AN ANALYSIS OF THE DESCRIPTORS OF ACUTE MYOCARDIAL INFARCTION USED BY SOUTH AFRICANS WHEN CALLING FOR AN AMBULANCE FROM A NATIONAL EMERGENCY CALL CENTRE

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ALS	Advanced Life Support
AMI	Acute myocardial infarction
CCA	Critical Care Assistant
CVD	Cardiovascular disease
ECP	Emergency Care Practitioner
ECT	Emergency Care Technician
EMD	Emergency medical dispatcher
EMJ	Emergency Medicine Journal
EMS	Emergency medical services
HIV/AIDS	Human immunodeficiency virus/ Acquired immunodeficiency syndrome
IHD	Ischemic Heart Disease
MeSH	Medical Subject Headings
NDIP	National Diploma
NSTEMI	Non-ST segment elevation myocardial infarction
PCI	Percutaneous coronary intervention
PRF	Patient report forms
STEMI	ST segment elevation myocardial infarction
USA	United States of America

PART A: LITERATURE REVIEW

Background

Acute myocardial infarction (AMI) is a time sensitive emergency requiring prompt identification and activation of a system of care. Urgent medical intervention is required to prevent the continued loss of cardiac function which may ultimately result in death (1). In the event of the public contacting an emergency medical services (EMS) contact centre for medical assistance, trained EMS call centre operators are tasked with identifying the caller, their location, and the nature of the emergency. Call centre operators in South Africa experience unique challenges in this regard; with 11 official languages in the country, call centre operators need to be able to adapt to the language preference of the caller in order to accurately identify the nature of the emergency and dispatch the appropriate level of care paramedic to the scene.

With highly varying demographics within the country related to language, socio-economic groups, geographical location and education (2-4), it is essential to understand how the South African population as a whole describes patients experiencing an AMI. Developing a reference list of terms for use in a triage algorithm, in the various languages spoken by the South African community when describing paramedic diagnosed AMI cases, will allow for optimisation of the performance of EMS call centre operators in their task of dispatching timely, appropriate care to these patients. Thus, the start of an efficient and community-based solution to the current problem faced by EMS providers may be attained.

Literature review objectives

This literature review will focus on defining AMI, describing the epidemiology of AMI in the South African setting, best practice management of AMI in the pre-hospital environment, and how the management of AMI in South Africa compares to this.

Furthermore, current knowledge on the recognition of AMI by EMS call centre operators will be reviewed, and the descriptors of AMI by callers to these centres will be identified. An understanding of the role of the call centre operators/ emergency medical dispatchers (EMD) and of what influences dispatch decisions will be sought.

Finally, this information will be compared to practices in the South African setting, identifying gaps and the need for further research in this domain.

Search strategy

A MEDLINE search in the PubMed database was conducted using Medical Subject Headings (MeSH) on June 25th, 2018. The search was filtered to English only texts, involving human subjects, not older than 10 years (2008). The following search strings were used with the Boolean operators, under the "Advanced" search option, yielding poor results:

- Search String one: (Emergency Medical Dispatch AND Myocardial Infarction AND South Africa): No results.
- Search String two: (Emergency Medical Dispatch AND Myocardial Infarction): One result, excluded at abstract level.
- Search String three: (Emergency Medical Dispatch AND South Africa): No results.

A broader MEDLINE search was then conducted in the PubMed database, without MeSH terms. The same filters were applied. The following strings were used with the Boolean operators:

- Search string one: (Call centre AND triage): 113 hits

  Subset string one: (Myocardial Infarction AND triage AND call centre): 10 hits
- Search string two: (cardiac AND descriptors AND public): 29 hits

The search was repeated using these filters again on January 18th, 2019, yielding no new results.

The search results of the above strings were scanned for titles that may be of relevance. These articles were separated for review of the abstract and excluded or included based on this. Review of the full text of the included articles further separated those for inclusion and exclusion. The resultant key articles' reference lists were then scanned for any titles that may be of relevance, and the process of review, inclusion and exclusion was repeated. Due to the limited number of articles found, a Google Scholar search using the three search strings was conducted, and the process of review, inclusion and exclusion repeated. The final collection of key articles was included in this review. The PRISMA Diagram below (Figure 1) depicts this literature review process.

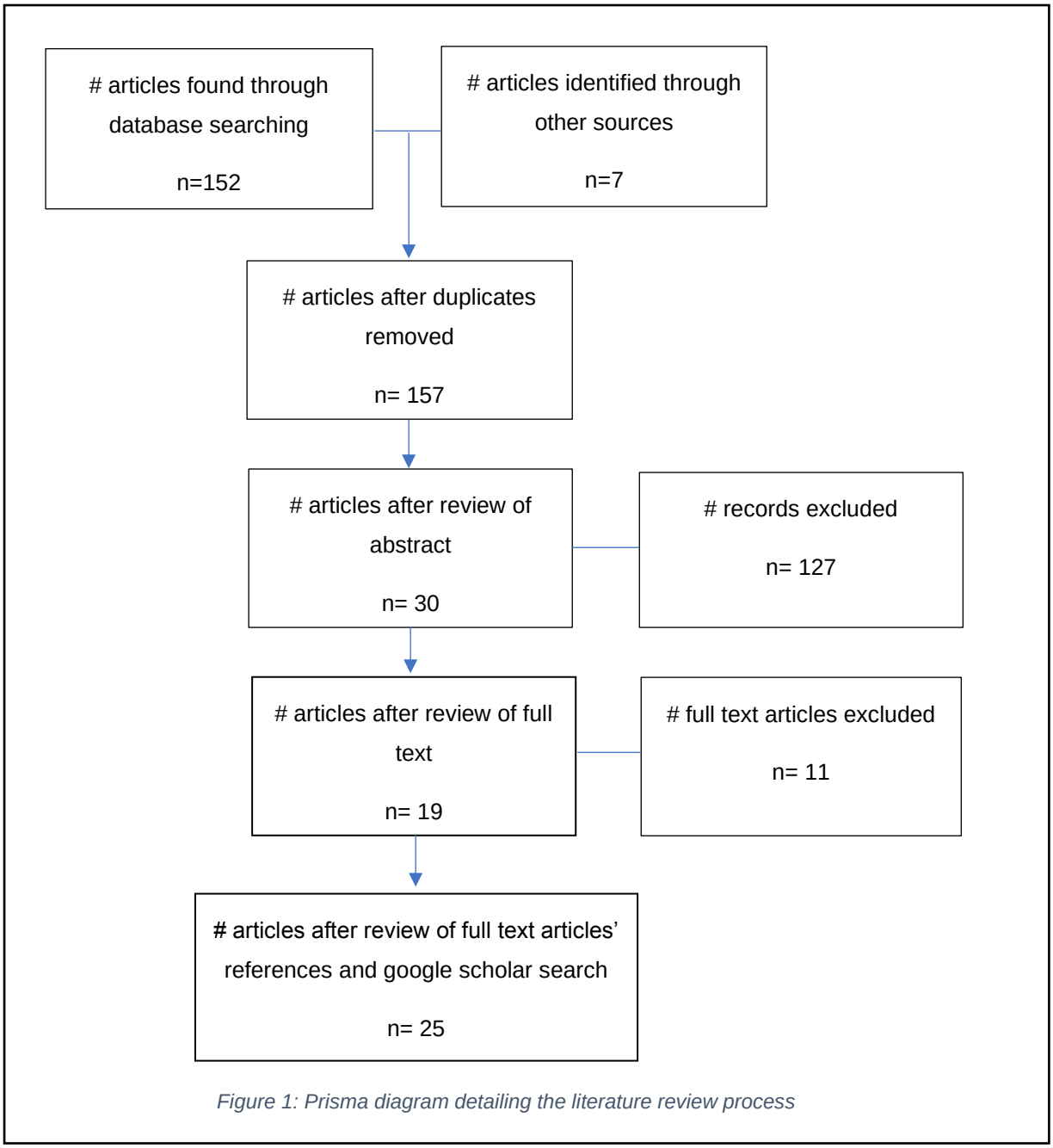

Figure 1: Prisma diagram detailing the literature review process

Literature review

Acute myocardial infarction

AMI is characterised as a cardiovascular disorder and is a potentially devastating consequence of chronic ischemic heart disease (IHD) (5, 6).

AMI refers to the pathological process of coronary blood vessel occlusion resulting in a loss of oxygen being supplied to cardiac tissue, and subsequent destruction and loss of function of the cardiac muscle (5, 6). Risk factors include the presence of comorbidities such as hypertension, diabetes mellitus, hyperlipidaemia and smoking (7). The patient experiencing an AMI may have typical AMI symptoms such as chest pain which may radiate, chest discomfort or tightness, diaphoresis (excessive sweating), nausea and vomiting (8). In some cases, however, notably in diabetic patients, females, smokers and young patients, symptoms may be atypical or absent (termed “silent AMI”) (9, 10).

In the prehospital environment, AMI is provisionally diagnosed based on patient presentation, assessment and medical history, in conjunction with the assessment of a 12-lead electrocardiograph. Encompassed under the provisional diagnosis of AMI, is the diagnosis of an S-T segment elevation myocardial infarction, non-S-T segment elevation myocardial infarction, or unstable angina (11).

The epidemiology of AMI in South Africa

Cardiovascular diseases (CVD) account for the second highest cause of death worldwide, with 80% of this global mortality occurring in low- middle income settings (12). While the incidence of IHD (a main contributor of CVD) in higher income settings is decreasing, the incidence in Africa is rising, and is expected to surpass communicable disease as the main contributor of mortality by 2030 (2, 3). Although conducted between 1999-2003, the African Inter- Heart study noted then that in patients who had experienced an AMI; body mass indices were higher, age was lower (52+- 12 years), and risk factor presence (smoking, diabetes, hypertension and depression) was higher in comparison to patients from the rest of the world. Specifically, Black African participants with lower levels of education (less than 8 years of schooling) had an increased risk of experiencing an AMI. Of the 538 African participants involved in this study, 80% were from South Africa (13-15). According to Statistic South Africa for the year 2016, non- communicable diseases accounted for 57.4% of natural deaths. IHD was among the top 10 contributors to this figure, steadily rising as a cause of death since 2014

(16). Health care that is variable and subject to accessibility, acceptability and affordability issues, and inefficient, unequitable health care systems are proposed as contributing factors to this increased burden of disease in settings like South Africa (12, 17).

Best practice recommendations for the treatment of AMI

Definitive care of patients experiencing an AMI involves management in a facility capable of percutaneous coronary intervention (PCI) within 60-120 minutes of symptom onset. If PCI is not available within 120 minutes of symptom onset, fibrinolysis is recommended (where indicated), followed by further management in a PCI capable facility; either rescue PCI in cases where fibrinolysis has been unsuccessful, or routine PCI strategy (1).

Pre-hospital EMS has a significant role to play in ensuring patients receive optimal care when experiencing AMI, particularly since 50% of mortality due to AMI occurs prior to these patients reaching a hospital (10). Well-structured EMS has the potential to timeously recognise the patient experiencing AMI; from the EMS call centre by call centre operators and EMD using clinical protocols (18, 19), to on scene by paramedics through symptom presentation and the performance and interpretation of 12 lead electrocardiographs. EMS personnel should then coordinate transfer of the patient from the scene to an appropriate, notified definitive care centre, and initiate appropriate management strategies *en* route, including oxygen and analgesia administration, recommended to reduce mortality and morbidity from AMI. Should PCI not be available within 120 minutes of symptom onset, it is recommended that paramedics trained to perform pre-hospital fibrinolysis (where indicated) should do so (1, 10).

Management of AMI in the South African setting

To achieve the goal of optimal prehospital care, factors contributing to delay in reperfusion management (patient, EMS and system delay, as described by Ibanez *et al*) need to be identified and mitigated (1). Indeed, Studnek *et al* identified in their 2018 retrospective analysis of 551 pre-hospital diagnosed ST segment elevation myocardial infarction patients, that for every 10-minute delay in reaching definitive care from the time the call to the EMS is placed, the mortality of patients at one-year increases by 30% (20). Beginning in the EMS call centre, all systems of care which follow; identification of AMI, dispatch of an advanced life support (ALS) paramedic, scene management, transfer to a definitive care centre and definitive management; need to be conducted in a timely manner (1, 10).

It has recently been identified by Stassen *et al* that, with only 62 PCI capable facilities in the country, the ratio of South African population to PCI capable facility is well above international recommendations (1 000 000:1 provided access is possible within 120 minutes) (2). With some provinces in the country lacking these facilities altogether, a significant proportion of South Africans who suffer an AMI will not have access to definitive care entirely, let alone within the recommended time- frame. Additionally, 77% of these facilities are located in the private sector, and thus limited to use by the 18.1% of South Africans who possess medical insurance (2).

In-hospital delays, related to atypical patient presentations and the need for guidance in the interpretation of 12 lead electrocardiographs, resulted in delay to fibrinolytic therapy (>30 minutes) in 79.5% of 161 patients in a 2012 South African based retrospective audit by Maharaj *et al* (21). Prehospital delays (call for help to arrival at hospital) resulting in delay to fibrinolysis were associated with paramedics becoming lost *en* route to the scene or the EMS being overburdened at the time of the call in another South African based prospective observational review in 2016 by Meel *et al* (22).

In the EMS sector, ALS paramedics who qualify as Emergency Care Technicians, Critical Care Assistants, National Diploma paramedics or Emergency Care Practitioners, registered with the Health Professions Council of South Africa, are trained to recognize, diagnose and manage AMI in the South African pre-hospital environment (23). Interventions within the scope of these professionals, found to decrease mortality by minimising the delay to identification and initiation of care, range from the possession of the equipment and knowledge to perform and interpret 12 lead electrocardiograms that may be sent via telemetry to the receiving facility from scene, to the administration of analgesic, vasodilatory and thrombolytic medication (10). The latter being of particular importance in rural areas where access to a PCI capable facility within the recommended time frame (or at all) is not possible (2). At the time of this review, there were 3210 registered ALS paramedics however, given that many of these paramedics are not in operational roles or have emigrated, this is likely an overestimation of available resources (24). Evidently, a shortage of ALS paramedics exists.

Diagnosis of AMI and initiation of advanced life support pre-hospital care from scene *en* route to an appropriate receiving facility by paramedics has been found to reduce the mortality of these patients (10). In order to achieve this in an African setting, a “network approach” as described by Stassen *et al* is recommended to expedite diagnosis and timely reperfusion management (2). This approach is aimed at increasing funds and resources to priority geographical areas, eliminating the barrier of access to care dependant on ability to pay, and

the upskilling of medical professionals in the care of AMI patients to address the issues of staff shortages within the country (2).

Additionally, it is recommended that a "prioritized and efficient ambulance service" link the definitive care of AMI patients in this network approach; beginning in the EMS call centre, continuing throughout the pre-hospital arena, and into the definitive care/ hospital environment (1). Risk stratification, whereby the nature of the patient's emergency is identified and triaged, is one approach, aimed at minimising the delay in access to care of these patients by the appropriately trained medical personnel (1). This risk stratification process should begin in the EMS call centre by call centre operators and EMD.

Recognition of AMI in EMS call centres

For patients seeking emergency care, the EMS call centre, staffed by call centre operators and EMD, represents the first available opportunity to identify AMI and prioritise the response. Indeed, Clawson *et al* in their study based in the United States of America (USA) on how EMD manage AMI cases in their dispatching centre, highlighted the importance of a scripted, clinically based protocol for time efficient and accurate triage of these priority cases (18). Using the Medical Priority Dispatch System, EMD in this study correctly triaged 90% of the 606 AMI cases reviewed. Based on the callers' descriptions of the patients' complaint and the design of the Medical Dispatch Priority System, the EMD categorised the patient into a chief complaint protocol, and dispatched resources according to the priority of these protocols. A limitation of this study was the absence of interactional data (i.e. the direct quote given by the caller) used by the EMD to discern the nature of the patient's emergency. Thus, the veracity of the EMD categorisation decision could not be verified, and a view of the overall interaction between the caller and EMD could not be assessed (18).

When a member of the public contacts the EMS call centre for aid, call centre operators and EMD are tasked with identifying the cause of the emergency, prioritising the case and dispatching the appropriate resources (25). There are numerous challenges faced by these personnel in performing these tasks:

- Identification: It is highly recommended that EMS call centres incorporate clinical protocols for use by call centre operators and EMD to aid their decisions (18, 19). These protocols guide the questioning of the caller, in order to timely and efficiently understand the nature of their emergency. However, these protocols do not necessarily account for the descriptors used by the caller, which may affect the interpretation of the event by the call centre operator/ EMD (25). Importantly, the Task

Force on Chest Pain group describes identification of the problem based on the symptoms given, and that the call centre operator/ EMD should not strive to diagnose the patient's condition (25).

- Prioritization: Based on this interpretation, the case is categorized according to the suspected needs of the patient, ranging from basic to advanced care. Incorrect prioritization has the consequences of delayed appropriate care to the current case, or over-triage, which affects the availability of resources for other emergencies (26).
- Dispatch: According to the prioritization phase, the appropriate level of care medical professional is sent to the scene. In some settings, notably the South African EMS environment, the availability of ambulances and/or appropriately qualified paramedics is limited (24). As a result, the accuracy with which the above tasks are conducted is of paramount importance in avoiding over and under-triage.

To address these challenges, the interaction between the caller and EMD should be facilitated as far as possible to ensure timely and accurate identification of the emergency, and appropriate response by the EMS. Lindstrom *et al*, in their Swedish study identifying barriers and opportunities in assessing calls to an emergency medical call centre, identified the following hinderances to an efficient caller- call taker interaction: insufficient information gathering by call centre operators, an inability to identify a primary problem, minimal analysis of an evident problem, unnecessary questioning and poor call structure (19).

In response, Lindstrom *et al* similarly recommends the use of validated screening tools (also recommended by Clawson *et al*), to facilitate dispatch decisions (18, 19). These tools should promote closed loop communication (repeating and confirming the information given) and appropriate follow up questioning. Communication opportunities were also described when callers used descriptors that reference a specific medical condition as described by literature. Interestingly though, despite seeing a third of calls to the emergency call centre in a "non-native" language, the authors did not identify language differences as a barrier to communication (19).

Tate *et al* made different conclusions in their 2015 systematic review of the literature related to language barriers in the EMS (27). Particularly within dispatch settings, it was found in their review of USA based studies that accuracy in identification and triage of the caller/patient's emergency was impaired when dispatchers dealt with callers with limited English proficiency. This inaccuracy often resulted in over-triage of calls. Additionally, in cases where the dispatcher should have provided telephonic instruction to the caller to manage the patient

while awaiting the arrival of EMS (e.g. guided telephonic cardiopulmonary resuscitation), language barriers were often cited as the reason the dispatcher did not initiate this (27).

The review by Tate *et al* identified the effects of language barriers in the EMS in settings within the USA, Canada, United Kingdom and Sweden. There were no African studies in this review. It stands to reason, however, that language barriers may have similar consequences in the African setting. In South Africa alone there are 11 official languages, and the consequences of immigration and travel into the country will likely result in more languages being spoken (4). The way in which dispatchers accommodate non-English callers to a South African EMS call centre was assessed by Penn *et al* (28). They found in their 2017 study that some call centre operators had an apparent bias against certain ethnic groups, particularly African callers, and as such were less courteous, less helpful, and less accommodating of an adaption ("shift") to the language preference of the caller. The historical South African context of Apartheid can of course be associated with this finding, as well as the more recent problem of xenophobia. However, in the majority of the 21 calls analysed (76%), language shifts were managed seamlessly, and this was attributed to a "cultural and linguistic match" to the callers in the region. This study was conducted in one EMS contact centre in one province of the country and it is unknown if the same results would be observed nationwide (28).

It is unknown whether the language discordance issues discussed above, as well as substantial variations in the level of education and literacy that exist in South Africa, have consequences on how South Africans describe their symptoms when experiencing a medical emergency (17). Although Lindstrom *et al* did not identify language differences as barriers to communication in their study, the results of the South African study by Penn *et al* suggests that a linguistic and/or cultural mismatch between the caller and call taker may impede the EMD goals of nature of emergency identification, prioritization and dispatch (19, 25, 28).

<u>Descriptors of AMI made by callers when requesting EMS</u>

In persons experiencing an AMI, chest pain is considered the hallmark symptom (8, 9, 29). However, in a 2011 study by Fourny *et al*, it was observed that the presence of chest pain in isolation is considered a poor indicator for a cardiac event. Their study, conducted in France, identified that 30% of 245 patients with confirmed AMI that were transported by EMS were under-triaged by the dispatcher, resulting in delays to definitive care. The authors did not identify specific causes of the triage inaccuracies and encouraged additional research to answer this question (26).

Additional information describing the nature of chest pain is required to substantiate the suspicion of the presence of AMI. Elaboration on the nature of the chest pain is associated with more accurate identification of AMI patients. Clawson *et al* found that certified EMD prioritised cases complaining of chest pain where the caller used additional terms describing "discomfort", "tightness", "numbness", "heaviness", "pressure", and "crushing", recognizing that the patient was potentially experiencing a heart attack as guided by the Medical Dispatch Priority System clinical protocol (18).

Similarly, Manzo-Silberman *et al*, in their 2015 French study, found that dispatchers (physicians) prioritized chest pain cases where the pain was described to be radiating to the left arm, and where the chest pain was determined to be in a retrosternal location. A limitation of this study was that these cases were prioritised by the dispatchers but the presence of acute coronary syndrome in these patients was not confirmed (30).

Importantly, recognition of these qualifying descriptors by the EMS call centre operators and EMD in terms of their significance requires additional training, to avoid misinterpretation of ambiguous caller replies. This was a concern in the 2017 study by Riou *et al* in their study on the linguistic factors that affect call taker recognition of agonal breathing in cardiac arrest cases. In cases where the caller responded, "*yes but gasping*", to the question, "I*s the patient breathing?"*, no further investigation was conducted by the call taker: the investigation into "gasping", a concerning sign, is not further investigated as the caller initially indicated that the patient was breathing. Thus, the opportunity to recognise cardiac arrest and initiated cardiopulmonary resuscitation was missed (27).

As well as additional information to describe chest pain, the presence of associated AMI symptoms can facilitate the prioritisation of potential AMI cases. Dos Santos et al identified in their analysis of 29 articles, that in the context of pain related to AMI, symptoms of nausea, vomiting, diaphoresis, weakness, fear, anxiety and sleep disturbance are to be expected (31). This is unsurprising, as AMI is typically associated with these symptoms (1, 9, 29).

Notably, none of these studies provided the interactional data given by the callers to the EMS call centre. Additionally, where these calls may not have been in English (Manzo-Silberman *et al*; Dos Santos *et al*), the translation of terms to English, and the possible misinterpretations that may have arisen, was not discussed (30, 31). This has implications for the application of the findings of these studies as we do not know what descriptors were used by the callers to describe the patient experiencing an AMI or what descriptions were extrapolated by the EMD/ researchers. Additionally, these studies were conducted in high-income (Fourny *et al*; Manzo-Silberman *et al*; Clawson *et al*) settings, and thus their application in an LMIC setting may be

limited, due to varying degrees of literacy and access to education, as well as availability of EMS resources in these settings (4, 17, 18, 24, 26, 30).

Atypical descriptors of AMI

Importantly, AMI is not always associated with chest pain. A patient's gender, race and comorbidities may lead to an atypical AMI presentation where the descriptor of "chest pain" may not be given (18, 32-39).

A 2011 meta-analysis of 26 studies published between 1990 and 2009 by Coventry *et al* compared symptoms experienced by males and females and identified that females are less likely than males to complain of chest pain when experiencing an AMI. Females tended to complain of fatigue, syncope, dizziness, neck, jaw and right arm pain. These studies were conducted in many different settings, including the USA, United Kingdom, Japan, Thailand, Canada, and various European countries, using data collection methods including medical chart reviews, interviews, surveys and questionnaires (32). While Berg *et al* found no difference in the presence of chest pain between 255 Swedish males and females, they did find that females more often complained of nausea, dizziness, back pain and palpitations, and appeared to complain of more symptoms than males. Both studies' review of patient medical records has limitations, including how the symptoms were documented by the treating physician versus how the patient described them (moderator bias). Additionally, data from patients who had died in hospital in the Berg *et al* study were not accessible, thus it is unknown if these patients experience different symptoms to those analysed in the study (33).

Similarly, a retrospective analysis of females in the USA who had experienced an AMI by McSweeney *et al* found that they most commonly complained of sleep disturbance, unusual fatigue and shortness of breath when experiencing an AMI (34). This study was a comparison of AMI symptoms in Black, White and Hispanic females. Differences in descriptors between these groups were observed; Black females predominantly complained of indigestion and being hot or flushed, White females experienced pain or discomfort to the back, chest, jaw, teeth and both arms, and Hispanic females most commonly complained of chest pain/discomfort. However, the descriptor of "chest pain" was present in <37% of the 1270 females in this study. Importantly, these findings are subject to the recall bias of participants who were interviewed four to six months after the acute event. Interestingly, McSweeney *et al* translated their measurement tool (the McSweeney Prodromal Acute Myocardial Infarction Symptom Survey) into Mexican-Spanish and Caribbean/South- American Spanish and recorded the answers in the language preference of the participant. Using two bilingual health

professionals, the translation of terms to English was 100% agreed upon, by a consensus judgement process (31).

Ghezeljeh *et al* found in their Tehran based study of 500 participants with angina pectoris, that females experienced pain more frequently in the left arm, scapula and hand, neck and jaw compared to males, who reported pain more frequently in the left lower chest. While descriptors qualifying pain as “heavy”, “exhausting” and “aching” were common between the sexes, woman were found to additionally describe pain as “crushing”, “sickening” and “punishing”, and appeared to experience pain at a higher intensity than males. This data was gathered using a questionnaire submitted to consenting out-patients previously admitted to a cardiac unit. Recall bias may have affected these results (35).

AMI descriptors of syncope, weakness and gastrointestinal symptoms were the predominant complaints of the “Atypical Cluster 3” group of Korean patients in a study by Hwang *et al.* In this group, 51% of the 59 participants in this cluster had a history of diabetes, significantly higher than patients in the other two categories identified. Follow up on these patients indicated that there was a higher mortality and longer duration of hospital stay in comparison to non-diabetic patients (36). Junghans *et al* similarly concluded that the frequency of atypical chest pain symptoms in a cohort group of 8662 patients was twice as high in diabetics compared to non-diabetics, where typical chest pain features were compared objectively for typicality using the Diamond Forrester criteria (which asks the patient to select whether or not the chest pain is constricting, central/left sided, </= 15 minute duration, provocation by exercise. Atypical pain was defined as the presence of less than 2 of these features in combination) (37).

In a review 2012 of a national registry of myocardial infarction containing over one million patients by Canto *et al*, atypical symptom presentation was associated with diabetes and female patients (38). They further found that older age (mean 74 years), a history of heart failure, and a diagnosis of non-ST segment elevation myocardial infarction was associated with an atypical AMI presentation that did not include chest pain (38). Fujino *et al* had similar results in their study of 3085 Japanese patients, associating older age, diabetes, female gender, history of heart failure and coronary artery disease with atypical (no chest pain) non-ST segment myocardial infarction. In-hospital mortality was also higher in this group (39).

These studies imply that it is not appropriate to develop a screening tool for the identification of AMI using only typical signs and symptoms. The symptoms experienced by a patient when suffering an AMI have implications for what they will describe when calling for help, be it directly to the EMS call centre or via a third party. Recognising symptom patterns indicative of

AMI in a diverse demographic, such as South Africa, for use in a screening tool may avoid the under- triage of these atypically presenting patients.

Contextualising caller descriptors

The descriptors of AMI that callers may use when calling an EMS call centre for assistance are dependent upon whether they present typically: with chest pain, the nature of which should be understood, or atypically: without chest pain. The typical and atypical signs and symptoms (silent AMI) have been identified above and, when described in isolation, can be non-specific i.e. fatigue, weakness, syncope, nausea, back pain etc. Screening tools that prompt for information that will provide contextualization of these descriptors would increase accuracy of AMI identification (18, 19).

Although not empirically proven, Fourny *et al* did comment that identifying the presence of a history of coronary artery disease and previous PCI in patients may assist with more accurate triage (26). In the Hwang *et al* study of 391 Korean patients who had experienced ST-segment elevation AMI, hypertension, diabetes, hyperlipidaemia, previous history of IHD and family history of CVD was present in 49.1%, 32.2%, 35.3%, 12%, 19.7% of the sample respectively (36). These results reflect both the groups of patients who presented with typical as well as those with atypical symptoms of AMI (36).

A history of previous AMI or angina was one of four factors predictive of a life- threatening condition, including ACS, in a 2016 retrospective study by Rawshini *et al* (40). This was concluded after a series of 10 specific questions were posed to 2285 patients experiencing chest discomfort who called a Swedish EMS call centre for assistance in the period 2009-2010 (40). Similarly, Goel *et al* identified hypertension (32.8%), diabetes (26.6%) and hyperlipidaemia (17.9%) in their sample of 609 patients who presented with a first onset AMI to hospitals in the Uttar Pradesh state in Northern India (41).

Interestingly, many of the patients in the study by Goel *et al* were unaware of their underlying risk factors until after the AMI event, attributed to unreliable access to healthcare. The authors highlight a need for more screening services to address this issue in their setting (41). Similarly, it is suspected that many South Africans live with undiagnosed risk factors for AMI, as 53% of South Africans live in poverty and thus have variable access to healthcare (42).

Consequently, the inclusion of risk factor analysis in the AMI screening tool is that if this information on chronic illness is not known by the patient/ caller, it may result in limited reliability of the tool itself.

The role of the call centre operator/ emergency medical dispatcher

Clinical gestalt of the EMS call centre operator/ EMD may aid in the identification of priority cases where a screening tool falls short; however, the qualifications of these role players in the different settings vary significantly. In the Cape Town and Utah setting, call centre operators are trained in the skill of emergency call taking, and some individuals may have a basic medical background (18, 28). In the Swedish setting, call centre operators are registered nurses (43), while Copenhagen uses either nurses, paramedics or physicians trained in emergency dispatch (44, 45), and France uses emergency physicians (46). The accuracy of triage by call takers with varying qualifications should be considered in future research.

Finally, EMS call centre operators and EMD can be trained in communication techniques that optimise the caller-call taker interaction, and subsequently aid the identification of the emergency. Lack of adequate communication, characterized in the study by Gamst-Jansen *et al* as a condescending, patronizing, irritated demeanour by the call taker, subsequently minimizing the problem or patients' point of view, results in poor collaboration with the caller (44). This was seen in the South Africa study by Penn *et al*, describing bias against certain types of callers by the call takers, resulting in poor caller accommodation related to language shifts (28).

Summary and conclusion

The EMS call centre operator and EMD in the EMS contact centre has arguably the highest degree of responsibility relating to identification of the caller or patients' emergency and coordinating an appropriate response in order to minimize mortality and morbidity.

It is evident that identification of patients experiencing AMI by the descriptors given to the EMS contact centre, while uncomplicated in instances of typical symptom description, is not without its challenges. These challenges relate to patients who experience atypical symptoms which, without contextualisation, may result in this time sensitive emergency going unnoticed.

Although there is a paucity of literature in the South African setting related to AMI identification in EMS call centres, varying levels of education and literacy, as well as the multitude of languages spoken suggest that additional challenges are faced by role-players in this setting, and these factors may impact how callers describe their symptoms.

Literature supports and recommends the use of a screening tool to optimise caller/call-taker interactions and aid dispatching decisions. When designing the tool for use in AMI cases,

further investigation into the chief complaint, additional symptoms and chronic medical history of the patient can facilitate the decision-making process. With a well-designed tool, this information gathering can be conducted in a timely, efficient way.

In order to individualise the screening tool for the setting in which it is intended, the creation of a reference of terms and phrases used by callers to describe AMI for use in an EMS call centre by EMS call centre operators, will allow for the smooth interaction between the appropriately matched caller/call taker and the swift and accurate conclusion of an emergency call. The study described in this Masters dissertation therefore aimed to identify the key words and phrases that are commonly used by members of the South African public to describe a patient experiencing an AMI when calling a private EMS call centre to request an ambulance.

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PART B: MANUSCRIPT IN ARTICLE FORMAT

AN ANALYSIS OF THE DESCRIPTORS OF ACUTE MYOCARDIAL INFARCTION USED BY SOUTH AFRICANS WHEN CALLING FOR AN AMBULANCE FROM A NATIONAL EMERGENCY CALL CENTRE

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Abstract

Introduction Acute Myocardial Infarction (AMI) is a time sensitive emergency. In resource limited settings such as South Africa, prompt identification and management of these patients in the pre-hospital setting may minimise the negative consequences of an overburdened emergency medical and hospital service. Expedited care thus, in part, relies on the dispatch of appropriate pre-hospital medical providers by emergency medical dispatchers. Identification of these patients in the call centre is challenging due to a highly diverse South African society, with multiple languages, cultures, and levels of education. The aim of this study was therefore, to describe the terms used by members of the South African public when calling for an ambulance for patients suffering an AMI.

Methodology In this qualitative study, we performed content analysis to identify keywords and phrases that callers used to describe patients who were experiencing an AMI. Using the patient report form number of randomly selected paramedic- diagnosed AMI cases, original voice recordings between the caller and call centre operators at the time of the emergency were extracted and transcribed verbatim. Descriptors of AMI were identified, coded and categorised using content analysis, and quantified.

Results Of the 50 randomly selected calls analysed, 5 were not conducted in English. The descriptors (meaning units) used by callers were and found to fall into three categories; **Pain: Thorax, No pain: Thorax** and **Ill- health.** The code that occurred most often was no pain, *heart related* (n=16; 23.2%), followed by the code describing pain *in the chest* (n=15; 21.7%).

Conclusion South African callers use a consistent set of descriptors when requesting an ambulance for a patient experiencing an AMI. The most common of these are non- pain descriptors related to the heart (“heart attack”). These descriptors may ultimately be used in developing validated algorithms to assist dispatch decisions. In this way, we hope to expedite the correct level of care to these time- critical patients and prevent the dispatching of resource limited advanced life support paramedics to inappropriate cases.

Keywords:

Acute myocardial infarction; Emergency Medical Dispatchers; Heart attack; Chest pain

Key Messages

What is already known on this subject

AMI is a life-threatening, time sensitive emergency requiring rapid identification and reperfusion to decrease morbidity and mortality.

EMS has a vital role to play in improving the outcome of these patients.

Over and under-triage can be mitigated by emergency medical dispatchers using validated screening tools, ensuring the appropriate level of care is received by the patient *en* route to hospital.

What this study adds

When calling for an ambulance, caller descriptors affect how accurately emergency medical dispatchers identify the nature of an emergency.

A reference of terms and phrases used when describing AMI, tailored to specific settings, can aid dispatching decisions.

This is especially important in settings where multiple languages are spoken.

Introduction

Acute myocardial infarction (AMI) is a time sensitive emergency, where even minimal delay in the time from onset of symptoms to receiving definitive management is associated with increased mortality (1, 2). Globally, cardiovascular diseases (CVD), including ischemic heart disease (such as AMI), are a leading cause of morbidity and death (3). In the Sub-Saharan African population, CVD incidence is rising (4). According to Statistic South Africa, non-communicable diseases accounted for 57.4% of natural deaths in the year 2016. IHD was among the top 10 contributors to this figure, steadily rising as a cause of death since 2014 (5).

Approximately 50% of AMI related mortality occurs in the pre-hospital environment (6). Indeed, for every 10-minute delay in reaching definitive care from the time the call to the emergency medical services (EMS) is placed, the mortality of patients at one year increases by 30% (7). To address this increasing burden of CVD, it is not always feasible to adopt the health system strategies that are effective in high-income countries (8). The timely dispatch of appropriate EMS resources, capable of initiating advanced life support on the scene and *en* route to an appropriate receiving facility, may improve the outcome of these patients (9). However, resource-limited settings face unique challenges in this regard, in part due to the unequal coverage of EMS and inadequate access to definitive care (10). In South Africa, economic inequality results in a disparity of care between poor, uninsured citizens residing in rural areas, and wealthier, insured citizens residing in urban areas (8).

Expedited care of patients experiencing an AMI in the pre-hospital environment can be facilitated by call centre operators and emergency medical dispatchers (EMD) operating in an EMS call centre, achieved by recognising potential AMI through the descriptors used by members of the public when calling for help (11). Additionally, over-triage and the subsequent unnecessary dispatch of these finite resources may be avoided (2).

Call centre operators and EMD in South Africa face unique challenges in recognising high priority emergent conditions. The description of the nature of a medical emergency may occur in one of 11 official languages, and there is substantial variation in literacy and level of education within the population (12, 13). This language discordance is not a uniquely South African problem as increases in immigration, recreational travel and migration related to political unrest create broadening communities worldwide, with increasing numbers of languages spoken in addition to the officially recognised languages of a country (14). Additionally, culture influences how a group communicates health related information. An understanding of the characteristics of the different cultural groups within South Africa may aid the customisation of health care communication programmes, and may provide an

understanding as to when and how various groups of people seek help for their ailments (12, 15).

In addition, limited advanced life support (ALS) paramedic resources are available within the EMS for EMD to dispatch to priority scenes. At the time of this study, there were 3283 ALS paramedics trained to recognize, diagnose and manage AMI, registered under the Health Professions Council of South Africa (16). However, given that many of these paramedics are not in operational roles or have emigrated, this is likely an overestimation of available resources (17, 18). Evidently, a shortage of ALS paramedics exists, particularly in the public sector and rural areas (14).

At the time of this study there was no published literature detailing the terms and phrases South Africans use to describe patients experiencing an AMI when calling for an ambulance. The speed and accuracy with which these calls are identified may be improved through the development of a triage algorithm featuring a reference of terms used by callers to describe this emergency in this setting (11).

This study therefore seeks to identify the key words and phrases that are commonly used by members of the South African public to describe a patient experiencing an AMI when calling a national, private EMS call centre to request an ambulance.

Methodology

In this descriptive, retrospective study, we performed content analysis at the manifest level to identify and quantify keywords and phrases that callers used to describe patients who were experiencing an AMI (19).

Study setting

The study was conducted in a national, private EMS call centre based in the Gauteng province of South Africa. The health care system in South Africa is currently separated into private and public sectors, servicing 16% and 84% of the public, respectively (20). Despite this divide, health care spending in the private health care sector far outweighs that of the public sector (12). Access to healthcare in the private sector is determined by an individuals' ability to pay for services, whilst access in the public sector is limited by overcrowding and limited resources (12). Although this private EMS predominantly services citizens with medical insurance, the call centre is available to all people residing in South Africa. In this EMS call centre, call centre

operators act as call takers, receiving the emergency call from members of the public. Although mostly non-medically trained, they undergo one month of pure system training and EMS orientation before working in this call centre. Most call centre operators, while all fluent in English, also communicate in other South African vernacular. Information related to the nature of the emergency, caller information and location is relayed to the EMD, who decides on the level of care resources to send to the scene. EMD have medical training and experience in EMS operations, ranging from basic to intermediate life support qualifications. On average, the call centre receives approximately 600 calls per day from all over the country. Of these, an estimated 40 calls per day relate to cardiac emergencies (Personal communication: S Van Heerden, 2019).

Data collection

Over an eight-month period (January to August 2016), patient report forms (PRFs) that were categorised as acute emergency (primary) cardiac cases (ICD I21.0-I23.8) were randomly selected. These PRFs describe a member of the South African population who called the ER24 emergency contact centre for an ambulance during this time, who was then diagnosed, treated and transported by an ALS paramedic for AMI. These PRFs detailed the events surrounding the emergency call; patient information (which was anonymised prior to data extraction), medical history, clinical and diagnostic findings, and patient management. Using Microsoft Excel, random numbers where generated and the corresponding PRF (from a numerical list) was evaluated. This process was repeated until a sample of 50 cases meeting the inclusion criteria was identified. This data collection period was purposively selected because, during this timeframe, calls were not stringently managed according to a call centre drop down system script that was implemented after this period. Callers were, therefore, not potentially influenced in their choice of words by the call centre operators who were referencing the script.

The selected PRFs were evaluated according to the inclusion criteria of primary emergency cases with an ALS paramedic diagnosis of AMI; this includes the description of S-T elevation myocardial infarction (STEMI), non-S-T elevation myocardial infarction (NSTEMI) or unstable angina as the provisional diagnosis (21). The diagnosis was evaluated together with the findings on the 12 lead electrocardiogram recordings (or a written description of the findings on the electrocardiogram), vital signs, medical history and presentation of the patient, as well as management by the paramedic. PRFs were excluded if the patient was being transferred between hospital facilities, if the call had not gone through the call centre (self-dispatched

calls), if the patient was in the presence of a medical professional at the time of the call (at a doctors rooms/ nursing home) or if the patient was a minor (<18 years of age).

Using the PRF case number, original audio recordings between the caller and call centre operator at the time of the emergency were extracted. All calls in English and Afrikaans were transcribed verbatim by the researcher. The audio recordings of the other four vernacular calls were examined by the researchers during a process of consensus judgement described below.

Data analysis

The transcribed calls were subjected to content analysis at the manifest level, noting the unprompted keywords and phrases describing the nature of the patient's medical emergency spoken by the caller (in their own words, not descriptors given by the EMD).

A separate process of consensus translation and judgement was used for analysis of calls in vernacular. Two senior EMS call centre agents, who were experienced in both call taking and dispatching responsibilities and who speak the vernacular of the specific calls, assisted by transcribing the call in the vernacular. Consensus judgement was then reached among the EMS call centre agents and the three other investigators of terms that were used to describe the nature of the patients emergency (22, 23). Consensus translation was achieved by the two EMS call centre agents as to the most accurate translation of these terms to English. These senior call centre agents, as well as the other agents in the call centre, are considered real-world experts in the content of this data. Due to the nature of their daily work, they are regularly exposed to keywords and phrases spoken by callers with various first languages, requiring experience and developing adaption techniques to facilitate the dispatch of resources based on what they have interpreted the nature of the call to be. Indeed, it was noted that these EMS call centre agents were able to identify not only the type of medical emergency being described, but also the location of the caller based on their language pronunciation and greeting style.

Using Creswell's five steps to Qualitative Data Analysis (24), the terms indicative of AMI (codes) identified in the content analysis and consensus judgement process were categorized using NVivo12 Pro qualitative data analysis (QSR International Pty Ltd, Australia). The frequency at which identified terms occurred was then quantified.

To ensure qualitative rigour and trustworthiness, the following provisions described by Shenton were made to ensure credibility, confirmability and dependability (25);

- Credibility was ensured by extracting data from randomly selected PRFs to prevent researcher bias via the purposive selection of cases for review, and through the identification of meaning units describing the nature of the emergency based on the clinical knowledge of the first and senior authors, who possess clinical qualifications and experience in the identification of signs and symptoms of illness.
- Credibility was further ensured with frequent debriefing sessions held between authors during the content analysis process, member checks during the consensus judgement process involving the authors, two experienced senior contact centre agents, and the collaborating team from the Health Communication Research Unit of the University of the Witwatersrand,
- Confirmability was ensured through investigator triangulation of the evaluation of the randomized calls related to inclusion and exclusion criteria, content analysis and consensus judgement process, and through the checking of the transcribed calls by the senior author,
- The dependability of the data gathering process, involving the analysis of the PRF's, was subject to the involvement of appropriately trained medical ALS paramedics. Both the first and senior authors were part of every individual consensus judgement process, to ensure the data gathering and analysis process was uniformly conducted. Consensus between the first and senior authors regarding coding and theme development was employed, based on the background of experience and medical theory possessed by both.
- The transferability of this data is subject to its use in settings similar to that of the study- a private EMS service within South Africa. Transferability will be extended to other settings at a later stage, beyond the scope of this project, using the same methodology in different EMS settings (public and private) within South Africa, servicing a broader demographic of patients.

Results:

Of the 197 PRFs eligible for consideration (categorised as primary emergency cases matching the specified ICD codes), PRFs were extracted randomly and evaluated until a total of 50 PRFs were identified to meet the stipulated inclusion/ exclusion criteria. This sample size was

chosen based on a previous study using similar methods (26). Table 1 provides information on the patients corresponding to these PRFs.

Table 1: Demographic descriptors of patients included in the emergency calls analysed (according to PRFs).

	Total patients (n=50)
Mean (SD) age (years)	59.7 ± 16.2
Male Sex; n (%)	34 (68)
Population Group; n (%)	
White	30 (60)
African	10 (20)
Coloured	4 (8)
Indian	3 (6)
Other	1 (2)
Unknown	2 (4)
Medical History; n (%)	
Cardiac disease	28 (56)
Hypertension	21 (42)
Diabetes	12 (22)

SD: Standard deviation

Patients in this sample were predominantly male (68%), classified as white (60%) and older than 40 years of age (92%). More than half of these patients had an underlying chronic history of cardiac disease, with 10% having a combination of cardiac disease and diabetes, 10% with hypertension and diabetes, 12% having cardiac disease and hypertension and 4% with all three risk factors.

Objective demographic information describing callers was not available. In 90% of the included calls, callers chose to speak English. In the remaining five calls, callers chose to speak Afrikaans (n=1), Sesotho (n=2), Setswana (n=1) or isiZulu (n=1). Callers were immediate family members to the patient in 58% of the calls, strangers to the patient in 12%, the patient themselves in 10%, work colleagues in 8%, and of unknown relation to the patient in 12% of the calls. In 84% of the calls, the caller was in direct proximity to the patient.

A total of 69 meaning units (descriptors) were identified from the 50 calls following transcription (Table 2). These meaning units were condensed into nine different codes, and three categories during content analysis.

Table 2: Descriptors (meaning units) used by callers, coded and categorised

Category	Code	Meaning unit	Caller language
No pain: Thorax	*Chest related*	"very tight with her chest"	English
		"He grabbed his, um, chest"	English
	Heart related	"He is very sick; His heart"	English
		"…has a heart issue"	English
		"having a problem with the heart"	English
		"It's his heart"	English
		"I'm having a heart attack"	English
		"It's a heart attack"	English
		"…is having a heart attack"	English
		"A heart attack"	English
		"…a light heart attack"	English
		"had a heart attack"	English
		"…having another heart attack"	English
		"like a heart attack"	English
		"…having a heart attack"	English
		"…he's having a heart attack"	English
		"…a heart attack or something"	English
		"Krampe op haar hart"; cramp on her heart'	Afrikaans

No pain: Thorax (continued)	*Difficulty breathing*	"Short breath"	English
		"Breathing very erratically"	English
		"He can't breathe"	English
		"He can’t breathe"	English
		"He's suffering with his breathing, he can’t breathe"	English
		“If I breathe, I’ve got short breathing”	English
		“He can’t breathe”	English
		“Very short of breath”	English
		“Struggling to breathe”	English

Pain: Thorax	*In the chest*	"I've got a chest pain"	English
		"Chest, jaw, pains in the shoulders"	English
		"Sharp pain on my (left) hand side… chest"	English
		"He's got chest pain"	English
		"Pains on his chest"	English
		"Chest pains"	English
		"He has chest pains and they're affecting his left side"	English
		"… a bad chest pain"	English
		"Some chest pain"	English
		"…has got chest pain"	English
		"severe chest pains"	English
		"My chest and back pain"	English
		"Very bad chest pains"	English
		"Ukhala ngama chest pains"; complaining of chest pains	isiZulu
		"Una le chest pain"; has chest pain	Sesotho
	In the heart	"Heart pains"	English
		"Sharp pain…on the heart"	English
		"Severe heart pain"	English
		"paini eko pelong"; pains in the heart	Setswana
	In the arm	"Under the arm…under the left arm"	English
		"Left arm is numb"	English
		" His arm is painful"	English
		"His left arm"	English

Ill-health	*Vomiting/ nausea*	"He's vomiting"	English
		"very nauseas"	English
		"nauseous"	English
		"is vomiting"	English
		"…she starts vomiting"	English
	Mobility problem	"…has had a stroke…no movement in her arms and her legs"	English
		"He can't walk"	English
		"He can't get up"	English
		"He just fell, I think he has epilepsy"	English
		"He was walking and suddenly he just collapsed on the floor"	English
		"…just collapsed"	English
		“He fell on the ground”	English
		“He just dropped”	English
		"Ha kangoni le hotsamaya"; cannot walk	Sesotho
		"O faintile nou"; collapsed	Sesotho
	Non-specific ill-health	"He's too weak…high temperature and cold shivers"	English
		"Isn't feeling well"	English
		“He wants to pass out and now he’s just sitting there”	English
		"Hlulehang…Asenang monate"; not well…not feeling well	Sesotho

NOTE: *>1 meaning unit per call possible*

An analysis of the categorised meaning units shows that callers most frequently described the category of **No pain: Thorax** (39.1%) with the codes *heart related*, *difficulty breathing,* and *chest related* when calling the emergency contact centre (Figure 1). This was followed by the category **Pain: Thorax** (33.3%) with the codes *in the chest*, *in the heart*, and *in the arm* and the category **Ill health** (27.5%) which was described with the code's *mobility problems, vomiting/ nausea* and *non-specific ill health*.

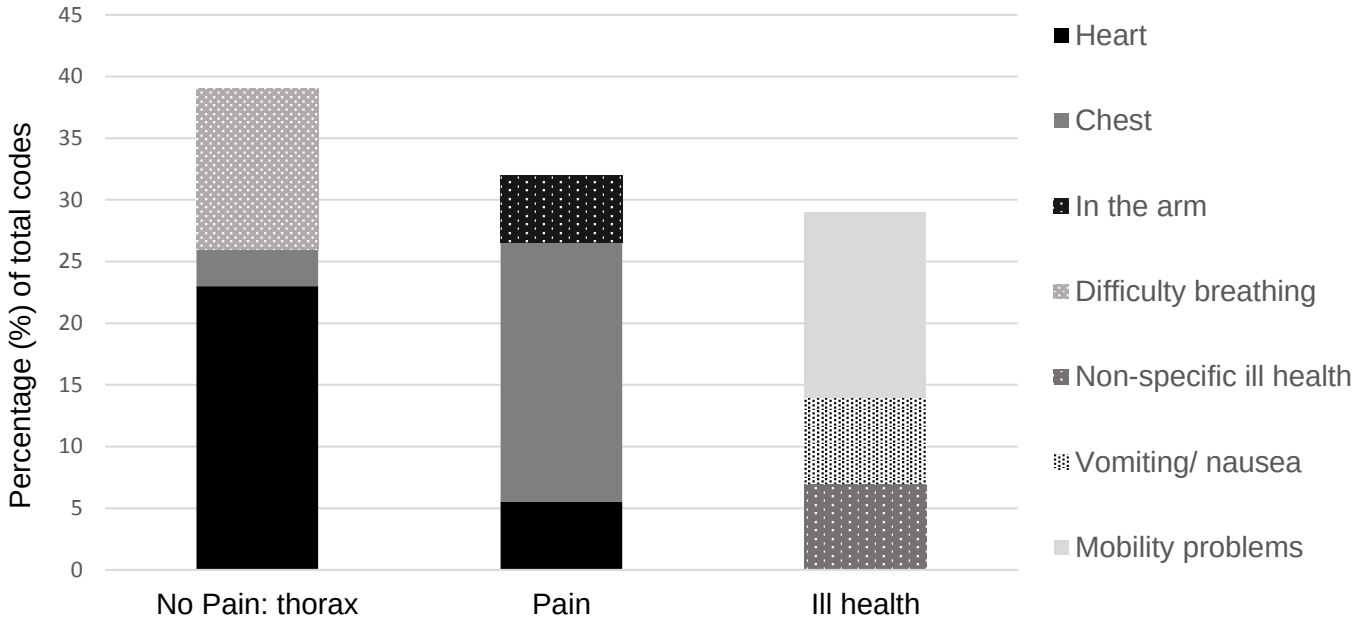

Figure 2: Descriptors used by callers to describe patients suffering an acute myocardial infarction

When analysing codes on a per call basis (Table 3), "heart attack" was used most frequently as a single descriptor (20%) followed by "chest pain" (16%), and descriptors of ill health: poor mobility (12%). In 32% of the sampled calls, two or more descriptive codes were used in combination to describe the patient suffering an AMI. The codes *pain in the chest* and *vomiting/ nausea* occurred most frequently in combination (two or three descriptors; 6%).

In fourteen (28.0%) of the calls, no pain, heart or chest related descriptors were given, and only descriptors of *mobility problems, difficulty breathing, non-specific ill health* or *vomiting/ nausea* were used, in isolation or in combination.

Table 3: Frequencies of codes identified in the content analysis process and combinations of codes that occurred.

Code combination	n	Percentage of total calls (%)
One code:	**32**	**64.0**
Heart related	10	
Pain in the chest	8	
Mobility problem	6	
Difficulty breathing	4	
Non- specific ill health	1	
Pain in the heart	1	
Pain in the arm	0	
Vomiting/ nausea	0	
Chest related	0	
Non- cardiac descriptor	1	
No descriptor given	1	
Two codes:	**16**	**32.0**
Pain in the chest + vomiting/ nausea	2	
Difficulty breathing + chest related	1	
Chest related + mobility problem	1	
Difficulty breathing + mobility problem	1	
Difficulty breathing + heart related	1	
Pain in the chest + pain in the arm	1	
Heart related + mobility problem	1	
Heart related + non-specific ill health	1	
Non- specific ill health + mobility problem	1	
Heart related + pain in the chest	1	
Pain in the heart + pain in the chest	1	
Vomiting/ Nausea + difficulty breathing	1	
Pain in the chest + difficulty breathing	1	
Pain in the arm + heart related	1	
Pain in the arm + pain in the heart	1	
Three codes:	**1**	**2.0**
Pain in the chest + Vomiting/ nausea + Non-specific ill health	1	
Four codes:	**1**	**2.0**
Pain in the heart + Vomiting/ nausea + Pain in the arm + Heart related	1	

Discussion

The way in which callers to an EMS call centre describe the nature of their emergency impacts greatly on call centre operators' and EMD ability to identify and triage patients' needs. The accuracy with which this is done has consequences for resource allocation and ultimately, patient outcome (27). In this study we identified that the term "heart attack" and phrases related to "chest pain" are most commonly used by members of the South African public to describe a patient experiencing an AMI when calling a private EMS call centre to request an ambulance.

Patient descriptors

Callers most frequently described the patient to be experiencing a "heart attack" in this study. In light of the desire to ultimately use the results of this study in the creation of screening tools/ clinically based algorithms, recommended to assist call centre operators and EMD in the identification of the nature of the caller's emergency, it must be noted that the accuracy of "self-diagnosis" varies in the literature: Patients who have experienced an AMI before are more likely to accurately identify its reoccurrence; "*My wife is having another heart attack*". Meel *et al* identified this accuracy in identifying reoccurring AMI identification in 3% of patients in their 2016 South African based prospective, observational study, which investigated reasons for delays in the administration of fibrinolytic therapy (28). However, over-triage is a risk when relying on the descriptor of a "heart attack" alone: In a 1999 study which surveyed 3085 patients over the age of 65 years annually over a period of six years, conducted in the United States, only 54% of self-reported AMI was accurate in the group of 147 patients where complete medical records were available for confirmation. In the 46% of patients where AMI was not the diagnosis, other CVD's were the cause (29).

Similarly, the description of "chest pain", the second most frequent term used by callers in our study, when used alone, has a low specificity as an indicator of AMI (2). This is despite "chest pain" being considered the cardinal symptom in patients experiencing an AMI (29). In a descriptive, retrospective study conducted in the United States by Clawson *et al*, they too identified "chest pain" as the predominantly described symptom of patients experiencing an AMI (30). Additional information related to the nature of the patient's chest pain, such as descriptors of the quality of the chest pain (pressure; heaviness), the location (retrosternal; epigastric) and the presence of radiation (to the left arm; jaw; back) should therefore be sought (31). Additional symptoms, such as nausea and vomiting described by Andersson *et al*, and

weakness, sleep disturbance, diaphoresis, fear and anxiety described by Dos Santos *et al*, are also useful in triaging the patient's chest pain (32, 33). In our study of unprompted descriptors, some callers provided such additional information to describe the patients' chest pain, and the combination of chest pain, nausea and vomiting descriptors was seen.

In some examples in our study, callers did not use descriptors of typical AMI symptomatology-descriptors of pain to the heart or of the chest. This atypical AMI presentation may be as a result of the patient's gender, ethnicity or comorbidities. The female sex in particular has been associated with atypical AMI symptomatology (34, 35). Coventry *et al* found descriptions of syncope, dizziness, neck, jaw and right arm pain to be most common (36). Sweeney *et al* previously reported that African women in particular tend to predominantly complain of indigestion and being hot/ flushed, white women tend to experience pain/ discomfort to the back, chest, jaw/teeth and both arms, while Hispanic women most commonly complain of chest pain/ discomfort (23). Similar findings were not observed in the current study however, it must be noted that the sample of patients in this study are predominantly white males.

Chronic conditions such as diabetes may also result in atypical cardiac symptoms, and these patients may describe syncope, weakness and gastrointestinal symptoms rather than chest pain (35, 37, 38). Patients with a history of heart failure may also experience no chest pain during AMI (34). Although we did not analyse the possible association between chronic medical history and symptom description in our study, we did find an example of a patient with a history of previous AMI, hypertension and diabetes that was described only as "*weak… has cold shivers*", while another patient with diabetes was described to be experiencing vomiting and difficulty breathing (no chest pain).

Thus, in order to increase the accuracy of AMI identification, the literature recommends an investigation by the call centre operator and EMD for more information, supplementing the initial description by callers to an EMS call centre. This includes additional signs and symptoms, chronic illness and previous medical history of the patient to aid the call centre operator and EMD in making a more informed decision on the nature of the patients emergency, rather than relying on the phrases of "heart attack" or "chest pain" alone.

Information gathering

In the current study, the majority of calls were made by the patient or when callers were in direct proximity to the patient. It is in these scenarios that information gathering techniques by call centre operators and EMD are conducted best; the caller is able to provide additional descriptors as to how the patient presents, facilitating problem identification (11).

Problem identification and triage accuracy is improved further by ensuring that EMS call centres are able to match the cultural and linguistic needs of the caller with an appropriate call centre operator and EMD, particularly in the diverse South African context (39). The benefit of this matching was evident in the consensus judgement process of this study, where the senior EMS call centre agents were able to identify not only the type of medical emergency being described, but also the location of the caller based on their language, pronunciation and greeting style. This was possible through both their medical knowledge and cultural familiarity with the caller's description techniques. This approach, rather than a third party translator as recommended by Tate *et al*, may mitigate the cost of hiring interpreters and the time delay involved in translating the ongoing call (14).

The vernacular caller descriptions in our study were minimal, and the gap in our understanding of the impact of language discordance on patient management by the EMS across low, middle and high- income settings remains (14). Research in the South African setting conducted by Penn *et al*, found that bias against certain ethic groups and unwillingness of call centre operators to accommodate language shifts are barriers to EMS call centre functioning (39). Language discordance has been discussed in other settings by Tate *et al*, in their systematic review of 21 published studies conducted in the United States, United Kingdom and Canada. The subsequent poor call centre operator/ caller interactions result in inaccurate identification of the nature of the callers' emergency resulting in over- and under-triage, and delays in the dispatch of necessary resources (14). Although call centre operator/ caller interactions were not analysed in this study, it was noted that the calls not held in English transitioned smoothly into the vernacular, and there was no obvious indication of misunderstanding or delay of the call due to language.

Additionally, the use of scripted, clinically based protocols is recommended by Lindstrom *et al* and Gamst- Jansen *et al* in their Swedish and Danish studies respectively, to optimize information gathering techniques by call centre operators (11, 40). Closed loop communication, negotiation of atypical symptoms, encouraging communication techniques (respectful, friendly, collaborative), appropriate questioning and a structured approach to the call are suggested. The settings of these studies and the level of training of these call centre operators and EMD does not match that of our study, however the same recommendations can be applied in our setting.

This study has a few limitations. Firstly, this study included a small sample of 50 calls made to a private EMS call centre. The patient sample was predominantly white males and is likely skewed towards those of a higher socioeconomic status who possess medical insurance (41). This was unavoidable, due to the randomisation of the data gathering process. This limits the

applicability of these results to a more diverse setting. Future research needs to be conducted in both the private and public EMS sectors using a larger sample. Stratified randomisation in future studies may also address this limitation.

A second limitation to the study is the limited number of vernacular calls included in the data analysis. Again, this was unavoidable, due to the randomisation of the data gathering process, and may be addressed by stratified randomisation. As a result, limited conclusions can be made regarding how vernacular callers describe AMI when calling an ambulance.

Lastly, it was beyond the scope of the study to describe the relationship between the meaning units used by callers and the in- hospital diagnosis of the patient. With the goal of optimising dispatching practices through the creation of an AMI triage algorithm in the SA setting, this sample of ALS paramedic diagnosed and managed AMI cases was considered an example of appropriately dispatched resources, and thus was deemed sufficient on which to base our study. Additional research which applies the results of this study and evaluates the degree of over and under triage that arises is needed.

Despite these limitations, this data can inform the development of future algorithms that take preferred language into account. Furthermore, this study provides a methodological approach that can be repeated in different language groups to identify language specific descriptors, in this and many other settings.

In conclusion, callers in this study predominantly use a consistent set of descriptors when requesting an ambulance for a patient experiencing ALS paramedic diagnosed AMI. The most common of these are non-pain descriptors related to the heart, pain descriptors related to the chest, and patient mobility. However, not all patients experiencing an AMI will be identified by descriptors of “heart attack” or “chest pain”. Thus, the development of validated algorithms which optimise the use of the call centre operators in seeking additional information and call facilitation techniques, and consideration of atypical presentations and the unique South African context, is needed to assist dispatch decisions. In this way, we hope to expedite the correct level of care to these time-critical patients and prevent the dispatching of resource limited ALS paramedics to inappropriate cases.

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Contributors

CB- Conceptualisation of the study, data collection, transcription, data analysis and consensus judgement process, interpretation, manuscript preparation.

CS- Study design, data analysis, interpretation, manuscript preparation.

WS- Conceptualisation of the study, study design, data analysis and consensus judgement process, interpretation, manuscript preparation.

JW- Study design, data analysis and consensus judgement process, final manuscript review.

All authors approved the final manuscript for submission.

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Conflict of interest

The authors of this study have no conflict of interest.

Patient consent

The study was retrospective and did not affect the level of care experienced by the patients. The PRFs and voice recordings were anonymised by redacting identifying information from the transcript so that patients and callers remained anonymous. For this reason, a waiver of consent was sought and received.

Ethics Approval

This study was conducted with the approval of the University of Cape Town Human Research Ethics Committee (Ref number 637/2017).

Data sharing statement

The data used in this study was extracted from ER24 patient report forms following ethical and organisational research approval. Similar data may be obtained following ethical approval on application to the ER24 Emergency Care Research Unit.

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PART C: APPENDICES

APPENDIX 1: Instructions for authors

Emergency Medicine Journal: Instructions for Authors

The journal selected for publication is the Emergency Medicine Journal (EMJ), as the recommendations made in our study are applicable to an international audience, and open access is available.

The instructions for Authors can be found at the following link:

https://emj.bmj.com/pages/authors/

APPENDIX 2: Research Protocol

An analysis of the descriptors of Acute Myocardial Infarction (AMI) used by South Africans when calling for an ambulance from a national emergency call centre

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This study is in partial fulfilment of the requirements for a Masters in Philosophy: Clinical Emergency Care

Declaration

I, Chloe Ashton Buma, hereby declare that the work on which this 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 in this or any other university.

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An analysis of the descriptors of Acute Myocardial Infarction used by South African's when calling for an ambulance from a national emergency call centre.

Purpose of the study

Acute Myocardial Infarction (AMI) is a time sensitive emergency, requiring the time from onset of symptoms to definitive management having minimal delay.[1] The time taken to reach definitive care at a hospital in part relies on the timely dispatching of an appropriate pre-hospital medical provider by emergency contact centre agents. Additional factors which delay in this process include the challenge of a highly diverse South African society, with multiple languages, socio-economic and educational backgrounds.

This study seeks to describe the terms used by members of the South African public when calling for an ambulance at a national emergency medical services (EMS) provider call centre. Through a process of content analysis, we will identify and quantify keywords and phrases that callers used to describe a patient who experienced an AMI through retrospective evaluation of patient report forms completed by the treating paramedic.

Background

AMI is a rising cause of death in the sub-Saharan African population.[2,3]According to the Stent For Life initiative in conjunction with the South African Heart Association and the South African Society of Cardiovascular Intervention, coronary vascular disease was the cause of death in 28% of South African mortalities in 2016, and is likely to rise in the coming years.[2,3] South African citizens, particularly lower socioeconomic groups living in rural settings are often subject to delayed access to EMS and transport to a definitive care, percutaneous coronary intervention (PCI) facility, of which there are 62 in the country.[2,3] These delay factors have a negative impact on the mortality of these patients.[1,3]

AMI is a time sensitive emergency, requiring the time from onset of symptoms to definitive management having minimal delay.[1] One way to achieve this goal is for emergency medical service call centre call takers to recognize potential AMI through the descriptors used by members of the public when calling for help. Ultimately, this would result in the timely dispatching of the correct resources to diagnose and manage the patient en route to an appropriate receiving facility, which is prepared to provide definitive management. Diagnosis of AMI and initiation of advanced life support pre-hospital care from scene en route to an appropriate receiving facility by paramedics has been found to reduce the mortality of these patients.[4] In South Africa there are currently 3210 paramedics trained to recognize, diagnose

and manage AMI, namely Emergency Care Technicians (ECT), Critical Care Assistants (CCA), National Diploma (NDip) paramedics and Emergency Care Practitioners (ECP) who are registered with the Health Professions Council of South Africa.[5] Interventions within the scope of these professionals range from the interpretation of 12 lead electrocardiograms (ECG) to the administration of analgesic, vasodilation and thrombolytic medication. Given that many of these advanced life support paramedics are not in operational roles, the ratio of paramedic to South African population for the management of AMI is approximately 1:17 742.[6]

This shortage of practitioners,[7] coupled with the diversity of South Africa's 11 official languages, imposes a unique challenge on emergency contact centre call takers. Call takers are tasked with adapting to the language preference of the caller, accurately identifying the nature of the emergency, and dispatching the appropriate, limited resource to the scene. International recommendations on addressing the barriers to communication in the emergency call centre include identifying terms used by the community when phoning for an ambulance that reference a specific medical condition as described by literature.[8] Ultimately, these terms can be incorporated into cardiac and AMI algorithms based on unique South African descriptors for emergencies in the South African setting.

There is a paucity of literature describing the terms and phrases South Africans use to describe AMI when calling for an ambulance. Due to the highly varying demographics of the country, related to language, socio-economic group, geographical location and education,[2,3,9] it is essential to identify AMI descriptors representative of the whole South African population that can be used to design South African specific algorithms. By developing a reference of terms spoken by the South African community which have been found to describe diagnosed AMI cases, in the various languages used by the callers in this setting, an efficient and community- based solution to the current problem faced by EMS providers may be attained.

This study therefore seeks to identify the key words and phrases which are commonly used by members of the South African public to describe a patient experiencing an AMI when calling an emergency services centre to request an ambulance.

Research Question

When calling for an ambulance, how do callers in South Africa describe the signs and symptoms of patients with AMI?

Aim and Objectives

The aim of this study is to identify the key words and phrases that are commonly used by South African callers to describe a patient experiencing an AMI when calling an emergency service centre to request an ambulance.

In order to address this aim, the objectives of this study are to:

1. Identify ER24 patient report forms (PRF's) containing a paramedic diagnosis of AMI over a three- month period.
2. Identify terms used to describe AMI during the call to the ER24 emergency service centre through content analysis and group consensus judgement.
3. Quantify the frequency of the most commonly used terms.

Study Methodology

Study Design

This is a descriptive, retrospective qualitative study using content analysis.

Characteristics of the study population

The study will be set in the ER24 EMS call centre, based in Gauteng. ER24 is a private EMS company which operates across South Africa. They render an EMS service which, although predominantly caters for citizens with medical insurance, is available to all South African citizens, and includes transport services such as primary emergency care, Helicopter Emergency Medical Services , fixed wing air ambulance service and interfacility transfers. The control room call takers, although mostly non-medically trained, undergo one month of system training and EMS orientation before starting. On average, the call centre receives approximately 2000 calls per day from all over the country. Of these, an estimated 650 calls per month relate to AMI.[10]

Sampling Method

Over an eight-month period (January to August 2016, approximately 6000 calls), all PRF's with a paramedic (ECP, NDIP, CCA) diagnosis of AMI will be identified.

This data collection period was purposively selected as a timeframe where calls were not stringently managed according to contact centre scripting. After this period, an algorithm using the HEART score[11] was implemented in the contact centre to assist call takers with identification of the chief complaint, and the level of care resource to dispatch to the scene. The importance of the use of this period is that the callers were not potentially influenced in their choice of words by the call takers who were referencing the script.

Of the approximately 2000 identified PRF's, a random sample of 150 of these PRF's[12] will be selected using Microsoft Excel. This sample size is based on a previously successful study using similar methods.[13] PRF's will be included if they meet the following inclusion criteria:

- Primary emergency cases
- Paramedic diagnosis of ST elevation myocardial infarction (STEMI), AMI, non-ST elevation myocardial infarction (NSTEMI).[14]

PRF's will be excluded if they meet the following criteria:

- Inter-hospital transfers
- Patients who are minors (<18 years of age).

This process will be followed for each PRF until a total of 50 PRF's that meet all the aforementioned inclusion and exclusion criteria have been identified.

Research procedures and data collection methods

1. Using the PRF case number, original voice recordings between the caller and call taker at the time of the emergency will be extracted.
2. All calls in English and Afrikaans will be transcribed verbatim by the researcher.
3. The descriptors of AMI will be identified using a process of consensus judgement.[15]

Basic demographic data of the caller will be identified, namely gender, language and geographical area. Calls not in English or Afrikaans will be listened to by the researcher, co-supervisor, and a contact centre agent fluent in the specific vernacular. The descriptors` used by the caller that relate to AMI will be noted through a process of consensus judgement.[15] Consensus judgement involves the agreement by all involved in the process that the identified terms were indeed used to describe AMI. In this study, consensus will need to be achieved between the researcher, a supervisor, a contact centre agent (in the cases of non-English vernacular) and an expert in language content analysis from the Speech and Audiology department of the University of Witwatersrand who has prior experience in similar research.[16]

The contact centre call taker is considered a real-world expert in the content of this data, due to the nature of their daily work. They are regularly exposed to keywords and phrases spoken by callers with various first languages, and dispatch resources based on what they have interpreted the nature of the call to be. For this reason, the contact centre call taker will assist in the consensus judgement process.

A possible limitation to the study is the translation/ interpretation of terms indicative of AMI by one individual fluent in the vernacular of the call. However, the goal of the consensus judgement is not to translate all the terms to English; rather, it is to identify terms within the context of the call that results in the call takers interpretation of the nature of the emergency. As such, "terms" refers to a single word, or a phrase used by the caller which is deemed to describe AMI by those involved in the consensus judgement. Furthermore, the original term, in English or vernacular, will be used in the triage algorithms.

Should a query around interpretation result in two or more possible translations, additional persons fluent in the vernacular will join the process of consensus judgement, and the final decision will be made by the full committee.

Data analysis

The transcribed data will be content analysed by the researcher, who has completed the online Coursera Qualitative Research Methods course (University of Amsterdam), together with the research supervisors who are experienced in qualitative research designs. The content analysis principles from a combined linguistic (via consensus judgement of the terms) and medical (the terms describing AMI) perspective will be done, an approach used in previous emergency contact centre based research.[16,17] A similar approach was employed by Prof Penn who is experienced in the analysis of the interaction between callers to an emergency centre and contact centre agents based on the linguistic profile of South Africans.[16]

Using Creswell's five steps to Qualitative Data Analysis (organization, immersion into data, coding, generation of themes, development of concepts),[18] the terms indicative of AMI (codes) identified in the content analysis process will be categorized according to themes; chest pain descriptors, patient presentation descriptors (pale, ashen, cyanosed), difficulty breathing descriptors, etc. This will be done using NVivo10 software.[19] These themes are the framework to the eventual goal of developing an AMI algorithm; this is beyond the scope of this project, which is the foundational start.

The frequency at which common identified terms occur will be quantified.

Qualitative rigor and trustworthiness will be addressed according to the following headings;

- Credibility

Through the consensus judgement process, which involves the assistance of experts in the field of language content analysis in emergency contact centre's as well as the call takers who, on a daily basis, interact with South African callers in emergency situations.

- Transferability

Transferability will be assessed at a later stage, beyond the scope of this project, when the algorithm produced is subjected to use by the call takers in real world scenarios. Post call analysis of the patient condition and the level of care paramedic dispatched will be evaluated to determine the success of the algorithm.

- Dependability

The repeatability of the data gathering process, involving the analysis of the PRF's, is subject to the involvement of appropriately trained medical practitioners. Both the researcher and supervisor will be a part of every individual consensus judgement process, to ensure the data gathering and analysis process is uniformly conducted. Consensus between the researcher and the supervisor regarding coding and theme development will also be employed, based on the background of experience and medical theory possessed by both.

- Confirmability

Checking of transcribed calls will be done by the supervisor.

Data management

This is a low risk study and adverse events are unlikely to occur. Should unforeseeable adverse events occur, they will be reported to the primary supervisor within 24 hours.

Data will be kept solely by the researcher on a password protected personal laptop computer. Files will be appropriately backed up.

Ethical considerations

Risks and benefits for participants

This study involves retrospective review of call recordings and PRF's. Both calls and PRF's are records relating to clinical practice. It is standard practice that call recordings are audited monthly as part of the quality assurance systems at ER24. Employees in the contact centre are aware of this, thus their inclusion in this study poses no more risk than experienced during the performance of their jobs. In included cases, it may be possible to identify call takers from the voice recording of the call. However, given that there are 109 employees in the call centre, this is unlikely. There is no potential risk to, nor any direct benefits for, the call contact centre agents assisting with the consensus judgement process.

The risk of identifying the individual patient, paramedics, crews, doctors, hospital etc involved on the PRF's will be mitigated by anonymising the PRF's prior to extraction by a data manager external to the research team.

The development of validated algorithms to detect callers describing an AMI, of which this study is the first step, is a direct benefit to employees in the call centre. This will assist in performance of their tasks and alleviate work-related stress during the decision of which level of care resource should be dispatched to the emergency.

Informed consent process

When a caller phones the national call centre for assistance, a short, automated message is given informing the caller that the call is recorded. This study aims to describe the descriptors of AMI in a real-world setting. Obtaining informed consent from callers in an emergency situation will significantly affect the quality of care given and confer more risk on the caller or patient than if consent is waived. It is therefore not possible to conduct this study should full informed consent be required. The study is retrospective and will not affect the level of care experienced by the patient. The PRFs and voice recordings will be anonymised by redacting identifying information from the transcript so that patients and callers remain anonymous. For this reason, a waiver of consent is sought.

Any calls by minors will be excluded.

Although employees in the contact centre are aware of the monthly audit of their calls, an additional memo has been sent to the employees advising them that the call recordings will be revised for research purposes.

Privacy and confidentiality

Privacy and confidentiality of patient data will be maintained by anonymising the PRF's prior to data extraction.

Data will be kept solely by the researcher on a password protected personal laptop computer. Files will be appropriately backed up.

Reimbursement for participation

There will be no reimbursement for contact centre agents assisting with vernacular identification as there are no direct costs nor inconvenience associated with their participation in this study.

Emergency care and insurance for research-related injuries

The proposed study is low risk and research-related injuries are highly unlikely. Insurance for research-related injuries is therefore not applicable.

Strengths and limitations

The strength of this study is the eventual development of validated algorithms which will assist in the detection of caller emergencies related to AMI, and the dispatching of appropriately trained paramedics to these emergencies. In this way, we hope to expedite the correct level of care to these- time critical patients, and prevent the dispatching of resource limited paramedics to inappropriate cases.

Although the study setting is a private service and the included sample is likely to be skewed towards an insured population, the ER24 call centre receives emergency calls from both the insured and uninsured population. Despite this limitation, the findings of the study may in future be applied in both the private and public setting. Potential limitations related to the consensus judgement process of vernacular calls has already been discussed and addressed.

Conflict of interest

Permission to access and use the information required for this study will be sought from ER24. One research supervisor is currently employed as the chair of the Research Committee at ER24, and this might pose a conflict of interest. However, all research submitted to ER24 is evaluated by a full research committee. If research involves any member of this committee (in

this instance the chair), that member will defer voting rights for the approval of said project. The conflict of interest will therefore not impact on the approval of the project.

Should a situation arise during the completion of this study in which the supervisory team believes that this potential conflict of interest may impact the scientific integrity of the study, any necessary decision will be deferred to the primary supervisor, who is not an employee of ER24.

Dissemination of findings plan

The dissertation will be submitted to the open University of Cape Town's central repository, collaborators at the University of the Witwatersrand, ER24 and Stent for Life. The findings will be prepared and submitted for publication in a peer reviewed scientific journal with due consideration for open access.

Project timeline

2017/2018	Jun	Jul	Aug	Sep	Oct-Dec	Jan-Feb	Mar-Jun	Jun-Dec
EM-DRC	X	X	X					
Ethics				X	X			
Facility approval					X			
Data collection					X	X		
Data analysis							X	
Compilation of final Report								X
Submission								X

Resources utilisation and budget

Item	Description	Total cost
Consumables		
1. office supplies, printing & reproduction for data collection	Printing, filing, photocopying, notes	**R500**
Research travel		
1. travel to contact centre	For consensus judgement sessions with research supervisor	**R2000**
Total		**R2500**

Funding

The student conducting this research is funded by a DST/NRF Grant-holder Bursary through a research grant held by Professor Penn at the University of the Witwatersrand. The research project is funded by the Emergency Care Research Unit at ER24 and includes protected research time for the student, who is an employee of ER24. Both funding sources will be acknowledged in all related outputs.

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07 September 2017

HREC REF:637/2017

Dr C Saunders
Division of Emergency Medicine
c/o Ms A Maas
J-Floor
OMB

Dear Dr Saunders

PROJECT TITLE: AN ANALYSIS OF THE DESCRIPTORS OF ACUTE MYOCARDIAL INFARCTION USED BY SOUTH AFRICAN'S WHEN CALLING FOR AN AMBULANCE FROM A NATIONAL EMERGENCY CALL CENTRE (MPHIL CANDIDATE - MS C BUMA)

Thank ycu 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 30 September 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: - Miss C Buma 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, where necessary, before the research may occur.

Yours sincerely

signature removed to avoid exposure online

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

HREC 637/2017