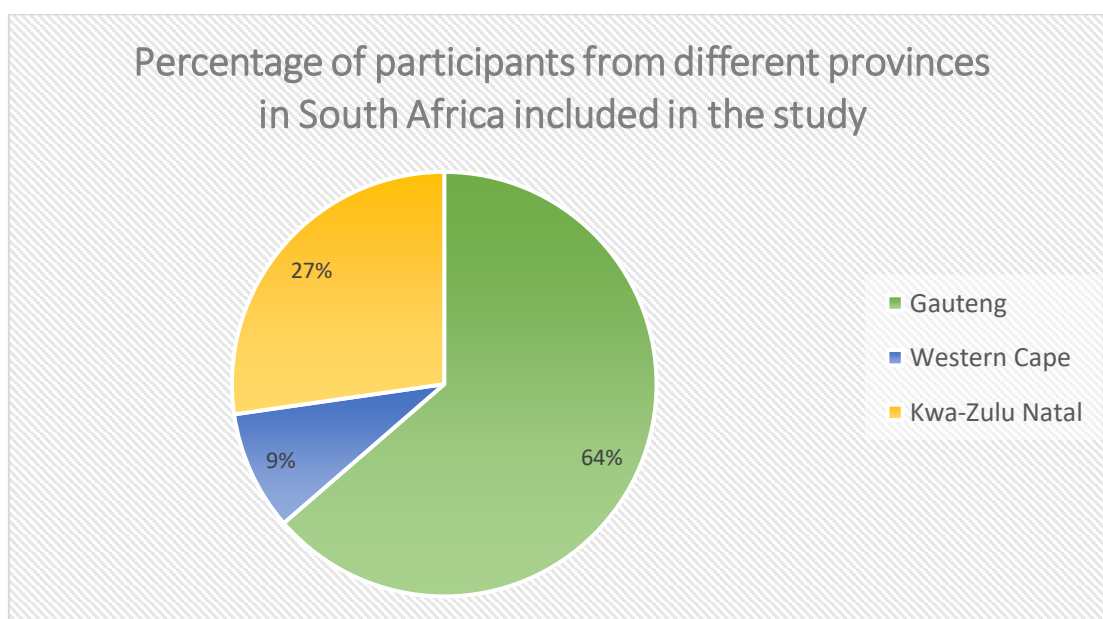


Figure 4.5: Percentage of participants from different provinces in South Africa included in the study

All physiotherapists of this study reported having a protocol or guideline within their respective physiotherapy practices or departments that was adhered to by all physiotherapists involved in treating patients after CABG surgery. Furthermore, all participants reported that they adopted an early mobility approach when treating patients following CABG surgery. However, the focus of the study results was on the details regarding the use or lack thereof of NPPV in participants' treatment approaches. These findings are summarised below in a figure to highlight the theme and emerging sub-themes. The specific codes under each sub-theme are explored in more detail.

4.3 PARTICIPANTS' CURRENT INVOLVEMENT IN THE USE OF NPPV TO TREAT PATIENTS POST CABG SURGERY

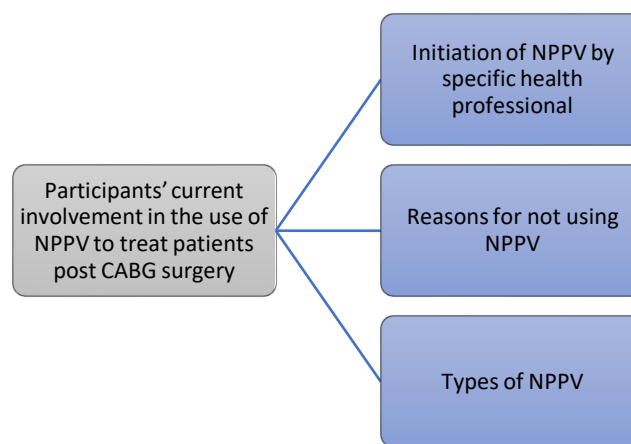


Figure 4.6: Emerging Sub-Themes from Participants' Reports on Involvement in use of NPPV Techniques

Patients' rehabilitation journey begins as soon as they are admitted to the cardiothoracic ICU post CABG surgery. Of the physiotherapists interviewed in this study, all eleven expressed that they were significantly involved in patients' recovery post-surgery. All participants further reported that there was some form of a protocol for physiotherapy management of patients after CABG surgery at each facility. Some physiotherapists reported that the protocols were guidelines, that were governed more by experience and clinical reasoning of the treating physiotherapist. However, a few participants felt that the protocols were strictly adhered to for all patients without proper clinical reasoning as to whether the treatment approach was appropriate for each specific patient. The clinical reasoning of use of NPPV techniques is highlighted later on in this chapter.

4.3.1 Initiation of NPPV by Specific Health Professional

Interestingly, four participants reported that despite physiotherapists being the drivers of rehabilitation post CABG surgery, the administration of NPPV was directed by the doctor. Participants 4, 6 and 8 reported that use of NPPV techniques at their respective facilities was

administered by the managing physician or cardiothoracic surgeon for the patient and was dependant on the patients' clinical outcomes and symptoms. Furthermore, participant 4 [female/private sector/Gauteng] also added that *'...as much as we [physiotherapists] are giving the hint towards it, it is more [the] doctors making the decision if we use high flow or like an NIV [technique].'*

'...we don't obviously have any say in what is used'. [Participant 6/female/private sector/KwaZulu Natal].

Similarly, participant 8 stated *'...if they [patients] are hypoxic then doctors will use it. We don't administer [NPPV] the doctors will decide.'* [Participant 8/female/Gauteng].

4.3.2 Reasons for not using NPPV

Conversely, only four out of the eleven participants did not make use of any NPPV device or technique to treat patients after CABG surgery.

Participants 6, 9, 10 and 11 reported that they did not make use of NPPV techniques and perceived it to be an unnecessary addition to treatment protocols that were already in place for patients after CABG surgery. *'...there's never been a need for it. I have actually never seen a cardiac patient on the CPAP mask. It would be very uncomfortable.'* [Participant 10/female/KwaZulu Natal].

Similar sentiments were expressed by another participant, *'...based on my experience; what we are currently using [as physiotherapy treatment techniques] the doctors are satisfied [with].'* [Participant 11/female/public sector/Gauteng].

In addition, participants 6 and 9 were not familiar with and had never used any NPPV techniques or devices before. *'...so I haven't seen or used it but I know of course there is benefit to it and NPPV.'* [Participant 6/female/private sector/Gauteng].

4.3.3 Types of NPPV

Of the physiotherapists that made use of NPPV techniques as a treatment for patients after CABG surgery, five used IPPB as a treatment technique for patients post CABG surgery. *'...we used IPPB for our cardiac surgery patients and other patients with respiratory failure, but mostly CABG patients.'* [Participant 2/male/private sector/KwaZulu Natal].

Participants that made use of IPPB found it to be a helpful addition to the patients' treatment protocol as it improved patients' respiratory outcomes post-surgery. *'...the reason we use it is to recruit part of the lung that may be collapsed. To improve lung volumes; and we use that*

through the machine called the Bird's. And to help with their lung capacity. It also helped a lot with drainage of ICD's. [Participant 3/female/Gauteng].

'So we do IPPB because we don't want to lose the PEEP when we take them off the vent[ilator] and lose those lung volumes.' [Participant 5/female/Western Cape].

A popular treatment choice that was used by five participants included HFNO. The participants reported that their facilities made use of HFNO as a form of NPPV for oxygen support as opposed to a physiotherapy treatment technique for patients after CABG surgery. *'...it is patient dependent, but we have started using high flow more often in the post-op cardiac patients.'* [Participant 4/female/private sector/Gauteng]. Participants 6 and 7 reported that patients at their facility were placed on high flow nasal cannula post extubation if patients were unable to cope without the oxygen support, in order to avoid re-intubation. *'...we do see patients that are on high flow if they are struggling, then that's what they go onto.'* [Participant 6/female/private sector/KwaZulu Natal].

'...if they are not coping the doctors like to use the high flow.' [Participant 7/female/private sector/Gauteng].

In addition, participants 2 and 5 also made use of NPPV as a form of oxygen support through the use of CPAP. Both participants reported that it was for patients who were struggling with ventilation after extubation and still needed pressure support to offload their respiratory muscles. *'...so if patients have pulmonary issues they are usually put on CPAP after being extubated.'* [Participant 2/male/private sector/KwaZulu Natal].

'...we work very closely with the nursing staff before we make a decision that the patient maybe needs further help like CPAP.' [Participant 5/female/private sector/Western Cape].

Interestingly, participant 4 used BIPAP as part of the physiotherapy treatment for some of the patients post extubation, as it increased patients' lung volumes as well as aided in secretion clearance. *'...We put BIPAP on the ventilator before they take the vent[ilator] out the room and let them take about ten to fifteen breaths with the mask on, getting that seal around their face, and just open[ing] up with a little bit of PEEP. And that really seems to help in terms of clearance of secretions'* [Participant 4/female/private sector/Gauteng].

The results thus showed that various forms of NPPV techniques were used by some participants as a ventilation technique with the added benefit of assisting in airway clearance post-extubation. *'...So we generally use it [NPPV] for patients that are struggling post*

extubation; or if they [patients] are starting to desat[urate] or if they have a really quick resp[iratory] rate.’ [Participant 4/female/private sector/Gauteng].

4.4 PARTICIPANTS’ PERCEPTIONS OF BARRIERS TO THE USE OF NPPV IN THEIR PATIENT MANAGEMENT POST CABG SURGERY

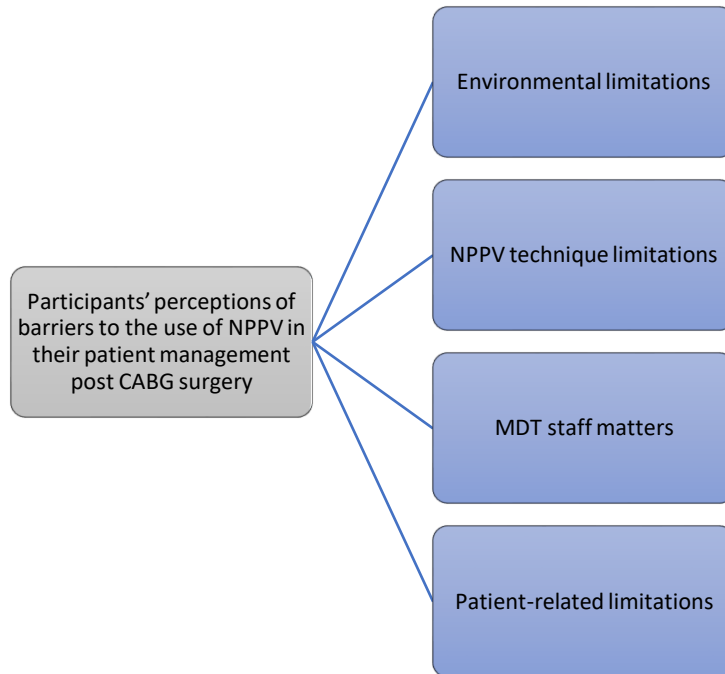


Figure 4.7: Emerging Sub-Themes from Participants’ Perceptions of Barriers on the use of NPPV for Patients following CABG Surgery

4.4.1 Environmental Limitations

The most reported barrier by participants was the lack of availability with regards to equipment for the different NPPV devices. Five participants found this to be a barrier. Four participants specifically referred to the lack of availability of the IPPB devices, namely the Mark 7 BIRD machines as well as the accompanying circuit.

Participant 3 stated that their facility treated patients post CABG surgery every day, however, the facility only had one IPPB machine available to share amongst the team of physiotherapists. The participant found this to be a major limitation as patients’ treatments were often delayed. *‘...it lands up being six beds of bypass patients and we only have one BIRD [machine].’ [Participant 3/female/private sector/Gauteng].*

In addition, participant 1 expressed the frustration of having to wait on medical suppliers to have stock of the IPPB circuits. *‘...the stock process tends to be a barrier sometimes which delays therapy.’ [Participant 1/male/private sector/Gauteng].*

Participant 5 expressed similar sentiments with regards to limited stock of IPPB circuits, *'...if the company doesn't have [IPPB circuits] or they are waiting on stock, it becomes a problem.'* [Participant 5/female/private sector/Western Cape].

Participant 2 further reported that the IPPB machine is generally not a well-stocked device, making it difficult for physiotherapists to have access to it. *'...accessibility especially with the IPPB- it's very rare that you find them.'* [Participant 2/male/private sector/KwaZulu Natal].

With regards to use of NPPV devices as a whole, some participants found the space around patients' bedsides in the cardiothoracic ICU to be an issue. Participant 1 reported that some of the oxygen ports are faulty and thus physiotherapists have to connect the NPPV device further away where it may not necessarily reach the patient. *'...one pressure socket doesn't work, and you have to use another socket that is a bit far from where your patient is sitting and you have to find a way to move your patients towards a socket.'* [Participant 1/male/private sector/Gauteng].

Participant 5 shared similar thoughts to participant 1 where, *'...some of the ports is a common problem like when you push the oxygen in, it shoots back out.'* [Participant 5/female/private sector/Western Cape].

Similarly, participant 3 reported that sometimes faulty plug points in the ICU meant that the NPPV device had to be connected at another plug point away from the patient's bedside. Furthermore, if all plug points were being used at the patient's bedside, the NPPV device would also need to be connected at another site making it difficult to manoeuvre with the patient. *'...plug points-if you maybe have drips running, the humidifier and then especially if one [plug point] is not working.'* [Participant 3/female/private sector/Gauteng].

Participant 5 also reported the general design and architecture of their facility was older and this meant less space around patients' bedsides. This meant that the NPPV device in use had to be connected to an electrical socket further away from the patient. Participant 5 continued to explain that this made it difficult for physiotherapists to manoeuvre around the bedside with the NPPV device in use, and made it further challenging to mobilise patients around the bedside. *'...space is a big one. We have a lot of old electrical work in the way.'* [Participant 5/female/private sector/Western Cape].

4.4.2 NPPV Technique Limitations

In addition to the lack of space in the ICU reported by some participants, the portability of some of the NPPV devices can make physiotherapy treatment difficult to execute efficiently. Participant 8 revealed that the lack of portability of the high-flow machine was a barrier for physiotherapists as they were unable to mobilise their patients away from the bedside in the cardiothoracic ICU. *'...the down-side is that we can't mobilise on high flow because the machine is not portable.'* [Participant 8/female/private sector/Gauteng].

In contrast to earlier reports of the portability of the HFNO, participant 2 reported that the IPPB was easily portable around the ICU unit. However, their facility was subject to a high number of patients needing treatment after CABG surgery which made it difficult for the physiotherapists to manage their time and utilise the IPPB machine between patients in the ICU. *'... [the] workload [is high]. There's just no time to move it around between patients.'* [Participant 2/male/private sector/KwaZulu Natal].

Furthermore, participant 1 reported that the IPPB device was difficult to source and added that the cost to service the device as well as the costing to the patient, can make this an expensive treatment for the physiotherapist and the patient. *'...you need to use a filter that you need to connect between the BIRD [IPPB] machine and the actual circuit that goes to the patient. So, everything has to be charged and billed accordingly.'* [Participant 1/male/private sector/KwaZulu Natal].

Although the IPPB device was commonly used by some of the participants in their facilities, participants 3 and 5 question whether use of the IPPB device at their respective facilities was evidence-based practice. Participant 3 felt that although their practice had a protocol to treat patients after CABG surgery, the protocol was followed blindly without clinical reasoning to determine whether NPPV was a necessary treatment option. *'...I don't think we are being very evidence-based in the first hospital.'* [Participant 3/female/private sector/Gauteng].

Participant 5 shared similar sentiments, *'...So we used it [IPPB] a lot- without any clinical reasoning'*. [Participant 5/female/private sector/Western Cape].

4.4.3 Multidisciplinary Team Staff Matters

Furthermore, the knowledge of how to handle and properly use the NPPV devices by physiotherapists and nursing staff also proved to be a barrier to some participants. Participant 8 reported that some of the nursing staff at their facility do not know how to manage some of the NPPV interfaces. Furthermore, participant 8 stated that since the nursing staff work in tandem with all MDT members to manage CABG patients, they are sometimes involved in

managing the NPPV device in use when the physiotherapists are not present, even without any formal training on use of the device. *'...sometimes the staff aren't that competent, but that doesn't stop them from putting them (face masks) on.'* [Participant 8/female/private sector/Gauteng].

Participant 4 further adds that due to the nursing staff's lack of training and knowledge on use of the NPPV devices, patients can experience discomfort and complications as a result. *'...the nursing staff doesn't know how to adjust the masks on the patients, so they land up getting pressure sores from the NPPV masks.'* [Participant 4/female/private sector/Gauteng].

In addition, some of the nursing staff are unaware of the equipment used for some of the NPPV devices which can result in mishandling thereof. Participant 3 thus explains *'...then sometimes we [would] have the night staff throw away the circuit.'* [Participant 3/female/private sector/Gauteng].

Adding to the lack of skills and knowledge some of the ICU staff members have of NPPV, three participants reported that some ICU staff members also had reservations regarding physiotherapists' use of NPPV techniques to treat patients post CABG surgery. Participant 2 found that the cardiothoracic surgeons at their facility were not accustomed to NPPV techniques and thus did not always approve of their use to treat patients post CABG surgery. *'...the mentality they [the surgeons] have where they are not used to something or it hasn't been done yet, so they will rather stick to what they know.'* [Participant 2/male/private sector/KwaZulu Natal].

Further, participant 2 found it frustrating that instead, the surgeons tend to gravitate towards percussions as a necessary treatment technique for chest physiotherapy. *'...it's a general culture that percussions is the mainstream physio. Whereas, what we actually do, is open the lungs to improve ventilation and not just move secretions.'* [Participant 2/male/private sector/KwaZulu Natal]

Participant 3 adds that some of the ICU nursing staff are opposed to physiotherapists' use of NPPV techniques as they perceive the treatment could disrupt the patient's condition. *'...you know those sisters who don't want you to upset their patients.'* [Participant 3/female/private sector/Gauteng].

Participant 8 also found the perceptions of some of the nursing staff to be a barrier. *'...the willingness of nursing staff is a problem. But we make a plan.'* [Participant 8/female/private sector/Gauteng].

Participant 2 also shared similar thoughts about nursing staff perceptions and stated, *'...they [the nurses] control what needs to be done especially with the bypasses. They [the nurses] would prefer percussions and would not accept anything else.'* [Participant 2/male/private sector/KwaZulu Natal].

The nursing staff were not the only reported staff members who may not be equipped to use the NPPV techniques. Some participants also found that physiotherapists' undergraduate training, in terms of NPPV techniques, was inadequate. Participant 3 felt that undergraduate studies did not provide enough practical exposure to NPPV techniques. *'...if I think back to varsity, we never touched a BIRD. It was one lecture slide- NIV, IPPB.'* [Participant 3/female/private sector/Gauteng].

Participant 5 shared equal frustration stating, *'...I definitely will say in varsity we need to be introduced to the devices. They need to actually be taught to us and explained properly.'* [Participant 5/female/private sector/Western Cape].

4.4.4 Patient-Related Limitations

Another barrier reported by Participants 8 and 4 included patients' level of comfort during the use of NPPV devices that required use of a full facemask. Participant 8 stated that *'...normally with a mask, a full facial mask, they are quite uncomfortable, and patients don't tolerate them well.'* [Participant 8/female/private sector/Gauteng].

Participant 4 also shared the same thoughts and stated *'...with the NIV it can become difficult to eat and drink.'* [Participant 4/female/private sector/Gauteng].

Additionally, some participants found that patients' post-operative condition was a barrier to effective use of NPPV techniques as a treatment. Three participants stated that patients' pain levels after CABG surgery made use of NPPV techniques as a treatment difficult to execute, especially with regards to its efficacy. *'...we find that when patients are in a lot of pain it's obviously not as effective- you then have to dial down your [IPPB] sensitivity.'* [Participant 3/female/private sector/Gauteng].

Participant 3 further adds, *'...I feel like that first day or two you are not as effective [as] you are using really low volumes to activate the breaths.'* [Participant 3/female/private sector/Gauteng].

Participant 1 found that post-operative pain also made patients less likely to comply with the treatment. *'...the patient will focus more on their discomfort than the actual therapy that you are giving them. You lose your ability to reach those goals.'* [Participant 1/male/private sector/Gauteng].

Participants 5 and 8 also agreed that pain was a major barrier to effective use of NPPV techniques.

In contrast, participant 5 found patients' level of sedation to be more of a barrier than their post-operative pain levels. *'...they [patients] never wake up in pain. It's more the sedation; that's the big one.'* [Participant 5/female/private sector/Western Cape].

Participant 1 shared that if patients were still sedated, they struggled to co-ordinate with the IPPB machine which made treatments difficult. *'...if you find that the patient is over-sedated or they are still coming out of sedation, they are unable to synchronise their breaths with the machine.'* [Participant 1/male/private sector/Gauteng].

Participant 3 added that language occasionally proved to be a barrier between the physiotherapist and some patients. This meant patients could not understand instructions on use of NPPV techniques. Participant 3 specifically refers to use of the IPPB machine where, *'...[patients] who don't speak much English, and the Afrikaans that they speak is not at a level where they understand what this machine [IPPB] is.'* [Participant 3/female/private sector/Gauteng].

4.5 PARTICIPANTS' PERCEPTIONS OF THE ENABLERS ON THE USE OF NPPV IN THEIR PATIENT MANAGEMENT POST CABG SURGERY

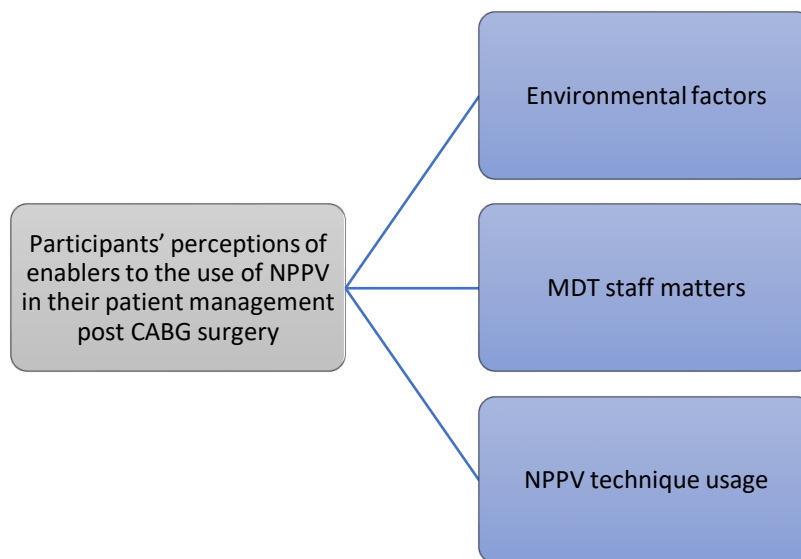


Figure 4.8: Emerging Sub-Themes from Participants' Perceptions of the Enablers on the Use of NPPV for Patients Following CABG Surgery

In contrast to the barriers reported above, there were many positive aspects relating to the layout of the cardiothoracic ICU along with the staff and resources that enabled physiotherapists' use of NPPV to manage patients after CABG surgery.

4.5.1 Environmental Factors

Three participants reported that the cardiothoracic ICU is spacious enough and thus made it easy to manoeuvre the NPPV machines around patients' bedsides. *'...[of] the two ICU's I've worked in, they are both quite spacious because it is a cardiac ICU. So, there's always enough space.'* [Participant 3/female/private sector/Gauteng].

Likewise, participant 4 stated that the cardiothoracic ICU in their facility was equipped to fit extracorporeal membrane oxygenation (ECMO) machines, which are significantly larger than any NPPV device. Thus, space in the subsequent ICU was not deemed to be a barrier for use of NPPV devices. *'...in our new cardiothoracic ICU we can fit in [NPPV equipment] and because we are an ECMO unit we can fit in ECMO ventilators, so [space] is definitely not an issue.'* [Participant 4/female/private sector/Gauteng].

Participant 8 also shared similar insights, stating that space in the cardiothoracic ICU at their facility is not a disadvantage. *'...it's a fairly spacious [cardiothoracic] unit. But it's not a limitation at all.'* [Participant 8/female/private sector/Gauteng].

Participants 4 and 8 were further pleased that access to resources and equipment needed for NPPV devices was not a problem. Thus, patients' treatments post CABG surgery was not affected by accessibility to NPPV equipment. *'...I always have access to different resources as I say with the two different masks we are using. So, we are really spoilt in terms of that.'* [Participant 4/female/private sector/Gauteng].

Participant 8 also shared *'...we get everything we need and in private it is always easier.'*

Participant 5 reported that as a result of the high demand for usage of the IPPB machine in the cardiothoracic ICU, subsequent resources for its use were easily available to the physiotherapy department. *'...obviously access to it [IPPB]. We have about five which is really great.'* [Participant 5/female/private sector/Western Cape].

4.5.2 Multidisciplinary Team Staff Matters

Many of the participants also found that the efficiency of the ICU multidisciplinary team (MDT) and the helpfulness of the staff made the ICU environment conducive to use NPPV techniques. *'...You will be told the day before that a bypass is coming the next day, and they would even order the circuits [for the IPPB machine].'* [Participant 1/male/private sector/Gauteng].

Participant 6 stated that the nurses, physiotherapists and surgeons work well together at their facility, which subsequently allowed for efficient physiotherapy treatments. *'...he [the surgeon] really gets the staff to do what's needed and [for treatment to] be patient and physio[therapy] centred.'* [Participant 6/female/private sector/KwaZulu Natal].

Participants 4 and 8 also expressed their satisfaction with a conducive MDT approach. The provided ease of mind for physiotherapists and their treatment plans. *'...because I work in a really good unit I always have access to really qualified staff and doctors. That really makes it easy for me and accessible.'* [Participant 4/female/private sector/Gauteng].

Participant 8 also added, *'...the nurses are quite competent.'*

Subsequently, physiotherapists' skills and competency regarding use of NPPV techniques was also found to be an important enabler for participants 1 and 2. Participant 1 reported that

in order to ensure efficient clinical skills of physiotherapists using NPPV devices, regular training of their team members was encouraged. *‘...we orientate as much as we can and teach and train on how to use the device.’ [Participant 1/male/private sector/Gauteng].*

Participant 2 *[male/private sector/KwaZulu Natal]* found that physiotherapists’ ease of use of NPPV devices, specifically the IPPB machine, came with regular training and use of the device. *‘...your level of comfort comes with using it [IPPB] so regularly; and you can then see those who don’t know [how to use the IPPB machine].’*

4.5.3 **Non-invasive Positive Pressure Ventilation Technique Usage**

Participant 2 found that having a pre-operative physiotherapy protocol was beneficial as it allowed physiotherapists to teach patients how to use the IPPB machine prior to their surgery. *‘...if they did well pre-op with IPPB, they grasp it well afterwards.’ [Participant 2/male/private sector].*

Additionally, participant 5 felt that that pre-operative physiotherapy was useful as it made the post-operative treatments more efficient. *‘...we build patient rapport. And then obviously let them get comfortable and when they are woken up, it’s [IPPB] not something we have to teach them.’ [Participant 5/female/private sector/Western Cape].*

Lastly, participants 1 and 5 report that their respective facilities make use of the IPPB machine due to the documented benefits of its use. Thus, both participants reported that evidence-based practices are important to allow for more efficient management of patients’ post-operative complications after CABG surgery. *‘...the research still supports that this equipment [IPPB] is efficacious in its use and its goals to have improved functional outcomes- it meets all the targets. I think that’s a big enabler.’ [Participant 1/male/private sector/Gauteng].*

Participant 5 further adds, *‘...if we do have access [to the IPPB machine] it’s something we should be using and not just reading about. It’s important.’ [Participant 5/female/private sector/Western Cape].*

4.6 **CONCLUSION**

The research findings here will be compared to the existing literature next, in Chapter five. The strengths and limitations of this study will also be highlighted.

CHAPTER 5

5. DISCUSSION

5.1 INTRODUCTION

This chapter provides a description of the study findings in relation to the available literature. Each study objective with the corresponding codes will be unpacked, with comparison to available literature in South Africa; Sub-Saharan Africa and other international countries. A summary of the codes that emerged for each sub-theme is presented in the table below.

5.2 PARTICIPANTS' CURRENT INVOLVEMENT IN THE USE OF NPPV TO TREAT PATIENTS POST CABG SURGERY

It is evident that patients are subject to a plethora of complications, particularly of the respiratory system, in their post-operative journey following CABG surgery. As such, it is understandable that physiotherapists are very much involved in their treatment post-operatively to prevent and treat such complications.

In this study, all eleven participants reported being significantly involved in patients' post-operative treatment regime in the cardiothoracic ICU settings in which they work. This is supported by previous studies having reported that physiotherapists are an important contribution to patient care in ICUs globally, including South Africa (Hanekom et al., 2015; Lottering and Van Aswegen, 2016). Similarly, with specific focus on treating patients with CAD or post cardiac surgery, the findings of this study are similar to that of Roos and Van Aswegen (2011) where more than half of the South African physiotherapists included in the study were involved in treating this patient population.

In addition, all participants of this study reported having developed a protocol or guideline within their respective physiotherapy departments that was adhered to by all physiotherapists involved in treating patients after CABG surgery. Similarly, in a survey that explored physiotherapy mobility-focused protocols for patients post CABG surgery in Sweden, the authors found that physiotherapists in the cardiothoracic ICU followed a locally developed guideline from their respective departments to treat this patient population (Westerdahl and Möller 2010). Similarly, in a survey conducted in Australia and New Zealand to report on physiotherapy practices following CABG surgery, the authors found all respondents adhered to a clinical care pathway that was developed within each facility (Filbay et al., 2012). However, they point out that having a protocol does not guarantee good clinical reasoning and practice (Filbay et al., 2012). Therefore, consistent review of hospital protocols is necessary to ensure clinical practices of physiotherapists are based on the most recent

available evidence (Filbay et al., 2012). Furthermore, whilst the study by Filbay et al. (2012) included the use of positive pressure devices, the study by Westerdahl and Möller (2010) did not and thus the focus of these protocols was more on mobility practices and not that of NPPV techniques. Further research into the effectiveness of NPPV therapy as an adjunct to patient management after CABG surgery is required to establish its effect on patients' clinical outcomes.

Regarding use of NPPV techniques, NPPV therapy was utilised in patient care by more participants than not, in the present study. This contrasts with the findings in the report on South African physiotherapists' treatment of patients with CAD by Roos and Van Aswegen (2011), who found IPPB to be the least used treatment technique by physiotherapists. Likewise in Australia and New Zealand, use of positive pressure devices to treat patients after CABG surgery was not a common choice by physiotherapists (Filbay et al., 2012). Instead in both of the above-mentioned studies, deep breathing exercises and early mobilisation were the most popular treatment choices for this patient population (Filbay et al., 2012; Roos and Van Aswegen, 2011). Renault et al. (2008) suggests that this could be because DBE's are an easy to execute treatment technique that requires no additional equipment, however, this treatment technique was not the focus of the present study.

In Switzerland, NPPV is a popular treatment choice by clinicians for acute cases in the ICU including extubation failure; COPD exacerbations as well as post-operative respiratory failure (Salvadè et al., 2012). Non-invasive positive pressure ventilation techniques are a common treatment modality used by physiotherapists to treat patients after CABG surgery in Brazil (Fiore et al., 2010). The most commonly used devices were found to be IPPB and CPAP (Fiore et al., 2010). Their results are similar to the current study where IPPB was the most frequently used NPPV technique, along with HFNO. Participants in the present study who made use of IPPB found that it was an invaluable addition to the conventional breathing exercises given to patients after CABG surgery. The general impression from participants was that IPPB was able to encourage deeper breathing patterns as opposed to DBE's and thus improve patients' overall respiratory outcomes. Intermittent positive pressure breathing is also reported to increase patients' tidal volumes as well as improve expansion of the lungs (Müller et al., 2006). This statement is supported by Romanini et al. (2007) who found that IPPB showed a marked improvement in patients' oxygenation levels in the first 48 hours after cardiac surgery when compared to incentive spirometry.

One participant reported using IPPB because it provided respiratory support to patients with the addition of PEEP. This misconception from the participant does not represent the physiology of IPPB, which instead, increases patients' vital capacity through the improvement

in thoracic expansion and lung compliance (Denehy and Berney, 2001). This perhaps highlights the need to investigate South African physiotherapists' knowledge and understanding of the clinical indications for use of NPPV techniques. The general lack of knowledge of administration and handling of NPPV techniques reported by participants of this study is discussed later in the chapter.

The least used NPPV technique by participants in this study was BiPAP. The one participant that reported using BiPAP found that this modality helped to provide support to the alveoli with the addition of PEEP and subsequently aided in clearing of secretions if patients were struggling to do so. Bi-level positive pressure is well documented regarding the improvements shown in patients' tidal volumes, lung expansibility and reduced work of breathing when used after cardiac surgery (Liu et al., 2020; Renault et al., 2008). However, there is limited evidence regarding its efficacy on secretion clearance. Non-invasive positive pressure ventilation therapy is generally not indicated as a standalone treatment for clearing secretions, but rather as a device to augment secretion clearance along with traditional physiotherapy techniques (Piper and Moran, 2006). Physiotherapy techniques that can be used in addition to NPPV techniques include the active cycle of breathing, postural drainage, assisted coughing and breath stacking (Piper and Moran, 2006). Takami and Ina (2003) share similar sentiments stating that BiPAP is not necessarily suitable for patients with excessive secretions as it may be difficult for clinicians to access and subsequently clear secretions due to the interface used. Similarly, Polastri et al. (2016) report that IPPB is not a suitable technique to aid in chest clearance. However, since evaluating the effectiveness of NPPV techniques on patients' clinical outcomes was not the focus of this study, further research may be necessary to determine if use of NPPV techniques for secretion clearance post cardiac surgery is beneficial.

The common consensus amongst participants that made use of NPPV techniques in the present study was to utilise it as a form of oxygen support for patients once they were extubated. High-flow nasal oxygen was a common treatment choice administered by the treating physician or cardiothoracic surgeon to provide the necessary respiratory support and prevent respiratory decline in patients struggling to ventilate post extubation. This practice is supported across a broad spectrum of studies which acknowledge that NPPV has shown improvements in gaseous exchange through efficient alveolar recruitment, which subsequently aids the patient to better oxygenate and ventilate their lungs, particularly those with a risk of ARDS after cardiac surgery (Gonçalves de Lima et al., 2024; Guarracino and Ambronsino, 2011; Renault et al., 2008).

In terms of prescribing the NPPV techniques to patients after CABG surgery, some participants in the present study reported that the treating physician was responsible for directing the choice of NPPV modality and the subsequent treatment parameters. These findings are in line with a survey reporting on the practices of non-invasive ventilation use in India, where the authors report that NPPV prescribed for patients in the ICU and wards is only directed by the treating physician (Chawla et al., 2008). Similarly, physiotherapists in the British Isles were not involved in administering NPPV techniques but rather, only in treating patients who were already placed on NPPV therapy (Moran et al., 2005). In a meta-analysis that examined the effects of prophylactic NPPV therapy on patient outcomes after cardiac surgery, the results showed a mixed prescription of NPPV techniques from physicians and physiotherapists (Liu et al., 2020). In contrast, physiotherapists in Australia were able to safely administer NPPV therapy to patients within the first twenty-four hours after abdominal surgery (Lockstone et al., 2020).

A possible explanation for physiotherapists being more involved in NPPV administration for patients after abdominal surgery as opposed to cardiac surgery could be because of the latter being a more complex procedure dealing with vital organs, thus increasing the risks involved for the patient. As a result, practitioners involved in managing such patients require a certain level of skill and understanding of the procedure and the subsequent effect it has on the physiology of the patient. This can enable the treating practitioner to appropriately manage any adverse effects from NPPV treatment. Additionally, further training may be needed for physiotherapists treating patients after cardiac surgery with NPPV therapy in order for them to be involved in safely administering this treatment.

It is fitting to conclude that different hospitals across many countries carry different rules regarding the involvement and scope of practice of each health care professional working in the ICU (Westerdahl and Olsén, 2011). It is also worth highlighting that only a few studies explicitly state whether treatment and prescription of NPPV therapy was guided by a specific health care professional. There are no other known studies in the South African setting, besides the one at present, to indicate physiotherapists involvement in the prescription of NPPV techniques for patients after cardiac surgery. Further observational studies are needed to determine if the prescription of NPPV therapy in South African ICUs is guided by the surgeon, treating physician, or the physiotherapist.

In addition, clinicians working in the ICU often rely a great deal on their clinical experience to guide treatment choices for patients (Hanekom et al., 2015). This may explain the variability of clinical practice by physiotherapists in the ICU, particularly in the South African setting (Hanekom et al., 2015). In the present study, the most experienced physiotherapists of their

respective facilities were chosen to participate where some participants had a guideline at their respective facility in place, whereas some used clinical experience along with the patient's presenting condition to guide the choice of treatment modality used. Thus, there were varied treatment approaches on the use of NPPV techniques for patients following CABG surgery reported in this study. However, the small sample size and lack of participation of physiotherapists from other provinces make it difficult to compare the findings to the larger studies referenced above. More observational studies of physiotherapists' treatment approaches for patients after CABG surgery is warranted.

Similar findings are evident in an observational study exploring physiotherapists' use of NPPV techniques post abdominal surgery in Australia (Lockstone et al., 2020). The authors highlight the lack of consensus on the prescription parameters of NPPV techniques for patients in the ICU. Since this is the first study set in South Africa to look at physiotherapists' use of NPPV techniques to treat patient after cardiac surgery, further observational studies are needed in order to provide more conclusive reports on NPPV usage in South Africa.

5.2.1 Level of Evidence Obtained

The literature mentioned above about the involvement of physiotherapists in use of NPPV for patients after CABG surgery were mostly set overseas, with none conducted in South Africa. Since it was evident that not only did different facilities within the same country have different protocols and practices, so did the practices differ between the various countries mentioned above. This makes generalisability of the data difficult due to lack of standardisation of practices by physiotherapists. In addition, the sample sizes amongst the observational studies and randomised controlled trials varied. This increases the risk of bias due to the potential lack of data saturation and thus the results should be read with caution. It is also worth noting that some studies did not mention whether the questionnaires used were validated, which can further add to risk of bias. Majority of the studies included were cross-section observational studies and prospective randomised controlled trials. Thus, the evidence presented in this section mainly includes studies of a level two or three. Only one systematic review and meta-analysis were included respectively. The systematic review and meta-analysis were also conducted and published more recently in the last three years as opposed to the other studies, which makes the data more applicable to recent times. However, this does highlight the need for more experimental trials and subsequent systematic reviews in order to filter the information discovered from other studies. This can provide more conclusive statements regarding physiotherapy practices for this particular patient population. Thus, the quality of evidence available on this topic is moderate to low, indicating minimal publications of a higher quality of evidence.

5.3 PARTICIPANTS' PERCEPTIONS OF THE BARRIERS ON THE USE OF NPPV IN THEIR MANAGEMENT OF PATIENTS POST CABG SURGERY

Although most participants in this study made use of NPPV techniques, there were still many reported barriers which participants felt had a marked influence on their use of this treatment modality for patients following CABG surgery.

A commonly reported barrier by participants in the current study was the level of expertise and competency of the staff members involved in using NPPV techniques in the cardiothoracic ICU. Drawing on the minimal clinical standards needed by physiotherapists to efficiently work in the ICU, Hanekom et al. (2015) state that sufficient knowledge and skills are important traits needed by physiotherapists in order to encourage safe and effective clinical practices. Similarly, in an international survey inadequate staff training was a major reason why clinicians avoided use of NPPV techniques (Cabrini et al., 2015). Adequate training of healthcare professionals including physiotherapists and nurses, may be beneficial in cases where physicians are not available to prescribe NPPV therapy, as this can avoid delays in treatment as well as ensures proper use of the various NPPV modalities (Chawla et al., 2008). Similar results were reported in a survey exploring the perceptions of healthcare professionals on the use of NPPV in Switzerland, where respondents found a major limitation to use of this treatment technique was the lack of knowledge and subsequent training of staff members on NPPV techniques (Salvadè et al., 2012).

Participants in the present study further reported that improper handling of the face masks by staff members not familiar with the NPPV modality caused significant discomfort for some patients, sometimes resulting in the development of pressure sores on the nasal bridge. Thus, patient discomfort whilst using NPPV techniques was a barrier on its own that was commonly reported by participants in this study. A major reported flaw of NPPV interfaces is the pressure from oro-nasal masks, which can cause irritation to the nasal bridge of the patient, subsequently increasing their discomfort (Gilliland and Brainard 2015). Chawla et al. (2008) also found that the most frequently reported complication from physicians that made use of NPPV in the ICUs in India was nasal bridge pressure sores.

Similarly, in an international survey to explore use of NPPV devices in the hospital wards, forty-two percent of participants who made use of NPPV techniques reported that patient discomfort from the NPPV device in use was a major reason for failed compliance (Cabrini et al., 2015). It was thus concluded that better training of clinicians involved in the use of NPPV techniques would encourage a better choice of the interface used as well as the

specific NPPV modality, where the clinical decision was based on clinical reasoning and patient comfort (Cabrini et al., 2015). Furthermore, whilst patient discomfort can occur through use of the oro-nasal and nasal masks, poor training and lack of clinical experience can prevent practitioners from recognising patient distress and subsequently adjusting the interfaces as needed (Salvadè et al., 2012).

Adding to the lack of experience of some ICU staff members, some participants in the present study also felt that there was a lack of adequate undergraduate training regarding use of NPPV techniques, which could also affect clinicians' use of the modality. Similar results were reported from physiotherapists in the British Isles where basic training on the use of NPPV techniques was encouraged to begin at an undergraduate level, with more specialised skills related to administering and assessing patients' appropriateness for NPPV therapy to rather be offered at a post-graduate level (Moran et al., 2005).

Additionally, there is a growing interest amidst South African physiotherapists to further their undergraduate degrees in order to build on their clinical knowledge and skill set (Lottering and Van Aswegen 2016). However, whilst this is encouraging for future practices, further research into the content of undergraduate and post-graduate cardiopulmonary physiotherapy training programs offered at universities in South Africa for students who want to become physiotherapists may be required. Contrary to the South African physiotherapists in this study, clinicians in Switzerland showed consistent practices on the use of NPPV techniques across university and non-university affiliated ICUs and thus concluded that training of the ICU staff as well as clinical skills were homogenous in their country (Salvadè et al., 2012).

In addition to the lack of experience of some staff members, participants in the present study reported that some of the other ICU members including nursing staff and doctors, had reservations regarding the use of NPPV as a treatment technique for patients after CABG surgery. Participants often felt that nurses were unwilling to assist with NPPV therapy due to perceptions of the treatment increasing their workload. This is in line with a prospective, multicentre study conducted in France and Belgium that explored the perceptions of healthcare workers, patients and their relatives on use of NPPV in the ICU (Schmidt et al., 2016). The results of the study showed that healthcare workers perceived nurses to be less willing to use NPPV techniques as opposed to ICU physicians due to their high patient load (Schmidt et al., 2016). Furthermore, since nurses spend majority of their shift with patients compared to physicians, they are able to closely monitor changes and responses to NPPV. Thus, unfavourable patient responses to the NPPV treatment may also affect nurses'

willingness to prescribe this treatment (Schmidt et al., 2016). However, perceptions of the nursing staff was not the focus of this study and could be explored in future research.

A few participants in the current study felt that NPPV was administered to patients without proper clinical reasoning, which could perhaps tie back to the lack of knowledge and experience of staff members using the techniques. There are various risk factors in patients after cardiac surgery which may validate use of NPPV namely: hypercapnia, increased secretion retention with poor cough efforts, more than one failed attempt at extubation, and an age of over 65 years, to name a few (Gonçalves de Lima et al., 2024). However, whilst these factors suggest potential use of NPPV therapy, additional screening for appropriateness is necessary as most patients admitted to the ICU may present with some, if not all of these factors which may lead to NPPV being administered without proper clinical reasoning (Gonçalves de Lima et al., 2024). Thus, the screening of patients and administering process of NPPV techniques in the cardiothoracic ICU requires further research to determine whether practices by physiotherapists and other members of the ICU team are appropriate and evidence-based.

Subsequent to the staff perceptions of NPPV use in the cardiothoracic ICU, the lack of both financial and staffing resources was another reported barrier by some participants in the present study. These results are similar to the findings of an international survey that highlighted a lack of human and financial resources as common reasons why participants avoided use of NPPV techniques (Cabrini et al., 2015). Similarly, physiotherapists in Australia report that it was difficult to deliver timeous and efficient treatments using NPPV therapy due to under-staffing, particularly on weekend shifts, as well as the amount of NPPV-specific equipment needed for this form of treatment (Lockstone et al., 2020).

Furthermore, the funding for equipment and subsequent resources needed for NPPV therapy were also often reported as a barrier by participants in the present study. In a mixed methods study conducted in a public sector hospital in South Africa to determine the costs of ICU care, the authors concluded that staffing and equipment costs were the most expensive components of ICU care (Mahomed and Mahomed 2019). The authors further explain that the high costs of human resources are due to the need for specialised nurses, doctors and other clinical experts involved in the multidisciplinary care of patients in the ICU. Furthermore, patients admitted to ICU in the private sector are billed separately according to all services and consumables used during their stay (Mahomed and Mahomed 2019). This can make physiotherapy services with the addition of NPPV a costly service for some patients.

Similar sentiments are shared for patients who have undergone cardiac surgery in that they are subject to a plethora of costs during their ICU stay, with the inclusion of physiotherapy services (Arcêncio et al., 2008). The authors propose further research into a cost-benefit analysis on use of NPPV and other physiotherapy techniques that require specific equipment, in order to determine whether the benefits of these physiotherapy practices outweigh the cost factor (Arcêncio et al., 2008). Intermittent positive pressure breathing is also reported as a more costly treatment as opposed to incentive spirometry due to the accompanying circuit needed for the device (Polastri et al., 2016). This statement was supported by participants who made use of IPPB in the present study. However, costs related to use of NPPV techniques has not been formally researched in the South African setting and thus requires further exploration. A comparison of costs and resources between the South African private and public sector cardiothoracic ICUs, specific to use of NPPV therapy, is worth further investigation.

Whilst barriers relating to the staff members involved with administering NPPV techniques to patients after CABG surgery was the dominant narrative of this study objective, a few participants also reported that patients' clinical condition was a factor that sometimes prevented efficient use of NPPV techniques. Participants perceived that patients' level of sedation and subsequent delirium had a negative impact on the efficacy of NPPV techniques. The delirium and over-sedation of patients post-extubation after cardiac surgery is also associated with an increased risk of patient asynchrony with the NPPV device in use (Scala and Pisani 2018). Interestingly, patient's experience with use of NPPV has been poorly documented, as opposed to their experiences whilst on invasive mechanical ventilation (Schmidt et al., 2016). Pain was often a negative factor associated with invasive mechanical ventilation; however, no such reports are associated with NPPV (Schmidt et al., 2016). Patients' levels of anxiety associated with use of NPPV is frequently documented to hinder the efficacy of this treatment technique (Schmidt et al., 2016). In contrast to the findings of Schmidt et al. (2016), participants in the present study reported pain as a barrier to use of NPPV techniques, whereas anxiety was not reported at all.

Lastly, one participant reported that since the HFNO machine was not portable, this made it difficult for physiotherapists to mobilise patients away from their bedside. Whilst this is true, physiotherapy mobilisation does not only involve moving away from the bedside. Mobilisation in the ICU can also include sitting over the edge of the bed, standing, marching on the spot, and sitting out in a chair by the bedside (Santos et al., 2017). Thus, considering these mobilisation techniques, the portability of the HFNO should not necessarily pose a barrier to mobilisation.

5.3.1 **Level of Evidence Obtained**

The evidence reported on in this section of the discussion included a literature review, two narrative reviews and only two systematic reviews. The systematic reviews indicate a higher quality of evidence and thus aided in providing more reliable conclusions about the barriers relating to NPPV use as opposed to the narrative and literature reviews, which are of a lower quality. There is also a large number of cross-sectional observational survey studies included in the discussion which indicate a moderate to lower quality of evidence. Thus, the inclusion of some systematic reviews assists to reduce the level of bias when interpreting the findings of the observational and cohort studies included. The systematic reviews were also published within the last ten years which makes the findings more relevant to current times. The rest of the studies included however, were published in much later years and thus may present evidence that is outdated. A need for newer observational studies is necessary to update the existing literature.

5.4 **PARTICIPANTS' PERCEPTIONS OF THE ENABLERS FOR THE USE OF NPPV IN THEIR MANAGEMENT OF PATIENTS POST CABG SURGERY**

After exploring the barriers reported by participants in this study, it is only fitting to delve into the enablers that were also reported on regarding the use of NPPV techniques for patients after CABG surgery.

Although some participants stated the lack of support from multidisciplinary team members in the ICU on use of NPPV techniques as a barrier, others found a great deal of support from ICU staff members to using this treatment technique. It is widely documented that ICUs worldwide, including South Africa, require a multidisciplinary approach to treatment with physiotherapists forming an integral part of the team (Hanekom et al., 2015). Specific to use of NPPV techniques, this statement is supported by Australian physiotherapists and nurses who report a collaborative approach between staff members allows for more efficient administration of this ventilation therapy (Lockstone et al., 2020). A collaborative approach between ICU staff members allows physiotherapists to share the workload with the nurses which unburdens the nurse and subsequently lessens the amount of time spent using NPPV techniques per patient, especially on weekends when the number of physiotherapists working were scarce (Lockstone et al., 2020). Therefore, the results of this study are promising regarding support from other members of the ICU team in delivering NPPV therapy to patients after CABG surgery in South Africa.

Participants who felt that support from the ICU staff was an important enabler to NPPV use mainly made use of the IPPB machine, and further reported that the nursing staff played an

important role in ensuring the equipment needed was ready at the patients' bedside, whilst also assisting to direct treatment when the physiotherapist was not present. The IPPB machine is documented to be easy to use and is generally administered by a physiotherapist skilled in the use thereof. Thus, the skills and expertise of the professional handling this treatment technique can assist in ensuring the comfort and safety of patients when using NPPV therapies (Müller et al., 2006). However, nurses in the cardiothoracic ICU are often experienced and well-versed in care for patients with a high severity of illness and can thus learn to administer NPPV techniques. It is well-known that nurses in the ICU spend a great deal of time at the patient's bedside and are thus able to monitor the NPPV device in use and the patient's response to it (Sørensen et al., 2013). Nurses are, as a result, able to problem-solve and address any clinical and technical issues relating to the NPPV device with the more exposure and experience they have whilst using this treatment technique (Sørensen et al., 2013). It was therefore clear that participants of this study valued a team effort from all members of the multidisciplinary team in the ICU when making use of NPPV techniques.

The actual administration of NPPV was only reported by a few participants in the present study to be prescribed according to appropriate clinical reasoning. As previously discussed, most participants in the current study felt that the prescription of NPPV therapy in their respective facilities was not always evidence-based. The few participants who supported use of NPPV therapy based on the available literature made use of the IPPB machine. Intermittent positive pressure breathing is documented to improve expansion of the lungs and thus assist in counteracting hypoxaemia after cardiac surgery (Romanini et al., 2007). It is further justified to use IPPB in the first few postoperative days after cardiac surgery due to its effects on increasing patients' inspiratory volumes with a subsequent reduction in the respiratory effort needed (Romanini et al., 2007). However, the evidence regarding the effect of IPPB on gaseous exchange in patients without severe hypoxaemia remains conflicted (Fiore et al., 2010). Additionally, IPPB was often preferred by participants in the present study where conventional breathing exercises were perceived to be more difficult for patients to execute post CABG surgery and subsequently less effective. However, there is limited evidence to support this notion (Fiore et al., 2010).

Only a few participants saw patients pre-operatively in order to provide education on the CABG procedure as well as on the treatment techniques used post-operatively. Participants deemed this to be a useful way of preventing anxiety as well as managing expectations of physiotherapy treatment and pain in patients after CABG surgery. This is supported by patients' perceptions on the use of NPPV in France and Belgium, stating that they experienced anxiety associated with use of NPPV techniques in the ICU (Schmidt et al., 2016). As a result, patients preferred clear explanations from healthcare providers prior to

commencement of treatment in order to manage their expectations and fear associated with this ventilation therapy (Schmidt et al., 2016).

Lastly, and perhaps a surprising finding from the current study, was that only three participants reported having access to all the resources needed relating to use of NPPV techniques in the private sector of South African cardiothoracic ICUs. However, the participants were all from Gauteng and thus may not be a true reflection of access to resources needed for NPPV techniques in all private ICUs throughout South Africa. These findings are however, similar to reports in developing countries in the Asia-Pacific region where NPPV resources are reported to be easily accessible and a relatively cost-effective treatment modality (Guan et al., 2019). However, there are no reports on access to resources related to NPPV techniques in the South African setting. Thus, further research into this is warranted.

5.4.1 Level of Evidence Obtained

This section included evidence from two prospective randomised trials. Whilst these studies are a level two quality of evidence, they were both conducted more than fifteen years ago. Newer trials with equipment that is currently available is necessary to determine more concrete findings regarding use of NPPV therapy. This continues to highlight the lack of more recent publications on this topic. The other studies included were narrative reviews, cross-sectional observational and qualitative descriptive studies. These studies fall into the lower end of the quality of evidence hierarchy as there is the potential for bias with the results reported. This highlights the lack of high-quality clinical trials, systematic reviews and meta-analyses published on the enablers to use of NPPV, specific to physiotherapists. Furthermore, all the studies included were set in Europe and Australia. Since these are first-world countries with varying practices and access to resources, the results do not necessarily represent the enablers and perceptions of physiotherapists in South Africa.

CHAPTER 6

6. CONCLUSION, RECOMMENDATIONS, STRENGTHS AND LIMITATIONS

6.1 CONCLUSION

There is a limited body of evidence regarding use of NPPV therapy for patients after CABG surgery. Most of the studies reporting on NPPV use for this patient population are outdated. The strongest body of evidence is related to early mobilisation and walking programs as treatment for patients after CABG surgery. This could explain the general consensus of participants in the present study who all adopted early mobility practices in the early phases of patient recovery after CABG surgery. All participants were involved throughout patients' recovery process in the hospital and were the drivers for rehabilitation as soon as patients were admitted to the ICU. However, there were varied approaches reported, in terms of physiotherapy treatment involving NPPV techniques, used for patients following CABG surgery.

The use of NPPV techniques by participants included CPAP, BiPAP, HFNO, and IPPB, with no report of one technique being superior to another. The participants who made use of NPPV techniques were from the private healthcare sector. Only two participants were from the public sector and made use of DBE's instead of NPPV therapy as a treatment for patients after CABG surgery. The use of NPPV techniques was mostly administered and prescribed by the treating physician or cardiothoracic surgeon of the facility. Despite this, a major enabler for some participants to use of NPPV techniques, was the multidisciplinary approach adopted by some facilities which allowed for a more efficient application of this therapy for patients. Thus, the administration of the technique was not deemed problematic. Furthermore, the nursing staff also played an integral role in ensuring patient compliance as well as in assisting physiotherapists in using NPPV therapy.

In contrast, some participants did not have support from other members of the multidisciplinary team when using NPPV therapy, which was found to be a major barrier for most participants to using NPPV techniques as part of their patient management. Additionally, the skills of staff members involved in using NPPV techniques was sometimes lacking. This was perceived to add to poorer patient outcomes and subsequent discomfort whilst using the NPPV interfaces. This further translated to the lack of training received in physiotherapy undergraduate studies on the use of NPPV techniques, which was also perceived as a barrier by some participants.

Lastly, resources relating to NPPV techniques was mainly seen as a barrier for participants in the present study. The lack of equipment and staff needed when using NPPV techniques

was a barrier that was frequently reported by participants. Furthermore, the costs involved for the hospital and the patients were perceived to be more when NPPV techniques were used. Conversely, only a few participants felt that resources were not a hindrance to utilising this treatment technique.

Findings of this study suggest that use of NPPV management for patients after CABG surgery is more common in the private sector than the public sector of South Africa. There were more reported barriers to use of the technique as opposed to enablers. Physiotherapists in general form an integral part of recovery of patients after CABG surgery, and those that make use of NPPV techniques, find this to be a useful addition to the conventional physiotherapy treatment techniques used to treat this patient population.

6.2 CLINICAL/PRACTICAL RECOMMENDATIONS

Although post-operative pulmonary complications have been widely reported and explored in patients after cardiac surgery, there has been no standard of care developed in order for physiotherapists to manage them in this patient population, particularly in South Africa. This could explain the varied approaches adopted by physiotherapists to treat patients after CABG surgery, with the addition of NPPV techniques. This highlights the need for a clinical guideline to better guide physiotherapists in treating this patient population. Use of a clinical guideline encourages physiotherapists to use evidence-based practice whilst facilitating clinical reasoning. This can further extend to improving patient outcomes and the incidence of post-operative pulmonary complications after CABG surgery.

6.3 RECOMMENDATION FOR FUTURE RESEARCH

The evidence regarding efficacy of NPPV on patient outcomes after CABG surgery still remains conflicted. Furthermore, most studies have been conducted overseas with no studies from South Africa to test this. Therefore, more observational studies and randomised controlled trials in the South African setting examining use of NPPV to treat patients after CABG surgery would be beneficial to better understand the efficacy and influencing factors of this treatment technique in this country. Furthermore, it is important to differentiate high versus low risk patients, as well as their different responses to NPPV therapy. The progression of evidence regarding this treatment modality is also important to acknowledge in order to make sure the most current and evidence-based techniques are being used. There is also a need to investigate South African physiotherapists' knowledge and understanding of the clinical indications for use of NPPV techniques to ensure proper administration of the technique. This extends to the undergraduate and post-graduate training programs of physiotherapists in South Africa. Research into the different programs throughout all provinces in South Africa can provide more insight into potential gaps in the training and

knowledge of qualified physiotherapists, specifically regarding that of NPPV therapy, that need improvement. Lastly, since cost factors are important to consider in a developing country that is South Africa, research into the funding required for NPPV techniques may also be worth exploring to ensure it is a feasible treatment choice for patient management.

6.4 **STRENGTHS AND LIMITATIONS**

A major limitation was the lack of responses of participants from other provinces in South Africa. As a result, the study findings cannot be generalised to physiotherapy practices in cardiothoracic ICUs throughout South Africa. In addition, the small sample size due to the design of the current study also limits the conclusions drawn. Whilst the calculation from Guest et al. (2020) indicated data saturation was met, having included additional participants from more provinces, could have resulted in different findings from the study. Lastly, most participants included in the study were from the private sector of the healthcare system. This limits the conclusions one can draw from the results of this study as the public and private sectors of the healthcare system in South Africa are vastly different from one another. As such, this also impacts the generalisability of the results of the present study. Thus, it may be more beneficial to conduct an observational study with use of surveys in order to reach a larger number of physiotherapists throughout all provinces in South Africa. This will enable better generalisability of the study results due to the variety of participants included and the health care sectors in which they work.

In contrast, a key strength of this study is that no such study has been conducted in South Africa to date. Furthermore, use of a descriptive qualitative study design allowed for rich descriptions from participants to provide a more detailed understanding of their involvement in NPPV use. Lastly, the study findings indicate some misconceptions regarding the indications for use of NPPV techniques. This highlights the need for more training among physiotherapists who work with patients after CABG surgery to improve their competence. This can be done through practical workshops incorporated into the lecture timetable where students can engage with the different NPPV devices to improve their understanding and skills of each device. It would be worthwhile and more practical to have workshops in the ICU where students can observe real-life examples of using the devices for patients by physiotherapists that are skilled in operating various NPPV devices. Observational studies in the South African setting are needed to explore specific treatment guidelines in place in clinical settings that use NPPV techniques for this patient population. These clinical guidelines may be adopted by other cardiac surgery facilities to empower their staff in safe use of NPPV therapy as part of patient care.

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APPENDIX A

■ COMMUNICATION TO PUBLIC FACILITY PHYSIOTHERAPY DEPARTMENT HEADS

● Msc Physiotherapy Research Report 2

Yahoo/Sent ☆



Komal Soni <komalsoni96@yahoo.com>

To: Mthetheli.Ndlangisa@kznhealth.gov.za, samke.mncube@kznhealth.gov.za, Christelle.vanderwalt@lalch.co.za, zama.msibi@kznhealth.gov.za, Menitha.Samjowan@kznhealth.gov.za, tiny.khanyile@kznhealth.gov.za, Alaric.Jacobs@westerncape.gov.za, laticia.plenaar@westerncape.gov.za, Gladys.bogoshi@gauteng.gov.za, thabile.ndlovu@gauteng.gov.za, aubrey.mudau@up.ac.za, ChristidaM@mpuhealth.gov.za, ZaleM@mpuhealth.gov.za, physiotherapy@ncpg.gov.za, mpanzas@fshealth.gov.za, dreyers@fs.universitas.gov.za, tobyn.may@impilo.ecprov.gov.za Hide
Cc: Helena Van Aswegen



Tue, Jan 24 at 9:49 AM ☆

Good day

My name is Komal Soni. I am currently completing my final year Msc Physiotherapy in cardiology, respirology and cardio-thoracic surgery at the University of the Witwatersrand, Faculty of Health Sciences.

My research project will be exploring South African physiotherapists' perceptions of and involvement with the use of non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery. The physiotherapy department of your facility is the only sector that I will need to contact with regards to involvement in my study.

To explore this topic, I would like to conduct an online interview with the most senior physiotherapist (2 or more years of experience, excluding community service year) in your department who is involved in treating such patients. I would thus like to request your permission to include your physiotherapy department in this project. Furthermore, I would need your assistance to identify the relevant person in your department with whom the interview should be conducted and to give me permission to contact that person to find out if they are willing to participate in this research project.

I have attached an information sheet explaining the research in more detail. If you agree to allow me to conduct my research with the relevant people from your staff, please sign the consent form (in your capacity as HOD) to indicate consent for your department to be included in the sample for the project. I will obtain consent from the participating staff member before I arrange a time for the online interview with them.

Looking forward to hearing from you.

Kind regards
Komal Soni
Bsc Physiotherapy (UCT)

[Download all attachments as a zip file](#)



14.5 KB



14.9 KB



From: komalsoni96@yahoo.com

To: Rozaun.Botes@westerncape.gov.za

Cc: Helena Van Aswegen

Good day

My name is Komal Soni. I am currently completing my final year Msc Physiotherapy in cardiology, respirology and cardio-thoracic surgery at the University of the Witwatersrand, Faculty of Health Sciences.

My research project will be exploring South African physiotherapists' perceptions of and involvement with the use of non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery. The physiotherapy department of your facility is the only sector that I will need to contact with regards to involvement in my study.

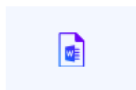
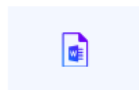
To explore this topic, I would like to conduct an online interview with the most senior physiotherapist (2 or more years of experience, excluding community service year) in your department who is involved in treating such patients. I would thus like to request your permission to include your physiotherapy department in this project. Furthermore, I would need your assistance to identify the relevant person in your department with whom the interview should be conducted and to give me permission to contact that person to find out if they are willing to participate in this research project.

I have attached an information sheet explaining the research in more detail. If you agree to allow me to conduct my research with the relevant people from your staff, please sign the consent form (in your capacity as HOD) to indicate consent for your department to be included in the sample for the project. I will obtain consent from the participating staff member before I arrange a time for the online interview with them.

Looking forward to hearing from you.

Kind regards
Komal Soni
Bsc Physiotherapy (UCT)

[Download all attachments as a zip file](#)





● **Ncebakazi Gixela**

From: ncebagixela22@gmail.com

To: komalsoni96@yahoo.com



Fri, Feb 3, 2023 at 12:05 PM ☆

Dear Ms Soni

Kindly, receive the attached research approval letter. Kindly note the conditions stipulated in the approval letter and comply with them.

Kind Regards

Y.N. Gixela

Secretariat of the Eastern Cape Provincial Health Research Committee

Manager: Epidemiology and Health Research Directorate



Research ap....PDF

24.2kB



● **Dr. Jerry Sigudla**

From: jerrys@mpuhealth.gov.za

To: komalsoni96@yahoo.com



Wed, Feb 1, 2023 at 12:38 PM ★

Dear Soni

Your request is being considered. Kindly complete the letter of support and request the CEOs of both Hospitals to sign the attached document for you. Once signed, upload on the website.

Regards,

Dr Sigudla

[Download all attachments as a zip file](#)



Letter of Su... .pdf

2.2MB



Mpumalang... .pdf

582.3kB

APPENDIX B

▪ INFORMATION SHEET

INFORMATION SHEET

Study title: South African physiotherapists' perceptions of and involvement with non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery

Dear physiotherapist

My name is Komal Soni and I will be exploring South African physiotherapists' views and use of non-invasive positive pressure ventilation (NPPV) techniques as treatment for patients after coronary artery bypass surgery (CABG). For this study, the focus is specifically on the use of NPPV techniques. Although there is conflicting evidence in the literature regarding the benefits of NPPV for patients after CABG surgery- it is still used as a treatment technique by physiotherapists. Thus, this study will provide more insight into physiotherapists' perceptions regarding their treatment approaches, more specifically related to the use of NPPV, in treating patients after CABG surgery. Exploration of this topic may lead to further discussions on which elements to include in the development of local clinical practice guidelines regarding the management of patients after CABG surgery. This will provide a foundation for future research on the effectiveness of NPPV to reduce the incidence of postoperative complications in patients following CABG surgery.

I would greatly appreciate your participation in my study. It will take place over the period of December 2022 to July 2023.

Who is eligible to participate in this study?

Male and female qualified physiotherapists in all provinces across South Africa involved in the management of patients following CABG surgery in ICU's. All physiotherapists included must have 2 or more years of experience in working with patients after CABG surgery excluding their community service year.

What does the study entail?

The study will involve an online interview in English with participants via Zoom/Microsoft Teams. Each interview will be 20-30min long and will be audio and video recorded for data collection purposes. All the questions will relate to the aim of this study.

How will confidentiality of the participants be kept?

The recordings of each interview will be transcribed without the use of any of the participants' identifying features respectively. All the participants' anonymity will be maintained when reporting the results in the research report. All the recordings and transcripts will be kept on a password protected laptop. Only myself and my supervisor will have access to these folders. All information will be deleted after a period of 2 years should the results be published otherwise after 6 years if the results are unpublished on completion of the study.

Are participants able to withdraw from the study?

All participants are able to withdraw from the study at any point. There will be no consequences should this occur, and the participants' information will not be used in the data collection and subsequently the final research report.

Should you require any further information please contact me on 082 312 5570 or on komalsoni96@yahoo.com

For more information on, or to report any ethical concerns, you may contact the chair of the Human Research Ethics Committee of the University of the Witwatersrand

Clement Penny: 011 488 3820

HREC secretariat: Zanele Ndlovu: 011 717 2700 or zanele.ndlovu@wits.ac.za

Kind regards

Komal Soni

Department of Physiotherapy

University of Witwatersrand

APPENDIX C1

▪ CONSENT FORMS

INFORMED CONSENT FORM: Participation of Participant in Interview

Study title: South African physiotherapists' perceptions of and involvement with non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery

I.....voluntarily agree to participate in this research study. (email address:.....)

- I understand that participation involves: an online interview where I will be answering questions related to my work with CABG patients in the ICU.
- I understand that although I may agree to participate currently, I can withdraw at any time or refuse to answer any question without any consequences of any kind; in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- I understand that I will not directly benefit from my participation in this interview.
- I understand that all information I provide during the interview for this study will be confidential.
- I understand that in any report of the data retrieved from the interviews, my anonymity will be upheld. This will be ensured through changing my name and disguising any details revealed during my interview that may reveal my identity or the identity of people I speak about.
- I understand that disguised extracts from my interview may be quoted in the research report.
- I understand that I can contact the researcher and those involved in the report at any point for more information or clarification.

Signature of participant _____ Date _____

Signature of researcher _____

APPENDIX C2

▪ CONSENT FORMS

INFORMED CONSENT FORM: Audio and Visual Recording of Interview

I..... (full name of participant) agree to my interview being audio and video recorded.

- I understand that a transcript of my interview where any information that can identify me will be disguised or removed. The information will be retained for 2 years if the results are published or 6 years if the results are unpublished on completion of the study.
- I understand that I may access the information I have provided during the interviews at any time while it is in storage during the time period specified above.

Signature of participant _____ Date _____

Signature of researcher _____

APPENDIX D

▪ COMMUNICATION TO SECRETARY OF SOUTH AFRICAN SOCIETY OF PHYSIOTHERAPY

From: Komal Soni <komalsoni96@yahoo.com>
Sent: Tuesday, 24 January 2023 10:41 AM
To: SASP Reception <info@saphysio.co.za>
Subject: Msc research project

Good day

My name is Komal Soni. I am currently completing my final year Msc Physiotherapy in cardiology, respiratory and cardio-thoracic surgery at the University of the Witwatersrand, Faculty of Health Sciences.

My research project will be exploring South African physiotherapists' perceptions of and involvement with the use of non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery. The physiotherapy department of facilities involved in the management of this patient population is the only sector that I will need to contact with regards to involvement in my study.

To explore this topic, I would like to conduct an online interview with the most senior physiotherapist (2 or more years of experience, excluding community service year) working in a private hospital, who is involved in treating such patients. I would thus like to request your permission to include the relevant members from the cardio-pulmonary physiotherapy group in this project. Furthermore, I would need your assistance to identify the relevant people in the cardio-pulmonary group with whom the interview should be conducted, and to then give me permission to contact those that qualify for my study criteria to find out if they are willing to participate in this research project. I will thus require your assistance as head of the cardio-pulmonary rehabilitation group to identify which physiotherapists from the group would be relevant to my study.

I have attached an information sheet with more detail regarding my study as well as a consent form which I will need you to sign as head of the cardio-pulmonary rehabilitation group, giving permission for me to contact the relevant physiotherapists to participate in the study.

Looking forward to hearing from you.

Kind regards

Komal Soni

Good day Ms Mofolo

I just wanted to follow up regards to my email with the required documents below- I my request underconsideration or is there anything else you require?

Looking forward to hearing from you.

Kind regards

Komal

▼ Hide original message

On Tuesday, January 24, 2023 at 04:04:43 PM GMT+2, Komal Soni <komalsoni96@yahoo.com> wrote:

Dear Ms Mofolo

Please find attached my ethics approval as well as departmental approval for my study.

Kind regards

Komal

On Tuesday, January 24, 2023 at 01:49:10 PM GMT+2, SASP Reception <info@saphysio.co.za> wrote:

Good day Komal,

Thank you for your email.

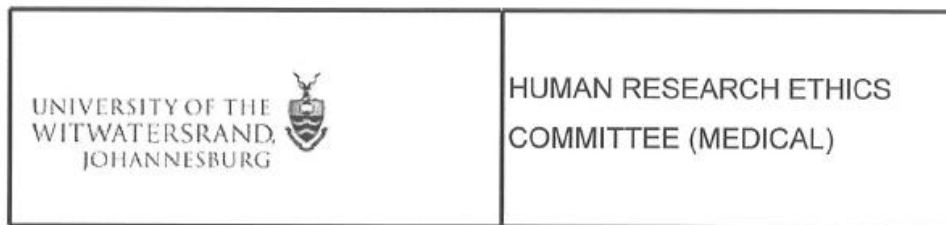
For any research to be done on our platforms we require an Ethics Clearance Certificate.

Once that has been received, we send it for approval then distribute to members as per request.

Regards,

APPENDIX E

▪ ETHICAL CLEARANCE FROM HUMAN RESEARCH ETHICS COMMITTEE



Office of the Deputy Vice-Chancellor (Research and Innovation)

TO: Ms K Soni
School of Therapeutic Sciences
Department of Physiotherapy
Medical School
University

E-mail: komalsoni96@yahoo.com

CC: Supervisor: Professor H van Aswegen
<Helena.vanAswegen@wits.ac.za>
and <HREC-Medical Research Office@wits.ac.za>

FROM: Mr Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2022/11/22

REF: R14/49

PROTOCOL NO: **M220932** (This is your ethics application reference number. Please quote it in all enquiries, oral or written, relating to this study.)

PROJECT TITLE: *South African physiotherapists' perceptions of and involvement with non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to Government funding of the University.



MSWorks2000/Iain0007/Clearscan.wps



R49 Ms K Soni

**HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M220932**

NAME:
(Principal Investigator)

Ms K Soni

DEPARTMENT:

School of Therapeutic Sciences
Department of Physiotherapy
Medical School
University

PROJECT TITLE:

South African physiotherapists' perceptions of and involvement with non-invasive positive pressure ventilation therapy in the management of patients following coronary artery bypass graft surgery

DATE CONSIDERED:

2022/09/30

DECISION:

Approved unconditionally

CONDITIONS:

NOTE:

If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>

SUPERVISOR:

Professor H van Aswegen

APPROVED BY:


Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL:

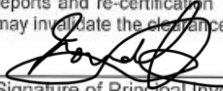
2022/11/22

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report.** When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **September** and therefore reports and re-certification will be due in the month of **September** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).


Signature of Principal Investigator

22/11/2022
Date

APPENDIX F

▪ TRREE CERTIFICATE

	Zertifikat Certificat	Certificado Certificate
Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale Promoting the highest ethical standards in the protection of biomedical research participants		
Certificat de formation - Training Certificate		
Ce document atteste que - this document certifies that		
	Komal Soni	
a complété avec succès - has successfully completed		
Archived - Module 1 - Introduction to Research Ethics		
du programme de formation TRREE en évaluation éthique de la recherche of the TRREE training programme in research ethics evaluation		
Release Date: 2022/08/01 CID : lzt2Yo8b4		 Professeur Dominique Sprumont Coordinateur TRREE Coordinator
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[REV : 20220217]

APPENDIX G

▪ INTERVIEW SCHEDULE

- Introduction: the researcher will introduce herself to the participant and give the participant the opportunity to introduce themselves.
- The purpose of the study and the interview will be explained to the participant
- Participants will be given the opportunity to ask questions about any information regarding the study and interview that they do not understand or require more clarity on.
- Once the participant is content with the information provided and is happy for the interview to commence, the interview questions (see Appendix H) will then be asked by the researcher.
- Once all the interview questions have been answered, the participant will be given the opportunity to add any additional remarks involving the use of non-invasive positive pressure ventilation to treat patients post CABG surgery.
- Once the participant has concluded with additional comments, the researcher will provide a summary of the interview for the participant to comment on the accuracy of the researcher's account of their interview.
- Conclusion: once all concluding remarks are accounted for from the participant and researcher, the researcher will thank the participant and end the interview

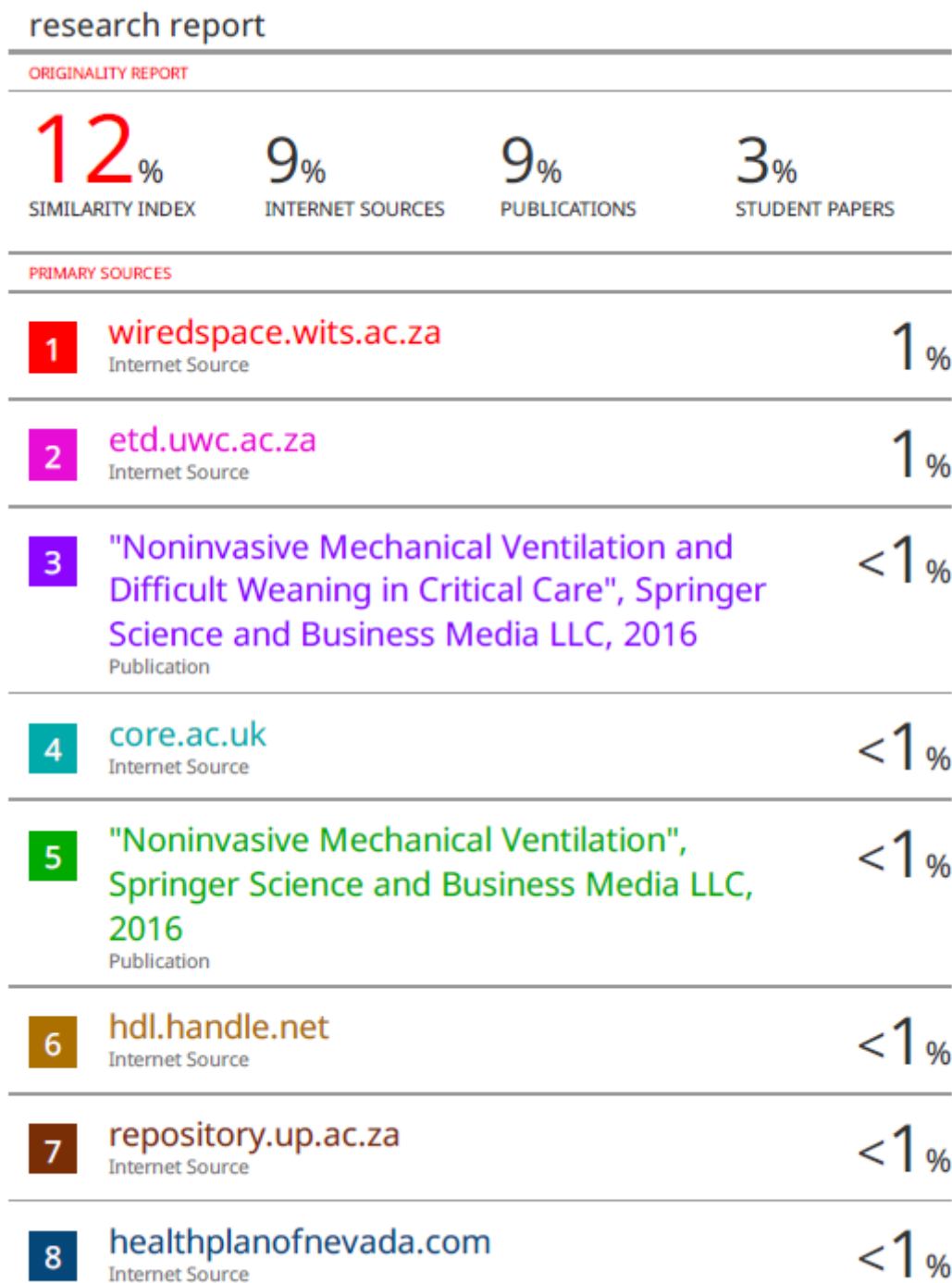
APPENDIX H

▪ SCREENING AND INTERVIEW QUESTIONS

Screening questions for participants	Answers	
In the period of working after completing your community service, how long have you worked in a cardiac ICU setting? (2 or more years?)		
Are you currently working in a government or private facility?		
How often do you treat patients following coronary artery bypass (CABG) surgery at your facility?		
How involved are you in their post-operative treatment?		
Does your facility/department have a protocol in place to treat patients after CABG surgery? If yes: can you provide a brief description of the protocol? If no: could you briefly describe your treatment approach to this patient population?		
Do you know what non-invasive positive pressure ventilation (or NPPV) is?	Yes	No
If yes: can you briefly describe your knowledge regarding the mechanism of this type of ventilation? (if participant answers no, briefly describe NPPV)		
Have you or do you currently make use of any NPPV device to treat patients as they recover from CABG surgery?	Yes	No
If so, what is the device?		
What are the barriers within your working environment to the use of NPPV techniques? (prompt if necessary: it can relate to space, staff members, qualifications etc.)		
What do you think are the barriers, in general, to the use of this treatment modality on patients after CABG surgery?		
What are the enablers within your working environment to the use of NPPV techniques? (prompt if necessary: it can relate to space, staff members, qualifications etc.)		
What do you think are the enablers, in general, to the use of this treatment modality on patients after CABG surgery?		

APPENDIX I

▪ TURN-IT-IN REPORT



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