Anaesthetists' Knowledge of Neonatal Resuscitation

Hatem Jahrani

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

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Declaration

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

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Abstract

Background

Knowledge of basic resuscitation of neonates is vital. Factors such as delays in decision making and inaccuracies in estimation of drug dosage during resuscitation may result in poor patient outcome. The aim of this study is to describe the knowledge of anaesthetists in the Department of Anaesthesiology at the University of the Witwatersrand regarding the 2015 Neonatal Resuscitation Guidelines.

Methods

A prospective, contextual, descriptive study design was used. Data were collected using convenient sampling and a self-administered questionnaire.

Results

The 169 anaesthetists that took part in the study represented 81.3% of the department. The mean (SD) score obtained was 43.4% (14.2%), no anaesthetist achieved ≥80% (adequate knowledge). There was no significant difference between anaesthetists who have attended a neonatal resuscitation course to those who have not (p=0.272). There was no significant difference in the level of knowledge between medical officers, registrars and consultants (p=0.636). Of the anaesthetists, 72.2% perceived their competence with neonatal resuscitation as average.

Conclusion

Knowledge of neonatal resuscitation in this study was inadequate. The majority of anaesthetists perceived their competence with neonatal resuscitation as average. Neither previous resuscitation training nor professional designation influenced knowledge.

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Abbreviations

AHA	American Heart Association
ALS	Advanced Life Support
BLS	Basic Life Support
CPAP	Continuous Positive Airway Pressure
CPR	Cardiopulmonary Resuscitation
ERC	European Resuscitation Council
ILCOR	International Liaison Committee on Resuscitation
PEEP	Positive End-Expiratory Pressure
Wits	University of the Witwatersrand

Statement

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

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the rest of the Research Report in order to comply with the author guidelines of the South African Journal of Anaesthesia and Analgesia, the journal to which it is intended to be submitted.

Section 1: Review of the literature

1.1 Introduction

Cardiopulmonary resuscitation (CPR) “is an emergency procedure that combines chest compressions often with artificial ventilation in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person who is in cardiac arrest. It is recommended in those who are unresponsive with no breathing or abnormal breathing, for example, agonal respirations”(1).

In 1960, CPR as it is known today, was developed (2). During the first conference on CPR in 1966, the need for training of medical and other health care workers in external chest compression was recognised. The basic CPR, also known as the Basic Life Support course, was then created. This was then followed by the Advanced Life Support course, which requires medically trained personnel and invasive procedures such as intubation, drugs, and defibrillation (3).

Vali et al (4) highlight that the Working Group on Paediatric Resuscitation suggested that the focus of resuscitation in the neonate should be on the ventilation of the lung rather than on restoring of cardiac activity as in adult patients (4). In 1985 the American Academy of Paediatrics and American Heart Association (AHA) recognised the need for the development of a neonatal resuscitation training program. The first neonatal resuscitation algorithm was published in 1987 (4).

This chapter will discuss the incidence of CPR in neonates, followed by causes of perinatal deaths and the importance of effective neonatal CPR. Thereafter, the neonatal CPR guidelines will be explored. Finally, the knowledge of health care workers regarding neonatal resuscitation will be discussed.

1.2 Incidence of CPR in neonates

It is predicted that delivery room resuscitation is required in 4 –7 million neonates every year, “making this one of the most commonly practiced and important global medical intervention” (5). At least 10% of neonates need some support to start

respiration (6), such as tactile stimulation or airway clearing (7). Comprehensive resuscitation measures, such as cardiac compressions and medications, are needed in less than 1% of neonates (6).

1.3 Neonatal deaths

The majority of neonatal deaths are perinatal (8). Perinatal deaths are either stillbirths or early neonatal deaths if the neonate dies in the first week after birth (9). In South Africa, the Birth and Deaths Registration Act (Act No. 51 of 1992) (10) states that “A stillborn in relation to a child, means that it has at least 26 weeks of intra-uterine existence but showed no sign of life after complete birth”.

1.3.1 Incidence of neonatal deaths

Approximately 130 million babies are born annually, of which four million die in the neonatal period (11). The World Health Organization documented that two-thirds of neonatal deaths occur in the African and Southeast Asia regions (11). In South Africa, neonatal deaths have increased from 30% in the early 2000s to 40% of the under-five mortality rate in 2013 (12).

Wall (7) in 2010 concluded that 99% of intrapartum related deaths occurred in low and middle income countries, and that annually 60 million births did not occur in health facilities with a skilled birth attendant (7). The World Health Organization in 2006, estimated the number of perinatal deaths worldwide at around 6,3 million. Stillbirths constitute 3,3 million of these deaths with three million being early neonatal deaths (9).

In South Africa, based on data from the South African Civil Registration System for the years 2011 –2013, the number of perinatal deaths increased significantly from 13 020 in 1997 to a high of 25 287 in 2009, of which stillbirths were higher than early neonatal deaths (9). In March 2018, Statistics South Africa used death notification forms from the Department of Home Affairs and determined that the total number of perinatal deaths in 2016 was 18 683. This showed a marked decrease of 12,6% from the 2015 perinatal deaths of 21 378 (9).

In general, perinatal deaths are considered a good indicator of the quality of prenatal, neonatal and maternal care, which means that the reduction of perinatal deaths is an important step to reduce child and infant mortality as well as improving the health status of pregnant women (9)

1.3.2 Causes of neonatal deaths

There are many causes of neonatal deaths and these commonly include; respiratory disorders, cardiovascular disorders, disorders related to gestational age, disorders related foetal growth, congenital malformations, chromosomal abnormalities, infections specific to the perinatal period, conditions related to temperature regulation of the foetus and metabolic and haematological disorders specific to the neonate (9).

Common risk factors for perinatal death are summarised in Table 1.

Table 1.1 Common risk factors for perinatal death (7).

Antepartum risk factors	Primiparity Febrile illness Pregnancy induced hypertension Severe preeclampsia/eclampsia Antepartum haemorrhage Anaemia
Intra-partum risk factors	Mal presentation Prolonged labour Maternal fever Meconium stained amniotic fluid Premature rupture of membranes Oxytocin augmentation of labour Umbilical cord prolapse
Infant risk factors	Prematurity Gestation > 41 completed weeks Multiple gestation Polyhydramnios Oligohydramnios Intrauterine infection Low birth weight Intrauterine growth restriction

1.4 The importance of effective neonatal CPR

Hazinski et al (3) highlight that CPR alone is not sufficient to restart the heart beating, but its benefit is to restore blood flow to the brain and the heart. The main advantage of CPR, when there is no neurological deficit, is to delay tissue death until successful resuscitation. Defibrillation is sometimes needed to restore cardiac rhythm; however, it is only effective in specific cardiac conditions namely ventricular fibrillation or pulseless ventricular tachycardia. CPR should continue until the patient has a return of spontaneous circulation or is confirmed dead (3).

“The birth of the baby represents one of the most dramatic physiological transitions in human life. Although this transition most often proceeds naturally and smoothly, the day of birth also carries a high risk of death when the transition is disrupted” (13). A challenge for healthcare workers is the difficulty in predicting which labours will produce a baby requiring intervention (14). It is therefore essential that healthcare workers, including anaesthetists, have up to date knowledge of neonatal resuscitation.

Shikuku et al (15) noted that worldwide, almost three-quarters of all neonatal deaths occur during the first week of life, with a million babies dying on the day they are born. Furthermore, the authors are of the opinion that resuscitation may prevent 5 –10% of deaths secondary to complications of preterm birth.

CPR improves survival and long-term outcomes, especially for those neonates who are exposed to intrapartum hypoxia and show signs of neonatal encephalopathy. Neonates experiencing episodes of hypoxia may have recurrent apnoeic attacks which require short or long periods of assisted ventilation or continuous positive airway pressure (CPAP) ventilation (7).

In neonatal emergencies, it is vital to initiate resuscitation of neonates without delay. Any delay in emergency care may result in hypoxic related injuries which may result in permanent disability in those surviving. There are many kinds of delays, such as delays related to the decision to ask for emergency care, delays in reaching the health facility and delays in providing emergency care. Delays related to the decision to ask for emergency care can be due to problems with diagnosis, cultural influences and prolonged decision making by family. Long distances and lack of transport can result in delays to reaching the health facility timeously. Shortage of appropriately trained staff and lack of equipment contribute to delays in providing emergency care (7).

International evidence shows that the risk of neonatal death increases by 16% for every 30 second delay in initiating ventilation up to six minutes, and 6% for every minute of delay of bag and mask ventilation (16). It has also been suggested that successful neonatal resuscitation by well-trained health care workers delivering appropriate and adequate resuscitation reduces neonatal mortality caused by

intrapartum related asphyxia in about two million neonates per annum (17). Ineffective resuscitation skills are linked to persistently high neonatal deaths from birth asphyxia (18).

Murila et al (19) concluded that “adequate knowledge and awareness about neonatal resuscitation play a major role in early diagnosis, appropriate management and reduction of adverse consequences”. Ibrahim (20) stated that the survival rate following CPR could be as high as 49 –75% if it is done effectively within 3 –5 minutes .

Niermeyer (13) is of the opinion that having knowledge improves skills. One of the factors that influence successful neonatal CPR is the knowledge of neonatal CPR guidelines.

1.5 Neonatal CPR guidelines

There are many neonatal resuscitation guidelines internationally, but this literature review will focus on the 2015 AHA Neonatal Resuscitation Guidelines (6) (hereafter referred to as AHA Guidelines) and the 2015 United Kingdom Neonatal Resuscitation Guidelines (21) (hereafter referred to as United Kingdom Guidelines). Both these guidelines are a summary of the evidence presented at the 2015 International Consensus on CPR and Emergency Cardiovascular Care Science with Treatment Recommendation (6) and they inform the 2015 South African Neonatal Resuscitation Guidelines (22) that form the basis of this study.

The guidelines (6, 21) were updated in 2015, and the changes from 2012 to 2015 guidelines will be briefly discussed. Although the guidelines pertain mainly to neonates transitioning from intrauterine to extrauterine life, they are also pertinent to neonates who require resuscitation during the first few weeks after birth (6).

1.5.1 Changes and additions made to the 2015 AHA Neonatal Resuscitation Guidelines

The following changes and additions were made in 2015 (6). The initial three assessment questions have changed to:

- What is the term gestation?

- Does the baby have good muscle tone?
- Is the baby breathing or crying?

In term and preterm infants who are stable and do not require resuscitation at birth cord clamping should be delayed for more than 30 seconds. The baby's temperature must be recorded as it is predictive of outcome. Furthermore, the baby's temperature must be maintained between 36.5 –37.5°C. Hypothermia must also be prevented with the use of various strategies such as radiant warmers, plastic wrapping, thermal mattresses and warmed humidified gases. If infants are born with poor muscle tone, inadequate breathing and meconium stained amniotic fluid, it is recommended that they be placed under a radiant warmer and given positive pressure ventilation if needed. Routine endotracheal intubation is not recommended due to insufficient evidence. Accurate assessment of heart rate in the first minute by auscultation or palpation is difficult, therefore, the use of 3-lead ECG is recommended. In preterm neonates with a gestational age of less than 35 weeks, who require resuscitation, it is recommended that ventilation be started with a low oxygen concentration of between 21% –30%. In case of failed mask ventilation or unsuccessful tracheal intubation, a laryngeal mask airway should be considered as an alternative, especially in neonates 34 weeks or more of gestation. In preterm infants with respiratory distress who are breathing spontaneously, the recommendation is to support their breathing with CPAP rather than routine intubation and positive pressure ventilation (6).

1.5.2 Changes and additions made to the 2015 United Kingdom Neonatal Resuscitation Guidelines

The following changes and additions were made to the United Kingdom Guidelines in 2015 (21). It is recommended, for uncomplicated term and preterm infants, that cord clamping should be delayed for at least one minute after delivery. However, for infants who are severely compromised at birth, the time for delaying cord clamping has not yet been recommended. The body temperature of the infant should be actively maintained between 36.5 – 37.5°C, unless therapeutic hypothermia is indicated. Additional interventions should be used to keep preterm infants, less than 32 weeks of gestation, at a body temperature between 36.5 – 37.5°C. These interventions include warm humidified respiratory gases, thermal

mattresses and increased room temperature, with the use of plastics or any other heat insulators to wrap the head and the body of the infant. An electrocardiogram, if available, should be used to accurately and continuously monitor the heart rate of the infant. For term infants, the resuscitation should start with room air, while for preterm infants a low oxygen concentration of 21% –30% is recommended and should be guided by the use of pulse oxymetry. Aspirating meconium from the nose or the mouth while the head is still on the perineum is not recommended. In spontaneously breathing preterm infants who have respiratory distress, the recommendation is to use nasal CPAP rather than intubation for initial respiratory support (21).

1.5.3 2015 South African Neonatal Resuscitation Guidelines

The 2015 South African Neonatal Resuscitation Guidelines (22) published by the Resuscitation Council of South Africa (Appendix 3). Neonatal resuscitation guidelines are usually condensed onto one page for practical purposes and consist of algorithmic sequential steps to guide resuscitators in clinical management and decision making.

The first 60 seconds, also known as the “Golden Minute” after neonatal birth, are vital to commence the initial assessment steps, re-evaluate the neonate and begin ventilation if required (22).

1.5.4 Sequence of actions of neonatal resuscitation guidelines

The sequence of actions in the neonatal resuscitation guidelines regarding keeping the neonate warm and assessment of the neonate, airway management, breathing, chest compression, the need for drugs, meconium aspiration, use of oxygen, delaying cord clamping, post resuscitation care and discontinuing resuscitation will be briefly discussed.

Keeping the neonate warm and assessment of the neonate

Neonates get cold very easily as they are born naked and wet (6). All term or near-term infants should be covered with dry towels (21). However, preterm infants should not be dried but rather placed into a polyethylene wrapping under a radiant warmer (21). Assessment of heart rate, breathing, colour and tone must be

performed as soon as possible after birth. Furthermore, reassessment of heart rate and breathing needs to be done every 30 seconds (21).

Airway management

The AHA Guidelines (6) state that the airway must be patent to allow the neonate to breath. The best method to accomplish this is to place the neonate on his or her back with the head in the neutral position. If the infant is placed on a flat surface on his or her back, this will tend to flex the neck because infants have a prominent occiput. Neck flexion can be avoided by providing support under the shoulders, while making sure the neck is not overextended. In floppy infants, a jaw thrust manoeuvre for further airway maintenance is beneficial (6).

Neonates born with obvious airway obstruction must immediately undergo airway suctioning. In a few cases, the oropharynx or trachea can be blocked by mucus, blood or meconium, which requires direct visualisation and suctioning. In the case of tracheal obstruction, intubation is needed and suctioning through the endotracheal tube might be beneficial (23).

Breathing

The United Kingdom Guidelines (21) state that after birth, most neonates have an adequate heart rate and breathing. “If the infant is not breathing adequately aerate the lungs by giving 5 inflation breaths, preferably using air. Until now the infant’s lungs will have been filled with fluid. Aeration of the lungs in these circumstances is likely to require sustained application of pressures of about 30 cm H_2O for 2 – 3 s; these are ‘inflation breaths’. Begin with lower pressures (20 – 25 cm H_2O)”. If the heart rate increases, this means that the lungs are successfully aerated. In contrast, if the heart rate does not increase after the inflation breaths, this can be due to either unsuccessfull aeration of the lungs or that the infant requires more than lung aeration. If lung aeration is not successful, consider rechecking the infant’s position, confirm the head is in the neutral position and that the face mask size is adequate to attain a good seal. Assess the need for a jaw thrust manoeuvre or longer inflation time or both. In the case of oropharyngeal obstruction use a laryngoscope and suctioning to view and remove the obstruction (21).

Chest compression

Infants will respond to successful lung inflation with an increase in heart rate within 30 seconds, followed by normal breathing, but in some cases chest compression is needed (6). The AHA Guidelines (6) suggest that chest compression is indicated if the infant's heart rate drops to less than 60 beats per minute, despite adequate ventilation. Compressions are delivered on the lower third of the sternum to a depth of approximately one-third of the anterior-posterior chest diameter. There are two techniques for chest compressions.

- The two finger technique, where compressions are done with two fingers of one hand and the second hand supports to the back, as shown in Figure 1.
- The two thumb technique, where compressions are done with two thumbs and the fingers surround the chest and support the back, as shown in Figure 1.

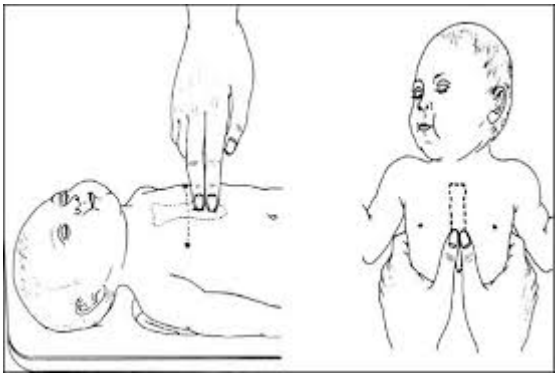

Figure 1.1 Chest compression techniques (24)

It is advised that chest compressions and ventilation are coordinated to avoid delivering both compressions and ventilation at the same time. The ratio of compression to ventilation for neonatal resuscitation is 3:1. If the arrest is believed to be due to cardiac causes a higher ratio, for example, 15:2 can be considered without using 100% oxygen during CPR (6).

The need for drugs

Drugs are rarely needed during the resuscitation of neonates (19). Bradycardia is usually secondary to hypoxaemia due to inadequate lung inflation. If the heart rate remains below 60 beats per minute, despite adequate ventilation with 100% oxygen and chest compression, then drugs such as adrenaline, a fluid bolus or both should be administered intravenously (6).

If adrenaline is indicated the suggested dose is 0.01 – 0.03 mg/kg of 1:10 000 adrenaline. A higher dose of 0.05 – 0.1 mg/kg may be indicated in the case of endotracheal administration prior to establishing intravenous access (6). Sodium bicarbonate is not usually recommended and should be used only after adequate ventilation and circulation has been established in the case of a prolonged arrest. The dose of sodium bicarbonate is between 1 – 2 mmol/kg which is 2 – 4 ml/kg of 4.2% bicarbonate solution (21). If there is no response to the resuscitation drugs given centrally, 10% glucose at a dose of 2.5 ml/kg must be given (21). It is advised to use isotonic crystalloid rather than albumin for emergency volume replacement. In the presence of hypovolemia, a rapid response is obtained by administering a bolus of 10 ml/kg over 10 – 20 seconds of 0.9% sodium chloride intravenously and the bolus can be safely repeated (21).

Meconium aspiration

Airway obstruction before or during birth, secondary to aspiration of meconium, will interfere with ventilation and is a major cause of death in the neonatal period (23). The initial step, as part of resuscitation, is to put the neonate under a radiant warmer and start positive pressure ventilation if no breathing or the heart rate is less than 100 beats per minute (6, 21). Tracheal intubation should not be routine and only performed if there is evidence of tracheal obstruction (21).

Neonates born with meconium stained amniotic fluid are at risk of developing meconium aspiration syndrome. Perlman et al (25), in a randomised control study among neonates born with meconium stained amniotic fluid, found that the use of tracheal suctioning does not reduce the development of this syndrome. The authors concluded that there was “no difference in outcome for those who received suctioning versus those who did not receive suctioning” (25).

Oxygen use

The AHA Guidelines suggest that for term neonates, ventilation support should start with room air. If there is no increase in heart rate or very poor oxygenation on room air ventilation, a higher oxygen concentration is required to maintain adequate oxygenation. However, it is important to keep in mind that the use of a higher oxygen concentration is associated with increased morbidity (such as retinopathy of prematurity, bronchopulmonary dysplasia) and mortality. Therefore, weaning of oxygen should be initiated as soon as oxygenation is achieved (6).

For preterm infants who are less than 35 weeks of gestation at birth, the recommendation is to use either room air or up to 30% oxygen which should be titrated to achieve an acceptable pre-ductal oxygen saturation (6). The normal pre-ductal saturation after birth is as follows:

- 1 minute: > 60%
- 2 minutes: > 65%
- 3 minutes: > 70%
- 4 minutes: > 75%
- 5 minutes: > 80%
- > 10 minutes: 90 – 95% (6).

A meta-analysis (26) of multiple randomised trials, which compared the initial resuscitation with a high oxygen concentration (65% or more) or low oxygen concentration (21% – 31%) for preterm infants less than 35 weeks of gestation at birth, showed no improvement in the survival rate with the use of higher concentrations of oxygen.

Delaying cord clamping

The AHA Guidelines (6) state that previously the common practice was to clamp the umbilical cord of all infants immediately after birth to transfer the infant for optimisation as soon possible. It is now suggested for term and preterm infants who are stable and do not require resuscitation, to delay cord clamping until after 30 seconds. Advantages include less association with intraventricular haemorrhage, higher blood volume and blood pressure and less necrotising

enterocolitis. The only side effect of delayed cord clamping is a minimal increase in the level of bilirubin, which may result in the need for phototherapy (6).

Post resuscitation care

Effective post resuscitation care improves survival outcomes for neonates who are exposed to intra-partum hypoxia and develop signs of neonatal encephalopathy (7). The first step in post resuscitation care is to transfer the neonate to the neonatal unit for 12 – 24 hours for monitoring and support such as ventilation and adequate oxygenation, prevention of hypothermia, maintenance of glucose and fluid status (7). Neonates who have experienced hypoxia may develop periods of apnoea and need mechanical ventilation or CPAP if available (7).

Hypoxia post resuscitation has serious adverse outcomes for the brain. Furthermore, hypoglycaemia post a hypoxic episode can exacerbate the brain injury, and therefore blood glucose level should be closely monitored and maintained within the normal range (7). Of neonates who developed encephalopathy secondary to hypoxia, 50% will develop episodes of seizures which will require administration of anticonvulsant medications (7).

Temperature control is crucial for neonates. Hypothermia should be avoided as it exacerbates the central nervous system injury and worsens apnoeic attacks. Induced hypothermia is useful in the management of neonatal encephalopathy secondary to hypoxia (6).

Discontinuing resuscitation

It is appropriate to consider discontinuing resuscitation for a neonate with an Apgar score of zero with no detected cardiac activity for 10 minutes (6, 21). The difficulty with decision making regarding discontinuing resuscitation confirms the need for the help of an expert as soon as possible. Furthermore, the decision to stop neonatal resuscitation when the heart rate has been less than 60 beats per minute for 10 – 15 minutes of continuous resuscitation is much less clear (21).

1.6 The knowledge of health care workers regarding neonatal resuscitation internationally

Several studies (27-32) in both developed and developing countries have evaluated the level of knowledge of health-care workers regarding the different aspects of neonatal resuscitation. Adequate knowledge (pass rate) was inconsistently defined in these studies making cross-study comparison difficult. However, all these studies reported relatively limited knowledge of neonatal resuscitation. No research specific to anaesthetists' knowledge of neonatal resuscitation was identified for this review.

Szarpak (31) conducted a study in Poland in 2013 among emergency medical personnel (physicians, nurses and paramedics) using a self-administered questionnaire, evaluating their knowledge of neonatal resuscitation. The authors concluded that physicians and paramedics are best prepared to deliver neonatal resuscitation and had better knowledge than nurses. The nurses, compared to physicians and paramedics, knew little about energy shock, tidal volume and sodium bicarbonate.

Murila et al (19) using a self-administered questionnaire showed inadequate training and knowledge of neonatal resuscitation among nurses and clinicians in Kenya in 2012. One hundred and ninety two participants were involved from all counties of Kenya. Most participants had heard of neonatal resuscitation (85.4%), but only 23% participants had received formal training. More than 70% of the participants considered their neonatal resuscitation knowledge as below average (31).

Noor et al (33) conducted a cross sectional study in Pakistan in 2013 using a self-administered questionnaire to assess the gap in neonatal resuscitation knowledge of obstetrical trainees in order to determine training requirements. Of the 102 participants, 43% were house officers and 56.9% were postgraduate trainees. Only 18.6% of participants had adequate neonatal resuscitation knowledge. The majority of participants (90.2%) considered their knowledge inadequate and 97% indicated that updated neonatal resuscitation programmes should be periodically arranged (33). The authors concluded that there were no significant differences

between those who had previous training, those who had performed neonatal resuscitation or those who had no such exposure. This is in contrast to other studies (12, 13, 30, 34-39) that concluded that after receiving neonatal resuscitation training there is an improvement of neonatal resuscitation knowledge and skills.

Kester-Green and Lee (32) conducted a study in Canada in 2014 using a self-administered questionnaire evaluating the neonatal resuscitation knowledge of emergency medicine physicians and nurses in order to assess their preparedness for neonatal resuscitation. The authors concluded that the knowledge of, and preparedness for neonatal resuscitation were poor. There were 107 participants, of whom 77 were nurses and 30 were physicians. Of the participants, 95.8% reported never having been involved in neonatal resuscitation. A total of 74.9% rated their level of comfort with neonatal resuscitation as very poor, 83.3% rated their sense of preparedness as very poor, and 76.3% rated their knowledge of managing a sick neonate as very poor.

Basu (40), in India, 2014, determined the knowledge and practice of neonatal resuscitation among nursing staff working in paediatric health-care using a self-administered questionnaire and an objective structured clinical examination. The study enrolled 116 participants, none of whom had training in neonatal resuscitation in the recent past. Participants had very poor knowledge of using bag mask ventilation and chest compression. The author concluded that the nurses have poor practical and theoretical knowledge of neonatal resuscitation.

Suresh et al (41), used a self-administered questionnaire in India, in 2017, to determine the knowledge and skills of neonatal intensive care unit (NICU) and labour room nurses regarding neonatal resuscitation. The study was conducted in four government hospitals and three private hospitals. Included in the study were 53 nurses working in the NICU and 40 nurses in the labour room. All the nurses were trained in neonatal resuscitation. Only 15% of nurses scored more than 85% for identifying the sequence of resuscitation. The nurses' knowledge of chest compression was particularly poor with 15% of nurses scoring more than 85%. The authors concluded that neonatal resuscitation training was urgently needed (41).

Alhassan et al (42) conducted a cross sectional study in three large hospitals in Ghana, in 2019, to determine knowledge and experience of neonatal resuscitation among midwives using a self-administered questionnaire. The majority of participants (98.1%) had poor knowledge of neonatal resuscitation. Participants with graduate training followed by a postgraduate certificate in midwifery scored significantly better than those with only a diploma in midwifery. The authors concluded that there was an urgent need for all practicing midwives to be trained in neonatal resuscitation skills (42).

From the above evidence, there seems to be limited knowledge of neonatal resuscitation amongst health care workers, however, it has been shown that training improves neonatal resuscitation knowledge and skills (12, 13, 30, 34-39).

1.7 Summary

In this chapter the incidence of CPR in neonates, the causes of perinatal deaths and the importance of effective neonatal CPR were briefly discussed. The neonatal CPR guidelines were explored and the knowledge of health care workers regarding neonatal resuscitation was discussed.

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Section 2: Author's guidelines

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3. Notification within 3 months if accepted for publication, if revisions are required or if rejected by both reviewers.
4. Publication within 6 months after submission.

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The *SA Journal of Anaesthesia and Analgesia* aims to publish original research and review articles of relevance and interest to the anaesthetist in academia, public sector and private practice. Papers are peer reviewed to ensure that the contents are understandable, valid, important, interesting and enjoyed. All manuscripts must be submitted online.

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The following contributions are accepted (word counts exclude abstracts, tables and references):

- **Original Research** (2 800 – 3 200 words / 4-5 pages)
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All articles must have a title page with the following information and in this particular order: Title of the article; surname, initials, qualifications and affiliation of each author; The name, postal address, e-mail address and telephonic contact details of the corresponding author and at least 5 keywords.

Abstract

All articles should include an abstract. The structured abstract for an Original Research article should be between 200 and 230 words and should consist of four paragraphs labeled Background, Methods, Results, and Conclusions. It should briefly describe the problem or issue being addressed in the study, how the study was performed, the major results, and what the authors conclude from these results. The abstracts for other types of articles should be no longer than 230 words and need not follow the structured abstract format.

Keywords

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when available and appropriate. Key words are used to index the article and may be published with the abstract.

Acknowledgements

In a separate section, acknowledge any financial support received or possible conflict of interest. This section may also be used to acknowledge substantial contributions to the research or preparation of the manuscript made by persons other than the authors.

References

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

In the References section, references must be typed double-spaced and numbered consecutively in the order in which they are cited, not alphabetically.

The style for references should follow the format set forth in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (http://www.icmje.org) prepared by the International Committee of Medical Journal Editors. Abbreviations for journal titles should follow Index *Medicus* format. Authors are responsible for the accuracy of all references. Personal communications and unpublished data should not be referenced. If essential, such material should be incorporated in the appropriate place in the text.

List all authors when there are six or fewer; when there are seven or more, list the first three, then “;et al.”; When citing URLs to web documents, place in the reference list, and use the following format: Authors of document (if available). Title of document (if available). URL. (Accessed [date]).

The following are sample references:

1. Jun BC, Song SW, Park CS, Lee DH, Cho KJ, Cho JH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-

dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.

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Tables should be self-explanatory, clearly organised, and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and numbered in Roman numerals (I, II, etc) in order of its appearance as called out in text. Tables must me inserted in the correct position in the text. Authors should place explanatory matter in footnotes, not in the heading. Explain in footnotes all non-standard abbreviations.

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Authors must declare all financial contributions to their work or other forms of conflict of interest, which may prevent them from executing and publishing unbiased research. [Conflict of interest exists when an author (or the author's institution), has financial or personal relationships with other persons or organizations that inappropriately influence (bias) his or her opinions or actions.] **Modified from: Davidoff F, et al. Sponsorship, Authorship, and Accountability.

(Editorial) JAMA 2001: 286(10) The following declaration may be used if appropriate: “I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in writing this paper.”

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2. Please consult the guide on Vancouver referencing methods at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=citmed.TOC&depth=2
3. The submission must be in UK English, typed in Microsoft Word or RTF with no double spaces after the full stops, double paragraph spacing, font size 10 and font type: Times New Roman.
4. All author details (Full names, Qualifications and affiliation) must be provided.
5. The full contact details of corresponding author (Tel, fax, e-mail, postal address) must be on the manuscript.
6. There must be an abstract and keywords.

7. References must strictly be in Vancouver format. (Reference numbers must be strictly numerical and be typed in superscript, not be in brackets and must be placed AFTER the full stop or comma.)
8. It must be clear where every figure and table should be placed in the text. If possible, tables and figures must be placed in the text where appropriate. If too large or impractical, they may be featured at the end of the manuscript or uploaded as separate supplementary files.
9. All photographs must be at 300dpi and clearly marked according to the figure numbers in the text. (Figure 1, Table II, etc.)
10. All numbers below ten, without percentages or units, must be written in words.
11. Figure numbers: Arabic, table numbers: Roman

Section 3: Draft article

Anaesthetists' Knowledge of Neonatal Resuscitation

Hatem Jahrani MBBCh, FCA (SA)

Juan Scribante, PhD

Helen Perrie, MSc

Nadav Ravid MBBCh, FCA (SA), MMed, DA (SA)

Department of Anaesthesiology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand

Corresponding Author

Dr H Jahrani

Department of Anaesthesiology
Helen Joseph Hospital
1 Perth road
Westdene
Johannesburg
2092

haithemjuhrane@yahoo.com

Contact number: 0799348110

Key words: Knowledge, neonatal resuscitation

Abstract

Background

Knowledge of basic resuscitation of neonates is vital. Factors such as delays in decision making and inaccuracies in estimation of drug dosage during resuscitation may result in poor patient outcome. The aim of this study is to describe the knowledge of anaesthetists in the Department of Anaesthesiology at the University of the Witwatersrand regarding the 2015 Neonatal Resuscitation Guidelines.

Methods

A prospective, contextual, descriptive study design was used. Data were collected using convenient sampling and a self-administered questionnaire.

Results

The 169 anaesthetists that took part in the study represented 81.3% of the department. The mean (SD) score obtained was 43.4% (14.2%), no anaesthetist achieved ≥80% (adequate knowledge). There was no significant difference between anaesthetists who have attended a neonatal resuscitation course and those who have not (p=0.272). There was no significant difference in the level of knowledge between medical officers, registrars and consultants (p=0.636). Of the anaesthetists, 72.2% perceived their competence in neonatal resuscitation as average.

Conclusion

Knowledge of neonatal resuscitation in this study was inadequate. The majority of anaesthetists perceived their competence with neonatal resuscitation as average. Neither previous resuscitation training nor professional designation influenced knowledge.

Introduction

Cardiopulmonary resuscitation (CPR) “is an emergency procedure that combines chest compressions often with artificial ventilation in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person who is in cardiac arrest. It is recommended in those who are unresponsive with no breathing or abnormal breathing, for example, agonal respirations”(1).

In 1960, CPR as we know it today was developed (2). During the first conference on CPR in 1966, the need for training of medical and other health care workers in external chest compression was recognised. The basic CPR, or also known as the Basic Life Support (BLS) course was then created. This was then followed by an Advanced Life Support (ALS) course, which requires medically trained personnel and invasive procedures such as intubation, drugs, and defibrillation (3).

The Working Group on Paediatric Resuscitation suggested that the focus of resuscitation in the neonate should be on the ventilation of the lung rather than the restoring of cardiac activity as in adult patients. In 1985 the American Academy of Paediatrics and American Heart Association realised the need for the development of a neonatal resuscitation training program. The first neonatal resuscitation textbook was published in 1987 (4).

The CPR guidelines are regularly modified, approximately every five years, by the International Liaison Committee on Resuscitation (ILCOR) Consisting of Representatives from the AHA, European Research Council (ERC), Australia, Latin America, South Africa and Canada (5). The early edition of the neonatal CPR guidelines was mainly based on the opinions of experts in the field. In the past two decades the guidelines are increasingly being based on research evidence. However, certain aspects of the current guidelines remain controversial due to the difficulties conducting randomised clinical trials (4).

In South Africa, neonatal resuscitation is guided by the Neonatal Resuscitation Guidelines of 2015 from the Resuscitation Council of South Africa (6), that is it self based on American Heart Association (AHA) Neonatal Resuscitation Guidelines (7) and European Guidelines (8).

Approximately 130 million babies are born annually worldwide, of which four million die in the neonatal period. The majority of neonatal deaths (99%) occur in low and middle- income countries. The World Health Organisation documented that two-thirds of neonatal deaths occur in the African and Southeast Asia regions (9). In South Africa, in the under-five years of age mortality category, the rate of neonatal deaths has increased from 30% in the early 2000s to 40% in 2013 (10). Statistics South Africa reported the stillbirths, early neonatal and perinatal death rate in South Africa to be 22 116 in 2013 (11).

It is predicted that delivery room resuscitation is required in 4 to 7 million neonates every year, “making this one of the most commonly practiced and important global medical interventions.” (12) At least 10% of neonates need some support to start respiration (7), such as tactile stimulation or airway clearing (13). Comprehensive resuscitation measures, such as cardiac compressions and medications, are needed in less than 1% of neonates (7).

There are various factors that contribute to the need for neonatal resuscitation. These include but are not limited to: preterm birth, low birth weight, severe sepsis, birth asphyxia, maternal health and intrapartum complications, poverty and the standard of health care delivery.

“The birth of the baby represents one of the most dramatic physiological transitions in human life. Although this transition most often proceeds naturally and smoothly, the day of birth also carries high risk of death when the transition is disrupted.” (14).

A challenge for healthcare workers is that it is difficult to predict which deliveries will produce a baby requiring intervention (15). It is therefore essential that healthcare workers, including anaesthetists, have up to date knowledge of neonatal resuscitation

Several studies (16-21) in both developed and developing countries have evaluated the level of knowledge of healthcare workers regarding the different aspects of neonatal resuscitation. Adequate knowledge (pass rate) was inconsistently defined in these studies making cross study comparison difficult. However, all these studies reported a relatively limited knowledge of neonatal

resuscitation. No research specific to anaesthetist knowledge of neonatal resuscitation was identified.

Noor et al (22) conducted a cross sectional study in Pakistan from January to March 2013 using a self-administered questionnaire to evaluate the neonatal resuscitation capability of obstetric trainees, in order to assess the gap in knowledge and to determine training requirements. Only 18.6% of participants had adequate neonatal resuscitation knowledge. The authors concluded that there were no significant differences between those who had previous training, those who had performed neonatal resuscitation or those who had no such exposure. The majority of participants (90.2%) considered their knowledge inadequate and 97% indicated that updated neonatal resuscitation programmes should be periodically arranged.

Xu et el (23) highlighted the impact of the Chinese Neonatal Resuscitation Program on policy and infrastructure changes and its effectiveness in decreasing the incidence of mortality among newborn infants. More than 110 659 professionals completed the Chinese Neonatal Resuscitation Program from 2004 to 2009, in 20 target provinces. Newborn intrapartum-related deaths in the delivery room decreased from 7.5 to 3.4 per 10 000 from 2003 to 2008, and the incidence of an Apgar score of equal to or less than seven at one minute decreased from 6.3% to 2.9%. The author concluded that the Chinese Neonatal Resuscitation Program contributed to policy changes promoting resuscitation, training large numbers of professionals, and contributing to a reduction in delivery room mortality.

The World Health Organization has identified neonatal mortality as a priority focus. It is estimated that four million neonates die annually in the first four weeks of their life (9). In hospital, neonates are the most common recipients of resuscitation and anaesthetists are frequently the first to initiate the resuscitation (24)

Knowledge of basic resuscitation of neonates is vital, as any significant delay in decision making as well as inaccuracy of drug dosage during resuscitation may be reflected by poor patient outcome.

The aim of this study is to describe the knowledge of anaesthetists in the Department of Anaesthesiology at the University of the Witwatersrand (Wits) regarding the 2015 Neonatal Resuscitation Guidelines (6).

Methods

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

The study population consisted of the 208 anaesthetists working in the department. Using a convenience sampling method, the entire accessible population was approached and invited to take part in the study. A minimum of 60% (125) of the anaesthetists were considered an acceptable response rate. Interns were excluded from the study as they only rotate through the department for a period of two months. Blank returned questionnaires were also excluded.

Data were collected using a self-administered questionnaire. No suitable questionnaires pertaining to the anaesthetists' knowledge regarding neonatal resuscitation guidelines could be identified. Following a review of the American Heart Association Neonatal Resuscitation Guidelines (3), European Neonatal Resuscitation Guidelines (8) and South African Neonatal Resuscitation Guidelines (6), a draft questionnaire was compiled, ensuring content validity. The draft questionnaire was reviewed by three anaesthesiologists with an interest in neonatology and resuscitation, ensuring face and content validity. The anaesthesiologists' recommendations were incorporated into the final questionnaire. The questionnaire consisted of a demographic section and 17 knowledge questions.

Data were collected at departmental academic meetings. An information letter and a questionnaire were handed out to anaesthetists willing to participate. One author (HJ) was present while the questionnaires were completed in order to attend to queries and also to prevent data contamination. Participants were requested to return all questionnaires folded, whether completed or not, into a sealed box. Consent was implied on return of the questionnaire.

Adequate knowledge in this study was a score of equal to or greater than 80%, as in the study of CPR knowledge and skills by Ravagan (25). Questionnaires returned blank were used to calculate the response rate but will be excluded from the data analysis. Incomplete questionnaires were included in the study and questions not answered were considered as incorrect.

Data were entered onto a Microsoft® Excel spread sheet and analysed in consultation with a biostatistician using Statistica version 12 (Statsoft, USA). Categorical data will be presented using frequencies and percentages and continuous data using means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Knowledge of anaesthetists who have attended neonatal resuscitation courses and those who have not and knowledge of professional designations of anaesthetists will be compared. If the data are normally distributed, independent t tests will be used and if not, Mann-Whitney tests will be used. A p value of <0.05 will be considered statistically significant.

Results

All of the 169 questionnaires distributed were returned and included in the study. This represents 81.3% of anaesthetists in the department. The characteristics of the participants are shown in Table I.

Table I Participant characteristics

Characteristic	Number	Percentage
Gender		
Male	55	32.5
Female	114	67.5
Professional designation		
Consultant/ Career Medical Officer	61	36.1
Registrar	74	43.8
Medical Officer	34	20.1
Age group		
<30 years	30	17.6
30 –40 years	118	69.8
41 –50 years	11	6.5
>50 years	10	5.9

The CPR training profile of anaesthetists and perceived level of competence with neonatal resuscitation are shown in Table II.

Table II CPR training profile and perceived level of competence with neonatal resuscitation

CPR training profile	Number	Percentage
Neonatal resuscitation course accreditation		
Yes	36	21.3
No	133	78.7
When last accredited?		
Within the last year	2	5.6
1 –2 years ago	7	19.4
3 –5 years ago	16	44.4
>5 years ago	11	30.6
Last involved in the resuscitation of a neonate		
<1 week ago	12	7.1
1 week –1 month ago	17	10.1
>1 month –2 months ago	24	14.2
>2 months –6 months ago	41	24.3
>6 months –1 year ago	35	20.7
>1 year ago	40	23.7
Never been involved	0	0
Neonatal resuscitations involved in per year		
None	18	10.7
1 –5	113	66.9
6 –10	23	13.6
>10	15	8.9
Perceived level of competence in neonatal resuscitation		
Poor	20	11.8
Average	122	72.2
Good	27	16.0

The mean (SD) overall knowledge score for anaesthetists was 43.4% (14.2%) with a range of 0 –76%. No participant achieved an adequate score of ≥80%. A

description of the questions and the number and percentage of correct responses are shown in Table III.

Table III Correct responses per question

Question and description	Correct	
	Number	**Percentage**
1: Indication for chest compressions	126	74.6
2: Ratio of chest compressions and ventilation cycle time	109	64.5
3: Chest compression and ventilation period	46	27.2
4: Recommended depth of chest compression	77	45.6
5: Gestational age and drying neonate	77	45.6
6: Supplemental oxygen and heart rate	107	63.1
7: Supplemental oxygen and preterm neonate	76	45.0
8: Oxygen administration for unstable preterm neonate	28	16.6
9: Recommended time interval for assessments	16	9.5
10: Intravenous adrenaline dose for neonates	114	67.5
11: Endotracheal adrenaline dose for neonates	64	37.9
12: Volume expansion dose for term neonates	85	50.1
13: Management of hypoxic ischaemic encephalopathy	74	43.8
14: Normal pre-ductal saturation 1 minute after birth	67	39.6
15: Normal pre-ductal saturation 5 minutes after birth	129	76.3
16: PEEP use for ventilated preterm neonates	36	21.3
17: Resuscitation period for unstable neonates	15	8.9

A comparison between the anaesthetists' knowledge scores for neonatal resuscitation according to whether a resuscitation course has been attended or not; knowledge scores according to professional designation and knowledge scores according to anaesthetists perceived level of competence in neonatal resuscitation is shown in Table IV.

Table IV Knowledge scores according to course attendance, professional designation and level of competence

Knowledge by:	Mean	SD	P-value
Resuscitation course attended			
Yes	45.71%	12.36%	0.272
No	42.76%	14.56%	
Professional designation			
Medical Officer	41.35%	14.00%	0.636
Registrar	43.64%	13.63%	
Consultant	44.17%	14.94%	
Perceived level of competence			
Good	43.57%	13.48%	0.064
Average	44.46%	13.08%	
Poor	36.47%	19.33%	

Discussion

Several studies (16-21) in both developed and developing countries have evaluated the level of knowledge of health-care workers regarding the different aspects of neonatal resuscitation. Adequate knowledge (pass rate) was inconsistently defined and reported in these studies making cross study comparison difficult. No research specific to anaesthetists' knowledge of neonatal resuscitation was identified.

The mean knowledge of anaesthetists in this study was 43.4%. This result is similar to other studies. Kester-Green and Lee (21) in Canada, in 2011, concluded that emergency medicine physicians' and nurses' knowledge and preparedness for neonatal resuscitation were poor. Basu (26) in India, in 2014, also concluded that paediatric nurses had poor knowledge of using bag mask ventilation and chest compression. Suresh et al (27) in India, in 2017, and Alhassan et al (28) in Ghana, in 2019, showed that midwives had poor knowledge of neonatal resuscitation.

In our study, no anaesthetist had adequate knowledge (80% or more) and there was no significant difference in the level of knowledge between medical officers, registrars and consultants. In a 2018 study by Noor et al (29) in Pakistan, 18.6% of obstetric trainees had adequate knowledge. Eriksson et al (16) conducted a study in Viet Nam, in 2009, and found that primary health care staff achieved 60% for the questionnaire assessing knowledge of neonatal resuscitation. Szarpak (20) conducted a study in Poland, in 2013, among emergency medical personnel that included physicians, nurses and paramedics. The author concluded that physicians and paramedics were better prepared to deliver neonatal resuscitation and had better knowledge than nurses. Of concern in our study is that the Department of Anaesthesiology is affiliated to three academic hospitals with high rate of deliveries. Furthermore, 36.1% of participants were consultants who teaches junior anaesthetists and they only obtained a mean score of 44.2%.

Most anaesthetists, 76.3%, answered the question regarding the normal pre-ductal saturation five minutes after birth correctly. The question regarding the appropriate resuscitation period for unstable neonates was answered correctly by the least number of anaesthetists (8.9%). Conversely, 89% of the participants in an emergency medicine study by Szarpak (20) knew the appropriate resuscitation period for unstable neonates. A possible explanation is that anaesthetists' may have a better physiology knowledge of neonates than emergency medicine health care workers, whereas emergency medicine health care workers may be more involved in practical resuscitation.

In our study, although the knowledge of anaesthetists was inadequate, 72.2% of anaesthetists perceived their competence in neonatal resuscitation as average. This is in contrast to Murila et al (30) in Kenya where 70% of nurses and clinicians working in the labour, maternity and newborn units considered their knowledge as below average. Noor et al (29) found that the majority of obstetric trainees, 90.2%, considered their knowledge of neonatal resuscitation inadequate. Kester-Green and Lee (21) reported that 74.9% of emergency medicine physicians and nurses rated their level of comfort with neonatal resuscitation as very poor, 80.3% rated their sense of preparedness as very poor and 76.3% rated their knowledge of managing a sick neonate as very poor.

There was no difference in knowledge between those anaesthetists who attended a resuscitation course and those who did not. This is similar to the results of Noor et al (29) who also did not show any significant difference between participants who had previous training and those who had no such exposure. However, Bookman et al (19) in Ghana, showed that there was an increase in midwives' knowledge of neonatal resuscitation following training. The midwives' knowledge improved significantly with a 27% increase in the written evaluation and a 45% increase in the practical skills evaluation from pre training to one day post training. The knowledge and practical skills were maintained when evaluated 9 –12 months post training. The authors concluded that the sustained knowledge and skills of neonatal resuscitation of the midwives were due to their practicing in a high risk referral hospital and using their skills on a daily basis. The results of our study highlighted that there is a need for neonatal resuscitation training in the Department of Anaesthesiology at Wits. However, measures must be put in place to ensure sustained improvement of neonatal resuscitation.

A limitation of the study is that it was done contextually in the Department of Anaesthesiology and the results may not be generalisable to other departments.

Conclusion

Knowledge of neonatal resuscitation in this study was inadequate. The majority of anaesthetists perceived their competence with neonatal resuscitation as average. Neither previous resuscitation training nor professional designation influenced knowledge.

Conflict of interest

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

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Section 4: Proposal

Anaesthetists' Knowledge of Neonatal Resuscitation

Hatem Jahrani

767164

Supervisor	Juan Scribante Department of Anaesthesiology
Co-supervisor	Helen Perrie Department of Anaesthesiology
Co-supervisor	Nadav Ravid Department of Anaesthesiology

4.1 Introduction and problem statement

Cardiopulmonary resuscitation (CPR) “is an emergency procedure that combines chest compressions often with artificial ventilation in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person who is in cardiac arrest. It is recommended in those who are unresponsive with no breathing or abnormal breathing, for example, agonal respirations”(1).

In 1960, CPR as it is known today was developed (2). During the first conference on CPR in 1966, the need for training of medical and other health care workers in external chest compression was recognised. The basic CPR course, also known as the Basic Life Support course, was then created. This was then followed by an Advanced Life Support course, which requires medically trained personnel and invasive procedures such as intubation, drugs, and defibrillation (3).

Vali et al (4) highlights that the Working Group on Paediatric Resuscitation suggested that the focus of resuscitation in the neonate should be on ventilation of the lung rather on restoring cardiac activity as in adult patients. In 1985 the American Academy of Paediatrics and American Heart Association recognised the need for the development of a neonatal resuscitation training program. The first neonatal resuscitation textbook was published in 1987 (4).

The CPR guidelines are regularly modified, approximately every five years, by the International Liaison Committee on Resuscitation consisting of representatives from the American Heart Association, European Research Council, Australia, Latin America, South Africa and Canada (5). The earlier editions of the neonatal CPR guidelines were mainly based on the opinions of experts in the field. Over the past two decades, the guidelines have increasingly been based on research evidence. However, certain aspects of the current guidelines remain controversial due to the difficulties conducting randomised clinical trials (4).

In South Africa, neonatal resuscitation is guided by the Neonatal Resuscitation Guidelines of 2015 from the Resuscitation Council of South Africa (6), that is based on the American Heart Association Neonatal Resuscitation Guidelines (7) and the European Guidelines (8).

Lawn et al (9) in 2005 states that, approximately 130 million babies are born annually worldwide, of which four million die in the neonatal period. The majority of neonatal deaths (99%) occur in low and middle- income countries. The authors refer to the World Health Organization that documented that two-thirds of neonatal deaths occured in the African and Southeast Asia regions (9). In South Africa, in the under-five years of age mortality category, the rate of neonatal deaths has increased from 30% in the early 2000s to 40% in 2013 (10). Statistics South Africa reported the stillbirths, early neonatal and perinatal death rate in South Africa to be 22 116 in 2013 (11).

It is predicted that delivery room resuscitation is required in 4 – 7 million neonates every year, “making this one of the most commonly practiced and important global medical interventions.” (12) At least 10% of neonates need some support to start respiration (7), such as tactile stimulation or airway clearing (13) Comprehensive resuscitation measures, such as cardiac compressions and medications, are needed in less than 1% of neonates (7).

There are various factors that contribute to the need for neonatal resuscitation. These include but are not limited to preterm birth, low birth weight, severe sepsis, birth asphyxia, maternal health and intrapartum complications, poverty and the standard of health care delivery (14).

“The birth of the baby represents one of the most dramatic physiological transitions in human life. Although this transition most often proceeds naturally and smoothly, the day of birth also carries high risk of death when the transition is disrupted.” (15). A challenge for healthcare workers is that it is difficult to predict which deliveries will produce a baby requiring intervention (16). It is therefore essential that healthcare workers, including the anaesthetists, have up to date knowledge of neonatal resuscitation.

Several studies (17-22) in both developed and developing countries have evaluated the level of knowledge of healthcare workers regarding the different aspects of neonatal resuscitation. Adequate knowledge (pass mark) was inconsistently defined in these studies making cross study comparison difficult. However, all these studies reported relatively limited knowledge of neonatal

resuscitation. No research specific to anaesthetists' knowledge of neonatal resuscitation was identified.

Noor et al (23) conducted a cross sectional study in Pakistan from January to March 2013 using a self-administered questionnaire to evaluate the neonatal resuscitation knowledge of obstetrical trainees, in order to assess the gap in knowledge and to determine training requirement. Only 18.6% of participants had adequate neonatal resuscitation knowledge. The authors concluded that there were no significant differences between those who had previous training, those who had performed neonatal resuscitation or those who had no such exposure. The majority of participants (90.2%) considered their knowledge inadequate and 97% indicated that updated neonatal resuscitation programmes should be periodically arranged.

Xu et el (24) highlighted the impact of the Chinese Neonatal Resuscitation Program on policy and infrastructure changes and its effectiveness in decreasing the incidence of mortality among newborn infants. More than 110 659 professionals completed the Chinese Neonatal Resuscitation Program from 2004 – 2009, in 20 the targeted provinces. Newborn intrapartum-related deaths in the delivery room decreased from 7.5 – 3.4 per 10 000 from 2003 – 2008, and the incidence of an Apgar score of equal to or less than seven at one minute decreased from 6.3% – 2.9%. The author concluded that the Chinese Neonatal Resuscitation Program contributed to policy changes promoting resuscitation, training large numbers of professionals, and contributing to a reduction in delivery room mortality (24).

The World Health Organization has identified neonatal mortality as a priority. It is estimated that four million neonates die annually in the first four weeks of life (9). In hospital, neonates are the most common recipients of resuscitation and anaesthetists are frequently initiating the resuscitation (25)

Knowledge of basic resuscitation of neonates is vital, as any significant delay in decision making, as well as inaccuracy in estimation of drug dosage during resuscitation, may result in poor patient outcome.

The knowledge of anaesthetists working in the Department of Anaesthesiology at the University of the Witwatersrand (Wits) regarding the 2015 South African Neonatal Resuscitation Guidelines (6) is unknown.

4.2 Aim and objectives

4.2.1 Aim

The aim of this study is to describe the knowledge of anaesthetists in the Department of Anaesthesiology at Wits regarding the 2015 Neonatal Resuscitation Guidelines (6).

4.2.2 Objectives

The primary objectives of this study are to**:**

- describe anaesthetists' CPR training profile
- describe anaesthetists' knowledge regarding the 2015 Neonatal Resuscitation Guidelines (6).

The secondary objectives of this study are to**:**

- compare knowledge between anaesthetists who have attended a neonatal resuscitation course to those who have not
- compare knowledge between medical officers, registrars and consultants
- compare actual knowledge with perceived level of competence of neonatal resuscitation.

4.3 Research assumptions

The following definitions will be used in this study.

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

Medical officer: is a qualified doctor practising in the Department of Anaesthesiology under specialist supervision. Medical officers with more than 10

years of anaesthethic experience are career medical officers and are regarded as consultants.

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

Consultant: is a specialist anaesthetist or career medical officer.

Neonate: is a baby from birth to 28 days in term infants and if preterm, from birth to 44 weeks post-conceptual age (26).

Resuscitation: in the context of this study, it means to correct any physiological defects or disorders the patients may be experiencing (27).

Adequate knowledge: in this study will be a score of equal to or greater than 80%, as in the study of CPR knowledge and skills by Ravagan. (28).

4.4 Demarcation of study field

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

- Charlotte Maxeke Johannesburg Academic Hospital, a 1200-bed central hospital.
- Chris Hani Baragwanath Hospital, a 2888-bed central hospital.
- Helen Joseph Hospital, a 500-bed tertiary hospital.
- Rahima Moosa Mother and Child Hospital, a 338-bed regional hospital.
- Wits Donald Gordon Medical Centre, a 190-bed public private hospital.

4.5 Ethical considerations

Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of the University of the Witwatersrand.

The researcher will explain the study at departmental meetings and invite anaesthetists to take part. Those who agree will receive an information letter (Appendix 1) and a self-administered questionnaire (Appendix 2). The return of a completed questionnaire will imply consent.

Anonymity will be ensured as the questionnaire will not request any identifying data and the completed questionnaire will be folded and placed in a sealed box. Only the researcher and the supervisors will have access to the raw data, thereby ensuring confidentiality.

If the results of the study show that anaesthetists have inadequate neonatal resuscitation knowledge, the researcher will organise a departmental neonatal resuscitation workshop.

Data will be stored securely in a locked cupboard for six years after completion of the study. The study will be conducted in adherence to the principles of the Declaration of Helsinki (29) and the South African Good Practice Guidelines (30).

4.6 Research methodology

4.6.1 Research design

A prospective, contextual, descriptive study design will be used.

A prospective study measures variables as they take place during the study (31). In this study, anaesthetists' knowledge will be measured during the study period.

A contextual study refers to research in a specific group, defined by de Vos et al (32) as a "small-scale world". This study is contextual as research will be done with anaesthetists working in the Department of Anaesthesiology.

According to Brink et al (31), a descriptive study is when "phenomena are described or the relationships between variables is examined; no attempt is made to determine cause and effect relationships." Anaesthetist knowledge regarding the 2015 Neonatal Resuscitation Guidelines (6) will be described.

4.6.2 Study population

The study population will be anaesthetists working in the Department of Anaesthesiology.

4.6.3 Study sample

Sample size

In this study, a convenience sampling method will be used. Convenience sampling involves using readily available participants in the study (33). All anaesthetists attending departmental academic meetings will be invited to participate in the study.

Sampling method

There are currently 208 anaesthetists working in the Department of Anaesthesiology. The entire accessible population will be approached and invited to take part in the study. A minimum of 60% (125) of the anaesthetists will be considered an acceptable response rate (34).

Inclusion and exclusion criteria

The inclusion criteria for this study are:

- anaesthetists attending departmental academic meetings
- anaesthetists agreeing to participate.

Exclusion criteria for the study will be:

- interns, as these doctors only rotate through the department for a period of two months
- anaesthetists on annual, special or sick leave at the time of data collection
- questionnaires that are returned blank.

4.6.4 Data collection

Questionnaire development

Data collection will be done using a self-administered questionnaire. No suitable questionnaires pertaining to the anaesthetists' knowledge regarding neonatal resuscitation guidelines could be identified. Following a review of the American Heart Association Neonatal Resuscitation Guidelines (3), European Neonatal Resuscitation Guidelines (8) and South African Neonatal Resuscitation Guidelines (6), a draft questionnaire was compiled, ensuring content validity. The draft questionnaire was reviewed by three anaesthesiologists with an interest in neonatology and resuscitation, ensuring face validity. The anaesthesiologists' recommendations were incorporated into the final questionnaire.

The questionnaire (Appendix 2) consists of a demographic and knowledge sections. In the demographic section, the following information is collected:

- professional designation
- gender
- age group
- neonatal resuscitation accreditation
- neonatal resuscitation experience
- self-perceived level of competence.

The knowledge section of the questionnaire consists of 17 knowledge questions.

Data collection

Data will be collected at departmental academic meetings once all relevant approvals have been received. Prior to the meetings, the researcher will approach the chairperson for permission to invite anaesthetists to participate in the study. An information letter (Appendix 1) and a questionnaire (Appendix 2) will be handed out to anaesthetists willing to participate. The researcher will be present while the questionnaire is completed in order to attend to queries and also to prevent data contamination. Participants will be requested to return all questionnaires folded, whether completed or not, into a sealed box labelled "Returned Questionnaires".

Questionnaires returned blank will be used to calculate the response rate but will be excluded from the data analysis. Incomplete questionnaires will be included in the study and questions not answered will be considered incorrect.

In order to achieve a minimum sample size, questionnaires will be distributed at more than one departmental academic meeting. It is acknowledged that anaesthetists could become aware of the study and therefore data contamination could occur, however, this has not been found to occur with previous knowledge studies in the Department of Anaesthesiology.

4.6.5 Data analysis

Data will be entered onto a Microsoft® Excel spread sheet and analysed using descriptive and inferential statistics. Statistica version 12 (Statsoft, USA) will be used for data analysis. Categorical data will be analysed using frequencies and percentages and continuous data using means and standard deviations or medians and interquartile ranges depending on the distribution of the data.

Knowledge between anaesthetists who have attended neonatal resuscitation courses and those who have not, knowledge between junior and senior anaesthetists and knowledge and perceived level of competence will be compared. If the data are normally distributed independent t tests will be used and if not, Mann-Whitney tests will be used. A p value of <0.05 will be considered statistically significant.

4.7 Significance of the study

The study aims to describe the neonatal resuscitation knowledge among anaesthetists working in the Department of Anaesthesiology. Inadequate resuscitation knowledge of anaesthetists will impact directly on the practice of anaesthesia, as anaesthetists are often required to perform neonatal resuscitation in theatre, namely obstetric, paediatric, general surgery and cardiothoracic theatres.

The results of this study may lead to an initiative for registrars and consultants to attend a neonatal resuscitation course, which may influence the quality of patients care.

4.8 Validity and reliability of the study

Validity is the extent to which a measurement in a study represents the true value. A study is said to be valid if the conclusions are justified based on the design of the study (35). Reliability refers to the consistency that a measure achieves (35).

Validity and reliability of this study will be ensured by implementing the following measures:

- choosing an appropriate research design
- content validity was ensured by basing the questionnaire on the American Heart Association Neonatal Resuscitation Guidelines (3), European Neonatal Resuscitation Guidelines (8) and South African Neonatal Resuscitation Guidelines (6)
- face validity was ensured by incorporating suggestions from expert anaesthesiologists with an interest in neonatology and resuscitation
- all participants completing the same standardised questionnaire
- preventing data contamination by the researcher being present during data collection
- checking every tenth data entry point on the spread sheet for accuracy
- analysing the data with the assistance of a biostatistician.

4.9 Potential limitations

Limitations are defined as restrictions or problems that may decrease the application of the findings to the general population (36).

- Due to the contextual nature of the study, the results may not be generalisable to other anaesthesiology departments or different populations. This study will, however, provide the Department of

Anaesthesiology at Wits with important information regarding anaesthetists' knowledge of the 2015 neonatal resuscitation guidelines.

- As convenience sampling is being used only the knowledge of anaesthetists attending departmental academic meetings will be represented. This may lead to over or under representation of certain elements (31).
- The sample size will be dependent on the number of anaesthetists attending the departmental academic meetings and their willingness to complete the questionnaire. The questionnaire will be handed out at meetings until at least 60% of anaesthetists in the department have completed a questionnaire.
- The sample size may not be large enough to adequately power the comparisons being made in the secondary objectives.

4.10 Project outline

4.10.1 Time frame

Activity	Nov 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018
Proposal preparation										
Literature review										
Proposal submission										
Ethics approval										
Postgraduate approval										
Data collection										
Data analysis										
Draft article										
Submission										

4.10.2 Budget

Item	Price per page	Number of pages	Copies	Total
Proposal	1	15	10	R 150
Ethics	1	10	25	R 250
Post graduate form	1	2	6	R 12
Complete report	1	100	4	R 400
Grand total				**R 812**

The Wits Department of Anaesthesiology will incur the costs of paper and printing.

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4.12 Appendices

Appendix 1- Information sheet

Dear colleague,

Hello, my name is Hatem Jahrani, and I am an anaesthesiology registrar in the Wits Department of Anaesthesiology.

I would like to invite you to participate in my research study: **Anaesthetists' knowledge of neonatal resuscitation**. This study will be handed in to the Faculty of Health Sciences at Wits in partial fulfilment of my specialist degree.

This study aims to describe the current knowledge of anaesthetists in the Department of Anaesthesiology at Wits regarding the 2015 Neonatal Resuscitation Guidelines. This will be determined by means of a self-administered questionnaire. Doctors specialising in anaesthesia are often involved with neonatal resuscitation and require knowledge of the latest neonatal resuscitation guidelines.

Participation is voluntary and consent will be implied on completion of a questionnaire. No personal incentive will be provided for completion of the questionnaire. No penalty will be incurred for not participating in this study.

No identifying information will be required to complete the questionnaire, all questionnaires whether complete or not, should be folded and dropped into the box supplied. Numbering of questionnaires is purely for data collection purposes. Only myself and my supervisors will have access to the raw data. The questionnaire shouldn't take longer than 15 minutes to complete and participants are encouraged not to share information provided on the questionnaire. If knowledge is found to be lacking then a lecture or workshop will be organised.

Before completion of this survey, please ensure you understand the above information.

This study has been approved by the Human Research Ethics Committee (Medical) (Number M170103) and the Graduate Studies Committee Wits.

Your time is greatly appreciated. Any questions regarding this study can be directed to the following people:

- Professor Cleaton-jones (chairperson of the HREC): (011) 717-1234
- Hatem Jahrani (researcher): 0799348110

Sincerely,

Hatem Jahrani

Appendix 2 - Questionnaire

Please answer the following questions by placing an “X” in the appropriate box.

Section 1: Demographic questionnaire

1. What is your professional designation?

	Consultant/ Career Medical Officer
	Registrar
	Medical Officer

2. Gender

	Male
	Female

3. Age group

	< 30 years
	30-40 years
	41-50 ears
	>50 years

4.1. Have you been accredited in a neonatal resuscitation course?

	Yes
	No

4.2. If yes, when last were you accredited in a neonatal resuscitation course?

	Within the last year
	1 to 2 years ago
	3 to 5 years ago
	> 5 years ago

5. When were you last involved in the resuscitation of a neonate?

	Less than 1 week ago
	Between 1 week and 1 month ago
	Between 1 month and 2 months ago
	Between 2 months and 6 months ago
	Between 6 months and 1 year ago
	Longer than 1 year ago
	Have never been involved

6. On average how many neonatal resuscitations are you involved in per year?

	None
	1 to 5
	6 to 10
	More than 10

7. How would you rate your level of competence in neonatal resuscitation?

	Poor
	Average
	Good

Section 2: Knowledge questionnaire

There is only one correct answer per question

1. With regards to a neonates, when are chest compressions indicated?

	Asystole
	If the heart rate is < 60 bpm despite adequate ventilation
	If the heart rate is < 80 bpm despite adequate ventilation
	If the heart rate is < 100 bpm despite adequate ventilation

2. What is the ratio of chest compressions to ventilation for a neonate if a cardiac cause is not suspected?

	2 compressions : 1 breath
	3 compressions : 1 breath
	2 compressions : 2 breaths
	3 compressions : 2 breaths

3. How long should each cycle of chest compression and ventilation take?

	1 second
	2 seconds
	3 seconds
	4 seconds

4. What is the recommended depth of chest compression?

	1/3rd of the anterior-posterior diameter of the chest
	1/2 of the anterior-posterior diameter of the chest
	2/3rd of the anterior-posterior diameter of the chest
	Enough to achieve a cardiac output

5. Under what gestational age should a neonate not be dried?

	< 30 weeks gestation
	< 32 weeks gestation
	< 34 weeks gestation
	< 36 weeks gestation

6. Under what heart rate should neonates receive supplemental oxygen?

	< 90 bpm
	< 100 bpm
	< 110 bpm
	< 120 bpm

7. How much oxygen would you give to resuscitate a stable preterm neonate < 35 weeks of gestation?

	21% to 30%
	31-60%
	61-90%
	100%

8. For a preterm neonate presenting with gasping, apnoea and bradycardia, which oxygen concentration would you start resuscitation with?

	30% to 40%
	50% to 60%
	>60% to 80%
	>80%

9. What is the recommended time interval for assessment of breathing, heart rate and oxygen saturation during neonatal resuscitation?

	Every 10 to 20 seconds
	Every 20 to 30 seconds
	Every 30 to 60 seconds
	Every 1 minute

10. what is the recommended dose for intravenous adrenaline for neonates?

	3 µ/kg
	5 µ/kg
	10 µ/kg
	15 µ/kg

11. What is the recommended dose for endotracheal adrenaline for neonates?

	5-10 µg/kg
	20-25 µg/kg
	30-40 µg/kg
	50-100 µg/kg

12. What is the recommended dose of volume expansion for a term neonate (isotonic crystalloid solution or blood)?

	5ml/kg
	10ml/kg
	15ml/kg
	20ml/kg

13. What is the recommended gestational age to induce therapeutic hypothermia as part of management of moderate-to-severe hypoxic ischaemic encephalopathy?

	<33 weeks gestation
	33 to 34 weeks gestation
	35 weeks gestation
	> 36 weeks gestation

14. What is the normal pre-ductal saturation 1 minute after birth?

	40%
	50%
	60%
	> 60%

15. What is the normal pre-ductal saturation 5 minutes after birth?

	60%
	65%
	70%
	> 80%

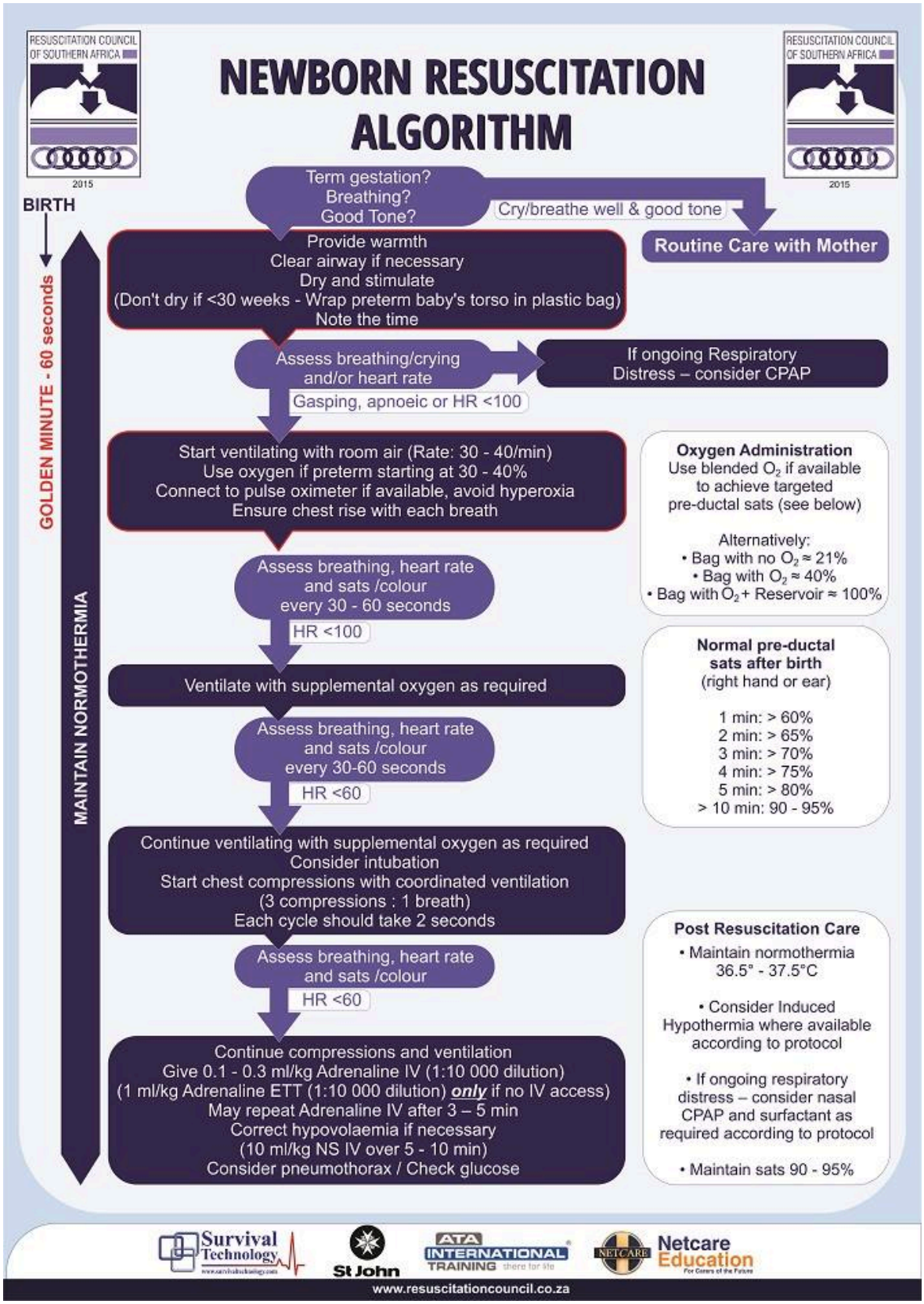
16. How much PEEP will you use when positive pressure ventilation is administered to a preterm neonate?

	None
	4 cm H_2O
	5 cm H_2O
	6 cm H_2O
	7 cm H_2O

17. For how long would you continue resuscitation for a neonate with asystole and no clinical improvement?

	5 minutes
	10 minutes
	15 minutes
	20 minutes

Appendix 3 - 2015 South African Neonatal Resuscitation Guidelines



Section 5: Annexures

5.1 Ethics approval

R14/49 Dr Hatem Jahrani et al

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170103

NAME: (Principal Investigator)	Dr Hatem Jahrani et al
DEPARTMENT:	Anaesthesiology
PROJECT TITLE:	Anaesthetists Knowledge of Neonatal Resuscitation
DATE CONSIDERED:	27/01/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Juan Scribante

APPROVED BY: Professor P Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 31/03/2017

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

DECLARATION OF INVESTIGATORS

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

Principal Investigator Signature Date 07/04/2017

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

5.2 Graduate studies approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

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

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

02 March 2017
Person No: 767164
PAG

Dr HSM Jahrani
103 Eberdeen Street
Westdene
2092
South Africa

Dear Dr Jahrani

Master of Medicine: Approval of Title

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

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.3 Turnitin report

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | FACULTY OF HEALTH SCIENCES

18 October 2019

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

Dear Professor Papathanasopoulos

Re: M Med: **Anaesthetists' knowledge of neonatal resuscitation**

Dr Hatem Jahrani, student number: 767164, has submitted her research report to Turnitin which revealed a similarity index of 10%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of the research.

Yours sincerely,

Juan Scribante
Supervisor

1

767164:Hatem2_.literature_R_turn.docx

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