A critical review of sudden unexpected deaths at Tygerberg Hospital Forensic Pathology Laboratory over a one-year period in 2016

By Jill Roman

Research assignment (study article) presented in partial fulfilment of the requirements for the degree of Master of Medicine (MMED) in the Division of Forensic Medicine, Department of Pathology at the Faculty of Medicine and Health Sciences at Stellenbosch University.

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Declaration

The study described in this article was carried out under the supervision of Dr J Verster, Head of Clinical Unit, and Prof JJ Dempers, Head of Department, in the Division of Forensic Medicine, Department of Pathology, Faculty of Medicine and Health Sciences at Stellenbosch University and covers the period 1 January to 31 December 2016.

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Date: February 2021

ABSTRACT:

Background

In South Africa, admissions of sudden and unexpected deaths to large Forensic Pathology Laboratories (FPL) for medicolegal post-mortem examination are generally on the increase. Research in this field is useful to identify disease patterns and to reduce unnecessary admissions to forensic pathology services.

Objectives

Our main aim was to determine the recent epidemiological profile of sudden and unexpected deaths admitted to Tygerberg FPL from 1 January to 31 December in 2016, compared to a past similar study that evaluated similar data of 2001 to 2005. A secondary objective was to ascertain the contribution of respiratory disease.

Method

A retrospective study was conducted. Anonymized data were obtained from post-mortem case files for analysis and comparison, using an electronic Open Data Kit application, Red Cap electronic database and Windows Excel for secure storage, and Statistical Package for Social Sciences for biostatistical analyses.

Results

The total number of cases that were admitted to Tygerberg FPL in 2016 for medicolegal post-mortem examination were 3766. The past epidemiological study at the same facility evaluating the data of 2001 to 2005, showed an annual average of approximately 2700 admissions. Admissions of more than 1000 above the previous annual average was thus demonstrated. Of the 3766 admissions in 2016, a sum of 770 cases comprised the study population of sudden and unexpected deaths, of which 539 (70%) were adults and 231(30%) children. All cases that were known to have an unnatural cause of death upon admission were excluded A younger average age of 34 years and continued male predominance was demonstrated in the study population. The manner of death was presumably natural in 496 (64.4%) cases, unnatural in 60 (7.8%) cases and undetermined in 214 (27.8%) cases. In the population of minors (<18 years of age), presumed natural deaths accounted for 145/231 (62.8%) cases. Diseases of the respiratory and cardiovascular systems continued to be the leading natural causes of death in the overall study population. Pneumonia was the most prevalent cause of death in the population of minors (<18 years of age) and ischaemic heart disease in adults. Lower socio-economic status areas were more significantly affected.

Conclusion

Regular epidemiologic studies of sudden and unexpected deaths are needed in Cape Town's Eastern Metropole for disease prevention and health promotion. Training of medical professionals and the South African Police Services is vital to better understand what a sudden and unexpected death is and when medico-legal referral is warranted.
[370 words]

Keywords

Sudden unexpected death, death registration, cause of death epidemiology, respiratory infection cause of death

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INTRODUCTION

Sudden unexpected death is a phenomenon that occurs in all age groups. The World Health Organization (WHO) according to the International classification of diseases, version 10 (ICD-10) defines it as death occurring within an estimated 24 hours of the onset of acute symptoms that is non-injurious in nature and is otherwise unexplained. Another definition by Mason describes it as "unexpected death following so rapidly from the onset of symptoms that the cause of death could not be certified with confidence by a medical practitioner familiar with the patient" (1–3). The Inquests Act 58 of 1959 stipulates that any death apparently occurring from other than natural causes need to be reported to the South African Police Services (SAPS) for an investigation into the circumstances of the death. Herewith, the suspicion of criminality is either established or excluded (4). Cases of sudden and unexpected deaths (SUD) form part of this death category and constitutes an increasingly large proportion of cases presenting to large Forensic Pathology Laboratories (FPL) in South Africa for medico-legal post-mortem examination and autopsy (5). Statistics on causes of death highlight health problems within a population which is important for the surveillance and development of public health interventions. The mortality statistics in South Africa from 1997−2015, revealed the 10 leading causes of death, accounting for 66% of deaths, were tuberculosis (TB), diabetes mellitus, cerebrovascular disease, ischaemic and other forms of heart disease, human immunodeficiency virus (HIV), influenza and pneumonia, hypertensive diseases and other lower respiratory tract diseases (5).

The Global Burden of Disease study (GBD) in 2013 showed that respiratory diseases and pneumonia are among the leading causes of disease and death. Vulnerable groups include the elderly over the age of 65, young children and immunocompromised persons. Pneumonia is the leading cause of death amongst children under the age of 5 years worldwide (6–9). TB is second to HIV as the leading cause of death from infectious disease worldwide (10). In Africa a young average mortality exists, masking the impact of more chronic non-communicable diseases that tend to occur in older age groups (11).

The leading causes of infant mortality worldwide are congenital (birth) abnormalities, sudden infant death syndrome (SIDS), prematurity and low birth weight (12). Infectious diseases are one of the major causes of SUD in the young. The main pathologies responsible are respiratory and cardiac diseases, including myocarditis and pneumonia (bacterial and viral), followed by meningococcaemia (13).

At Tygerberg FPL, a high proportion of sudden child and infant deaths are admitted to the facility annually. In a multicenter review by du Toit-Prinsloo et al., of sudden and unexpected deaths in infants (SUDI) cases that presented to five (5) large, metropolitan forensic mortuaries in South Africa over a 4-year period (2005-2009), 1271 SUDI admissions took place at Tygerberg FPL, with an average of 318 cases per year (14). The leading causes of death found were intestinal infections (mainly gastroenteritis), respiratory and cardiovascular conditions in the perinatal period, followed by influenza and pneumonia. The number of sudden infant death syndrome (SIDS) cases finally diagnosed over the 4-year period at Tygerberg FPL were 189 cases and thus 47 cases per year. SIDS was designated where a cause of death could not be ascertained in sleep-related deaths in children under one year of age, despite a thorough case investigation and complete autopsy. However, the cause of death in a significant number of cases were designated as "uncertain" instead of SIDS, and therefore the contribution of SIDS could not reliably be assessed. A

wide variation in post-mortem ancillary investigations were evident amongst the various facilities. This study suggested a movement toward a standardized investigation protocol in the post-mortem evaluation of SUDI cases in South Africa (14). Forensic pathology plays an important role in the investigation of death in society. Research done in forensic pathology provides useful epidemiologic information for disease prevention and control (15,16).

Mortality trends of SUD at Tygerberg FPL, was compared to past local and global trends to determine whether they similar or differ substantially in the Eastern Metropole of the Western Cape in South Africa.

METHODS AND ETHICAL CONSIDERATIONS

We conducted a retrospective, observational and descriptive study to determine the recent epidemiological profile of SUD admitted to the Tygerberg FPL over a one-year period from 1 January to 31 December 2016, of adults and children referred for medicolegal post-mortem examination according to the regulations stated in section 3 (2) of the Inquests Act (Act 58 of 1959) (4). All cases of sudden unexpected deaths where the post-mortem reports have not been concluded at the time of data collection, were excluded. Various possible reasons exist for cases not yet being finalized that may include; pending results from the Forensic Science Laboratory, outstanding investigative information, including medical records and SAPS statements in order to formulate the temporal profile and the overburdened system, resulting in delayed finalization of cases.

We compared the data of the adult population to a past similar study that was conducted at the same facility by Tiemensma et al, that evaluated the data for SUD in adults only for the period 2001 to 2005. We aimed to ascertain whether the SUD profile has remained stable over time or whether there are any substantial differences. Tiemensma et al. demonstrated in their retrospective review, that diseases of the cardiovascular, respiratory and central nervous systems were the most common causes of deaths in the studied adult population of SUD, with ischaemic heart disease being the major underlying cause, followed by pneumonia (17).

The data was obtained from the case files of the decedents that consisted of the following documentation:

- FPS sudden and unexpected death questionnaire (FPS006) that are used by the Forensic Pathology Officers to obtain pertinent information regarding the deceased,
- Forensic Pathologists' postmortem report, the South African Police Services (SAPS) 180 form that is issued when an individual dies, that contains information regarding the deceased's identity and presumed cause or nature of death and,
- FPS 100 document completed by a clinician from the referral medical facility, where appropriate.

The main variables that were chosen for collection centered around: demographic information of the deceased, symptoms preceding death, preceding medical and social history, autopsy findings and cause of death. These variables were used to design a case report form (CRF) that was translated to an electronic Open Data Kit (ODK) application downloaded on smart tablets that were used to capture the predetermined data variables. The data was then transferred and stored onto an electronic secure database called Red Cap on a network protected Stellenbosch University laptop. Each case was anonymized and was allocated a unique study identifier to ensure confidentiality. The anonymized data

was then transferred onto a Windows Excel file that was used by a biostatistician, who then used a program called Statistical Package for the Social Sciences (SPSS) for analyses. A waiver of informed consent and ethics approval was obtained by the Health Research Ethics Committee (HREC reference no. S17/10/250) of the Faculty of Medicine and Health Sciences at the University of Stellenbosch.

RESULTS

A total of 3766 cases were admitted to Tygerberg FPL for medico-legal death investigation in 2016. All cases where the manner of death on admission was deemed to be other than natural (including homicide, suicide and accident and all procedure-related deaths were excluded. A sum of 770 cases with the admission history reported as sudden and unexpected death (SUD) was studied. Autopsies were performed in 743 out of the 770 cases (96.5%); and "view-and-grant" post-mortem examinations were done in the remainder 27 cases, where the case history and external examination were deemed sufficient to formulate the most likely cause of natural death. For the total study population, the manner of death was concluded as presumably natural in 496 (64.4%) cases, unnatural in 60 (7.8%) cases and undetermined in 214 (27.8%) cases. In the population of minors (<18 years of age), presumed natural deaths accounted for 145/231 (62.8%) cases.

The demographic findings of the total study population demonstrated that males comprised 495 cases (64.3%) and females 275 cases (35.7%). The age range was from birth to 100 years, of which the mean age was 34 years. The majority of cases were adults (≥18 years of age) accounting for 539 (70%) of cases, followed by infants accounting for 25.5% (196/770) (Fig. 2). The three most frequent places of death were at home, 59.5% (458/770); followed by a medical facility, 8.7% (221/770); and a public place, 5.2% (40/770).

Figure 1 demonstrates the causative systems resulting in death or cause of death categories in order of highest to the lowest prevalence. The largest group was comprised by the "undetermined" category, where the cause of death had not been formulated by the time the data was collected for this study. The reasons for this included inconclusive autopsies where the cause of death could not be determined despite autopsy and/or ancillary investigations, or those where results of alcohol and/ or toxicology analyses were still pending (Table I). The next most prevalent systems were the respiratory (23.5%; 181/770) and the cardiovascular (21.7%; 167/770) systems. Surprisingly, unnatural deaths formed the fourth largest group (7.8%; 60/770) in the SUD population (Table I).

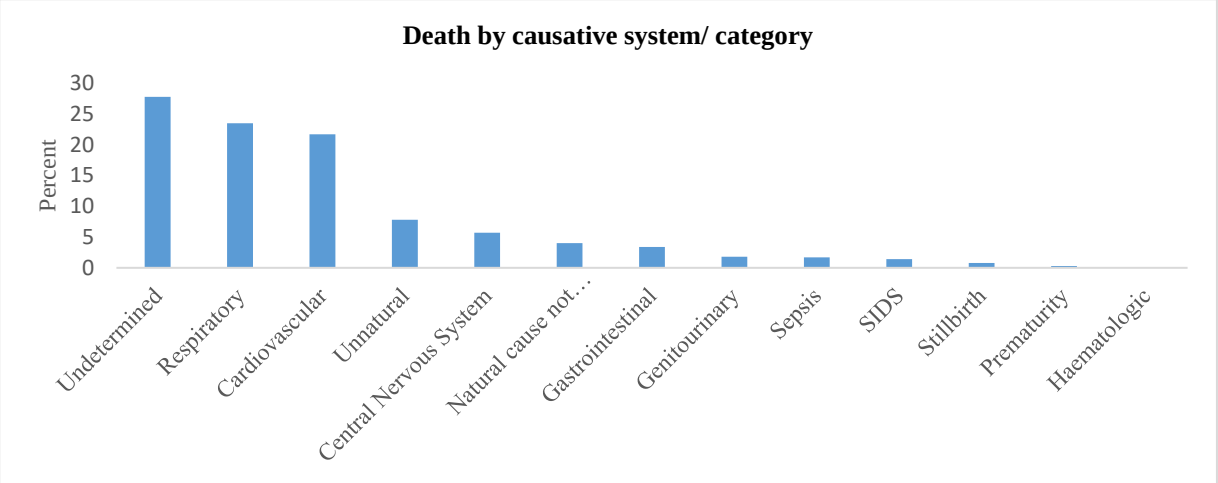

Fig. 1. Death by causative system or category.

Table I. Undetermined and unnatural causes of death per system/ category and gender

UNDETERMINED & UNNATURAL DEATHS		GENDER No. of cases			% of Total N=770
		Male	Female	Total	
No. and % of total cases	(% per system)				
Undetermined (N=214; 27.8%)	Awaiting alcohol or toxicology or both (62.1)	91	42	133	17.3
	Undetermined by autopsy (36.9)	40	39	79	10.3
	Awaiting carbon monoxide result (0.5)	1	0	1	0.1
	Suspected organophosphate poisoning (0.5)	1	0	1	0.1
Unnatural (N=60; 7.8%)	Trauma[ψ] (21.7)	11	2	13	1.7
	Aspiration pneumonia (16.7)	5	5	10	1.3
	Alcohol related cause[£] (11.7)	4	3	7	0.9
	Procedure related (8.3)	2	3	5	0.6
	Choking (6.7)	3	1	4	0.5
	Pneumonia related to unnatural cause[ʃ] (6.7)	4	0	4	0.5
	Blunt force head trauma (6.7)	4	0	4	0.5
	Substance poisoning or toxicity[≠] (5.0)	3	0	3	0.4
	Burns (3.3)	1	1	2	0.3
	Post traumatic epilepsy (3.3)	2	0	2	0.3
	Cerebrovascular accident associated with methamphetamine abuse (1.7)	0	1	1	0.1
	Not specified (8.3)	3	2	5	0.6

[ʃ]Includes pneumonia related to surgical procedure, previous trauma, head trauma, near drowning
[ψ]Includes head trauma, gunshot wound, stab wound, penetrating neck injury, cervical spine injury, femur fracture, multiple injuries
[£]Includes alcohol intoxication, poisoning, alcohol related subdural haemorrhage
[≠]Includes organophosphate poisoning, orphenadrine poisoning, warfarin toxicity

Table II displays the principal causes of natural death per system/ category and gender in the study population. The total *natura*l deaths consisted of 496 cases (64.4%) when *excluding the undetermined and unnatural groups*, which will be used to report and compare the findings of natural deaths.

Overall, diseases of the respiratory system were the most prevalent fatal natural causes of SUD, of which the majority were infectious in nature. Pneumonia accounted for most respiratory deaths (22.0%; 109/496) and were most commonly reported as lower respiratory tract infection, permutations of pneumonia, bronchitis and bronchiolitis. The next most prevalent were PTB (5.8%; 29/496) followed by pulmonary thromboembolism (4.0%; 20/496). In most of these cases, histology was taken in 136/181 cases (75.6%) for microscopic evaluation of the tissues. Comments of a Lodox *Statscan*® were only made in 11 case reports of respiratory deaths showing an underreporting thereof. A review of the electronic Lodox database of the stored images was not done in this study. These ancillary investigations were performed to aid in the formulation of the cause of death.

The majority of respiratory deaths occurred at home (66.7%; 120/181); then followed by a medical facility (23.8%; 43/181) where a medical professional would have been involved in the handling of the death and referral to forensic pathology services. Most of these individuals lived in informal housing (47.5%; 86/181) and a high unemployment rate was reported (26.0%; 47/181), indicating low socio-economic circumstances. Smoking is a risk factor for respiratory disease and was reported in 19.3% of adults (35/181) and in the household of 15.5% of infants (28/181) dying from respiratory disease. However, this information may have been underreported as the related section of the sudden unexpected death questionnaires were noted to be incompletely filled-in in a number of cases.

The second most prevalent were diseases of the cardiovascular system, of which ischaemic heart disease was the most common and the overall dominant of all underlying causes of death (23.2%; 115/496). This comprised coronary artery disease, myocardial infarction and myocardial ischaemia.

The third most prevalent were diseases of the central nervous system. The most common underlying causes were meningitis (2.8%; 14/496), followed by epilepsy (1.8%; 9/496) and cerebrovascular accident/ stroke (1.6%; 8/496). Deaths related to malignancies were low (1.5%; 12/770), and were most prevalent in the central nervous, respiratory and gastrointestinal systems.

Table II. Principal causes of natural death per system/ category and gender

SYSTEM/ CATEGORY No. and % of natural cases	UNDERLYING CAUSE OF NATURAL DEATHS (% per system)	GENDER No. of cases			% of Natural cases N=496
		Male	Female	Total	
Respiratory (N=181; 36.5%)	Pneumonia* (59.7)	67	42	109	22.0
	Pulmonary tuberculosis (16.1)	18	11	29	5.8
	Pulmonary thromboembolism (11.1)	5	15	20	4.0
	Chronic Obstructive Lung Disease (3.3)	5	1	6	1.2
	Chronic lung Disease (2.2)	1	3	4	0.8
	Upper Respiratory Tract Infection (2.2)	1	3	4	0.8
	Respiratory Malignancyø (2.2)	3	1	4	0.8
	Natural respiratory cause of death unspecified (1.7)	3	0	3	0.6
	Amniotic fluid embolism (0.6)	0	1	1	0.2
	Pulmonary granulomatous inflammation unspecified (0.6)	0	1	1	0.2

Cardiovascular (N=167; 33.7%)	Ischaemic heart disease[#] (68.9)	93	22	115	23.2
	Cardiac disease not specified (16.1)	19	8	27	5.4
	Infectious heart disease[¶] (4.8)	6	2	8	1.6
	Congenital cardiac abnormality (3.6)	3	3	6	1.2
	Aorta aneurysm[ß] (4.2)	7		7	1.4
	Vavular heart disease[ᵠ] (1.8)	1	2	3	0.6
	Hypertrophic cardiomyopathy (0.6)	1	0	1	0.2
Central Nervous System (N=44; 8.9%)	Meningitis (31.8)	8	6	14	2.8
	Epilepsy (20.5)	7	2	9	1.8
	Cerebrovascular accident (Stroke) (18.1)	4	4	8	1.6
	Ruptured saccular aneurysm (13.6)	3	3	6	1.2
	Brain Malignancy (9.1)	1	3	4	0.8
	Hypoxic ischaemic encephalopathy (2.3)	1	0	1	0.2
	Neurocysticercosis (2.3)	1	0	1	0.2
	Tuberculous meningitis (2.3)	0	1	1	0.2
Natural Cause Not Specified (N=31; 6.3%)	Natural Cause Unspecified (96.8))	21	9	30	6.0
	Multiorgan failure unspecified (3.2)	0	1	1	0.2
Gastrointestinal (N=26; 5.2%)	Gastroenteritis (30.8)	6	2	8	1.6
	Peptic ulcer disease (26.9)	5	2	7	1.4
	Gastrointestinal Malignancy[¥] (11.3)	3	0	3	0.6
	Peritonitis (7.7)	1	1	2	0.4
	Necrotizing enterocolitis (7.7)	2	0	2	0.4
	Pancreatitis (3.8)	0	1	1	0.2
	Hiatus hernia (3.8)	0	1	1	0.2
	Intestinal obstruction (3.8)	1	0	1	0.2
	Mesenteric adenitis (3.8)	1	0	1	0.2
Genito-urinary (N=14; 2.8%)	Pregnancy related disorders[§] (57.1)	0	8	8	1.6
	Pyelonephritis (28.6)	3	1	4	0.8
	Breast cancer (7.1)	0	1	1	0.2
	Traditional circumcision (7.1)	1	0	1	0.2
Sepsis (N=13; 2.6%)	Systemic sepsis (100)	6	7	13	2.6
SIDS (N=11; 2.2%)	SIDS (100)	4	7	11	2.2
Stillbirth (N=6; 1.2%)	Stillbirth (100)	4	2	6	1.2
Prematurity (N=2; 0.4%)	Prematurity (100)	2	0	2	0.4
Haematologic (N=1; 0.2%)	B-cell lymphoma (100)	1	0	1	0.2

[*]Includes pneumonia, bronchopneumonia, lobar pneumonia, lower respiratory tract infection, pneumonitis, interstitial pneumonia, interstitial pneumonitis, bronchitis, bronchiolitis, lung abscess
[#]Includes coronary artery disease, myocardial ischaemia, myocardial infarction
[¶]Includes myocarditis, pericarditis
[ß]Includes aorta aneurysm, dissecting aorta aneurysm, ruptured aorta aneurysm
[ᵠ]Includes aorta valve stenosis, mitral valve stenosis, valve stenosis not specified
[§]Includes ruptured ectopic pregnancy, abruptio placentae, post-partum cardiomyopathy
[ø]Includes lung tumour, bronchus tumour
[¥]Includes colorectal, hepatocellular and pancreatic cancer
[ʃ]Includes pneumonia related to surgical procedure, previous trauma, head trauma, near drowning
[ᵠ]Includes head trauma, gunshot wound, stab wound, penetrating neck injury, cervical spine injury, femur fracture, multiple injuries
[£]Includes alcohol intoxication, poisoning, alcohol related subdural haemorrhage
[♯]Includes organophosphate poisoning, orphenadrine poisoning, warfarin toxicity

Figures 2 and 3 demonstrate the most common natural causes of deaths by gender. In females, pneumonia was the underlying cause resulting in the majority of deaths, followed by ischaemic heart disease, pulmonary thromboembolism and pulmonary tuberculosis. Whereas in males, ischaemic heart disease dominated, then followed by pneumonia, other cardiac disease not specified and pulmonary tuberculosis.

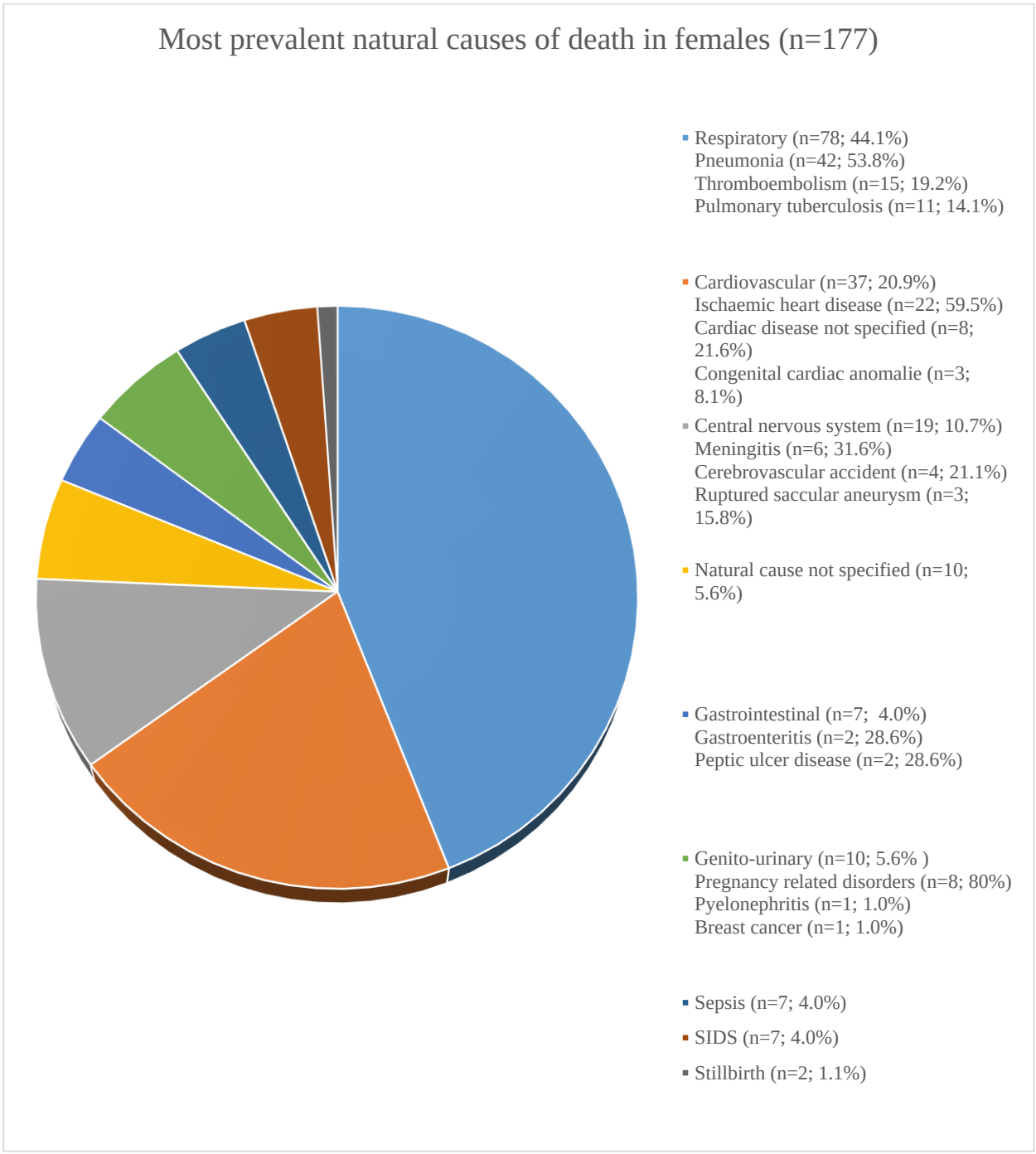

Fig. 2. The most prevalent causes of death in females.

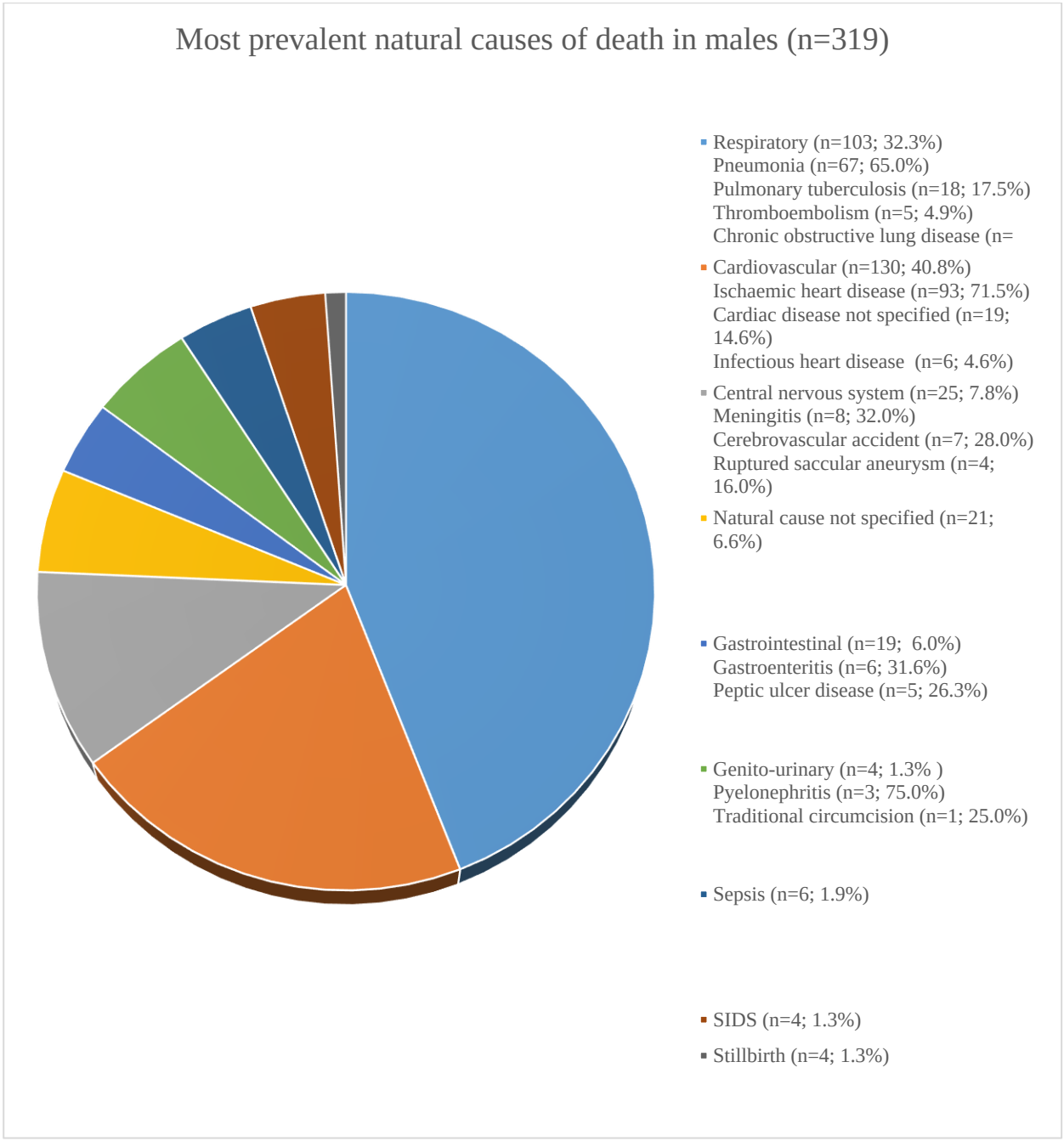

Fig. 3. The most prevalent causes of death in males.

Table III displays the top five causes of death per age group after excluding the undetermined cases. In the younger population, pneumonia was the leading cause of death in infants, children and teenagers. SIDS accounted for the second highest death prevalence in the infant group. Vaccination for the prevention of infectious diseases in infants according to the national vaccination schedule, were reported to be completely administered in only 26.2% (17/65) and incomplete in the majority of cases. A large number of infants were reported to have received the anti-tuberculosis vaccination, BCG (75.4%; 49/65), which is usually routinely administered at birth.

In the youngest adult group (18 to 29 years of age), meningitis was the most common cause. Ischaemic heart disease was consistently the topmost cause of death in adults 30 years and older. Respiratory disease remained an important cause of death in all age groups. The elderly group showed an increase in the proportion of deaths related to trauma comparatively.

Table III To five (5) most prevalent causes of death per age group			
Age group in years (no. of cases	Most prevalent cause of death	Number of cases	Percent per age group
Infants (0-1 year) N=196	Pneumonia	65	33.2
	SIDS	11	5.6
	Systemic sepsis	8	4.1
	Gastroenteritis	7	3.6
	Congenital cardiac abnormality	6	3.1
Children (1-9 years) N-27	Pneumonia	10	37.0
	Aspiration pneumonia	3	11.1
	Infectious heart disease	2	7.4
	Choking	1	3.7
	Epilepsy	1	3.7
Teenagers (10-17 years) N=8	Pneumonia	3	37.5
	Systemic sepsis	2	25.0
	Brain tumour	1	12.5
	Pulmonary tuberculosis	1	12.5
Adults (18-29 years) N=68	Meningitis	6	8.8
	Pneumonia	5	7.4
	Pulmonary thromboemolism	5	7.4
	Pulmonary tuberculosis	4	5.9
	Pregnancy related disorders	4	5.9
Adults (30-39 years) N=124	Ischaemic heart disease	14	11.3
	Pneumonia	8	6.5
	Pulmonary thromboemolism	6	4.8
	Pregnancy related disorders	5	4.0
	Epilepsy	4	3.2
Adults (40-49 years) N=105	Ischaemic heart disease	18	17.1
	Pulmonary tuberculosis	8	7.6
	Pneumonia	7	7.6
	Natural cause not specified	7	6.7
	Cardiac disease not specified	5	4.8
Adults (50-59 years) N=106	Ischaemic heart disease	33	31.1
	Cardiac disease not specified	6	5.7
	Natural Cause not specified	5	4.7
	Pulmonary tuberculosis	5	4.7
	Cerebrovascular accident	3	2.8
Adults (60-69 years) N=93	Ischaemic heart disease	33	35.5
	Pneumonia	7	7.5
	Cardiac disease not specified	8	8.6
	Natural Cause not specified	6	6.5
	Aorta aneurysm	4	4.3
Adults (>70 years) N=43	Ischaemic heart disease	13	30.2
	Pulmonary tuberculosis	4	9.3
	Trauma	4	9.3
	Cardiac disease not specified	3	7.0
	Pneumonia	6	14.0

Symptoms prior to death were poorly reported as evidenced by the relevant sections on the sudden and unexpected death questionnaire being incompletely filled in. The most frequent complaint was that of coughing (9.4%; 17/181), followed by headache. In the infant group, irritability, vomiting and floppiness were frequently reported. The past

medical history was also poorly reported, and hypertension, diabetes, asthma and tuberculosis were the most prevalent underlying chronic medical conditions reported.

The geographical areas were taken from the local police stations where each case was registered. Twenty-eight areas were identified from the drainage suburbs of Cape Town's Eastern Metropole. The most prevalent areas, collectively accounting for approximately 50% of the study population, were found to come from Delft, Khayelitsha, Kraaifontein, Parow, Harare and Mfuleni, which are communities with low socio-economic circumstances.

DISCUSSION

Main study outcomes and comparison with previous studies at the same facility

The total number of cases that were admitted to Tygerberg FPL in 2016 was 3766. The past epidemiological study at the same facility by Tiemensma et al. evaluating the data of 2001 to 2005, showed an annual average of approximately 2700 admissions. Thus, an increase of an excess of 1000 admissions above the annual average was demonstrated for 2016. The increase in the admission of the SUD adult population was 374 cases (226%) above the then annual average of 165 cases (17).

For comparative reasons, when considering only the adult population, 18 years and above (as Tiemensma et al.'s study population only consisted of adults), natural causes for SUD accounted for 65% (351/539) in our study versus 79% of adult deaths in the previous study, showing a 14% decrease. Although less, autopsies performed on natural, non-forensic cases remains high. In addition, our study had a higher proportion of undetermined cases in the adult population of 27% (145/539), 16.4% higher than in the study by Tiemensma el al. (17). The large number of cases where the cause of death was undetermined could be due to outstanding results of special investigations analyzed by the Forensic Science Laboratory that experience significant delays due to the overburdened workload (18). Of the unnatural causes, alcohol related deaths only comprised 1.1% (6/539), compared to 35% in Tiemensma et al's study (17). Alcohol related deaths could form part of the undetermined group, considering that 24.7% (133/539) of cases had pending alcohol and/ or toxicology results at the time of capturing the study data, thus the possibility exists that the true contribution of alcohol in SUDs could actually be higher in our study.

The demographic profile in adults demonstrated a continued male predominance, however the average age of 34 years in our study is younger than the mean age of 42.6 years in the study by Tiemensma et al. (17). In terms of socio-economic circumstances, the geographical areas from where the majority of SUD admissions came from are impoverished communities in Cape Town. Poverty is a risk factor for poor health and increased mortality (16,19).

Diseases of the respiratory, cardiovascular and central nervous systems were the main causes of natural death resulting in the admission of SUDs, with ischaemic heart disease and pneumonia remaining the most prevalent underlying causes of death. Thus, still reflecting a continued high prevalence over time when compared to the previous epidemiological study. The reasons for this could be that the underlying risk factors for the diseases of these systems are possibly still similar. For example, the most prevalent pre-existing medical condition is still hypertension (17).

In infants, the number of admissions of 196 is significantly less than the yearly average of 318 shown in the review by du Toit-Prinsloo et al. (14). The main causes of SUDI in our study are pneumonia, SIDS, systemic sepsis, gastroenteritis and congenital cardiac anomalies. This is similar to causes of infant mortality worldwide. However, in our study the 11 cases designated as SIDS is much less than the annual average of 47 cases at Tygerberg FPL than what was demonstrated by du Toit-Prinsloo's el al. retrospective review of data from 2005-2009 (13,14). The reasons for these differences are not apparent in our study.

Contribution of respiratory disease

This study highlights that pneumonia is the second leading cause of death, which is in keeping with what was shown locally by Tiemensma et al. and on a global level. It remains the leading cause of death in children under the age of 5 years. This study also demonstrates that it was the leading cause of death in the older child, teenage and young adult groups. In the middle-aged adult group, it is superseded by ischaemic heart disease but remains an important cause of death, at large ranking in the top five most prevalent causes. It was found that a large number of infants were incompletely immunized, which likely contributes largely to the high mortality rate in infants in this study population, of which pneumonia dominates (7,20). Tuberculosis accounted for only 3.7% (29/770) and was not a leading contributor to the admission of SUDs. This could be because those dying of TB are most likely known with the condition during life or were clinically ill for a prolonged period and thus were not classified as SUD and not referred for medico-legal investigation. This study also showed that almost half of the individuals lived in informal housing, denoting probable overcrowded conditions, which are important risk factors for communicable respiratory diseases. Smoking, a known important risk factor for respiratory disease, was shown to be prevalent either as a practice by the deceased individual or as a household exposure in infants, although this information may have been underreported in this study (9,19). The majority of respiratory deaths occurred at home, however, a substantial proportion occurred at a medical facility. Medical professionals may be hesitant to complete the death notification form as often the exact cause of death could not be diagnosed. This does not automatically qualify the death as a case that requires medico-legal death investigation. Thorough history-taking regarding the medical history of the deceased individual and circumstances of the death will enable the medical professional to formulate a fairly reliable opinion on the possible cause of death or which organ system resulted in the fatality and will enable the completion of the death notification form with more confidence.

The reason that respiratory disease is such an important cause of death and illness in the world, is that the lung is prone to airborne infections. With appropriate immunization, adequate nutrition and by addressing environmental factors (socio-economic, hygiene, smoking and the environmental exposure to smoking and air pollution), pneumonia by large is a preventable condition. It can also be treated with effective antibiotics. However, in impoverished environments, only one third of children with pneumonia receive the necessary antibiotics (9). The World Health Organization (WHO), has erected an Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea with the aim of putting an end to these preventable diseases by 2025, by means of the provision of essential health services and health interventions promoting practices known to protect children (21).

Unnatural deaths presenting as sudden death

Unnatural deaths formed the fourth largest group of admissions as SUDs, contributing 7.8% of the admitted cases (60/770). The top five unnatural death causes were trauma, aspiration pneumonia, alcohol related pathology, procedure-related deaths and choking. These are true forensic cases requiring medico-legal autopsies. Despite the relatively low number of unnatural deaths presenting as SUD, the number of autopsies performed in SUD increased from 74% to 96.5% (17). Autopsies in SUDs are performed when after considering the case history together with the external examination, the cause of death could still not be determined. Often an adequate case history is lacking, resulting in the performance of a full autopsy. A careful balance is thus required to reduce unnecessary referrals of natural deaths to forensic pathology laboratories, so as not to overburden the service, and to refer appropriate unnatural cases. There is a need for a more thorough investigation into the circumstances of death before admission to forensic pathology services. Tiemensma et al. improved the interviewing structure for verbal autopsies to ascertain a more comprehensive pre-autopsy history with the aim of reducing the need for the performance of autopsies on natural death cases (17).

STUDY LIMITATIONS

The previous epidemiological study by Tiemensma et al., was performed on the data of adults only, and thus a trend comparison cannot be made on the infant, child and teenage population. In addition, that study evaluated data over a five-year period, as opposed to a one-year period in this study.

The large undetermined category, where the causes of death could not be determined by autopsy, formed just over a quarter of the study population. The cases for which the reports were not yet finalized were excluded from the study population when data was captured. The FPS sudden and unexpected death questionnaire (FPS006) that was used as a source of information for the capturing of the data, was also incompletely filled-in in certain areas.

CONCLUSION AND RECOMMENDATIONS

The annual increase of SUD admissions is, in part, a reflection of the burden of disease in the community. Regular follow-up epidemiological studies evaluating sudden and unexpected death (including infants and children) is recommended to continually evaluate the profile of these deaths, in order to identify health priorities in the most affected communities in Cape Town's Eastern Metropole. Public health and socio-economic development can be advocated for at a municipal or regional level, to alleviate risk factors for preventable diseases that claim a multitude of lives yearly. The aim would be to reduce the prevalence of the leading conditions causing illness and death, this study demonstrating continued major causes of death related to cardiovascular disease and respiratory infections. Measures may include efforts to improve the administration of vaccinations in infants, children and vulnerable groups, more proactive health promotion interventions to reduce the incidence of smoking and poverty reduction strategies to improve the general health status and practices in the community.

The high admission rate also highlights the imposed burden at the Forensic Pathology Laboratory. It is vital to adequately and persistently train medical professionals and SAPS to better understand what a SUD is and when medico-legal referral is warranted. Training of this nature should be formerly incorporated into academic programs. Outreach

teaching and workshops could also regularly be employed by FPS. This is likely to dramatically reduce the unnecessary referral of cases where the manner of death is natural, in turn alleviating the workload and financial strain on the overburdened Forensic Pathology Laboratories.

In the light of the current global COVID-19 pandemic and the evidence that there has been a decline in respiratory illness as a result of influenza, similar mitigation measures enforced by advocacy and national regulations, such as the wearing of filtering face-mask respirators in public, hand washing and social distancing, may very well reduce the overall impact of respiratory infections on death and disease (22).

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CONFLICTS OF INTEREST

I declare that there were no conflicts of interest in this study. Bias was reduced by anonymization of the cases included in the study. The data collection strategy was discussed with the supervisors, co-investigator and peers prior to the collection of the data. The text was reviewed by the supervisor prior to submission.

AUTHOR GUIDELINES

The article was written using the generic post graduate thesis/ dissertation guidelines by Stellenbosch University as a guide for the general text and format instructions, in conjunction with the author guidelines for the following journals,

1. Forensic Science International
2. Journal of Epidemiology and Community Health
3. Forensic Science, Medicine and Pathology

The general journal author guidelines for the text are to make use of a plain font (e.g. New Times Roman fonts size 10), the abstract should consist of up to 250 words and the recommended word count is in the region of up to 4000 words. Up to 40 references may be cited and an electronic referencing manager may be used. Up to 5 illustrations is permitted (including tables, graphs, charts, etc.).

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