# Retrospective analysis of abandoned live births, stillbirths and non-viable foetuses admitted to Salt River Mortuary, Cape Town

**by**

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## DECLARATION

I, Chanté du Toit, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree at this or any other university.

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**Abstract**

The abandonment of neonates in locations where discovery and survival is not intended is a global concern. These cases comprise non-viable foetuses and stillbirths (natural deaths), as well as abandoned live births (unnatural deaths); the latter having possible legal consequences. To describe the profile of abandoned neonates and obtain a global perspective of the post-mortem investigation in such cases, a systematic review of the literature on abandoned foetuses, concealed births and neonaticide was conducted. This revealed a paucity of research on the subject; only one published South African study and less than 30 studies from other parts of the world were obtained. While guidelines were available, a standard protocol for conducting the medico-legal investigation on abandoned neonates did not exist and the necessary extent of the investigation was debated. Furthermore, seemingly higher rates of abandoned neonates were observed in South Africa compared to elsewhere in the world, warranting investigation of these cases in a local setting. In an attempt to add to the data concerning abandoned neonates in South Africa, a case file review was carried out on abandoned live births, stillbirths and non-viable foetuses at Salt River Mortuary between 1 January 2012 and 31 December 2016 (n=249). Despite the majority of the cases being natural deaths, the cause of death frequently remained 'undetermined' in these cases, often due to the presence of decomposition. Histological analyses were only performed in a small fraction of undetermined cases. Furthermore, the hypothesis that the prosecution rate of abandoned live births is extremely low was supported by this study, with only one case prosecuted in the 5-year period. For the remainder of the cases, the court status was given as either 'under investigation' (47.8%) or 'case closed' (47.8%). In the majority of the instances, the case was closed due to the unknown identity of the biological mother; however, DNA analyses were not performed in all of these cases. Overall, the data highlighted the need for the development and implementation of standard protocols, to ensure that cause of death and identification of the neonate can be established as far as possible.

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**Abbreviations**

| | |
|---|---|
| AC | Abdominal circumference |
| CAS | Crime Administration System |
| CC | Chest circumference |
| CDR | Child Death Review |
| COB | Concealment of birth |
| COD | Cause of death |
| CRL | Crown-rump length |
| CT | Computed tomography |
| DNF | Death notification form |
| DPP | Director of Public Prosecutions |
| EE | External examination |
| FL | Foot length |
| GA | Gestational age |
| HC | Head circumference |
| HREC | Human research ethics committee |
| IE | Internal examination |
| MeSH | Medical Subject Headings |
| MRI | Magnetic resonance imaging |
| n | Number of individuals |
| NA | Not applicable |
| OAD | Office Autopsy Database |
| PE | Partial examination |
| PIE | Pulmonary interstitial emphysema |
| PM | Post-mortem |
| PMCT | Post-mortem computed tomography |

PMLL Pretoria Medico-Legal Laboratory

PMMR Post-mortem magnetic resonance imaging

pmMSCT Post-mortem multislice computed tomography

SAPS South African Police Service

SD Standard deviation

SRM Salt River Mortuary

TOP Termination of pregnancy

WC Western Cape

WHO World Health Organisation

# Chapter 1
# A systematic review describing the profile and medico-legal investigation of abandoned neonates

## 1.1 Introduction

The discovery of abandoned neonates in locations where survival is not the intention is a global concern. Despite the prevalence of reports of 'baby dumping' found on social media, scientific research concerning abandoned neonates, and particularly the medico-legal investigation of such cases, is scarce. To date, only one South African study has been published (du Toit-Prinsloo et al., 2016a) and a limited number of studies from other parts of the world could be sourced.

Additionally, while guidelines are available, a standard protocol for conducting the medico-legal investigation on abandoned neonates does not exist (Schulte et al., 2013). It is, however, generally accepted that upon discovery of the remains of abandoned neonates, it is paramount to determine aspects of the death that will aid in the determination of the nature of the suspected crime. The process involves estimating the gestational age (GA) of the neonate in order to establish viability (Schwär et al., 1988; Saukko and Knight, 2004). If deemed viable, it is necessary to determine whether the neonate was stillborn or born alive (Saukko and Knight, 2004). Upon establishing live birth, the cause of death (COD) needs to be determined (Schwär et al., 1988; Saukko and Knight, 2004; Maroun and Graem, 2006; Gilbert-Barness and Debich-Spicer, 2010).

While non-viable foetuses and stillborn neonates are deemed natural deaths, a viable, live born neonate that died due to an act of omission or commission is considered unnatural; criminal charges should thus be brought in such cases. Unfortunately, the prosecution rate of abandoned live births is suspected to be extremely low, although this aspect is not routinely assessed in studies (Herman-Giddens et al., 2003; du Toit-Prinsloo et al., 2016a).

A contributory problem to the investigation and ultimately the prosecution of these cases is the presence of decomposition and post-mortem scavenging or mutilation (Saukko and Knight, 2004; Byard, 2010; du Toit-Prinsloo et al., 2016a). Important parameters such as live birth and COD cannot always be established (Ong and Green, 2003); an adequate

investigation is thus not always possible. The reliability of the methods used to determine these parameters, especially in the context of post-mortem changes, needs to be evaluated.

Therefore, a systematic review of the literature on abandoned foetuses, concealed births and neonaticide was conducted to identify research studies and case reports that have assessed cases of this nature; to describe the profile and investigation of these cases and assess the methods used to determine important parameters, such as GA, viability and live birth.

## 1.2 Objectives

This literature review comprised three major objectives:

- To gain an understanding of the profile of abandoned neonates, as well as obtain a global perspective of the investigation conducted when such cases are encountered.
- To identify different methods used to estimate the GA (and therefore viability) of the neonate.
- To identify the methods used to determine whether the neonate was born alive or not.

## 1.3 Search strategy

A systematic search was conducted to identify articles reporting on abandoned neonates. Articles included retrospective review studies as well as case reports. The references of the relevant articles were hand-searched for additional relevant articles concerning abandonment. Likewise, the references of these hand-searched articles were hand-searched for relevant articles reporting on methods to estimate GA and methods to determine live birth. Articles were chosen based on inclusion and exclusion criteria (section 1.3.2) for each aspect (abandonment, GA and live birth).

The search strategy used to conduct this review included searching the databases PubMed, EbscoHost, Science Direct and Scopus, as well as the meta-database, Web of Science™. Web of Science™ allows for searching in a number of databases, including: Web of Science™ Core Collection; Biological Abstracts®; KCI-Korean Journal Database; MEDLINE®; Russian Science Citation Index; SciELO Citation Index; Zoological Record®. Eight discipline-specific journals were also searched to guarantee that all relevant articles were

included during database searching. Furthermore, Google Scholar was used to search for possible additional articles not returned during database or journal searching. Hand-searching was performed by assessing every reference in the reference list of all the chosen journal articles.

Web of Science™ and all but one journal returned only redundant or irrelevant articles. Hand-searching articles selected from PubMed, ScienceDirect and Google Scholar produced additional articles.

### 1.3.1 Search terms

The keywords used to search the databases and journals are presented in Table 1.1. Refer to Appendix A for the full search output generated in the searches of PubMed, Scopus, Science Direct and the journals.

**Table 1.1 Keywords and Boolean operators used to search databases and journals**

| Keyword | Boolean operator |
|---|---|
| Medico-legal investigation | |
| Forensic investigation | |
| Legal medicine | OR |
| Forensic medicine | |
| **AND** | |
| Abandonment | |
| Concealment | OR |
| Dump | |
| **AND** | |
| Foetus | |
| Foetal | |
| New-born | |
| Neonate | OR |
| Baby | |
| Stillbirth | |
| Live birth | |
| Non-viable foetus | |

### 1.3.2 Inclusion and exclusion criteria

The articles were included or excluded by reading the abstract and/or scanning the article and applying the criteria in Table 1.2. Only English articles were included. Articles concerning abandoned neonates were included regardless of the year. For articles pertaining to GA or the

determination of live birth, only articles published after 1990 were included, to ensure inclusion of the most recent information. Exceptions to this were James et al. (1979), Mitchell and Davis (1984), Mercer et al. (1987), Platt et al. (1988) and Schwar et al. (1988).

**Table 1.2 Inclusion and exclusion criteria applied to articles returned during the search**

| Inclusion criteria | Exclusion criteria |
|---|---|
| ***Abandonment articles*** | |
| Studies reporting on abandoned, dumped or concealed neonates | Child homicide in general (older than 1 week) |
| Discarded neonates that died within the first week of life | Studies reporting on perpetrator characteristics |
| Review articles | Infection-related deaths |
| Case reports | Psychological or psychiatric review studies |
| | News reports |
| | Abandoned children that survived |
| ***Gestational age articles*** | |
| Methods used to estimate GA in neonates | Animal model studies |
| Novel methods to estimate GA | Estimation of GA based on menstrual history |
| Existing methods to estimate GA | Methods used in foetuses with abnormal growth |
| Methods used to predict GA in deceased neonates | Methods used to predict GA in diseased neonates |
| | Methods used to predict GA in in-vitro patients |
| | Neurological methods assessing the responses of neonates |
| ***Live birth articles*** | |
| Methods used to determine live birth in neonates | NA |
| Novel methods to determine live birth | |
| Existing methods to determine live birth | |
| Methods to determine live birth in the presence of decomposition or post-mortem changes | |

### 1.3.3 Quality criteria

The search strategy produced 450 articles, which were subjected to certain criteria in order to evaluate the quality of the information presented. If an article did not meet all of the core criteria given in Table 1.3, the article was excluded.

**Table 1.3 Quality criteria used to evaluate the 450 returned articles**

| Criteria type | Quality criteria |
|---|---|
| **Core criteria** | Is the information associated with one of the objectives? |
| | Does the information include at least one of the parameters discussed in the review? |
| **Other criteria considered** | Is this a novel study? |
| | Was suitable literature cited? |

## 1.4 Summary of articles retrieved

The systematic search of the literature and the application of the inclusion, exclusion and quality criteria produced 51 relevant articles to be included in this review of the literature. A summary of the search results (articles returned during database and journal searches) and the articles included in the literature review is given in Table 1.4.

The search produced seven relevant review articles, however all the articles did not have the same inclusion criteria or objectives. Some articles did not focus exclusively on abandonment cases, but rather neonaticide as a whole, which included a few instances of abandonment. Additionally, the articles reported on at least one aspect included in the review (Appendix A). The search also produced ten case reports on abandoned or concealed foetuses and the subsequent investigations of these cases. Furthermore, 19 and 15 additional articles were included for GA and live birth, respectively.

**Table 1.4 Summary of the number of articles returned and included during the search**

| Source | Date accessed | Number of articles returned | Number of articles included | Articles included from hand searching | Total |
|---|---|---|---|---|---|
| PubMed | 2017/03/11 | 18 | 5 | 14 | 19 |
| EbscoHost (Academic Search Premier, AfricaWide,Cinahl) | 2017/03/11 | 16 | 2 | 0 | 2 |
| Scopus | 2017/03/11 | 43 | 2 | 0 | 2 |
| Web of Science | 2017/03/11 | 8 | 0 | 0 | 0 |
| ScienceDirect | 2017/03/11 | 205 | 1 | 0 | 1 |
| Forensic Science International | 2017/05/01 | 11 | 1 | 2 | 3 |
| Journal of Forensic Sciences | 2017/05/01 | 63 | 0 | 0 | 0 |
| Journal of Forensic and Legal medicine | 2017/06/28 | 1 | 0 | 0 | 0 |
| Journal of Forensic Science and Medicine | 2017/06/28 | 84 | 0 | 0 | 0 |
| International Journal of Legal Medicine | 2017/06/28 | 0 | 0 | 0 | 0 |
| Legal medicine | 2017/06/28 | 1 | 0 | 0 | 0 |
| Forensic Science, Medicine and Pathology | 2017/06/29 | 0 | 0 | 0 | 0 |
| American Journal of Forensic Medicine and Pathology | 2017/06/29 | 0 | 0 | 0 | 0 |
| Google Scholar | 2017/03/31 | NA | 13 | 11 | 24 |
| | | | | **Total** | **51** |

## 1.5 Interpretation of the literature

**The profile of abandoned neonates and the investigation conducted when such cases are encountered**

Given the small number of articles on the topic, generalisations based on the search results were challenging to make; as such an overview of the search findings is presented below. Seven relevant review articles and ten case reports were included. It must be noted that case reports represent findings which are not the norm, but rather isolated cases with unique findings.

### 1.5.1 Profile

*Prevalence of cases*

From the literature it is clear that abandoned neonates are encountered all over the world, however the extent of the problem differs from country to country. While some studies reported rates of one case per year, others reported 150 cases over 15 years across 27 institutes. The biggest problem was observed at a medico-legal laboratory in South Africa that reported 289 cases over a five-year period. An overview of the number of cases reported in the studies included in this systematic review and the number of years that the studies spanned, is given in Table 1.5.

**Table 1.5 Comparison of the prevalence of abandoned neonates included in the studies conducted in different countries**

| Area/Country | Time period | Number of years over which study was conducted | Number of cases included in the study | Reference |
|---|---|---|---|---|
| North Carolina, USA | 1985-2000 | 16 | 35 | Herman-Giddens et al., 2003 |
| Eastern Croatia | 1980-2004 | 25 | 24 | Marcikic et al., 2006 |
| Denmark | 1997-2008 | 12 | 11 | Gheorghe et al., 2011 |
| France | 1996-2000 | 5 | 27 | Tursz and Cook, 2011 |
| Germany | 1993-2007 | 15 | 150 | Schulte et al., 2013 |
| South Delhi, India | 1996-2012 | 17 | 238 | Behera et al., 2016 |
| Pretoria, South Africa | 2004-2008 | 5 | 289 | du Toit-Prinsloo et al., 2016a |

*Demographics*

Some countries report sex-specific neonaticide. In India, for example, the killing of female children is reportedly more common than the killing of male offspring (Bhullar et al., 2014; Singh S. B. et al., 2015). However, a search of the literature revealed four case reports of abandoned male neonates (Chanana and Bala, 2011; Bhullar et al., 2014; Singh S. B. et al., 2015; Singh P. et al., 2015). Furthermore, three studies reported more male than female victims (Herman-Giddens et al., 2003; Tursz and Cook, 2011; du Toit-Prinsloo et al., 2016a), however this could be due to the sex remaining undetermined in some cases. Of the 11 abandoned new-borns in the study by Gheorghe et al. (2011), approximately two-thirds were female; however the authors cautioned that the numbers in their study were too low to be interpreted as sex-specific neonaticide or abandonment. Reasons given for undetermined sex included decomposition, skeletonisation, early GA and no invasive autopsy being conducted in an effort to identify the internal genitalia (Marcikic et al., 2006; Herman-Giddens et al., 2003; Schulte et al., 2013; Behera et al., 2016; du Toit-Prinsloo et al., 2016a). The victims in the remaining half of the studies tended to be equally distributed between males and females (Marcikic et al., 2006; Schulte et al., 2013; Behera et al., 2016).

*Anthropometric measurements*

The most frequently recorded anthropometric measurements in the post-mortem reports were mass, followed by crown-heel length (Gheorghe et al., 2011; Schulte et al., 2013; du Toit-Prinsloo et al., 2016a). Two of the studies reported similar mean weights of 2700g and 2821.8g (Marcikic et al., 2006; Gheorghe et al., 2011), with a third study reporting a much lower mean weight of 1288g for the abandoned neonates in the study (du Toit-Prinsloo et al., 2016a). The mean lengths also differed at 485mm and 340mm (Gheorghe et al., 2011; du Toit-Prinsloo et al., 2016a). Other measurements recorded at autopsy included foot length, head circumference, crown-rump length, rump-heel length, and at times long bone lengths and abdominal circumference (du Toit-Prinsloo et al., 2016a).

*Gestational age and viability*

The age of viability varied, with authors considering it to be after 210 days (seven months) or in rare cases, after 180 days (six months) (Chanana and Bala, 2011; Bhullar et al., 2014). Other studies reported a GA of 24 (Behera et al., 2016), 26 (du Toit-Prinsloo et al., 2016a) or 28 weeks (Kahana et al., 2005) as viable.

The study by Behera et al. (2016) showed an increase in the number of cases with increasing GA, which ranged from four weeks to full-term (majority) and new-born. In the du Toit-Prinsloo et al. (2016a) study, GA was recorded in the post-mortem report in only 60% of the cases, with 37% of the foetuses considered to be viable when the GA was not recorded. In almost 8% of the cases the GA was not recorded at all. Estimations ranged from nine weeks to term, with an average of 26 weeks and with 4% of the cases recorded as more than 42 weeks GA (du Toit-Prinsloo et al., 2016a).

i) Methods used to estimate the gestational age of neonates

Estimation of GA is necessary to aid in establishing whether or not the foetus was viable, yet only two studies reported how GA was estimated in their settings (Schulte et al., 2013; du Toit-Prinsloo et al., 2016a). Although putrefaction can hinder the ability to observe certain features used to estimate GA, Schulte et al. (2013) reported that these features were recorded in more than 95% of the cases in their study. All features were not necessarily observable in any single autopsy; however, the length, weight and extension of the fingernails past the fingertip were recorded most often. In Pretoria, South Africa, Haase's rule of thumb was used as a basic method to establish GA (du Toit-Prinsloo et al., 2016a). This rule states that up to the 20$^{th}$ week of the gestational period, the square root of the length (in cm) of the foetus correlates to the GA of the foetus in months; thereafter, the length divided by five correlates to the age in months (Saukko and Knight, 2004).

Other reported methods to estimate GA include examination of the developing teeth (especially in skeletonised remains), examination of the basilar part of the occipital bone, DNA methylation, computed tomography, anthropometric parameters, percentile charts, ossification centers, histological examination and anthropological measures (Table 1.6) (Bareggi et al., 1994; Scheuer and MacLaughlin-Blac, 1994; Nambiar et al., 2000; Tocheri and Molto, 2002; Kahana et al., 2005; Taneja et al., 2011; Nagaoka et al., 2012; Sieswerda-hoogendoorn et al., 2012; Schulte et al., 2013; Pandey et al., 2015; du Toit-Prinsloo et al., 2016a; Knight et al., 2016).

ii) Foot length

Numerous studies also supported the use of foot length as a reliable estimator of GA (Mercer et al., 1987; Mandarim-de-Lacerda, 1990; Merz et al., 2000; Bulandra et al., 2004; Hirst et

al., 2012; Conway et al., 2014; Pandey et al., 2015; Van Wyk and Smith, 2016; Geldenhuys et al., 2017). A small sample size was, however, a limitation in some of the studies (Hirst et al., 2012; Van Wyk and Smith, 2016; Geldenhuys et al., 2017). Only one study reported that GA was not accurately estimated using foot length, due to a wide range of foot length measurements at each GA and substantial overlap in foot length measurements for different GAs (James et al., 1979).

Hirst et al. (2012) found an increased error with advanced GA and Geldenhuys et al. (2017) reported a slight underestimation of GA using foot length. Additionally, one study reported that GA estimation based on foot length is not suitable after the $7^{th}$ month of pregnancy, and cautioned that GA should not solely be based on lower extremity measurements, but recommended using humerus length as a control in instances of disturbed growth (Bulandra et al., 2004).

James et al. (1979) reported that foot length was generally not influenced by intrauterine growth retardation; this observation was later contradicted (Hirst et al., 2012; Geldenhuys et al., 2017). Furthermore, foot length was considered to be unaffected by sex or congenital anomalies (Hirst et al., 2012; Van Wyk and Smith, 2016). Additionally, while one study reported that foot length was not influenced by maceration (Hirst et al., 2012), another study found that foetal maceration compromised the reliability of foot length as an indicator of GA, with significant differences in GA when mild or severe maceration was present (Geldenhuys et al., 2017).

A standardised foot length chart does not exist, particularly for a diverse population such as South Africa (Van Wyk and Smith, 2016). A pilot study was thus undertaken to determine if post-natal foot length measurement could accurately estimate GA in a South African population. The study data was compared to existing foot length models and was found to most closely resemble the Merz model (Merz et al., 2000); subsequently a modified model was used to estimate GA of the study participants. The study found that foot length correlated well with GA and, despite the study lacking ethnical representivity, foot length was not influenced by race. The authors recommended further study to confirm the findings of the pilot study, as well as to create a foot length model for a South African population (Van Wyk and Smith, 2016).

**Table 1.6 Reported parameters and methods used to estimate gestational age of abandoned neonates**

| Parameter or method | References |
|---|---|
| Anthropometric parameters | Schulte et al., 2013; Pandey et al., 2015; du Toit-Prinsloo et al., 2016a |
| Ossification centers | Bareggi et al., 1994; Schulte et al., 2013 |
| Histological examination | du Toit-Prinsloo et al., 2016a |
| Anthopological measures | Kahana et al., 2005; Pandey et al., 2015 |
| Percentile charts | du Toit-Prinsloo et al., 2016a |
| Fingernails and toenails extend past tip | Schulte et al., 2013 |
| Presence of lanugo hair | Schulte et al., 2013 |
| Development of cartilage | Schulte et al., 2013 |
| Haase's rule of thumb | du Toit-Prinsloo et al., 2016a |
| Foot length | James et al., 1979; Mercer et al., 1987; Platt et al., 1988; Mandarim-de-Lacerda, 1990; Croft et al., 1999; Merz et al., 2000; Bulandra et al., 2004; Hirst et al., 2012; Conway et al., 2014; Pandey et al., 2015; Van Wyk and Smith, 2016; Geldenhuys et al., 2017 |
| Developing teeth | Nambiar et al., 2000 |
| Basilar part of occipital bone | Scheuer and MacLaughlin-Blac, 1994; Tocheri and Molto, 2002; Nagaoka et al., 2012 |
| DNA methylation | Knight et al., 2016 |
| Computed tomography | Taneja et al., 2011; Sieswerda-hoogendoorn et al., 2012 |

*Determination of live birth*

i) Methods used to determine whether neonates were born alive

Determining whether the neonate was born alive and breathed is one of the most important factors that need to be established during the post-mortem examination of abandonment cases (Dressler et al., 2011). However, the retrospective determination of live birth is nearly impossible based on autopsy findings alone (Gheorghe et al., 2011). As the bodies are routinely disposed of in secret and are easy to hide, discovery is usually later rather than sooner, resulting in decomposition, which often hinders the determination of live birth (Ong and Green, 2003; Marcikic et al., 2006; du Toit-Prinsloo et al., 2016a).

ii) Hydrostatic test

After live birth, inspiration aerates the lungs and initiates post-natal pulmonary blood circulation (Ong and Green, 2003). Subsequent lung changes include a colour change and an increase in weight and volume (Ong and Green, 2003). Assessment of the lungs is thus one of the most important aspects used to establish live birth.

In fresh bodies, the method most commonly used to determine whether a neonate was born alive is the controversial hydrostatic test (Tabata et al., 2000; Ong and Green, 2003; deRoux and Prendergast, 2006; Marcikic et al., 2006; Kozawa et al., 2010; Schulte et al., 2013; Krajkovic et al., 2014; Baber et al., 2015; du Toit-Prinsloo et al., 2016a). The basic principle behind the test is that if a neonate was born alive and breathed, the lungs will float when placed in water; if the lungs sink, the neonate was stillborn (Moar, 1997). The entire thoracic pluck is tested for aeration, as well as individual lungs, individual lobes and lung sections to compensate for irregular aeration (DiMiao and DiMiao, 2001; Grosse-Ostendorf et al., 2012). A positive result is obtained when at least a single piece of lung floats (Grosse-Ostendorf et al., 2012). Additionally, the lungs or sections thereof can be compressed, which will remove decomposition gas, but not inspired air (Moar, 1997). The hydrostatic test can also be used to test for air in the stomach and duodenum (Guddat et al., 2013). The liver and spleen can be used as a control to test for the presence of decomposition, as putrefaction occurs at a similar rate in these organs as in the lungs (Schwar et al., 1988; Moar, 1997; Spitz 1993; Guddat et al., 2013)

The value of the test is, however, debated. Some authors advocate that the test is only suggestive and only consider the test significant if, in fresh remains, the entire pluck floats, in which case it is likely that respiration occurred (Saukko and Knight, 2004). Other modifications, such as testing lung sections and the compression test, have no value (Saukko and Knight, 2004). Other criticisms include false positive and false negative results (Schwar et al., 1988; DiMaio and DiMaio, 2001; Saukko and Knight, 2004; DiMaio and Dana, 2007; Grosse-Ostendorf et al., 2012). False positives can occur due to putrefaction gas and attempted resuscitation; false negatives can occur due to fluid in the lungs after a water birth, death of the neonate shortly after birth and thawing of a frozen body.

The overall consensus is that attempted resuscitation and the presence of decomposition negate the outcome of the hydrostatic test (Schwar et al., 1988; Moar, 1997; Ong and Green, 2003; Grosse-Ostendorf et al., 2012; Guddat et al., 2013; Krajkovic et al., 2014; du Toit-Prinsloo et al., 2016a). Surprisingly, the test is often performed despite the presence of decomposition (Kozawa et al., 2010; Schulte et al., 2013; Krajkovic et al., 2014), in which case the result should only be considered significant if the lungs sink (DiMaio and DiMaio, 2001; DiMaio and Dana, 2007).

Despite criticism in the literature, and in the absence of other reliable methods, some consider the hydrostatic test the most reliable test to determine live birth, provided that it is not the only factor upon which this determination is based, the test is used under controlled conditions and the limitations are acknowledged (Moar, 1997; DiMiao and DiMiao, 2001; Kozawa et al., 2010; Grosse-Ostendorf et al., 2012).

iii) Other methods and signs of live birth

In addition to the presence of air in the lungs, other findings in cases of live birth and methods used to determine live birth have been described (Table 1.7). Some signs may take several hours or days to appear; unfortunately neonaticide is usually committed soon after birth.

Traditional findings include the macroscopic appearance of the lungs, the presence of air in the middle ear and stomach, the presence of food in the stomach and a vital reaction of the umbilical cord stump (Mitchell and Davis, 1984; Spitz, 1993; Ong and Green, 2003; Dressler et al., 2011; Gheorghe et al., 2011). Again, the presence of decomposition negates the finding of air in the middle ear or stomach. Food in the stomach is absolute proof of live birth, as swallowing is the only way for this to occur (Spitz, 1993), however the absence of food does not indicate stillbirth (Lavezzi et al., 2003; Lavezzi et al., 2004). Similarly, the absence of an inflammatory reaction of the umbilical cord does not indicate stillbirth; this is, however, a sign that can be observed from the first day of life and with the use of histology, within three hours (Ong and Green, 2003). Furthermore, thrombus formation in the umbilical vessels indicates survival of several days (Ong and Green, 2003). Histology can be useful to identify microscopic evidence of uneven or fully expanded alveoli, another reliable finding of live birth (Lavezzi et al., 2003; Ong and Green, 2003; Lavezzi et al., 2004). Histological examination and macroscopic findings combined is considered to be more useful than histology alone (Turan et al., 2012).

Other findings and methods include froth in the internal air passage, the micro- and macroscopic examination of the placenta, and the examination of the developing tooth for the presence of the neonatal line (Mitchell and Davis, 1984; Tabata et al., 2000; Ong and Green, 2003; Janardhanan et al., 2011; Schulte et al., 2013). The neonatal line represents the first enamel formed after birth and can be used to estimate the survival period after birth, thus proving live birth (Janardhanan et al., 2011).

Another useful indicator that live birth occurred when the birth and death were not attended is pulmonary interstitial emphysema (PIE) (Lavezzi et al., 2003; deRoux and Prendergast, 2006). PIE is histologically identified as the presence of air that disrupts the interlobular perivascular and peribronchial tissue spaces, and may spread to the visceral subpleural space (Lavezzi et al., 2003; Lavezzi et al., 2004). Multiple lung sections need to be sampled (Lavezzi et al., 2003; Lavezzi et al., 2004) and the assessment of radiographs or the use of multi-slice computed tomography (Rutty et al., 2010) is recommended to observe the often unclear evidence of PIE (deRoux and Prendergast, 2006).

Post-mortem multi-slice computed tomography (pmMSCT) (Guddat et al., 2013) and post-mortem magnetic resonance imaging (PMMR) (Barber et al., 2015) have also been recommended as non-invasive tools to detect signs of live birth (Guddat et al., 2013). Despite small sample sizes, noticeable differences were observed between stillborn and live born neonates with regard to lung aeration, with PMMR having the added advantage of providing more soft tissue detail (Barber et al., 2015). Post-mortem computed tomography (PMCT) showed a positive correlation with the hydrostatic test (Guddat et al., 2013; Mazuchowski et al., 2017), however live birth could not be determined using PMCT in cases with severe post-mortem changes (Sieswerda-Hoogendoorn et al., 2013). It is thus recommended to use pmMSCT and PMMR in conjunction with the conventional autopsy, histology and the hydrostatic test (Guddat et al., 2013; Michiue et al., 2013; Sieswerda-Hoogendoorn et al., 2013; Barber et al., 2015; Mazuchowski et al., 2017).

iv) Live versus stillbirth as reported in the review articles

Behera et al. (2016) reported almost equal counts of stillbirth (nearly 35%) and non-viable cases (36%), with 29% of the cases recorded as live births. More than half (57%) of the cases in the du Toit-Prinsloo et al. (2016a) study were non-viable foetuses. Of the total case load, 28% were stillborn and 13% showed signs of live birth, with no differentiation made between live and stillbirth in the remaining 59%. Of the viable foetuses, 41% were stillborn and 28% were live births.

Although cases of abandoned neonates are scarce in developed countries such as Denmark, five of the 11 cases were live births (Gheorghe et al., 2011). Twenty-three of the 26 infants in the Tursz and Cook (2011) study were autopsied and determined to have breathed. In the Eastern Croatian study, 66.5% (n=16) of the neonates were live births, two were stillborn and

the determination of live birth was impossible for the remaining six due to the presence of putrefaction (Marcikic et al., 2006). The North Carolina study included only live-born infants (Herman-Giddens et al., 2003). In some instances pathologists go so far as to report specific time spans of survival of the neonate (Schulte et al., 2013).

**Table 1.7 Reported methods used to determine live birth in abandoned neonates and findings in cases of live birth**

| Method or finding | References |
|---|---|
| Hydrostatic test | Schwar et al., 1988; Spitz, 1993; Moar, 1997; Tabata et al., 2000; DiMaio and DiMaio, 2001; Ong and Green, 2003; Saukko and Knight, 2004; deRoux and Prendergast, 2006; Marcikic et al., 2006; DiMaio and Dana, 2007; Kozawa et al., 2010; Grosse-Ostendorf et al., 2012; Turan et al., 2012; Guddat et al., 2013; Michiue et al., 2013; Schulte et al., 2013; Krajkovic et al., 2014; Baber et al., 2015; du Toit-Prinsloo et al., 2016a; Mazuchowski et al., 2017 |
| Appearance of the lungs | Tabata et al., 2000; Ong and Green, 2003; Saukko and Knight, 2004; Turan et al., 2012; Michiue et al., 2013 |
| Air lungs, middle ear, GIT | Spitz, 1993; DiMiao and DiMiao, 2001; Ong and Green, 2003; Dressler et al., 2011; Gheorghe et al., 2011 |
| Food in stomach | Ong and Green, 2003; Dressler et al., 2011 |
| Vital reaction of umbilical cord stump | Mitchell and Davis, 1984; Spitz, 1993; Ong and Green, 2003; Dressler et al., 2011; Gheorghe et al., 2011 |
| Histology | Lavezzi et al., 2003; Ong and Green, 2003; Lavezzi et al., 2004; Saukko and Knight, 2004; Turan et al., 2012; Michiue et al., 2013; Baber et al., 2015; Mazuchowski et al., 2017 |
| pmMSCT, PMMR, PMCT | Rutty et al., 2010; Guddat et al., 2013; Michiue et al., 2013; Sieswerda-Hoogendoorn et al., 2013; Baber et al., 2015; Mazuchowski et al., 2017 |
| Froth in air passage | Mitchell and Davis, 1984; Tabata et al., 2000; Ong and Green, 2003 |
| Examination of the placenta | Schulte et al., 2013 |
| Pulmonary Interstitial Emphysema | Lavezzi et al., 2003; Lavezzi et al., 2004; deRoux and Prendergast, 2006; Turan et al., 2012; Baber et al., 2015 |
| Post-mortem magnetic resonance imaging | Barber et al., 2015 |
| Neonatal line | Janardhanan et al., 2011 |

*Cause of death in live births*

The COD is often (up to 50% in some studies) (Schulte et al., 2013) indeterminable due to post-mortem scavenging and mutilation or the presence of decomposition, and thus remains undetermined in many cases (Marcikic et al., 2006; Gheorghe et al., 2011; Schulte et al., 2013; Behera et al., 2016; du Toit-Prinsloo et al., 2016a). Despite preservation, establishing the COD in frozen neonates also poses some challenges (Kozawa et al., 2010). Furthermore, in skeletonised remains, with a lack of soft tissue and an absence of any skeletal injury, COD

is impossible for both the pathologist and the anthropologist to determine (Kahana et al., 2005). A lack of standard recording and inconsistency in the phrases used in the post-mortem reports also hinder proper assessment of the COD (Schulte et al., 2013). Additionally, COD is often simply stated as non-viable product of conception/abortus or stillbirth (du Toit-Prinsloo et al., 2016a).

Among the live births, death by homicide was more common than natural causes and accidental methods (Herman-Giddens et al., 2003; Behera et al., 2016). The majority of the studies reported asphyxia (forms of strangulation/suffocation) as the main COD (Herman-Giddens et al., 2003; Marcikic et al., 2006; Gheorghe et al., 2011; Tursz and Cook, 2011; Schulte et al., 2013; Krajkovic et al., 2014), with only one study reporting no suffocations (du Toit-Prinsloo et al., 2016a). Other causes included abandonment and trauma, both sharp-force and head trauma, as well as drowning (Herman-Giddens et al., 2003; Marcikic et al., 2006; Gheorghe et al., 2011; Tursz and Cook, 2011; Behera et al., 2016; du Toit-Prinsloo et al., 2016a).

*Condition of the remains*

Decomposition and post-mortem scavenging or mutilation can hamper the medico-legal investigation. In addition, the condition in which the remains are discovered is scarcely described in the literature; only two studies reported on the presence of decomposition. In one study, features of decomposition were observed in one third of the cases (35%), of which almost half were viable (du Toit-Prinsloo et al., 2016a). In another study, the degree of putrefaction ranged from no putrefaction in more than half of the cases, to severe putrefaction to such an extent that the post-mortem examination was limited in 27% of the cases (Schulte et al., 2013). Another study did not specifically report on the degree of decomposition present, but stated decomposition as the reason why sex remained undetermined in certain cases (Herman-Giddens et al., 2003).

Other studies, as well as one case report, reported on cases consisting of only skeletal remains (Kahana et al., 2005; Gheorghe et al., 2011; Tursz and Cook, 2011), in which case a multi-disciplinary approach, including forensic pathology, anthropology and biology experts, should be adopted to ensure difficult to establish parameters can be investigated (Kahana et al., 2005). One case consisted of only the lower body of a new-born that was cut by a machine where it was buried in a construction site (Gheorghe et al., 2011), and one case

report mentioned that the head of the foetus was amputated post-mortem by a rubbish truck's compactor (Ong and Green, 2003).

*Manner in which remains were found – location and covering*

The most frequently reported locations where bodies were dumped included rubbish dumps or bins, on the side of the road, blind lanes, rivers and drains (Herman-Giddens et al., 2003; Ong and Green, 2003; Marcikic et al., 2006; du Toit-Prinsloo et al., 2016a; Behera et al., 2016). Other locations of disposal included burying in soil, various premises in or around the house, parks, jungles, railway stations, bus stands, religious places, schools and hospitals (Ong and Green, 2003; Marcikic et al., 2006; Gheorghe et al., 2011; Behera et al., 2016). In some instances the location of recovery remained unascertained (Behera et al., 2016). In one study a neonate was found in a refrigerator (Marcikic et al., 2006) and three case reports were also on frozen foetuses, highlighting the importance of pathologists being familiar with the location and circumstances of the concealment before conducting the autopsy (Tabata et al., 2000; Kozawa et al., 2010; Krajkovic et al., 2014).

Only one study reported on the manner in which the remains were covered. Gheorghe et al. (2011) reported that only one new-born was discovered wearing clothes, while five of the new-borns were naked and either in a plastic bag or buried. The most common method of disposing of the new-born was in a plastic bag, with seven out of 11 new-borns discarded in this manner. Four of the new-borns were wrapped, either in a blanket, bathrobe, towel or bath rug. Three new-borns were accompanied by personal belongings of the mother, including a bloodied towel or sheet, underwear or sanitary products. In one case a pacifier and plastic bottle were discovered with the new-born. In another case, an inscribed message from the parents was found on a stone with the new-born.

### 1.5.2 Medico-legal investigation

*Extent of post-mortem examination*

Information on the extent to which post-mortem examinations were carried out was only available in five of the studies. External examinations were described in detail, particularly with regard to signs of maturity, which is used to determine the viability of the neonate (Schulte et al., 2013). External only examinations were usually conducted on smaller

products of conception, with full post-mortem examinations usually conducted on cases with a mass of more than 1000g (du Toit-Prinsloo et al., 2016a). In instances where bodies were decomposed (du Toit-Prinsloo et al., 2016a) or only skeletonised remains were available (Tursz and Cook, 2011), no dissection was conducted. In other studies, a forensic autopsy was conducted on all (Marcikic et al., 2006; Gheorghe et al., 2011) or the majority (Tursz and Cook, 2011) of the cases. German law requires all three cavities (head, thorax and abdomen) to be opened (Schulte et al., 2013).

When encountered with frozen neonates, although thawing of the remains could accelerate post-mortem changes and hamper the post-mortem investigation, the remains cannot be examined in the frozen state (Kozawa et al., 2010). Thawing is thus necessary to allow a thorough examination (Tabata et al., 2000). Freezing the foetus, especially soon after death, and rapid thawing (Kozawa et al., 2010) resulted in well-preserved bodies (Tabata et al., 2000; Kozawa et al., 2010; Krajkovic et al., 2014), even in instances of long post-mortem intervals (Krajkovic et al., 2014). Thorough autopsies and histopathological examinations are thus possible (Tabata et al., 2000; Kozawa et al., 2010; Krajkovic et al., 2014) and can aid in answering forensically important questions on viability, survivability and the COD (Krajkovic et al., 2014). Additionally, changes observed in the skin can give an indication as to how soon after death the neonate was placed in the freezer (Tabata et al., 2000).

*Specimens retained and ancillary investigations conducted*

Possible ancillary investigations include DNA analysis, histology, toxicology and radiology and can aid in determining GA and COD (Kahana et al., 2005; Schulte et al., 2013; du Toit-Prinsloo et al., 2016a). Blood and bone (especially ribs) are normally retained for DNA analyses (du Toit-Prinsloo et al., 2016a). When only skeletal remains are available, a thorough anthropological examination should be conducted (Kahana et al., 2005).

Schulte et al. (2013) placed emphasis on establishing how often the recommended procedures were actually applied. Both histological examinations and toxicological analyses were not conducted frequently enough (Schulte et al., 2013; du Toit-Prinsloo et al., 2016a), perhaps due to financial restraints (Schulte et al., 2013). The value of performing non-destructive methods prior to opening the body should also not be underestimated, as X-rays and CT scans can aid in identifying skeletal development, thereby saving time and avoiding extensive preparations (Schulte et al., 2013).

*Prosecution rates*

Information on the prosecution rates of abandonment cases and neonaticide is scare, either due to unavailability of the information or lack of investigation of this aspect (Herman-Giddens et al., 2003; du Toit-Prinsloo et al., 2016a). Often, mothers were unidentified and could thus not be prosecuted (Ong and Green, 2003; Schulte et al., 2013), or they received suspended sentences (Marcikic et al., 2006). Additionally, difficulty in determining live birth and COD hinders the prosecution of these cases (Ong and Green, 2003; Kozawa et al., 2010).

The suspicion that prosecution rates are extremely low was corroborated by two studies (Marcikic et al., 2006; Gheorghe et al., 2011). In one study, of the ten mothers that were found guilty of infanticide, only one was convicted and sent to prison for a period of nine months (Marcikic et al., 2006). In the other study, one woman in 11 cases was prosecuted for the murder of a new-born (Gheorghe et al., 2011). In one case report, the mother was charged with concealment of birth and sentenced to two years in jail (Ong and Green, 2003).

Under the Croatian Criminal Code, women who kill new-born children are usually charged with the lesser crime of infanticide, with sentences ranging from one to eight years, instead of murder or manslaughter (Marcikic et al., 2006).

Although an investigation of the legal outcomes was beyond the scope of the North Carolina study, where legal information was obtainable, sentences ranged from 0-25 years imprisonment for the perpetrator, who, when known, was the mother in the majority of the cases (Herman-Giddens et al., 2003).

In France, infanticide is not considered as a separate concept from child homicide; therefore separate statistics and sentences do not exist (Tursz and Cook, 2011). Although 17 of the 27 mothers were identified in the France study, the prosecution rate was not reported (Tursz and Cook, 2011).

### 1.5.3 Conclusion

A review of the literature revealed a limited number of sources on the topic of abandoned neonates and the subsequent investigation in these cases. The overall profile and investigation of these cases is thus difficult to generalise. However, the most frequently reported scene of discovery of abandoned neonates was rubbish dumps or bins. The cases often comprise non-viable foetuses or stillbirths; among the live birth cases, death by homicide, typically asphyxia, was most frequently recorded. Sex-specific neonaticide or abandonment is difficult to conclude; despite some studies reporting more male victims, the majority of the studies had equal sex distributions or reported instances of undetermined sex.

GA and live birth are two of the most important parameters that need to be established when abandoned neonates are discovered. Foot length has been shown to be a good estimator of GA, but should be used with caution in stillbirth cases where maceration is present. The most frequently referred to and criticised method to determine live birth is the hydrostatic test. Additionally, histology and, more recently, the use of PMCT, are widely supported.
Decomposition remains a major problem, especially in the determination of live birth, but also hinders the determination of the COD, the extent to which the post-mortem examination can be conducted and the determination of parameters such as sex.

A standard protocol for the investigation of abandoned neonates does not exist. Despite the recommendation that ancillary investigations should be compulsory, histology and toxicology are not performed often enough. The extent to which the post-mortem examination is conducted, as well as the legal consequences in these cases, depends on the country in question. The scarcely available information on the prosecution of these cases suggests low prosecution rates.

The information assembled in this review provides an understanding of the profile of abandoned neonates and of the global consensus of the post-mortem examination and medico-legal investigation of these cases. Assessment of these aspects in a local context will supplement the limited literature on this topic, as well as provide an understanding of the extent of the problem and the nature of the investigation. This is the basis for chapter 2.

# Chapter 2
# Analysing the profile and medico-legal investigation of abandoned neonates admitted to Salt River Mortuary for the years 2012-2016

## 2.1 Introduction

### 2.1.1 Background

Children born in South Africa are at the highest risk of being killed in the first six days of life (Abrahams et al., 2016) and neonaticide and the abandonment of neonates are considered to be some of the least preventable crimes (Gheorghe et al., 2011). Every year, a high number of abandoned foetal and new-born remains are admitted to Salt River Mortuary (SRM) (Cape Town, South Africa) for post-mortem examination. These cases include non-viable foetuses and stillbirths (natural deaths), as well as abandoned live births (unnatural deaths); the latter having possible legal or criminal implications.

The medico-legal investigation of these cases depends on regional laws (du Toit-Prinsloo et al., 2016a) and in South Africa this includes the Births and Deaths Registration Act, the Criminal Procedure Act and the Inquests Act. The Births and Deaths Registration Act (Act 51 of 1992) stipulates that all live births and stillbirths need to be registered at the Department of Home Affairs to avoid being guilty of concealment of birth (the General Law Amendment Act (Act 46 of 1935)), which is applicable to foetuses that have reached 28 weeks gestation (S v Molefe, 2012). South Africa does not have special legislation protecting the lives of children, especially neonates (van der Westhuizen, 2009). Since there is no 'Infanticide Act', infanticide (and neonaticide) is not regarded as a separate crime under South African law, but falls under the common-law crime of 'murder' (van der Westhuizen, 2009). Under The Criminal Procedure Act (Act 51 of 1977), murder is defined as lawfully and intentionally causing the death of any such person who was born alive, where breathing is satisfactory evidence of live birth, regardless of an independent blood circulation (Snyman, 2008). In terms of the Inquests Act (Act 58 of 1959), if abandoned foetuses or new-borns are discovered, a police docket must be opened and the body must be admitted to a medico-legal mortuary for post-mortem examination.

Unfortunately, the prosecution rate of abandoned live births is suspected to be extremely low (du Toit-Prinsloo et al., 2016a). In the Western Cape, however, every child death (<18 years) is retrospectively reviewed on a monthly basis by the Child Death Review (CDR) team (Mathews et al., 2016), in an attempt to expedite legal decisions regarding child deaths. Consideration should thus be given to expanding the concept of the CDR to other regions of South Africa.

### 2.1.2 Rationale

While the concern of abandoned neonates is not unique to South Africa (Porter and Gavin, 2010; WHO, 2011), South Africa has seemingly higher rates compared to other countries. The reported abandoned babies rate in Gauteng and Mpumalanga was 0.1/100 000 in 2011 (Jacobs et al., 2014) and the national child homicide study showed that South Africa has one of the highest rates of neonaticide (killing of new-born within first 6 days of life) in the world (Abrahams et al., 2016). These high rates are thought to be indicative of the high rates of unwanted pregnancies and illegal abortions (Jacobs et al., 2014). Assessment of the profile of abandonment cases might aid in identifying risk factors for these cases and contribute to an improved understanding of the high rates observed in South Africa.

Another area of concern is the medicolegal investigation and post-mortem examination of such cases. While guidelines are available, a standard protocol does not exist and the necessary extent of the investigation is debated. Literature suggests that investigations should be done by skilled forensic pathologists (Gheorghe et al., 2011) and thorough ancillary investigations, which are seldom performed in South Africa (du Toit-Prinsloo et al., 2016a), should be compulsory for suspected cases of abandonment (Schulte et al., 2013). An adequate investigation is particularly important where death by abandonment is established and subsequent legal proceedings are necessary (du Toit-Prinsloo et al., 2016a).

There is thus a need for a legislative framework concerning the investigation and management of such cases (du Toit-Prinsloo et al., 2016a), and for the development and implementation of standard protocols to ensure that a thorough investigation is conducted (Schulte et al., 2013; du Toit-Prinsloo et al., 2016a). Assessment of the scope of the post-mortem investigation as it is currently conducted is a useful platform to determine whether resources are utilised optimally and investigations are conducted thoroughly.

Therefore, the aim of this study was to assess data pertaining to abandoned live births, stillbirths and non-viable foetuses admitted to SRM, with the following objectives: (i) description of the profile and assessment of the scope and nature of the post-mortem investigation of abandoned neonates; (ii) determination of the prosecution rate of abandoned live births; (iii) comparison of the prosecution rates before and after the implementation of the CDR.

## 2.2 Materials and Methods

### 2.2.1 Study design and ethical approval

A retrospective study approach was utilised to investigate cases of abandoned live births, stillbirths and non-viable foetuses admitted to Salt River Mortuary Forensic Pathology Service (a M6 mortuary; >2 000 bodies per annum) between 1 January 2012 and 31 December 2016. The years were chosen to include cases from before and after the CDR was established. The study was conducted using the Office Autopsy Database (OAD) (HREC REF: R036/2014), associated medico-legal case files and data from the CDR records, collected as part of the approved 'Child Death Review Pilot Study' (HREC REF: 396/2013). This study received approval from the University of Cape Town, Human Research Ethics Committee (HREC REF: 061/2017).

### 2.2.2 Identification of cases

Relevant cases were identified by filtering the OAD, covering the period from 1 January 2012 to 31 December 2016.

*Inclusion and exclusion criteria*

i. Cases were included in the study if:
   1. The case was admitted to SRM between 1 January 2012 and 31 December 2016;
   2. The case was recorded as either 'non-viable foetus', 'stillbirth' or 'concealment of birth' (including illegal termination of pregnancy);
   3. The neonate was determined to be less than one week old before dying.

ii. Cases were excluded from the study if:

1. The neonate was not abandoned i.e. the neonate was brought to the hospital by the mother seeking assistance or paramedics were called to assist;
2. A case file could not be obtained.

Due to the retrospective nature of the study, the quality of the data depended on data capturing at the time of each investigation. As such, a limitation of the study was the lack of information in some cases; in some instances only the post-mortem report, and no other scene information, was available. Cases with limited data were still included and all available variables were collected and analysed accordingly.

With the use of the WC number, the resultant dataset was then used to retrieve the associated medico-legal case files, which contained the CAS number, scene information and post-mortem findings. The WC numbers were also used to obtain the corresponding CDR numbers, which were used to access the CDR data for the relevant cases.

### 2.2.3 Data collection

Specific variables were captured from the OAD, CDR records and medico-legal case files, and included demographic details, anthropometric parameters, GA, COD and scope of the post-mortem examination (Appendix B).

Cases identified as abandoned live births were subsequently followed up with the South African Police Service (SAPS) using the CAS number and the name of the SAPS station where the case was opened, to track whether the cases went to court and determine the status of the cases in terms of prosecution. Possible court outcomes included under investigation, case closed and case finalised (refer to Appendix B for the definitions of the outcomes).

### 2.2.4 Data management and quality assurance

Data validation was performed on different days to ensure input errors did not occur, to verify data accuracy, completeness and consistency. This involved the verification of data recorded by the principle researcher, as well as the random selection of five cases from each year and verification of data recorded by an independent researcher. Drop-down lists, containing all

possible options for each variable, were included in the data collection form to ensure consistency in the recorded data.

Privacy, confidentiality and anonymity were maintained at all times. Case files were not copied and names and surnames were not collected as identifiers of subjects. Case particulars (WC, CAS and CDR numbers) were only used as a method of identifying, tracking and comparing medico-legal case files and CDR records. Upon completion of data collection, the data was de-identified by removing the case particulars, which were stored separately from the collected data and to which only the principle researcher had access. A unique identifying study number was used to link the case particulars to the corresponding collected data. Only de-identified, relevant data was used for subsequent data analysis. All collected data was stored on a password-protected database and saved on a password-protected backup drive.

### 2.2.5 Statistical analysis

Descriptive statistics, including means, proportions and standard deviations were conducted on numerical data. The Shapiro Wilk test was used to assess the normality of continuous data. Pearson's $\chi 2$ test was used to conduct hypothesis testing for categorical variables. A p-value of less than 0.05 was considered statistically significant. Statistical analyses were conducted using IBM SPSS Statistics for Windows (Version 24.0., Released 2016, Armonk, NY: IBM Corp) and Microsoft Excel® (Microsoft Office Professional 2010, version 14.0.7172.5000).

## 2.3 Results

### 2.3.1 Contextual overview

At SRM, from 1 January 2012 to 31 December 2016, there were a total of 16 890 admissions, of which 249 (1.5%) were identified for inclusion in this study (Fig. 2.1). The majority of these cases were natural deaths (70.3%), comprising non-viable foetuses, stillbirths and other natural causes. The post-mortem conclusion was used to classify these deaths. The COD remained undetermined in 51 (20.5%) cases. A total of 23 neonates (9.2%) were determined to be viable live births that died of unnatural causes; these cases were thus classified as unnatural deaths. Of these unnatural deaths, one case was prosecuted, and for the remainder of the cases, the court status was equally distributed between 'case closed' and 'under investigation'.

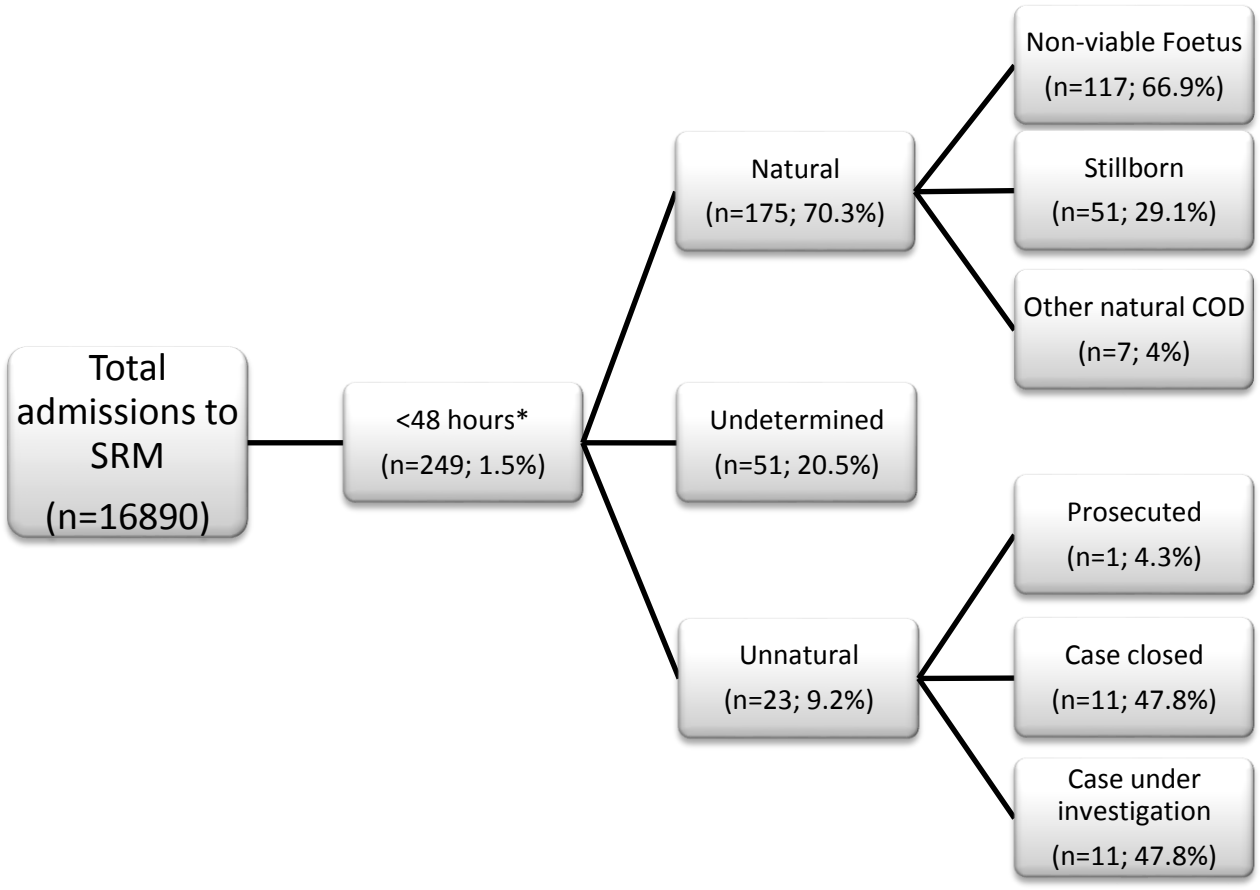



**Figure 2.1** Case progression of abandoned neonates (n=249) at Salt River Mortuary between 1 January 2012 and 31 December 2016. A total of 70.3% of cases were natural deaths, 9.2% were unnatural deaths and 20.5% remained undetermined. One case was prosecuted over the 5-year period.
* Two cases were excluded as the case files could not be obtained.

*Annual distribution*

The number of cases per year ranged from 44 to 56 (Fig. 2.2). Non-viable foetuses accounted for the majority of the cases in each year. In 2015 and 2016 natural deaths were only due to non-viable foetuses or stillbirths, no other natural CODs. The highest number of stillbirths, unnatural deaths and undetermined cases occurred in 2014, 2013 and 2015, respectively.

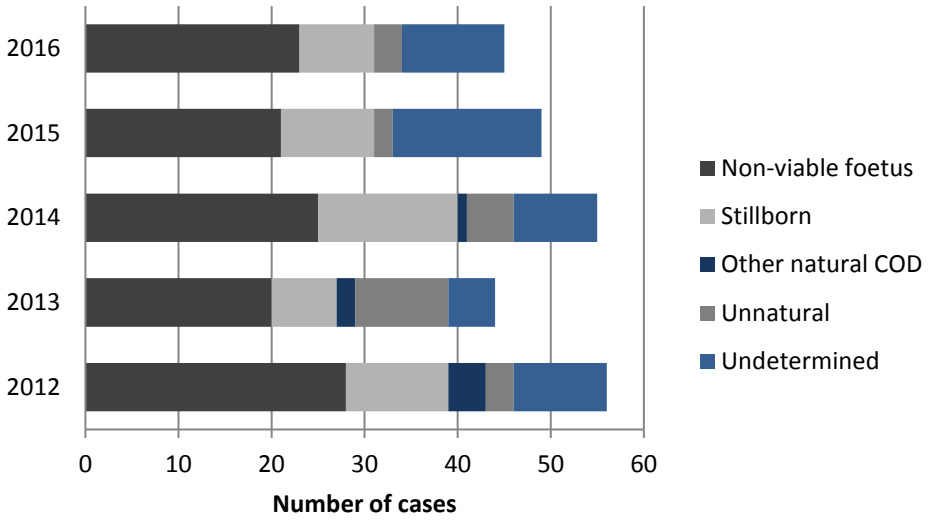



**Figure 2.2** Total number of cases per year defined as natural, unnatural and 'undetermined' deaths. The number of cases for each year (% of total cases for the 5-year period): *2012*: 56 (22.5%); *2013*: 44 (17.7%); *2014*: 55 (22.1%); *2015*: 49 (19.7%); *2016*: 45 (18.1%).

### 2.3.2 Demographic profile

*Sex*

There were 124 (49.8%) males and 88 (35.3%) females in the study period. The sex of the neonate could not be determined in 29 (11.6%) cases due to post-mortem mutilation (n=3), undifferentiated genitalia (n=3) or no reason given (n=23), and the sex was not recorded in the remainder of the cases (n=8, 3.2%). DNA analyses were, however, only conducted in 13.8% (n=4/29) of the cases of undetermined sex.

The date of death was taken as the day that the neonate was declared dead, which is usually when the remains are discovered and not necessarily when the neonate died. Overall, the majority of the deaths occurred between July and October each year and a male predominance was observed in the majority of the months (Fig. 2.3).

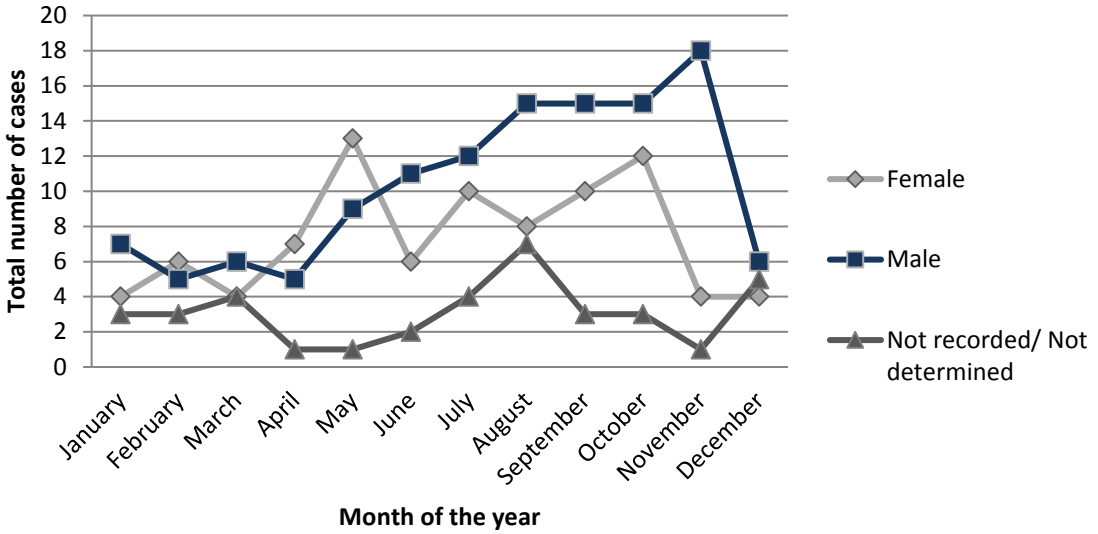



**Figure 2.3** Total number of cases by sex per month of the year. A total of 49.8% (n=124) of the neonates were male and 88 (35.3%) were female. The sex was undetermined and not recorded in 29 (11.6%) and 8 (3.2%) cases, respectively. The majority of the deaths were between July and October, with males accounting for the majority of the cases in most of the months.

*Anthropometric measurements*

The measurements recorded in the post-mortem report, in descending frequency, included mass, foot length (FL), length, crown-rump length (CRL), head circumference (HC), abdominal circumference (AC) and chest circumference (CC) (Table 2.1). In 15 cases all the measurements were recorded. In five cases, only FL was recorded. In another five cases, no measurements were recorded; possibly due to the condition of the remains in two cases (decomposition, post-mortem scavenging or mutilation), or the fact that the neonate was a very small product of conception in one case or no apparent reason in two of these cases.

**Table 2.1 Number of cases for which anthropometric measurements were recorded and not recorded (% of cases is given in brackets); and distribution of measurements according to minimum, maximum and mean**

| **Measurements** | **Mass** | **Length** | **CRL** | **HC** | **CC** | **AC** | **FL** |
|---|---|---|---|---|---|---|---|
| **Number of cases recorded** | 227 (91.2%) | 180 (72.3%) | 119 (47.8%) | 119 (47.8%) | 19 (7.6%) | 29 (11.6%) | 211 (84.7%) |
| **Number of cases not recorded** | 22 (8.8%) | 69 (27.7%) | 130 (52.2%) | 130 (52.2%) | 230 (92.4%) | 220 (88.4%) | 38 (15.3%) |
| | | | | | | | |
| **Measurements** | Mass (g) | Length (mm) | CRL (mm) | HC (mm) | CC (mm) | AC (mm) | FL (mm) |
| **Minimum** | 10 | 18 | 58 | 28 | 130 | 15 | 9 |
| **Maximum** | 4400 | 900 | 430 | 370 | 370 | 350 | 93 |
| **Mean** | 1419.7 | 377 | 257.6 | 273.8 | 265.3 | 244.2 | 53.6 |

The distribution of the measurements is given in Table 2.1 and Figure 2.4 A-D

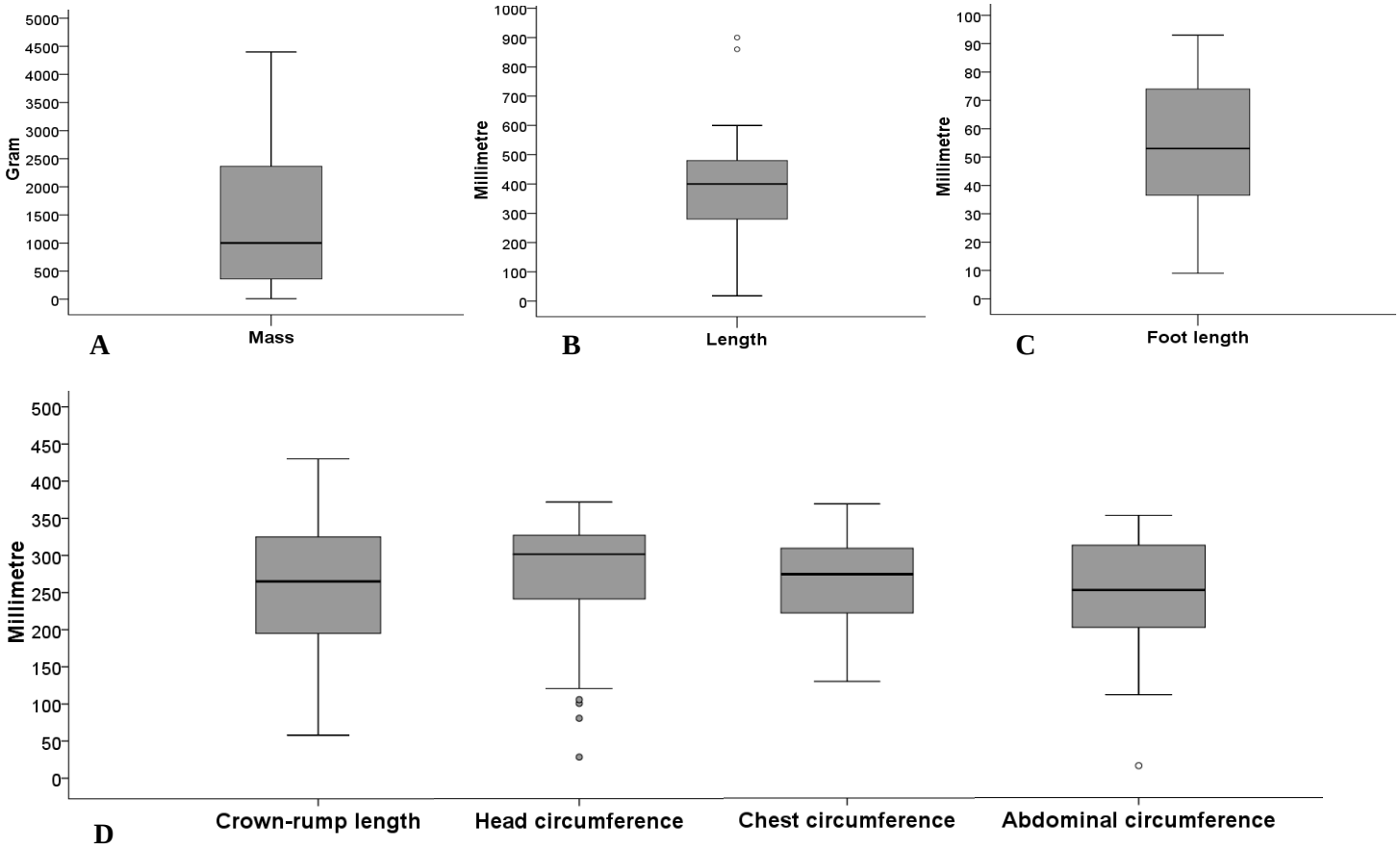



**Figure 2.4** Distribution of the anthropometric measurements: A) mass; B) length; C) foot length; and D) crown-rump length, head circumference, chest circumference and abdominal circumference.

*Viability, gestational age and foot length*

The age of viability was regarded as 28 weeks. Viability was not recorded in 15 cases (6%), of which six cases were determined to be stillborn, three cases were unnatural deaths and in the remaining six cases the COD was not determined.

GA was recorded in 81.9% (n=204) of the cases and ranged between seven and 42 weeks, with a mean of 28 weeks and a standard deviation of nine weeks (Fig. 2.5). The majority (53.4%) of the abandoned neonates had a GA of 28 weeks or more. Where the GA was recorded as 'term', this was taken as 39 weeks (WHO, 2014) and where a range was given for GA, the middle of the range was used. In 182 cases both GA and FL were recorded (Fig. 2.6). In the five cases where only the FL was recorded, GA was based on FL in four of these

cases. In the 15 cases where all the measurements were recorded, GA was based on the combined measurements in ten of these cases and on only FL in two of the cases.

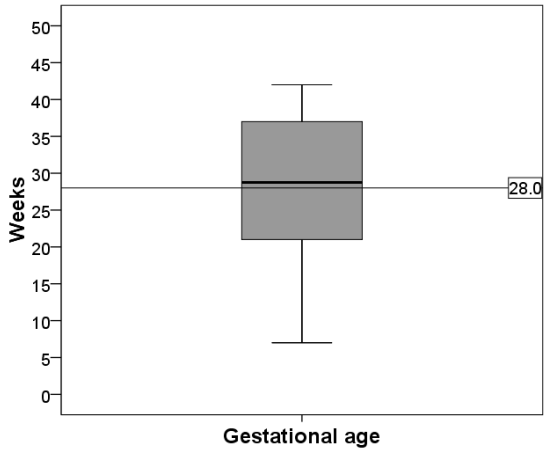



**Figure 2.5** Distribution of gestational age of the neonates. The age of viability (28 weeks) is indicated.

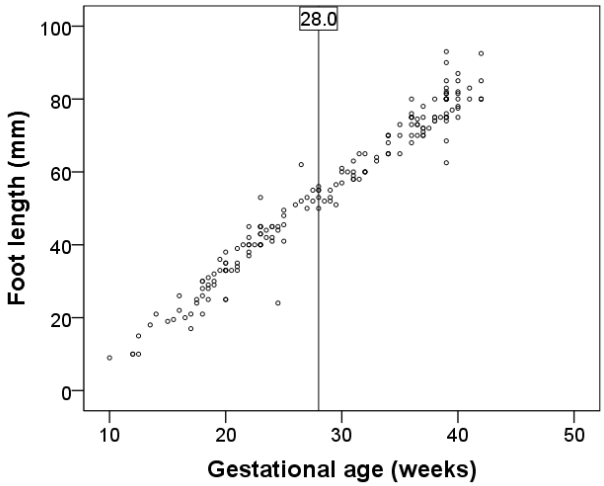



**Figure 2.6** Relationship between gestational age and foot length for the cases (n=182) where both parameters were recorded. The age of viability (28 weeks) is indicated.

*Manner in which the remains were discovered – location, scene, and covering*

i) Locations where the remains were discovered

SRM services Cape Town suburbs, townships and informal settlements falling within the Western metropole of the City of Cape Town. The majority (41.4%) of the neonates were discovered in the Cape Flats district, followed by the districts of Table Bay (18.1%), Mitchells Plain/Khayelitsha (16.1%), Blaauwberg (12.9%) and South Peninsula (11.6%) (Fig. 2.7).

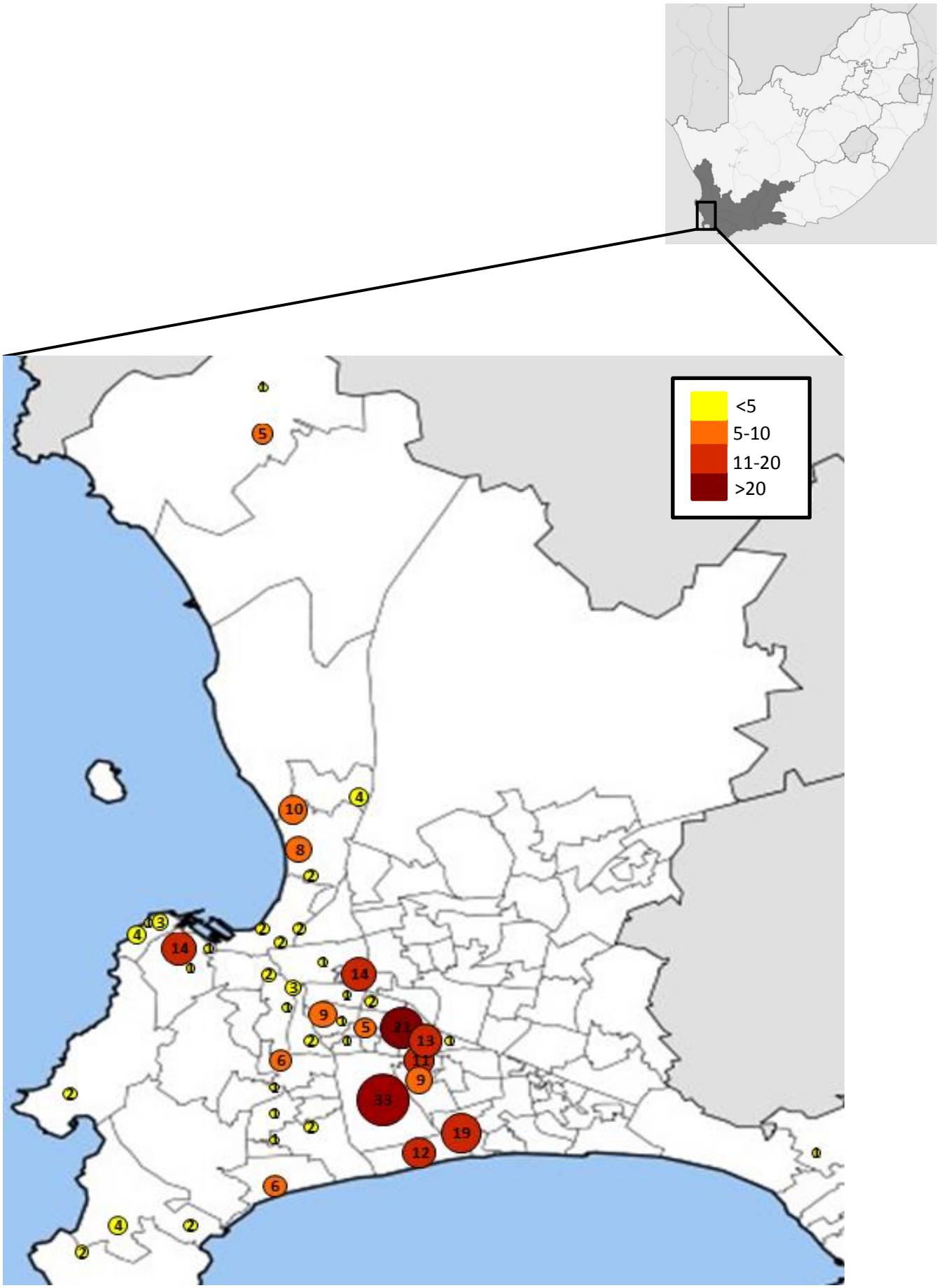



**Figure 2.7** Locations where abandoned neonates were discovered. The numbers represent the total number of cases in each location, i.e. including natural, unnatural and undetermined deaths. The Cape Flats region accounted for the most of the cases (41.4%).

ii) Scene of discovery

The majority of the neonates were discovered in open land (16.1%), followed by discovery of the neonate in a bucket (15.7%) (Fig. 2.8). An equal number of neonates were discovered in a drain, a house or in the road (7.6% each). The scene was recorded as 'Water' if the neonate was discovered in a lake, canal, river or in the sea, which was observed in 6% of the cases. 'Other' included all scenes of discovery other than the available categories (4.8%). In three (1.2%) cases the scene of discovery was not recorded.

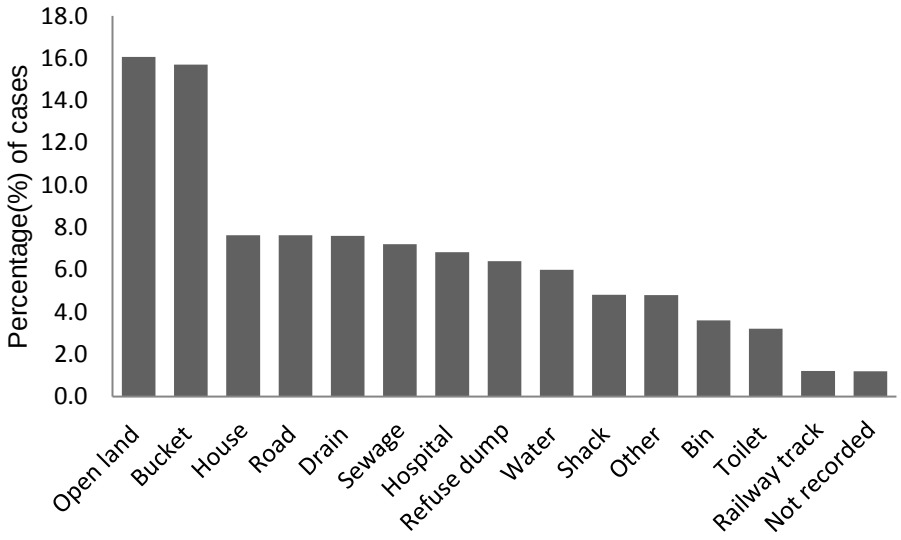



**Figure 2.8** Percentage (%) of cases by scene of discovery. The majority of the neonates were discovered in an area of open land (16.1%), followed by discovery in a bucket (15.7%), and found in a house, a drain or in the road (7.6% each).

iii) Covering

In 113 (45.4%) of the cases, the neonate was wrapped or placed in items, such as plastic or garbage bags in the majority of the cases, as well as towels, blankets, adult clothes, newspaper or other paper. The neonate was dressed in baby clothes in five (2%) cases, four of which were also wrapped in other items. In two cases the neonates were found in a handbag and a shoe box, respectively. In some instances accompanying items were found with the neonates; items included sanitary pads, adult clothing, newspapers, linen, diapers, towels and the placenta. In one case, a newspaper article titled "A mother's point of view" was found with the neonate. In 131 (52.6%) cases, the neonate was discovered unclothed and uncovered; however accompanying items were mentioned in 7 of these cases.

*Condition of the remains*

i) Traumatic injuries

Signs of traumatic injuries were present in 11 (4.4%) cases, with ante-mortem blunt force trauma to the head mentioned in seven of these cases. Other forms of trauma included a slit throat, a ligature abrasion around the neck, lacerations, abrasions and internal injuries. One case presented with multiple injuries, some of which were post-mortem.

ii) Decomposition and post-mortem mutilation

Decomposition was present in 103 (41.4%) cases, with the degree of decomposition ranging from early decomposition changes to advanced decomposition. Post-mortem mutilation or scavenging was observed in 43 (17.3%) cases and included puncture wounds, lacerations, and loss of organs and/or limbs. In one case, only a head and arm were available for examination.

### 2.3.3 Medico-legal investigation and post-mortem examination

*Extent of the post-mortem examination*

In two cases, a post-mortem examination could not be performed due to the condition (post-mortem mutilation and partial skeletal representation) of the remains. For the remaining 247 cases, the extent of the post-mortem examination was either external examination (EE), which included the use of the Lodox® (Xmplar-dr) X-ray imaging system, internal examination (IE) or partial examination (PE) (Fig. 2.9).

All of the unnatural deaths (n=23) underwent an IE. An EE was performed in six of the 49 cases with undetermined COD, with an IE performed in the remaining 43 cases. For the natural deaths, 68% (n=119/175) underwent an EE, 21.7% an IE and 10.3% a PE. The majority of the non-viable foetuses underwent an EE only (n=112/117; 95.7%).

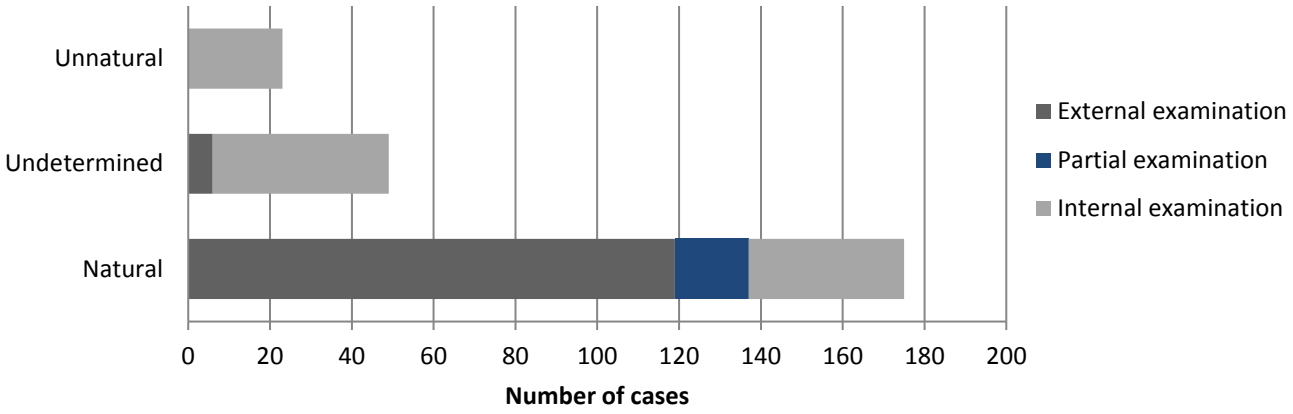



**Figure 2.9** Extent of the post-mortem examination for natural, unnatural and undetermined deaths. Post-mortem examinations consisted of either an external examination, partial examination or internal examination. An internal examination was performed in all of the unnatural deaths (n=23) and in the majority (n=43/49) of the undetermined cases. The majority of the natural deaths underwent an external examination (n=119/175).

*Ancillary investigations and specimens retained*

Ancillary investigations were conducted in 102 (41%) cases and included DNA analysis (n=87), histology (n=44), microbiology and toxicology (other: n=7) (Fig. 2.10). The outcome of histological analysis was not recorded in 50% (n=22/44) of the cases for which histological specimens were retained. The initial post-mortem conclusion changed in 12 cases after histology was performed; three cases were ultimately concluded to be natural deaths and nine cases were deemed unnatural.

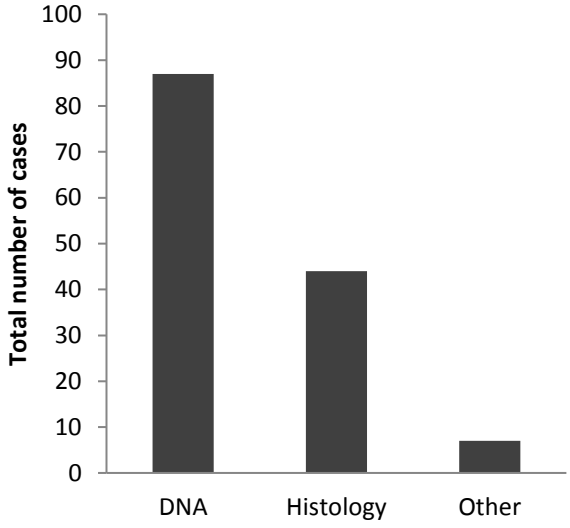



**Figure 2.10** Number of cases for which ancillary investigations were conducted as part of the post-mortem examination. Investigations included DNA analysis (n=87), histology (n=44) and other investigations (n=7) such as toxicology and microbiology.

Specimens were retained in 107 (43%) cases. Specimens retained for DNA included blood, various bones, muscle and a towel/clothing. In five cases, tissue sections were retained for histology, however a report was not issued as histology would only be performed if later indicated. Specimens are generally retained for histology as part of the post-mortem examination, however once a COD is determined, histology is not deemed necessary.

*Unnatural deaths*

A total of 23 (9.2%) cases were determined to be unnatural deaths, with DNA analysis and histology performed in 16 (69.6%) and 15 (65.2%) cases, respectively. Asphyxia was the most common conclusion stated, along with abandonment, improper care at time of birth and exposure (Table 2.2). In four cases the precise COD was undetermined, however the death was determined to be unnatural; possible reasons were suffocation and lack of appropriate care of the neonate. In one case the post-mortem conclusion was simply stated as "findings consistent with infanticide".

**Table 2.2 Post-mortem conclusions in 23 cases of unnatural death**

| Post-mortem conclusion | N (%) |
|---|---|
| **Asphyxia** | 4 (17.4%) |
| **Strangulation/suffocation** | 2 (8.7%) |
| **Drowning** | 2 (8.7%) |
| **Haemorrhage due to unclamped cord** | 1 (4.3%) |
| **Head injury** | 2 (8.7%) |
| **Hypoxia** | 1 (4.3%) |
| **Infanticide** | 1 (4.3%) |
| **Ingestion of organophosphate poison** | 1 (4.3%) |
| **Slit throat** | 1 (4.3%) |
| **Undetermined but unnatural** | 4 (17.4%) |
| **Abandonment/improper care/exposure** | 4 (17.4%) |

The court status was equally distributed between 'case closed' and 'under investigation' (11 cases each, 47.8%) (Table 2.3). In nine instances where the case was closed, the reason was stated as "unknown new-born baby, identity of the biological mother could never be established". DNA analysis was performed in six of these cases. In one case, the case was finalised and closed and the mother was charged with concealment of birth, but was acquitted

as the COD was determined to be natural; however this conclusion did not agree with the conclusion in the post-mortem report. In total, only one case was prosecuted; the accused was charged with murder and sentenced to eight years imprisonment. Both DNA analysis and histology were performed in this case.

**Table 2.3 Court status of unnatural deaths (n=23) for the 5-year period. Case finalised = case prosecuted.**

| Court status | Reason for 'case closed' | Information on court status | N (%) |
|---|---|---|---|
| Under investigation | NA | No information | 7 (30.4%) |
| | | Docket at Inquest Court | 3 (13%) |
| | | Case changed from inquest to murder | 1 (4.3%) |
| Case closed | Mother charged with COB, acquitted | Case withdrawn | 1 (4.3%) |
| | Accidental drowning | No information | 1 (4.3%) |
| | Unknown ID of mother | No information | 9 (39.1%) |
| Case finalised | NA | Accused charged with murder; sentenced to 8 years imprisonment | 1 (4.3%) |

Abbreviations: NA = Not applicable; COB = Concealment of birth

*Undetermined deaths*

The COD could not be determined in 51 (20.5%) cases, with the post-mortem conclusion stated as 'Under investigation' in five cases and 'Undetermined' or 'Unascertained' in the remaining 46 cases. In seven (13.7%) cases, no reason was given as to why the COD could not be determined; however, this was attributed to the presence of decomposition in 17 (33.3%) cases, decomposition and post-mortem mutilation in one (2%) case and decomposition and partial skeletal representation in one (2%) case. Histology was performed in 10.5% (n=2/19) of these cases. In total, DNA analysis and histology were performed in 38 (74.5%) and 22 (43.1%) cases, respectively. Samples were retained for histology in all five cases recorded as 'Under Investigation'.

i) Determination of live birth

Of the 51 cases in which the COD remained undetermined upon completion of the post-mortem examination, the post-mortem findings suggested that the neonate was stillborn in one case, with the examination findings concluding live birth in a further 18 cases. In 13 instances, live birth could not be determined due to the presence of decomposition (n=11), lack of internal organs (n=1) and no reason given (n=1). In 19 instances it was not recorded whether the neonate was born alive, with no reason given for not recording this parameter in

11 of these cases. In the remaining eight cases, an indication as to possible live or stillbirth was given, however it was not explicitly stated.

ii) Court status

The court status was given as 'under investigation' in 31 (60.8%) cases of undetermined death. In 10 (19.6%) instances, the case was closed, eight of which were due to the unknown identity of the mother. DNA analysis was performed in six of the eight cases. In one case no reason was given and the other case was finalised; the mother was charged with concealment of birth, but was acquitted as the COD could not be determined. For the remaining cases, the status was given as either 'at the Director of Public Prosecutions for decision' or 'court docket'.

*Child Death Review*

There were 28 cases of unnatural or undetermined deaths in 2012 and 2013, i.e. before the CDR was established, of which 39.3% were closed, 14.3% were court dockets and 46.4% were still under investigation (Table 2.4). After the establishment of the CDR (2014-2016), 46 cases were investigated. These cases were closed, court dockets and under investigation in 21.7%, 8.7% and 65.2% of the instances, respectively. No cases were prosecuted in 2012 or 2013. One case was prosecuted in 2014, after the CDR was established.

**Table 2.4 Court status of cases from before (2012-2013) and after (2014-2016) the establishment of the Child Death Review**

| | At DPP for decision | Case closed | Case finalised | Court docket | Under investigation | Total |
|---|---|---|---|---|---|---|
| **Before CDR** | 0 | 11 | 0 | 4 | 13 | 28 |
| **After CDR** | 1 | 10 | 1 | 4 | 30 | 46 |
| **Total** | 1 | 21 | 1 | 8 | 43 | 74 |

Abbreviations: DPP = Director of Public Prosecutions; CDR = Child Death Review

## 2.4 Discussion

The aim of this study was to assess the profile and scope of the medico-legal investigation of abandoned neonates at SRM. A major problem encountered in this study, which is unfortunately the nature of retrospective studies, is missing data due to the lack of recording at the time of the investigation. Nevertheless, the study identified 249 abandoned neonates admitted to SRM between 2012 and 2016, a seemingly higher number compared to other countries.

The largest retrospective study conducted in South Delhi, India, reported 238 abandoned foetuses and new-borns autopsied over a 17-year period (1996–2012) (Behera et al., 2016). Eleven cases of abandoned babies were observed at three forensic medical institutions in Denmark over a 12-year period (1997-2008) (Gheorghe et al., 2011). The study included all abandoned infant corpses or remains that were discovered in Denmark during that time, with a time span of a few hours to seven years between disposal and discovery of the remains. Marcikic et al. (2006) conducted a retrospective assessment of 24 babies discovered in various places in Eastern Croatia over a 25-year period (1980-2004).

A study of suspected neonaticides, carried out at 27 legal medicine institutes across Germany over a 15-year period (1993-2007), produced 150 cases (Schulte et al., 2013). In an attempt to emphasize the underestimation of neonaticides in France, Tursz and Cook (2011) identified 27 cases of neonaticide over a 5-year period (1996-2007) where infants died within the first 24 hours of life. The rate of neonaticides in North Carolina (USA) is similar to that seen in France, as revealed in a study where 35 live born infants were identified to have been killed or discarded by a parent before the fourth day of life over a 16-year period (1985-2000) (Herman-Giddens et al., 2003).

The high rates observed in the present study were comparable to the rates reported in the only published South African study, conducted at the Pretoria Medico-Legal Laboratory (PMLL) (du Toit-Prinsloo et al., 2016a). A total of 289 abandoned foetuses and new-borns that survived for less than 24 hours, were admitted to the PMLL over a 5-year period (2004-2008). The number of cases per year ranged from 28-99, which is more varied than the present study's more equally distributed 44-56 cases per year. The study cases comprised 2.5% of the total case load at the PMLL over the study period, in comparison with this study's 1.5% of the total case load at SRM. It is also important to bear in mind that the cases

included in studies such as the present one are only the cases that were discovered and admitted to the mortuaries for post-mortem examination; many cases are never found and the true rate of abandoned neonates is most likely higher than the reported rate.

Similar to the Pretoria study, the present study was limited to one region, further emphasising the problem of the alarmingly high rate of abandoned neonates in South Africa, especially considering the liberal termination of pregnancy (TOP) laws in South Africa (du Toit-Prinsloo et al., 2016a). The Choice on Termination of Pregnancy Act (Act 92 of 1996) stipulates when (up to 12 weeks gestation, with additional provisions for the second and third trimester) and where termination may be performed. Despite these liberal provisions, many women still choose illegal TOP, with many of these foetuses being dumped, further adding to the problem of abandoned neonates. Reasons why women choose illegal termination over the safer and legal option include inaccessible or inadequate TOP service delivery, poor counselling regarding the TOP procedure, the fear of being mistreated at public facilities and the stigma associated with TOP (Pickles, 2013a; Jacobs et al., 2014). Additionally, many women are still not aware of the Act and others are uneducated regarding the provisions of the Act (Pickles, 2013a; Jacobs et al., 2014). Focus should be on improving service delivery and quality of care at TOP facilities, as well as increasing awareness of the Act through public information campaigns on TOP rights and procedures (Pickles, 2013a). Furthermore, public education campaigns concerning contraception, reproduction, early pregnancy recognition and the availability of adoption services should receive more attention (Marcikic et al., 2006; Tursz and Cook, 2011; Pickles, 2013a). Before the number of abandoned neonates can be reduced, another option must first be available for the mothers; thus, by working with social scientists, the ongoing issue of illegal TOP can be addressed.

### 2.4.1 Demographic profile

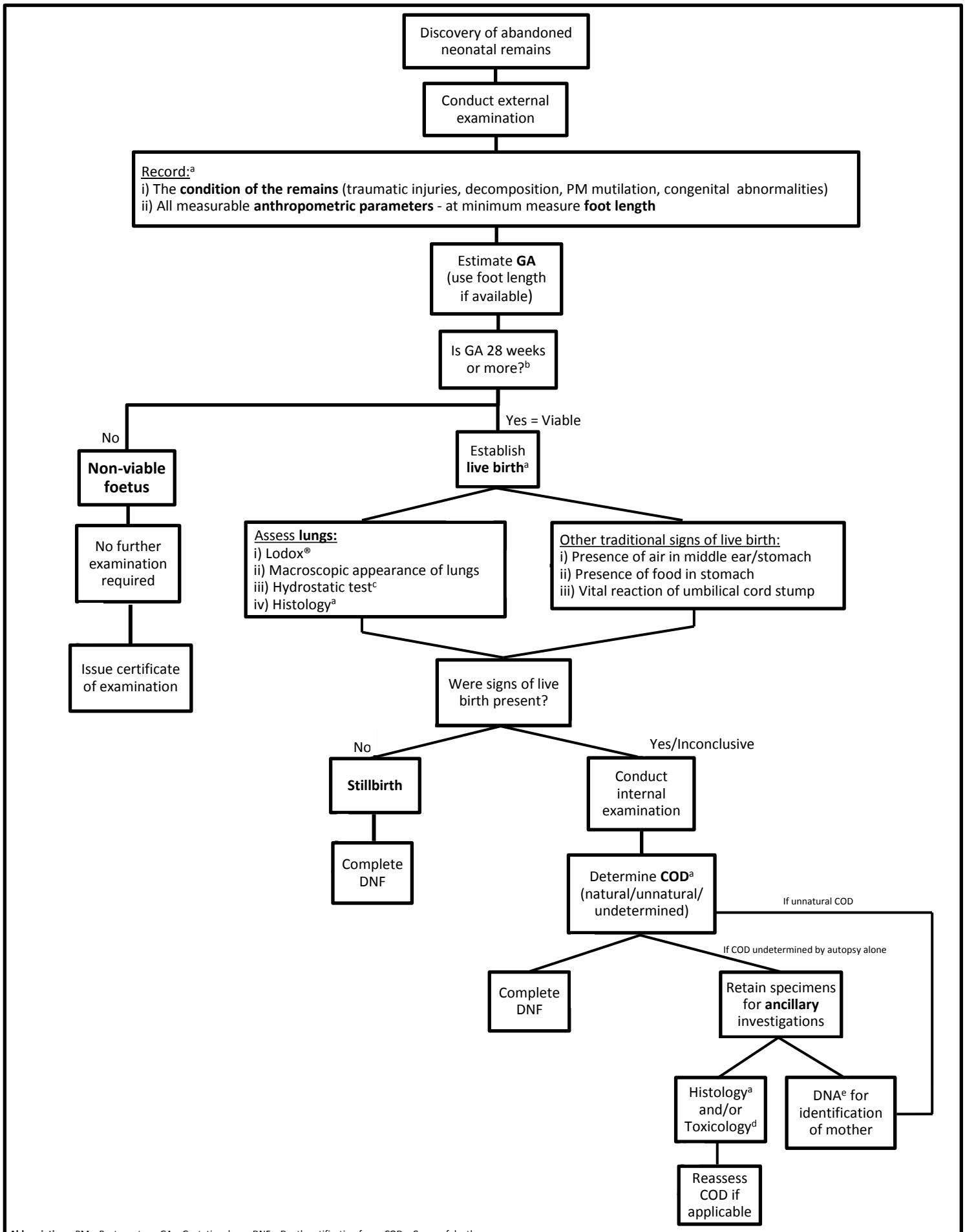
*Sex*

Half (49.8%) of the cases in this study were male and 35.3% were female, which is comparable to other studies that reported more male than female victims (Herman-Giddens et al., 2003; Tursz and Cook, 2011; du Toit-Prinsloo et al., 2016a). However, the sex was not determined in 11.6% of the cases, which could explain the difference in sex distribution. This percentage was less than the 19% of cases with unascertained sex in the Pretoria study. In 20.7% of the cases the sex was undetermined either due to post-mortem mutilation or

undifferentiated genitalia. No reason was specifically given for undetermined sex in the post-mortem report in the remaining 79.3% of the cases, but from the case context this could perhaps also be due to undifferentiated genitalia, as the majority of these neonates were non-viable. Furthermore, decomposition was not stated as a reason for undetermined sex in any of the cases, unlike other studies that reported decomposition (Herman-Giddens et al., 2003).

*Anthropometric measurements*

As reported in other studies, the mass was the most frequently recorded anthropometric measurement (Gheorghe et al., 2011; Schulte et al., 2013; du Toit-Prinsloo et al., 2016a). The Pretoria study reported a lower mean weight of 1288g than other studies, which is similar to the mean weight of 1419.7g in this study (du Toit-Prinsloo et al., 2016a). The two South African studies also reported similar mean lengths. However, foot length was recorded in 84.7% of the cases in the present study, with only 48% in the Pretoria study. Considering the compelling evidence for the reliability of foot length as an estimator of GA (Mercer et al., 1987; Mandarim-de-Lacerda, 1990; Merz et al., 2000; Bulandra et al., 2004; Hirst et al., 2012; Conway et al., 2014; Pandey et al., 2015; Van Wyk and Smith, 2016; Geldenhuys et al., 2017), and the fact that forensic pathologists are trained to use foot length to estimate GA (L.J. Martin, personal communication, October 17, 2017), it is difficult to understand why foot length is not recorded in all cases where it is possible to do so (barring decomposition and post-mortem scavenging). Abdominal circumference was recorded in 29 cases compared to one case in the Pretoria study. There was thus a lack of consistency in which measurements were recorded in these cases, and a standard protocol might direct the minimum necessary measurements that should be recorded (Fig. 2.11).




**Abbreviations:** PM = Post-mortem; GA = Gestational age; DNF = Death notification form; COD = Cause of death

[a]If decomposition permits

[b]Cut-off for viability needs to be determined by legislation to ensure consistency

[c]Any signs of decomposition exclude the use of this test

[d]If indicated by case history/scene findings/autopsy findings

[e] *Why not conduct DNA analyses in all viable cases?* Since stillbirths and other natural CODs would not be prosecuted as murder, but as concealment of birth (for failing to register the baby, under The Births and Deaths Registration Act (Act 51 of 1992)), a justifiable course of action, considering resource constraints in South Africa, might be to only conduct DNA analyses in instances of unnatural or undetermined CODs.
*Why conduct DNA analyses in instances of undetermined COD?* Although the neonate might have been stillborn or died due to natural causes (see point d), and although the COD might never be known, histological examination could possibly provide a (unnatural) COD, which would only be known at a later stage (upon completion of histology), and in which case the necessary samples for DNA analyses would have to have been taken at the time of the PM examination.

**Note:** Genetic screening could be conducted where congenital abnormalities were detected upon external examination; however, considering the resource constraints in South Africa, this investigation might not be feasible.



**Figure 2.11** Recommendations for conducting the medico-legal investigation of abandoned neonates in a South African setting

*Viability and gestational age*

The definition of viability differs among researchers and organisations and although many authors have debated this complex issue, Ballantyne already defined viability in 1902 in such a manner that summarised all the recurrent themes emerging from ongoing discussions today; i) the foetus' intrinsic anatomical features, as well as its "capability to maintain functional activity and intended survivability not only for a few hours, but potentially possible for months and years" play a role in viability, ii) not only the number of months (i.e. GA), but also the quality of the intrauterine months determine viability iii) and the advancement of technology could decrease the limit of viability (Ballantyne, 1902).

Although GA is often the deciding factor used to determine viability, other factors not commonly taken into account (Lorenz, 2000) include anatomical, functional, genetic, environmental, cultural, social, economic and technological variables (Breborowicz, 2001; Blackman, 2003; Ho, 2003; Levene, 2004). Each pregnancy is unique and as such each foetus experiences a unique "intrauterine quality of life" (Pignotti, 2010); the concept of viability is thus variable (Ballantyne, 1902; Blackman, 2003; Ho, 2003). As pointed out by Pignotti (2010), defining variability is essentially impossible and futile, at least clinically, due to its variability "from one individual to another and from one community to another and therefore the only way to describe it is statistically, with a specific gestation survival curve at a particular location and time."

Viability is also affected by a country's developmental level (du Toit-Prinsloo et al., 2016b) and varies between different societal contexts (Ho, 2003; Pickles, 2013b) – consider for example premature neonates born in facilities with specialised neonatal support compared to babies born in rural areas at mobile obstetric units, or at home, where the necessary technological resources are not always available, as is likely the case in instances where the neonates end up being abandoned.

The definition of viability also differs among the different disciplines involved, namely medicine, law and ethics (Pignotti, 2010). While medicine addresses "processes and grey areas", and while defining viability might seem pointless considering its variability, the law requires a fixed cut-off (Pignotti, 2010). Countries have different legislation concerning viability and in South Africa there is no statutory definition of viability (du Toit-Prinsloo et al., 2016b; du Toit-Prinsloo et al., 2016c). Viability is only 'defined' in case law (du Toit-Prinsloo et al., 2016b; du Toit-Prinsloo et al., 2016c), where the cut-off also differs from case

to case; in S v Mshumpa (2008), 25 weeks was accepted as viable, whereas according to S v Molefe (2012), the crime of concealment of birth is only applicable to foetuses that have reached at least 28 weeks GA.

Furthermore, viability also plays a role in the medico-legal management of foetal remains in clinical and forensic pathology practice. Unfortunately, South African law pertaining to this management is outdated (du Toit-Prinsloo et al., 2016c). The remains are allocated different statuses depending on how they originated (du Toit-Prinsloo et al., 2016c). According to the Births and Deaths Registration Act (Act 51 of 1992), a death notification (DNF) must be completed in order to obtain a burial order. However, a DNF is only issued in instances of live birth followed by death, or in cases of stillbirth, defined as a foetus that has completed "at least 26 weeks of intrauterine existence but showed no signs of life after birth". GA alone provides the dividing line for stillbirth or miscarriage (duToit-Prinsloo et al., 2016c); before 26 weeks, products of pregnancy loss are considered to be 'early pregnancy loss' and according to law should be treated as pathological waste, as foetuses are included under the definition of 'pathological waste" (Western Cape Health Care Waste Management Act, Act 7 of 2007). Furthermore, all foetal remains from TOP procedures are deemed pathological waste, irrespective of elective or therapeutic TOP procedure, or viable or non-viable pregnancy (du Toit-Prinsloo et al., 2016b; du Toit-Prinsloo et al., 2016c). Thus, a stillbirth can be legally buried, but a 26 week old foetus resulting from a TOP will be disposed of as pathological waste (The Choice on Termination of Pregnancy Act 92 of 1996). Although international literature provides alternative methods for managing foetal remains stemming from obstetric practice, there is little to no information regarding the forensic management of the remains of abandoned neonates (du Toit-Prinsloo et al., 2016c). Guidelines and legislation are thus needed and should respect the fact that the remains are still effectively human and should be managed as such (du Toit-Prinsloo et al., 2016c).

Despite the variability of viability, GA is still commonly used to determine viability and thus remains one of the most important factors that need to be established in abandonment cases. Various GAs for viability have been proposed by different authors and organizations, ranging between 22 and 26 weeks (Nishida, 1992; Allen et al., 1993; Rutter, 1995; Rennie, 1996; Lagercrantz, 2007), with the majority of these recommendations at or including 24 weeks GA (Saukko and Knight, 2004; Behera et al., 2016). With emerging technology, it is possible for babies to survive being born at a younger GA; these cases would, however, require extensive

care and treatment (Saukko and Knight, 2004). This would not be the case for abandoned neonates; regarding 24 weeks GA as viable in abandoned neonates thus seems improbable.

The lack of consensus regarding the age of viability made it difficult to compare study results. The Pretoria study considered 26 weeks GA as viable, with the mean GA at 26 weeks and with the majority of the neonates less than 26 weeks, thus non-viable (du Toit-Prinsloo et al., 2016a). In the present study, 28 weeks was used as the cut-off for viability according to S v Molefe (2012), however as mentioned, the post-mortem conclusion was the deciding factor used to classify the deaths as non-viable, stillborn, unnatural or undetermined. The mean GA in the present study was 28 weeks, with the majority of the neonates more than 28 weeks and thus viable. Additionally, it transpired that local forensic pathologists do not necessarily use the same GA to determine viability, more specifically concerning borderline cases, i.e. 26 or 27 weeks GA, further emphasizing the lack of consistency with regards to viability.

Furthermore, GA was not always recorded. Although recorded in more instances compared to the Pretoria study (81.9% versus 60%) (du Toit-Prinsloo et al., 2016a), a reason for not recording the GA, such as decomposition, was not always given. At the very least the GA could aid in assessing the statistics of viable versus non-viable foetuses, even if the COD remained undetermined. A standard protocol could stipulate the age of viability, as well as make it mandatory to record the GA, considering the importance of this parameter (Fig. 2.11).

*Location*

A total of 41.4% of the neonates were discovered in the Cape Flats district, which covers roughly 13 200ha and has a population of approximately 583 000 people (City of Cape Town 2011 Census, 2013). The majority of the population live in formal dwellings (79.5%), with 19.3% of the population living in informal dwellings (City of Cape Town 2011 Census, 2013). The areas identified in the study where high rates of abandoned neonates were discovered can be regarded as areas of low socio-economic status (SES). Based on annual household income, 51.5% of Cape Flats households fall within the low income bracket, with the households in the remaining areas falling within this low bracket ranging between 30.5% - 63% (City of Cape Town Socio-Economic Profile, 2016). Neonaticide is more likely to occur in regions of low SES, with reasons for this including AIDS, extramarital affairs and poverty (van der Westhuizen, 2009). Additionally, in a South African study assessing

pregnancy-related maternal deaths at SRM between 2008 and 2012, most of the deceased women belonged to the Black and Coloured population groups, which mainly make up the low income group in the Western Cape Province, indicating that a lower SES (and ethnicity) could be associated with an increased risk of maternal death (Khan, 2014). Higher SES has also been shown to be associated with a reduced risk for late ante-natal care (ANC) attendance (Mametja, 2009). Early ANC attendance allows for maternal and foetal health problems to be picked up and poor lifestyle behaviours to be addressed early on in the pregnancy (WHO, 2006). Poor maternal health and late ANC attendance might be resulting in an increase in spontaneous abortions, which could provide an explanation for the high rates of abandoned neonates seen in the areas identified in the study.

*Decomposition and post-mortem mutilation*

The determination of live birth, COD, sex and GA, as well as the extent to which the post-mortem examination can be conducted, can all be hindered by the presence of decomposition and post-mortem mutilation or scavenging. Varying degrees of decomposition can be observed, which is attributed to the fact that new-born babies are easily concealed and as such can remain hidden for a long time after death (Schulte et al., 2013).

A third of the cases in the Pretoria study (du Toit-Prinsloo et al., 2016a) and half of the cases in another study presented with decomposition, with the post-mortem examination limited in 27% of the cases (Schulte et al., 2013). In the present study, 41.4% of the cases showed signs of decomposition, and post-mortem mutilation or scavenging was observed in 17.3% of the cases. Although less than the 50% of undetermined deaths in the study by Schulte et al. (2013), in the present study the COD was undetermined in 51 cases (20.5%), 19 of which were attributed to the presence of decomposition and/or post-mortem mutilation and/or partial skeletal representation. Similarly, the Pretoria study reported 22% of cases with no anatomical COD, with some cases consisting of decomposed or mutilated remains. Furthermore, in the present study, in two cases the post-mortem examination could not be performed due to the condition (post-mortem mutilation and partial skeletal representation) of the remains. In one case, only a head and arm were available for examination and most parameters could not be established; the case thus remained an undetermined death.

*Live versus stillbirth*

In the present study, natural deaths accounted for 70.3% of the cases. Similarly, another study reported that approximately 70% of the cases were either stillbirths or non-viable foetuses, with 29% of the cases recorded as live births (Behera et al., 2016). The present study included fewer non-viable foetuses (47%) compared to the Pretoria study (54%), but slightly more stillbirths (20.5% versus 15.6%) (du Toit-Prinsloo et al., 2016a). In other studies, the majority of the neonates were live births, although fewer cases made up the total number of cases included in the studies (Herman-Giddens et al., 2003; Marcikic et al., 2006; Gheorghe et al., 2011; Tursz and Cook, 2011; Schulte et al., 2013).

*Unnatural deaths*

Similar to the majority of other studies that reported asphyxia (forms of suffocation or strangulation) as the main COD (Herman-Giddens et al., 2003; Marcikic et al., 2006; Gheorghe et al., 2011; Tursz and Cook, 2011; Schulte et al., 2013; Krajkovic et al., 2014), asphyxia was the most frequently recorded post-mortem conclusion for the unnatural deaths in the present study, along with abandonment, improper care at time of birth and exposure. The Pretoria study, however, reported no suffocations (du Toit-Prinsloo et al., 2016a). Interestingly, one death in the present study was due to the ingestion of organophosphate poison; no other review studies mentioned instances of poisoning.

### 2.4.2 Medico-legal investigation

*Extent of the post-mortem examination*

At mortuaries where one abandonment case is encountered per year, a full examination is possible in every case (Marcikic et al., 2006; Gheorghe et al., 2011), regardless of the nature of the case (natural or unnatural). However, at mortuaries with a high case load such as SRM (>2000 cases per year) and a high rate of abandonment cases, the best application of time and resources need to be considered. Additionally, the law is also at play. German law requires that all three cavities are opened (Schulte et al., 2013), whereas in South Africa the forensic pathologist is not lawfully required to investigate a natural death (Inquests Act 58 of 1959).

An external examination was conducted on 95.7% of the non-viable foetuses. Similarly, in the Pretoria study, external only examinations were conducted in 50% of the cases, which

were mostly smaller products of conception (du Toit-Prinsloo et al., 2016a). Thus, once non-viability is established, it is generally not deemed necessary to conduct any further examination. This is acceptable, considering natural deaths will not be prosecuted.

A partial examination comprised an external examination and usually included opening the chest cavity to examine the lungs, and was conducted on 18 cases, all of which were natural and the majority (n=15/18) of which were stillborn. The reason for conducting a partial examination was generally stated as "no reason to suspect foul play and an internal examination would thus not be conducted".

Full examinations were conducted on 50% of the cases in the Pretoria study, generally on neonates with a mass greater than 1000g (du Toit-Prinsloo et al., 2016a). An internal examination was conducted on 41.8% (n=104) of the total cases in the present study, including all deaths determined to be due to unnatural causes (n=23), 38 natural deaths and 87.8% (n=43/49) of the undetermined cases. The remaining six undetermined cases underwent an external examination only; which is surprising considering all available resources should be utilised in an attempt to establish the nature of the death. Decomposition was, however, mentioned in three of these cases.

*Ancillary investigations and specimens retained*

The conclusions made in post-mortem examinations are of little value if ancillary investigations are not performed, which should be mandatory in abandonment cases (Schulte et al., 2013). Despite this recommendation, ancillary investigations are seldom performed in South Africa (du Toit-Prinsloo et al., 2016a), with only 41% of cases in the present study receiving ancillary investigations. Histological examinations were performed in 17.7% of cases, which is slightly more than in the Pretoria study (11%) (du Toit-Prinsloo et al., 2016a). Conversely, DNA analysis was conducted twice as often in the Pretoria study (72%) compared to the present study (35%). A review of the final outcome of DNA analyses and its role in identification was beyond the scope of this study.

Toxicological analysis was performed in only two cases, suggesting that toxicology is likely only performed when there is reason to suspect the case might be drug- or poison-related. These findings support the opinion that especially histological examinations and toxicological analyses are not conducted frequently enough (Schulte et al., 2013; du Toit-Prinsloo et al., 2016a).

DNA analysis and histology were performed in 16 (69.6%) and 15 (65.2%) cases of unnatural death (n=23), respectively, and in 38 (74.5%) and 22 (43.1%) cases of undetermined death, respectively. In 37.3% (n=19/51) of the cases the reason for the undetermined status was decomposition; however histology was only performed in 10.5% (n=2/19) of these cases. This is especially concerning as in 12 out of 22 cases where histology results were available, the post-mortem conclusion changed, usually from undetermined to a definitive COD, after histology was performed. Moreover, in one case the macroscopic findings at autopsy were indicative of stillbirth, however after the histological examination the death was deemed unnatural. This case further emphasises the importance of performing ancillary investigations. Furthermore, in 17 out of 21 instances of either unnatural or undetermined COD, the case was closed due to the fact that the identity of the biological mother could never be established. However, DNA analysis was only performed in 12 of these 17 cases.

Understandably, it is not possible to perform all possible ancillary investigations in every abandonment case, although this would be the ideal approach in an attempt to answer questions of undetermined COD and unknown sex and identity. However, the value of performing ancillary investigations needs careful consideration. Consequently, a protocol might guide the investigation to ensure that resources are optimally utilised (Fig. 2.11).

*Prosecution rate of abandoned live births*

This study also set out to determine the prosecution rate of abandoned live births and compare the prosecution rates before and after the CDR was established. In terms of the court status, the majority of the unnatural and undetermined cases were either still 'under investigation' or the case was closed. The reason given for 'case closed' was largely due to the unknown identity of the mother, which was also reported in other studies (Ong and Green, 2003; Schulte et al., 2013). In one case the mother was charged with concealment of birth, but was acquitted as the COD could not be determined; a reason also previously reported in literature (Ong and Green, 2003).

Similar to other studies, the Pretoria study did not assess the prosecution rate of abandoned live births; a comparison can thus not be made between the prosecution rates of abandonment cases admitted to two South African mortuaries. It was, however, hypothesised that the prosecution rate is very low (du Toit-Prinsloo et al., 2016a). This was also shown to be true in other studies (Marcikic et al., 2006; Gheorghe et al., 2011) and was corroborated by the

present study. In total, only one case was prosecuted during the five-year study period; the accused was charged with murder and sentenced to eight years imprisonment.

*Child Death Review*

The CDR pilot was established in 2014 at two sites in South Africa, namely SRM in the Western Cape and Phoenix Mortuary in KwaZulu-Natal (Mathews et al., 2016). The CDR consists of a multi-disciplinary team, including law enforcement, social services, health, forensic pathology and prosecution services representatives, which meet on a monthly basis to retrospectively review child deaths (Mathews et al., 2016). Through co-ordinated investigations, in-depth case discussions and consideration of all case information, social factors and medical causes, the CDR has improved the identification of out-of-hospital COD and remedial factors, as well as reduced further deaths and improved policy and service provision (Mathews et al., 2016).

Due to the expedited medical and legal review of child deaths by the CDR team, legal decisions are made quicker compared to elsewhere in South Africa, which is evident by the only case in the present study that was prosecuted in 2014, after the CDR was established. Furthermore, the CDR provides a platform where the issues raised surrounding the medico-legal investigation of abandoned neonates and the best way to address these issues, can be discussed. This, in turn, will hopefully lay the foundation for the development and implementation of standard protocols for the investigation of abandoned neonates.

## 2.5 Conclusion

The present study, together with another South African study, demonstrated the high rate of abandoned neonates observed in South Africa compared to other countries.

Although the majority of the cases were deemed natural deaths, the cause of death frequently remained ‘undetermined’ in these cases; this was often due to the presence of decomposition. Histological analyses were, however, only performed in a small fraction of undetermined cases. Thus, as previously reported, decomposition proved to be a hindrance in the post-mortem examination and ancillary investigations were not performed often enough.

Furthermore, the hypothesised low prosecution rate of abandoned live births was supported by this study; only one case was prosecuted in the five-year period. The court status was

either ‘under investigation’ or ‘case closed’ for the remainder of the cases. In the majority of the instances, the case was closed due to the unknown identity of the biological mother; however, DNA analyses were not performed in all of these cases.

Although recommendations are available and guidelines can be followed, a standard protocol for conducting the medico-legal investigation on abandoned foetuses does not exist, but is long overdue (Schulte et al., 2013). In view of the findings of the present study, the need for a standard protocol was further emphasised; recommendations for the investigation were made based on these study findings and on established findings in the literature. In general, the protocol needs to advise on the minimum requirements of the investigation when dealing with non-viable foetuses and stillbirths, and, more critically, establish the course of action when faced with cases of undetermined cause of death. The minimum necessary parameters need to be set out, in order to ensure consistency in the information collected. Furthermore, a cut-off for viability and the association with measurements need to be established and the optimal utilisation of ancillary investigations needs to be guided. This protocol should not be viewed as a constraint, but rather as a valuable aid to ensure a thorough investigation is conducted (Schulte et al., 2013), such that cause of death and identification of the neonate can be established as far as possible. Ultimately, the aim should be to move toward a higher prosecution rate and in turn reduce the number of abandoned neonates.

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# Appendix A

**Table A 1.1 Search output generated in the search of databases**

| **PubMed** |
|---|
| ((((((Medico-legal Investigation) OR Forensic Investigation) OR Legal Medicine) OR Forensic medicine)) AND (((Abandonment) OR Concealment) OR dump)) AND (((((((((Fetus) OR Newborn) OR New-born) OR New born) OR Neonate) OR Baby) OR Stillbirth) OR Live birth) OR Non-viable fetus)<br>(((((Medico-legal[All Fields] AND ("evaluation studies as topic"[MeSH Terms] OR ("evaluation"[All Fields] AND "studies"[All Fields] AND "topic"[All Fields]) OR "evaluation studies as topic"[All Fields] OR "investigation"[All Fields])) OR (Forensic[All Fields] AND ("evaluation studies as topic"[MeSH Terms] OR ("evaluation"[All Fields] AND "studies"[All Fields] AND "topic"[All Fields]) OR "evaluation studies as topic"[All Fields] OR "investigation"[All Fields]))) OR ("forensic medicine"[MeSH Terms] OR ("forensic"[All Fields] AND "medicine"[All Fields]) OR "forensic medicine"[All Fields] OR ("legal"[All Fields] AND "medicine"[All Fields]) OR "legal medicine"[All Fields])) OR ("forensic medicine"[MeSH Terms] OR ("forensic"[All Fields] AND "medicine"[All Fields]) OR "forensic medicine"[All Fields])) AND ((Abandonment[All Fields] OR Concealment[All Fields]) OR ("2'-deoxyuridylic acid"[Supplementary Concept] OR "2'-deoxyuridylic acid"[All Fields] OR "dump"[All Fields]))) AND (((((((((("foetus"[All Fields] OR "fetus"[MeSH Terms] OR "fetus"[All Fields]) OR ("infant, newborn"[MeSH Terms] OR ("infant"[All Fields] AND "newborn"[All Fields]) OR "newborn infant"[All Fields] OR "newborn"[All Fields])) OR New-born[All Fields]) OR (New[All Fields] AND ("parturition"[MeSH Terms] OR "parturition"[All Fields] OR "born"[All Fields]))) OR ("infant, newborn"[MeSH Terms] OR ("infant"[All Fields] AND "newborn"[All Fields]) OR "newborn infant"[All Fields] OR "neonate"[All Fields])) OR ("infant, newborn"[MeSH Terms] OR ("infant"[All Fields] AND "newborn"[All Fields]) OR "newborn infant"[All Fields] OR "baby"[All Fields] OR "infant"[MeSH Terms] OR "infant"[All Fields])) OR ("stillbirth"[MeSH Terms] OR "stillbirth"[All Fields])) OR ("live birth"[MeSH Terms] OR ("live"[All Fields] AND "birth"[All Fields]) OR "live birth"[All Fields])) OR (Non-viable[All Fields] AND ("foetus"[All Fields] OR "fetus"[MeSH Terms] OR "fetus"[All Fields])))) |
| **Scopus** |
| ( ( TITLE-ABS-KEY ( medicolegal AND investigation ) ) OR ( TITLE-ABS-KEY ( medicolegal AND investigation ) ) OR ( TITLE-ABS-KEY (forensic AND investigation ) ) OR ( TITLE-ABS-KEY ( legal AND medicine ) ) OR ( TITLE-ABS-KEY ( forensic AND medicine ) ) ) AND ( ( TITLE-ABS-KEY (abandon*)) OR ( TITLE-ABS-KEY ( conceal* ) ) OR ( TITLE-ABS-KEY ( dump* ) ) ) AND ( TITLE-ABS-KEY ( nonviable AND foetus ) ) OR ( ( TITLE-ABS-KEY ( foetus ) ) OR ( TITLE-ABS-KEY ( fetus ) ) OR ( TITLE-ABS-KEY ( foetal ) ) OR ( TITLE-ABS-KEY (fetal)) OR ( TITLE-ABS-KEY ( newborn ) ) OR ( TITLE-ABS-KEY ( newborn ) ) OR ( TITLE-ABS-KEY ( new AND born ) ) ) OR ( ( TITLE-ABS-KEY ( neonat* ) ) OR ( TITLE-ABS-KEY ( bab* ) ) OR ( TITLE-ABS-KEY ( stillbirth ) ) OR ( TITLE-ABS-KEY ( live AND birth ) ) OR ( TITLE-ABS-KEY ( nonviable AND fetus ) ) OR ( TITLE-ABS-KEY ( nonviable AND fetus ) ) OR ( TITLE-ABS-KEY (nonviable AND foetus ) ) ) |
| **Science Direct** |
| (Medico-legal Investigation OR Medicolegal Investigation OR Forensic Investigation OR Legal Medicine OR Forensic medicine ) AND (Abandon* OR Conceal* OR Dump* ) AND (Foetus OR Fetus OR Foetal OR Fetal OR Newborn OR New-born OR New born OR Neonat* OR Bab* OR Stillbirth OR Live birth OR Non-viable fetus OR Nonviable fetus OR Non-viable foetus OR Nonviable foetus) |

**Table A 1.2 Search output generated in the search of journals**

| **Forensic Science International; Journal of Forensic Sciences** |
| --- |
| (Abandon* OR Conceal* OR Dump* ) AND (Foetus OR Fetus OR Foetal OR Fetal OR Newborn OR New-born OR New born OR Neonat* OR Bab* OR Stillbirth OR Live birth OR Non-viable fetus OR Nonviable fetus OR Non-viable foetus OR Nonviable foetus) |
| **Journal of Forensic and Legal medicine; Journal of Forensic Science and Medicine; International Journal of Legal Medicine; Legal medicine; Forensic Science, Medicine and Pathology; American Journal of Forensic Medicine and Pathology** |
| (Medico-legal Investigation OR Medicolegal Investigation OR Forensic Investigation OR Legal Medicine OR Forensic medicine ) AND (Abandon* OR Conceal* OR Dump* ) AND (Foetus OR Fetus OR Foetal OR Fetal OR Newborn OR New-born OR New born OR Neonat* OR Bab* OR Stillbirth OR Live birth OR Non-viable fetus OR Nonviable fetus OR Non-viable foetus OR Nonviable foetus) |

**Table A 2.1 Summary of the parameters reported on in the 7 review articles included in the systematic literature review**

| Article information | | | | Parameters reported on | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Area/ Country** | **Number of years** | **Number of cases** | **Prevalence** | **Sex** | **Anthropometric measurements** | **Age of viability** | **Method to estimate GA** | **Live vs still** | **Method to determine live birth** | **COD** | **Condition of the remains** | **Scene of discovery** | **Covering** | **PM extent** | **Ancillary investigations** | **Prosecution** |
| Behera et al., 2016 | South Delhi, India | 17 (1996-2012) | 238 | Yes | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | No | No | No |
| du Toit-Prinsloo et al., 2016a | Pretoria, SA | 5 (2004-2008) | 289 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Gheorghe et al., 2011 | Denmark | 12 (1997-2008) | 11 | Yes | Yes | Yes | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Marcikic et al., 2006 | Eastern Croatia | 25 (1980-2004) | 24 | Yes | Yes | Yes | No | No | Yes | Yes | Yes | No | Yes | No | * | No | Yes |
| Schulte et al., 2013 | Germany | 15 (1993-2007) | 150 | Yes | Yes | No | No | Yes | No | Yes | Yes | Yes | No | No | Yes | Yes | * |
| Tursz and Cook, 2011 | France | 5 (1996-2000) | 27 | Yes | Yes | No | No | No | Yes | No | Yes | * | No | No | Yes | No | No |
| Herman-Giddens et al., 2003 | North Carolina, USA | 16 (1985-2000) | 35 | Yes | Yes | No | No | No | Only live included | Only live included | Yes | * | Yes | No | No | No | Yes |

Abbreviations: GA = Gestational age; COD = Cause of death; PM = Post-mortem

*The studies did not specifically report on these parameters, but mentioned some information in this regard

Appendix B

**Section B 1 Variable definitions**

| Variable | | Description |
|---|---|---|
| **Case information** | ID | Identifying number in the study, used to track cases and compare case information. |
| | Year | The year that the PM examination was performed. |
| | Month | The month that the remains were discovered. This is not necessarily when the neonate died, but when the neonate was discovered and declared dead. |
| | Area | The area where remains were found, as recorded in the case file. If a street name was recorded, the area under which it falls was used. |
| | Scene | Primarily based on what was recorded on the Lab27 form, however all scene information was considered to ensure consistency. The options on the Lab27 form include: House, Swimming pool, Hospital, Shack, Bucket/Bin, Railway track, Road, Shebeen, Open land, Dam, Sea, Toilet, River, Lake, Other. Sea, dam, river, and canal were recorded as 'Water'. Bucket/bin were separated. Drain, sewage (including waste water treatment) and refuse dump (dump/rubbish dump/rubble) were added as possible categories. Any scene not included in the options was recorded as 'Other'. |
| **Demographic details** | Race | The race of the neonate, either ‘White’, ‘African’, ‘Coloured’, ‘Asiatic’, as recorded in the PM report. If the race was not explicitly stated or there was any uncertainty, for example could be one of two races, it was recorded as ND. |
| | Sex | The sex of the neonate, either Male or Female, as recorded in the PM report. If the sex was not explicitly stated or there was any uncertainty, for example undifferentiated genitalia, it was recorded as ND. |
| **Anthropometric parameters** | Mass | The weight of the neonate, recorded in gram. |
| | Length (crown-heel) | The full length of the neonate, recorded in millimetre. |
| | Crown-rump length | The sitting height of the neonate, recorded in millimetre. |
| | Head circumference | The head circumference of the neonate, recorded in millimetre. |
| | Chest circumference | The chest circumference of the neonate, recorded in millimetre. |
| | Abdominal circumference | The abdominal circumference of the neonate, recorded in millimetre. |
| | Foot length | The foot length of the neonate, recorded in millimetre. If both left and right foot lengths were given, the average was calculated. |

| Variable | | Description |
|---|---|---|
| **PM information** | Gestational age | The GA of the neonate, recorded in weeks. If a range was given, the middle of the range was used. 'Term' was taken as 39 weeks. |
| | Viable | Whether the neonate was viable or not, either 'yes' or 'no'. If this was explicitly stated in the PM report, it was recorded as is. If not stated, the GA (if recorded) was used to determine viability. A GA of 28 weeks was considered viable. |
| | Still vs Live | Either 'Still' or 'Live', based on what was recorded in the PM report. Recorded as ND if live birth could not be determined for whatever reason (e.g. decomposition). This variable was recorded as NA if the PM conclusion was stated as 'Non-viable foetus'. |
| | Natural/Unnatural | Either 'Natural', 'Unnatural' or 'Undetermined', based on the PM conclusion. |
| | PM conclusion | The final PM conclusion, as stated in the PM report. |
| | PM extent | Either 'External', 'Partial' or 'Internal', based on the extent of the PM examination that was conducted. External = body was not opened, only external information recorded. Partial = external information and the internal examination of a specific body compartment at the forensic pathologist's discretion. Internal = full PM examination. |
| **Ancillary investigation** | DNA | Either 'yes' or 'no', based on information in the PM report. |
| | Histology | Either 'yes' or 'no', based on information in the PM report. |
| | Other | Either 'yes' or 'no', based on information in the PM report stating that any ancillary investigation, other than DNA or histology, was performed. |
| | Specimens retained | Either 'yes' or 'no', if any specimens were retained, either for ancillary investigations or as evidence (exhibits). |
| **Covering** | Nothing | Either 'yes' or 'no', considering all scene information. If there was no information in the PM report or the case file stating that the neonate was clothed or wrapped, this variable was recorded as 'yes' (i.e. naked). If naked but accompanying items were recovered with the neonate, this variable was also recorded as 'yes', but a note was made stating the items. |
| | Clothing | Either 'yes' or 'no', considering all scene information. If there was information in the PM report or the case file stating that the neonate was dressed in clothes, this variable was recorded as 'yes'. |
| | Wrapped | Either 'yes' or 'no', considering all scene information. If there was information in the PM report or the case file stating that the neonate was wrapped in for example a plastic bag or towel, this variable was recorded as 'yes'. |

| Variable | | Description |
|---|---|---|
| **Condition of the remains** | Traumatic injuries | Either 'yes' or 'no', as recorded in the PM report. Any ante-mortem injuries were recorded as 'yes'. If no information was provided, the variable was recorded as 'no'. |
| | Congenital abnormalities | Either 'yes' or 'no', as recorded in the PM report. If no information was provided, the variable was recorded as 'no'. |
| | Umbilical cord | Either 'yes' or 'no', as recorded in the PM report. If the umbilical cord was present, either attached to or accompanying the neonate, this variable was recorded as 'yes'. If no information was provided, the variable was recorded as 'no'. |
| | Placenta | Either 'yes' or 'no', as recorded in the PM report. If the placenta was present, either attached to or accompanying the neonate, this variable was recorded as 'yes'. If no information was provided, the variable was recorded as 'no'. |
| | Decomposition | Either 'yes' or 'no', as recorded in the PM report. Any signs of decomposition were recorded as 'yes'. If no information was provided, the variable was recorded as 'no'. |
| | Scavenging/ Mutilation | Either 'yes' or 'no', as recorded in the PM report. Any post-mortem injuries, without a vital reaction (thus not ante-mortem), were recorded as 'yes'. If no information was provided, the variable was recorded as 'no'. |
| **Court** | Court status | The court status as provided by SAPS. Either 'Case closed' (the case was finalised; there was no prosecution); 'Under investigation' (the case is still being investigated; there is not enough information to make a final decision yet); 'Court docket' (the docket is at the court; a final decision has not been made) or 'Case finalised' (the case was prosecuted). |
| | Court status information | Any information as to why the case was closed (i.e. not prosecuted) or what the outcome of sentencing was. |

Unless otherwise stated in the above descriptions, a variable was recorded as 'NR' (Not recorded) if there was no information in the case file.
ND = Not determined

# Appendix C

Ethics approval letter

Supplementary material – Variables collected as part of data collection (first 50 cases)

Supplementary material – Locations where remains were discovered

**UNIVERSITY OF CAPE TOWN**
**Faculty of Health Sciences**
**Human Research Ethics Committee**

**Room E53-46 Old Main Building**
**Groote Schuur Hospital**
**Observatory 7925**
**Telephone** [021] 406 6492
**Email**: sumayah.ariefdien@uct.ac.za
**Website**: www.health.uct.ac.za/fhs/research/humanethics/forms

01 February 2017

**HREC REF: 061/2017**

**Ms L Heathfield**
Division of Pathology
Department of Forensic Medicine and Toxicology
Entrance 3, Level 1
Falmouth Building-FHS

Dear Ms Heathfield

**PROJECT TITLE: RETROSPECTIVE ANALYSIS OF ABANDONED LIVE BIRTHS, STILL BIRTHS AND NON-VIABLE FOETUSES ADMITTED TO SALT RIVER MORTUARY, CAPE TOWN (MPHIL CANDIDATE: MS C DU TOIT)**

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

**Approval is granted for one year until the 28 FEBRUARY 2018.**

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form If the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

***We acknowledge that the student, C du Toit will also be involved in this study.***

**Please quote the HREC REF in all your correspondence.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal Investigator.

Please note that for all studies approved by the HREC, the principal Investigator **must** obtain appropriate Institutional approval before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

| | Case information | | | | Demographics | | Anthropometric measurements | | | | | | | Post-mortem information | | | | | | Ancillary investigations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Year | Month | Area | Scene | Race | Sex | Mass | Length | CRL | HC | CC | AC | FL | GA | Viable | Still vs Live | Natural/ Unnatural | PM conclusion | PM extent | DNA | Histo | Other | Specimens |
| 1 | 2012 | January | Heideveld | House | Coloured | Female | 1460 | 400 | NR | 270 | NR | NR | 60 | 30 | Yes | NR | Natural | Extreme prematurity | Partial | No | No | No | No |
| 2 | 2012 | January | Heathfield | Other | NR | NR | 90 | 165 | NR | NR | NR | NR | 19.5 | 15.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 3 | 2012 | January | Mitchells Plain | Shack | ND | Male | 1660 | 460 | NR | NR | NR | NR | 70 | 35.5 | Yes | ND | Undetermine | Undetermined | External | Yes | No | No | Yes |
| 4 | 2012 | February | Mitchells Plain | House | African | Male | 2700 | 520 | 330 | 320 | NR | NR | 80 | 41 | Yes | Still | Natural | Stillborn | Internal | No | No | No | Yes |
| 5 | 2012 | February | Milnerton | Roads | NR | Male | 215 | 235 | NR | 145 | NR | NR | 28 | 18.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 6 | 2012 | February | Langa | Open land | ND | Male | 72 | 140 | NR | NR | NR | NR | NR | NR | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 7 | 2012 | February | Strandfontein | Sewage | ND | ND | 170 | NR | NR | NR | NR | NR | 27.5 | NR | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 8 | 2012 | March | Langa | Bin | African | Male | 3372 | 510 | 290 | 330 | NR | NR | 93 | Term | Yes | Live | Unnatural | Exposure | Internal | Yes | Yes | No | Yes |
| 9 | 2012 | April | Mouille Point | Drain | NR | NR | NR | NR | 60 | NR | NR | NR | NR | 10 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 10 | 2012 | April | Plumstead | Railway track | ND | Male | 18 | NR | NR | NR | NR | NR | 10 | 12 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 11 | 2012 | May | Gugulethu | Shack | African | Female | 256 | 210 | 140 | 150 | NR | NR | 33 | 20 | No | NA | Natural | Non-viable foetus | Internal | No | No | No | No |
| 12 | 2012 | May | Sea point | Hospital | Coloured | Female | 2372 | 480 | 280 | 320 | NR | NR | 70 | 36 | Yes | NR | Undetermine | Undetermined | Internal | No | Yes | No | Yes |
| 13 | 2012 | May | Hanover Park | House | Coloured | Male | 770 | 320 | NR | NR | NR | NR | 48 | NR | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 14 | 2012 | May | Atlantis | Hospital | Coloured | Female | 1700 | 430 | 310 | NR | NR | 200 | 62.5 | Term | Yes | Still | Natural | Stillborn | Internal | No | No | No | No |
| 15 | 2012 | May | Philippi | Toilet | African | Female | 945 | 370 | 255 | 248 | NR | NR | 52 | 29 | Yes | Still | Natural | Stillborn | Internal | No | No | No | Yes |
| 16 | 2012 | June | Table View | Refuse dump | NR | Male | 2520 | 520 | NR | NR | NR | NR | 81.5 | 40 | Yes | Still | Natural | Stillborn | Internal | Yes | Yes | No | Yes |
| 17 | 2012 | June | Muizenberg | Road | NR | Male | NR | NR | 58 | NR | NR | NR | NR | 12 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 18 | 2012 | June | Manenberg | Drain | ND | ND | 245 | 230 | NR | NR | NR | NR | 30 | 18 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 19 | 2012 | June | Table View | Hospital | ND | Male | 78.5 | 158 | 105 | 105 | NR | NR | 19 | 15 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 20 | 2012 | June | Rylands | House | ND | Male | 1760 | 395 | 300 | 300 | NR | NR | 63 | 33 | Yes | Live | Unnatural | Asphyxia neonatorum | Internal | Yes | Yes | No | Yes |
| 21 | 2012 | July | Browns farm | Refuse dump | NR | Male | 270 | 180 | NR | 150 | NR | NR | NR | 18.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 22 | 2012 | July | Cape Town CBD | Bin | NR | Male | 1343 | 390 | 250 | 270 | NR | NR | 56.5 | 29.5 | Yes | Live | Unnatural | Undetermined - possible s | Internal | No | Yes | No | Yes |
| 23 | 2012 | July | Gugulethu | House | NR | Female | 300 | 350 | NR | NR | NR | NR | 74 | 38 | Yes | Live | Undetermine | Undetermined | Internal | Yes | Yes | No | Yes |
| 24 | 2012 | July | Lusaka | Shack | ND | Male | 3188 | 490 | 342 | 348 | NR | NR | 82 | Term | Yes | Live | Natural | Congenital heart disease | Internal | Yes | No | No | Yes |
| 25 | 2012 | July | Gugulethu | Shack | ND | ND | 154.8 | NR | NR | NR | NR | NR | NR | NR | NR | NR | Undetermine | Undetermined | External | Yes | No | No | Yes |
| 26 | 2012 | July | Nyanga | Bin | ND | Female | 137.2 | 195 | 130 | 130 | NR | NR | 25 | 20 | No | NA | Natural | Non-viable foetus | External | Yes | No | No | Yes |
| 27 | 2012 | July | Nyanga | NR | ND | Male | 165,4 | NR | 140 | 140 | NR | NR | 25 | 20 | No | NA | Natural | Non-viable foetus | Partial | Yes | No | Yes | Yes |
| 28 | 2012 | August | Athlone | Toilet | Coloured | Male | 3400 | 500 | 300 | NR | NR | NR | 80 | 39 | Yes | Still | Natural | Stillborn | Internal | No | No | No | No |
| 29 | 2012 | August | Gugulethu | Drain | NR | Male | 270 | 220 | 160 | 160 | NR | NR | 30 | 19 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 30 | 2012 | August | Oceanview | Water | NR | ND | 144 | NR | NR | NR | NR | NR | 25.5 | NR | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 31 | 2012 | August | Milnerton | House | ND | Female | 4400 | 500 | 340 | 350 | NR | NR | 81.5 | 39 | Yes | Live | Undetermine | Under investigation | Internal | Yes | Yes | No | Yes |
| 32 | 2012 | August | Philippi | Open land | ND | Male | NR | 302 | 200 | NR | NR | NR | 44 | 23.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 33 | 2012 | August | Gugulethu | Bin | NR | Male | 1400 | NR | NR | NR | NR | NR | NR | NR | Yes | Still | Natural | Stillborn | Partial | No | No | No | No |
| 34 | 2012 | August | Strandfontein | Sewage | ND | Male | NR | NR | 140 | NR | NR | NR | NR | 7 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 35 | 2012 | September | Langa | Other | ND | Male | 393 | NR | 170 | NR | NR | NR | 39 | 21 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 36 | 2012 | September | Houtbay | Open land | African | Female | 1930 | NR | NR | NR | NR | NR | 72 | 37 | Yes | ND | Undetermine | Unascertained | Internal | Yes | No | No | Yes |
| 37 | 2012 | September | Cape Town CBD | Road | ND | Male | 1700 | 440 | 310 | 320 | NR | NR | 68 | 36 | Yes | Still | Natural | Stillborn | Internal | Yes | Yes | No | Yes |
| 38 | 2012 | September | Nyanga | House | African | Female | 2750 | 510 | 320 | 340 | NR | NR | NR | 38 | Yes | Live | Undetermine | Under investigation | Internal | No | Yes | No | Yes |
| 39 | 2012 | September | Philippi | Refuse dump | NR | Female | 3100 | 490 | 310 | 340 | NR | 312 | 80 | NR | Yes | Live | Natural | Intestinal obstruction | Internal | No | Yes | No | Yes |
| 40 | 2012 | September | Phoenix | Open land | ND | Female | 2500 | 480 | NR | NR | NR | NR | 83 | Term | Yes | ND | Undetermine | Undetermined | Internal | Yes | No | No | Yes |
| 41 | 2012 | October | Muizenberg | Refuse dump | Coloured | Male | 3650 | 590 | NR | NR | NR | NR | NR | 32 | Yes | NR | Undetermine | Unascertained | External | No | No | No | No |
| 42 | 2012 | October | Paarden Eiland | Water | ND | Female | 857 | NR | 250 | 240 | NR | NR | 52 | 27.5 | Yes | Still | Natural | Undetermined | Internal | Yes | No | No | Yes |
| 43 | 2012 | October | Gugulethu | Open land | NR | Male | 720 | NR | 180 | 245 | NR | NR | 45 | 23 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 44 | 2012 | October | Mitchells Plain | Hospital | African | Female | 2123 | 430 | 280 | 300 | NR | NR | NR | 32 | Yes | Still | Natural | Stillborn | Internal | No | No | No | No |
| 45 | 2012 | November | Langa | Toilet | ND | Male | 190 | NR | NR | NR | NR | NR | 25 | NR | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 46 | 2012 | November | Observatory | Bin | Coloured | Male | 950 | 330 | 240 | 230 | NR | NR | NR | 26 | No | Still | Natural | Stillborn | Internal | No | No | No | No |
| 47 | 2012 | November | Masiphumelele | Toilet | NR | Male | 450 | 250 | 180 | 180 | NR | NR | 33 | 21 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 48 | 2012 | November | Langa | Refuse dump | African | Male | 3900 | 600 | NR | NR | NR | NR | NR | NR | NR | Still | Natural | Stillborn | Internal | No | No | No | No |
| 49 | 2012 | November | Cape Town CBD | Bin | ND | Male | 386 | 280 | 180 | NR | NR | NR | 40 | 22.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |
| 50 | 2012 | November | Mitchells Plain | Bin | ND | Female | 79.5 | 193 | 120 | 120 | NR | NR | 20 | 16.5 | No | NA | Natural | Non-viable foetus | External | No | No | No | No |

| | Covering | | | Condition of the remains | | | | | | Court | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Nothing | Clothing | Wrapped | Traumatic injuries | Congenital abnormalities | Umbilical cord | Placenta | Decomp | Scavenging /Mutilation | Court status | Court status information |
| 1 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 2 | No | No | Yes | No | No | NR | No | Yes | No | NA | NA |
| 3 | No | No | Yes | No | No | Yes | Yes | Yes | No | Case closed | Case finalised, closed; mother charged with COB; accused acquitted - COD ND |
| 4 | Yes | No | No | No | No | Yes | Yes | No | No | NA | NA |
| 5 | No | No | Yes | No | No | Yes | No | No | No | NA | NA |
| 6 | Yes | No | No | No | No | NR | NR | Yes | No | NA | NA |
| 7 | Yes | No | No | No | No | NR | No | Yes | No | NA | NA |
| 8 | No | No | Yes | No | No | Yes | No | No | No | Case closed | Case finalised, closed; mother charged with COB; accused acquitted - COD nat |
| 9 | Yes | No | No | No | No | NR | NR | No | No | NA | NA |
| 10 | No | No | Yes | No | No | NR | No | No | No | NA | NA |
| 11 | No | No | Yes | No | No | Yes | No | No | No | NA | NA |
| 12 | No | No | Yes | No | No | No | NR | No | No | Under investigatic | NA |
| 13 | Yes | No | No | No | No | No | No | No | No | NA | NA |
| 14 | No | No | Yes | No | No | Yes | Yes | Yes | No | NA | NA |
| 15 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 16 | Yes | No | No | No | No | No | No | Yes | Yes | Case closed | COD determined natural |
| 17 | Yes | No | No | No | No | NR | NR | No | No | NA | NA |
| 18 | Yes | No | No | No | No | NR | NR | Yes | No | NA | NA |
| 19 | Yes | No | No | No | No | Yes | Yes | No | No | NA | NA |
| 20 | No | No | Yes | No | No | Yes | No | No | No | Case closed | Unknown newborn baby - identity of mother could never be establishe |
| 21 | Yes | No | No | No | No | Yes | No | Yes | Yes | NA | NA |
| 22 | Yes | No | No | No | No | Yes | No | No | No | Case closed | Unknown newborn baby - identity of mother could never be establishe |
| 23 | Yes | No | No | No | No | NR | NR | Yes | Yes | Court docket | NA |
| 24 | No | No | Yes | No | Yes | Yes | No | No | No | Case closed | Unknown newborn baby - identity of mother could never be establishe |
| 25 | Yes | No | No | No | No | NR | NR | Yes | No | Court docket | NA |
| 26 | No | No | Yes | No | No | Yes | No | No | No | NA | NA |
| 27 | No | No | Yes | No | Yes | Yes | No | No | No | NA | NA |
| 28 | No | No | Yes | No | No | Yes | NR | No | No | NA | NA |
| 29 | Yes | No | No | No | No | Yes | No | Yes | No | NA | NA |
| 30 | No | No | Yes | No | No | NR | NR | No | No | NA | NA |
| 31 | No | No | Yes | No | No | Yes | No | No | No | Under investigatic | NA |
| 32 | Yes | No | No | No | No | Yes | Yes | No | No | NA | NA |
| 33 | Yes | No | No | No | No | Yes | Yes | No | No | NA | NA |
| 34 | Yes | No | No | No | Yes | No | No | No | Yes | NA | NA |
| 35 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 36 | No | No | Yes | No | No | NR | NR | Yes | Yes | Under investigatic | NA |
| 37 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 38 | No | No | Yes | No | No | Yes | No | No | No | Under investigatic | NA |
| 39 | Yes | No | No | No | No | Yes | No | No | No | Case closed | Unknown newborn baby - identity of mother could never be establishe |
| 40 | No | No | Yes | No | No | Yes | NR | Yes | No | Under investigatic | NA |
| 41 | Yes | No | No | No | No | Yes | NR | Yes | Yes | Under investigatic | NA |
| 42 | Yes | No | No | No | No | Yes | No | Yes | No | NA | NA |
| 43 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 44 | Yes | No | No | No | No | Yes | NR | No | No | NA | NA |
| 45 | Yes | No | No | No | No | Yes | NR | Yes | No | NA | NA |
| 46 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 47 | No | No | Yes | No | No | Yes | No | No | No | NA | NA |
| 48 | No | No | Yes | No | No | NR | NR | No | Yes | NA | NA |
| 49 | No | No | Yes | No | No | Yes | Yes | No | No | NA | NA |
| 50 | No | No | Yes | No | No | Yes | Yes | Yes | No | NA | NA |

**Table C 1 Locations where remains were discovered according to Cape Town districts**

| Area | Number of cases |
|---|---|
| **Cape Flats District** | |
| Philippi | 33 |
| Gugulethu | 21 |
| Nyanga | 13 |
| Strandfontein | 12 |
| Athlone | 9 |
| Manenberg | 5 |
| Grassy Park | 2 |
| Heideveld | 2 |
| Lansdowne | 2 |
| Hanover Park | 1 |
| Rylands | 1 |
| Silvertown | 1 |
| **Total (percentage of case study)** | 103 (41.4%) |
| **Table Bay District** | |
| Cape Town CBD | 14 |
| Langa | 14 |
| Sea Point | 4 |
| Green Point | 3 |
| Kensington | 2 |
| Maitland | 2 |
| Observatory | 2 |
| Mouille Point | 1 |
| Pinelands | 1 |
| Woodstock | 1 |
| Zonnebloem | 1 |
| **Total (percentage of case study)** | 45 (18.1%) |
| **Mitchells Plain/Khayelitsha District** | |
| Mitchells Plain | 19 |
| Browns Farm | 11 |
| Samora Machel | 9 |
| Crossroads | 1 |
| **Total (percentage of case study)** | 40 (16.1%) |
| **Blaauwberg District** | |
| Table View | 10 |
| Milnerton | 8 |
| Atlantis | 5 |
| Dunoon | 4 |
| Paarden Eiland | 2 |
| Phoenix | 2 |
| Mamre | 1 |
| **Total (percentage of case study)** | 32 (12.9%) |
| **South Peninsula District** | |
| Muizenberg | 6 |
| Wynberg | 6 |
| Masiphumelele | 4 |
| Mowbray | 3 |
| Fish Hoek | 2 |
| Houtbay | 2 |
| Ocean View | 2 |
| Heathfield | 1 |
| Plumstead | 1 |
| Retreat | 1 |
| Rondebosch | 1 |
| **Total (percentage of case study)** | 29 (11.6%) |