A DESCRIPTIVE STUDY OF DEMOGRAPHICS, TRIAGE ALLOCATIONS AND PATIENT OUTCOMES FOR A PRIVATE EMERGENCY CENTRE IN PRETORIA FOR 2018

by

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This study is in partial fulfilment of the requirements for the degree Master of Philosophy in the Faculty of Health Sciences at the University of Cape Town

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June 2020

Declaration

I, Kirsty Hedding, 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 at any other university. I authorise the University to reproduce, for the purpose of research, either the whole or any portion of the contents in any manner whatsoever. I further declare the following:

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Disclaimer

This serves to acknowledge that in order to perform this research and have access to the hospital data, the hospital had to remain anonymous throughout this research. Therefore, there will be no mention of the hospital name in this paper. Should this paper be eligible for publication, this will have to be approved by the hospital's research committee in order to do this.

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Acknowledgement

I would like to thank my supervisors Enrico Dippenaar and Lee Wallis for their time, patience and knowledge. It was a huge learning curve for me, and I have learned greatly from their expertise and guidance.

I would also like to thank my family and friends for their continued support and encouragement during this period. Lastly, I would like to thank my employers and the research committee for their time and assistance.

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Abbreviations

ACS	Acute coronary syndrome
ACLS	Advanced Cardiac Life Support
AIDS	Acquired Immunodeficiency Syndrome
APLS	Advanced Paediatric Life Support
ATLS	Advanced Trauma Life Support
ATS	Australasian Triage Scale
BAA	Basic Ambulance Assistant
CEO	Chief Executive Officer
CTAS	Canadian Triage and Acuity Scale
DipPEC	Diploma in Primary Emergency Care
EC	Emergency Centre
ECMO	Extra-corporeal membranous oxygenation
ECP	Emergency Care Practitioner
EM	Emergency Medicine
EMS	Emergency Medical Services
EMSSA	Emergency Medical Society of South Africa
EN	Enrolled Nurse
ENA	Enrolled Nursing Assistant
ESI	Emergency Severity Index
HIV	Human Immunodeficiency Virus
HPCSA	Health Professional Council of South Africa
ICU	Intensive Care Unit
JSE	Johannesburg Stock Exchange
MEWS	Modified Early Warning Score
MI	Myocardial Infarction
MTS	Manchester Triage Scale
MBA	Motor bike accident
MVA	Motor Vehicle Accident
NFS	Not further specified
NHI	National Health Insurance
PC	Presenting complaint
RN	Registered Nurse

SA	South Africa
SATS	South African Triage Scale
STEMI	ST-Segment Elevation Myocardial Infarction
TEWS	Triage Early Warning Score
UAE	United Arab Emirates
UCT	University of Cape Town
USA	United States of America
WCA	Workers compensation assistance

Part A: Literature Review

Aims of the literature review

This review aims to:

- Develop an understanding of the history of triage and its evolution.
- Describe triage and its role in emergency medical care.
- Describe and compare different international triage scores.
- Describe the South African healthcare system
- Understand the development and use of triage in South Africa.
- Describe the current triage system used in a large private hospital in Pretoria, South Africa.

Literature review strategy

The University of Cape Town's online library portal was used to gain access to and search the PubMed and EBSCO host databases for relevant articles. The following search terms were used: "triage", "emergency AND triage", "triage scores", and the names of international triage scales, including the Manchester Triage scale (MTS), South African Triage Scale (SATS), Canadian Triage and Acuity Scale (CTAS), Emergency Severity Index (ESI) and Australasian Triage Scale (ATS). References of included articles were also scanned to find other sources that may be applicable.

Inclusion criteria

- Articles related to the use of triage
- Articles documenting the history of triage
- Articles related to the South African healthcare system

Exclusion criteria

- Non-English articles
- Articles focussing on triage accuracy (beyond the scope of this study)

History of triage

The word triage originally comes from the French word 'trier', which directly translates "to sort" (1, 2). Today, it is most commonly known for its use in the medical setting (1, 2). Collins English Dictionary defines it as "the process of quickly examining ill patients to determine who has the most serious condition, thereby determining who will be treated first" (3). It also includes the concept of allocating limited resources according to what is suitable for that particular circumstance or system (3).

Triage was initially designed for mass casualty situations found during warfare (1). It was first developed on battlefields in France in the 1800s (1). A French military surgeon by the name of Baron Dominique-Jean Larrey, who was Napoleon's chief surgeon, is believed to be the first to recognise the need for the evaluation of injured soldiers (2, 4). He began to categorise patients according to their injuries to determine order of care (2, 4). It was described as a sorting system whereby anyone who was critically wounded was attended to first, without regard for rank or designation (2, 4). Critical patients received urgent care in the field, including amputations, and were evacuated as soon as possible (2). Moderately injured soldiers were not cared for until after critical patients had been managed, and those with minor injuries waited the longest, sometimes up to a few days (4). The aim of this sorting process was to try and conserve the limited resources available in battle whilst still benefiting the largest number of people (4). This system was further modified by a British naval surgeon, John Wilson, who ensured that the limited resources available in war were used for those who had a fair chance of survival (2). Those with the highest probability of survival were treated first; treatment was delayed for those with less severe wounds and not given at all to those with fatal injuries (2, 5).

The development of destructive weapons during World War I complicated this system, as the number of casualties soon began to substantially outstrip available resources (2). Hospitals with capacity for 300 patients were suddenly treating numbers well over 1 000 (2). Staff began to realise that treating the critically ill took up large amounts of time and resources (2). The same resources could be used to treat more patients with less severe injuries (2). Research therefore suggests that resources were prioritised for treating those who would be likely return to battle sooner, above that of critically ill patients (2).

In the early 1960s, it was noticed that there was an uptick in the number of patients presenting to emergency centres (ECs) for acute care in the United States of America (USA) (6). A 1964 study in the USA sought to determine health-seeking behaviour of patients (6). It assessed major factors affecting the urgency of care received in ECs, such as socioeconomic status and general access to healthcare services (6). The study found that patients were examined and sorted into three categories: “urgent”, “emergent’ and “non-urgent” (6). These categories were based on the acuity and severity of the clinical condition, and the time patients could wait to receive treatment without increased morbidity or mortality (6). Categories were usually assigned by the resident physician, although some ECs had triage officers dedicated to sorting patients (6). Although categories were named, there were no specific criteria to assign patient urgency, resulting in a subjective process (6). Despite this, triage was found to play an important role in improving timeliness of care and improving throughput in the EC (6). The categories in this study formed the foundation from which a more organised and standardised system was developed (2, 7).

Modern triage

Overcrowding is one of the biggest problems faced in both private and public ECs around the world (8, 9). Excessive patient volumes result in needs of patients exceeding staff capacities; this in turn prevents ECs from functioning efficiently (8). A recent study in the USA found that 30% of presentations to ECs are non-urgent (10). It is largely attributed to misuse of ECs, which occurs when patients present with non-urgent conditions: care for these conditions could be delayed by many hours without negative outcomes and thus are not appropriate presentations (8-10). Misuse of ECs often leads to substantial increases in healthcare costs due to unnecessary investigations; however, more impactful than that are the consequences of overcrowding (8, 10). While misuse contributes substantially to the problem, overcrowding can also be the result of hospitals exceeding capacity: in these instances, admitted patients spend additional time in ECs while waiting for definitive care in wards (11). Overcrowding can greatly affect patient care and often has detrimental outcomes (11). For critically ill patients, it can cause increased delays in being seen by a physician, increasing the complication rate up to five times. (11). It can also result in delays in receiving life-saving treatments, such as antibiotics and analgesia (11). The EC staff therefore has to determine the urgency of treatment in order to avoid adverse patient outcomes (12).

Only some patients presenting to ECs have truly life-threatening conditions, and it is essential that these patients can be quickly and reliably identified (12). However, due to a set number of staff being available at any given time, it becomes difficult to treat multiple patients needing care at the same time (12). Hospitals make use of triage systems to cope with these demands, particularly in times of overcrowding, and to ensure that the quality of emergency care is maintained (8). By correctly prioritising certain cases, triage ensures that ill patients receive timely care (7). Most deaths occur within twenty four hours of admission, so in treating the sickest patient first, morbidity and mortality can be decreased for all patients (7, 13).

Triage systems have adapted over time to achieve this goal, and, as a result, are now considered to be one of the most critical processes occurring in ECs (1, 14).

Triage systems

Triage is the process used to assess patients to determine severity of illness or injury, as well as assign correct treatment pathways in ECs (12). It ensures that all patients undergo the same structured, objective assessment (15). Ideally, a patient is assessed by a triage officer or other staff trained in triage within the first few minutes of arrival (5). The person performing triage is often considered a gatekeeper to the healthcare system, as he/she is able to affect patient outcomes by determining order of priority (16). Vital signs, including blood pressure, pulse and respiratory rate, are taken, then an assessment of patient urgency is made in accordance with local practices or algorithms if a formal system is being used (4). Patients are assigned to a triage category and will be seen by a physician and treated accordingly, based on system-specific requirements (4).

An important concept to understand in triage is urgency (also known as acuity); this refers to the time in which a patient is seen by a physician (7). Conditions can be urgent – in need of immediate attention – and a threat to life, such as a patient in cardiac arrest (7). Some conditions can be emergent, but not life-threatening (7). For example, a dislocated joint requires urgent attention because of possible circulatory compromise if left untreated, but unlikely to cause mortality (7). Contrastingly, some illnesses and injuries are neither urgent nor emergent (7). An illness like cancer can be chronic and severe, but not life-threatening at the point of presentation to an EC; in this case, timely care may not even affect the patient's outcome (7). Many clinical and environmental factors play a role in determining urgency (7). Triage aims to balance these demands with the resources available (7). Another important concept of triage is that it is considered a continuous process: although the patient is initially assigned a triage category on arrival, the patient's condition (and category) may change at any point (7, 17).

Components of effective triage

A effective triage system is able to rapidly and correctly distinguish between high- and low-priority patients (18). As previously mentioned, this is important because incorrect identification of the most urgent patients can lead to poorer outcomes for these patients and put their safety at risk (18). Correctly identifying the acuity of all patients can lead to more efficient operations in ECs (18).

Most triage systems are limited as definitions of true urgency have been difficult to establish (12). In most studies, rates of hospital admission overall and specifically to intensive care units (ICUs), resource utilisation and mortality are used as markers to assess validity (12). A good triage tool is considered valid when it is able to identify the actual degree of urgency correctly, meaning that it serves the purpose for which it was designed (7, 12). A sound triage system will also provide continuity of care between the roadside and the EC (5). This means that ambulances with critically ill patients should be able to access the resuscitation area directly, instead of having to pass through a room of lower acuity patients (5). In addition to validity, a triage system must also be reliable, meaning that it is standardised and consistent (19). If different people were to use the tool on the exact same patient, it would produce the same results, and the patient in question would be categorised and treated with the same level of urgency each time (4, 7, 12, 19). The most common method of assessing reliability is through inter-rater agreement, usually via use of Kappa statistics (19).

Due to the variability of disease burden, resource availability and funding systems across the world, there is no one triage system appropriate to all settings (7). In general, it is desirable that a scale is simple to use and understandable to all clinical staff, as well as easy to implement (5, 7). Triage scores designed in high-income regions are usually created for use by an experienced and skilled healthcare professional, as these skills are more widely available (4). These systems rely on the fact that there are dedicated triage staff who have been extensively trained in their usage (5). In addition, these systems often dictate lengthier assessments by the triage officers (5). However, in low-income countries where staff and resources are far fewer, these systems are not necessarily practical to implement (5, 7). Low-income tools have been designed to be more objective in order to mitigate the lack of experience, fewer staff and ability to train staff extensively (4).

International triage systems

Many scores have been developed as the need for a dependable triage scale has increased with the higher workload in ECs worldwide (20). Some of the most widely used and published scores include the MTS, CTAS, ATS, ESI and SATS (20). Most of these tools were designed for high-resource settings, whilst the SATS is one of the few designed for low-resource settings (7). All systems are limited, as function is dependent on numerous factors, such as the environment, personnel and cultural differences (21).

Published scales share many core elements (7, 20). They include prioritising patients with time-sensitive needs and target times for patients in each category to be seen by a physician (20). Many scales have three to five categories, with five being considered in one study as more valid (12). Despite some similarities, each system is unique, with its own process of evaluating and assigning patients to categories (7, 20). The CTAS, MTS and SATS combine vitals with clinical discriminators (specific clinical presentations) to assign a specific category, while the ESI relies substantially on clinical judgement and predicted use of resources (20).

Comparing triage scale validity is difficult: this is often determined by the reference standard used, but these standards vary according to resources and context (22). Mis-triage is the extent to which a particular system under- or over-triages a patient relative to their true urgency (22). Under-triage occurs when critically ill patients are placed in lower urgency categories when they should be assigned to high urgency categories, based on their condition (23). Over-triage occurs when less ill patients are placed into more urgent categories than is required for their true urgency or illness (23). Under-triage is a problem, since it results in delayed waiting times for critically ill patients, leading to potential increases in morbidity and mortality (22). Over-triage has consequences for all patients as it diverts resources unnecessarily to patients that do not need them (22). The consequences of incorrect assignment differ for each category as the time to be seen can vary from 10 minutes to an hour (22). This is particularly important in the context of South Africa, where resources are seriously limited and access to healthcare is poor (22). It can lead to loss of life or an unacceptable financial burden due to an overuse of the available resources (22). The American College of Surgeons Committee on Trauma (ASCOT) has developed guidelines on how an ideal trauma system should work, ranging from prehospital care to in-hospital care at the most appropriate facility (23). Their standards for trauma care and guidelines for triage have become the norm against which international systems compare themselves (24). The group cites an acceptable rate of over-triage between 25% and 35%, and under-triage, less than 5% (23, 25).

Different studies use different reference standards to assess a scale's ability to determine patient acuity (18). The most commonly used standards are admission to ICU or ward, and discharge home (18). A 2019 systematic review looked at five major triage scales: MTS, CTAS, ESI, ATS and SATS (20). The study found that 20% of the patients who died after receiving emergency care had not been assigned to high urgency triage categories and were thus under-triaged (20). Another 2019 systematic review of the MTS, CTAS and ESI assessed the performance of these scales in prioritising high and low urgency patients within the EC (18). This review found that patients who were admitted to ICU were triaged into the two most serious triage categories (18). The proportion of patients from category one (the most urgent category) admitted to ICU was not predictable for the MTS, but this could not be evaluated or compared across the board (18). In general, most studies found that these triage systems were able to detect ill patients when it involved the diagnosis of ST-segment elevation myocardial infarction (STEMI), compared to other critical illnesses like pulmonary embolus or sepsis (20). The MTS, CTAS and ESI showed variability in their ability to identify low acuity patients correctly (18). Overall, it appears that the ESI shows the best prediction for hospital admission (18). Due to contrasting study designs and methodology used in available research, there is not adequate comparative data between these scales (20).

Manchester Triage System (MTS)

The MTS was first developed in 1994 and is currently in its third edition (17). This triage method uses flow charts to organise the thought-process during triage; these simple-to-use charts become especially useful during high-demand times (17). The presenting complaint of the patient is identified and then used to determine which flow chart from the list will be most appropriate for that patient (17). There are fifty-two pre-designed charts which then determine the triage category (21, 24). The design of the system is based on the fact that multiple chief complaints may lead to more than one flow chart (17). However, this is accounted for through the use of discriminators which will designate the patient with the same level of urgency, irrespective of the presenting complaint (17, 21, 24). Discriminators are factors that determine into which clinical priority category a patient must go (17). Patients can be placed into one of five categories (17). These discriminators are divided into general or specific (17). General implies that these discriminators are applied to all patients regardless of their presentation, whereas specific discriminators are used for particular conditions like chest pain or pleuritic pain (17). This algorithmic approach improves reliability by making decisions more repeatable (7). MTS is a system primarily used in the United Kingdom (UK) and Europe (26).

In recent studies, the MTS has been shown to have variable inter-rater agreement ranging from slight (Kappa coefficient <0.4) to near perfect (Kappa coefficient of 0.8-1) (27). A study done in Germany showed an almost perfect inter-rater agreement (Kappa coefficient of 0.95), though this was attributed to efforts taken to translate and adapt the tool to the environment in which it was used (27). A meta-analysis showed that the MTS is reliable, but because most of the studies reviewed used the weighted Kappa coefficient, the results must be interpreted with caution, placing the reliability of MTS as moderate (28). De Souza *et al*. (2018) found that, when used by nurses, with more experienced nurses (those with one to five years' experience) the MTS had a higher margin of safety for patients (27). This meant that patients were more likely to be placed in the correct acuity category both when compared to the gold standard (template case studies) and that of their peers (27).

In general, the biggest issue with the MTS has been in elderly patients who present with acute coronary syndrome (ACS), where symptoms are usually atypical (that is, not chest pain) (21). This was shown to lead to mis-triage whereby the patient was placed in a less urgent category (decreased priority) which often lead to clinical deterioration as they waited longer to be seen in the EC (21). Younger patients were more protected as their symptoms were more typical of ACS and so the appropriate flow chart was more readily able to place them in the correct urgency category (21). A review in 2014 shows that the MTS has a high level of under-triage (range of 11%-25% in various studies), which can negatively affect patient safety in a busy EC, as urgent patients may wait longer than clinically acceptable to be seen (26). De Souza *et al.* found that under-triage was more common in higher acuity categories (25%), compared to over-triage in lower categories (17%) (27). This means there is a higher chance of adverse events for critically ill patient as their care is delayed or resources are inappropriately diverted elsewhere (27). The MTS was also shown to have a high range of over-triage, ranging from 7.6%- 54% in adults and 40-54% in children (26). This means that unnecessary resources are used to treat patients who are in fact not critically ill, which may also be at the expense of other patients who will have to wait longer in consequence (26). These results align with a 2017 meta-analysis showing a mis-triage rate of around 59%, with 46% of that being over-triage (28); these rates are well above accepted rates defined by ASCOT (29).

Van der Hulpt (2008) showed that around 21% of patients were admitted when using the MTS (30). From the total number of patients seen, 1.9% were category red, 35% were orange and 48.9% were yellow category allocations (8). However, when looking at the categories individually, 68% of total red patients were admitted, 48% of orange patients and 26% of yellow patients were admitted, respectively (30). Thus, there may be an association between patient acuity as defined by the MTS and likelihood of admission: higher acuity patients are more likely to be admitted, and likelihood of admission declines with urgency (30).

Emergency Severity Index (ESI)

The ESI was designed in the USA to standardise the process of triage and to prioritise patients effectively (31). It is currently in its fourth edition (31). The ESI is a five-level system that determines both patient urgency and resources required to treat each patient (31). The inclusion of resources is unique to this system (31). ‘Resources’ refers to the different types of tests or procedures that are predicted to be required to treat the patient (31). Blood tests, x-rays, nebuliser and suturing are all considered one resource individually (31). If the patient does not fall into level 1 or 2 (high priority categories), then the number of resources required to treat the patient is calculated to determine urgency (31). The more resources required to treat the patient adequately, the more urgent their category (level) will be (31). In adults, vital signs are only taken if the patient is presenting in low-acuity condition: those that are critically ill or injured can be triaged into a more severe category without the need for time spent on establishing baseline vitals (31). However, in children under the age of three, vital signs must always be taken (31). The ESI relies heavily on clinical judgement and the knowledge of what is normal (31). This entails knowing what normal vital signs are, what common presentations look like and being able to identify quickly and easily what a patient in extremis looks like (that is, a patient who meets Level 1/red criteria, like severe respiratory distress) (31). So, although it is simple to use for those with robust clinical knowledge, nurses who have limited experience working in EC or who have not been comprehensively trained cannot use it, as they are not deemed to have sufficient knowledge to do so correctly (31). This is considered a major limitation of the tool as it limits its use in wide range of settings (4).

In comparison to those considered to be less urgent by the ESI, higher urgency patients have been found to require more procedures and have longer hospital stays (32). However, it also found that those in level 2 and 3 ended up using the most resources, as it was more challenging to determine the diagnosis and who was critically ill (32).

In general, mis-triage using the ESI is estimated to be near 10% (28). Mis-triage occurs mostly between level 2 and 3 and this seem to be as a result of inappropriate interpretation of vital signs and assessment of severe pain, in addition to altered mental status (33). Most of these misinterpretations were found to be on patients who had non-specific complaints (33). Grossman *et al.* (2012) showed an under-triage rate of 22% and over-triage of 2.9% when using the ESI (29, 33). Whilst over-triage was within acceptable limits as defined by ASCOT, under-triage was not (23). The ESI has a tendency to categorise the majority of patients into level 2, whereas MTS, CTAS and ATS distribute the patients better over all the categories (28). This may mean that the ESI has a tendency to over-triage patients which results in resources being unnecessarily diverted elsewhere (28). It can also create an influx of patients into one area of the EC, depending on the set up, causing overcrowding (28). The ESI is limited in its ability to correctly triage elderly patients, under-triaging some 25% of them; this is problematic as this population comprises 12-21% of EC visits and it may have adverse consequences as a result (33).

In Grossman *et al.'s* (2012) more recent study, the following was seen in terms of disposition according to the ESI level: level 5 saw 100% of patients discharged and level 4 had 90% discharged (33). Level 3 saw 10% admitted to ICU and around 60% admitted to ward; Level 2 saw 22% discharged with 28% admitted to ICU and level 1 saw no one discharged with 48% admitted to ICU (33). Level 4 and 5 showed that almost all patients were discharged - this implies that the ESI is successfully identifying less acute patients and that there is very little under triage occurring in these categories, making it a safe tool for these patients (33). Although a good percentage of level 1 patients are being admitted to ICU, a large portion are being admitted to the ward too (33). This implies that the ESI is detecting critically ill patients well, but that there may be an element of over triage if not all patients require ICU (33).

Canadian Triage and Acuity Scale (CTAS)

The CTAS is a 5-level system that focuses on patients' presenting complaints when categorising urgency (34). A rapid primary survey is conducted to pick up high-risk conditions requiring immediate attention (28). Each level has a detailed description of clinical signs and symptoms and includes discriminators like age and pain (34). The primary objective of this scale is to determine the length of time that a patient can reasonably wait to be seen by the physician, as the physician determines what treatment is given and what investigations are required (35). The Canadian system emphasises the fact that patients should be assessed continuously because their condition can change at any point (35).

A 2015 meta-analysis indicates that the CTAS has high reliability and agreement between raters, with an overall coefficient of 0.672 and a nurse-physician agreement of 0.8 (34). These high scores were also found when the CTAS was applied in Saudi Arabia (36). Of note is that these results were achieved despite varying levels of experience of triage nurses using the CTAS in these studies, meaning it is potentially adaptable to other settings (36).

The tool leads to a high percentage (over 40%) of mis-triage, with the predominant problem being over-triage (34). Over-triaged patients (around 25%) were considered acceptable as within expected range, but of greater concern was the 14% of patients that were under-triaged (34). This was noted in level 1 to 2 patients, which could significantly impact mortality (34).This is because patients in level 1 and 2 are critically ill with time-sensitive needs, like a threatened airway that requires imminent intubation (7). Therefore, if these patients are not in the correct category, waiting may lead to loss of life (7, 34). Lower category patients like those in levels 3 and 4, with a broken toe for example, can wait longer (7). Their conditions are not time-sensitive and so under-triaging them will simply delay time to definitive care (7).

Australasian Triage Scale (ATS)

The ATS was devised to standardise care and optimise patient safety in the face of increasing demand for emergency care in Australia (15). This triage system was developed in 1993 and was originally known as the National Triage System (15, 37). It underwent alteration in the late 1990s and was then renamed ATS (15, 37). This system was designed to use only objective clinical criteria (15). A primary survey approach is used, whereby a rapid assessment of the airway patency, breathing effort, circulatory function and level of consciousness is done (15).

The patient can be placed into one of five categories, with category one requiring immediate treatment and category five having the ability to wait two hours (15). If assessment of the patient reveals significant haemorrhage or poor respiratory effort, for example, this would place the patient into category one, requiring immediate treatment (15). A patient who has normal vitals, is fully conscious and has an injured ankle, but has minimal rated pain, would be placed into category five, allowing them to wait longer to be seen (15). The ATS times are based on when a patient should be seen by a doctor, relying on the fact that they are readily available (15). In rural areas, the focus is adjusted accordingly (15). There, a nurse may be both the triage officer and the treating practitioner (15). In these limited settings, the aim is to initiate treatment within set time frames, as a doctor may not be on site (15).

A 2014 meta-analysis by Christ *et al.* showed satisfactory reliability with a Kappa score of 0.25-0.56 (fair to moderate) (25). This was confirmed in a second meta-analysis done by Ebrahimi *et al.* in 2015, which also found that around 40% of patients were mis-triaged (37). Mis-triage was substantially higher than other tools, such as the ESI: 18% were under-triaged with the ATS and 20% were over-triaged (37). Under-triage was occurring primarily in the most ill patients in categories one and two like other scales, which as mentioned could potentially increase mortality in these patients (37).

Table 1: Comparison of the five most published triage scales.

	MTS (17)	**ESI** (31)	**CTAS** (35)	**ATS** (15)	**SATS** (13)
Current edition	Third	Fourth	Second (2.5b)	Second	Third
Number of categories	Five	Five	Five	Five	Five
Time to be seen for each category (minutes)	1 (Red) – 0 2 (Orange) – 10 3 (Yellow) – 60 4 (Green) – 120 5 (Blue) – 240	1 – 0 2 – 15 3 – 30 4 – 60 5 – 120	1 (Blue) – 0 2 (Pink) – 15 3 (Yellow) – 30 4 (Green) – 60 5 (White) – 120	1 – 0 2 – 10 3 – 30 4 – 60 5 – 120	Red – 0 Orange – 10 Yellow – 60 Green – 240 Blue – 120 (dead on arrival)
Use of vital signs	Yes, if patient is not initially assigned to high acuity category	Always for paediatrics, depends for adults	Yes	No	Yes
Developed in high- or low-resource setting	High	High	High	High	Low
Triage officer	Junior or senior staff	Requires senior staff	Preferably experienced	Senior staff (with clinical experience)	Junior or senior staff
Use of resources to allocate triage category (Bloods, ECG, Xray - each equal to one resource)	No	Yes	No	No	No
Discriminators (factors, both clinical and environmental, that increase a patient's urgency and place them in a higher triage category)	• Life threatening condition like airway compromise • Consciousness level • Haemorrhage • Pain • Acuteness of illness • Temperature	• Requires life-saving interventions • AVPU scale responds only to pain or unresponsive	• Primary survey approach • Pain • Extremes of age	• Pain • Extremes of age • High mechanism of injury • Cardiac risk factors • Drugs/alcohol • Temperature	• Pain • Presentation • Mechanism of injury • Senior's opinion
Process of assigning categories	Algorithm-based decision making using flow charts	Primary survey and resources, with or without vital signs	Clinical pictures and signs	Primary survey, physiological parameters and list of conditions	Triage early warning score (TEWS) and clinical signs

The South African healthcare system

In emergency care in SA, there are three main role players: nurses, emergency care services and doctors. In most ECs, the doctors that work there are junior (still undergoing training as interns) or medical officers (fully qualified but with variable years of experience) (38). Medical officers are predominantly found in the private ECs as well. Both sectors have predominantly surgical cover or minimal senior supervision in the EC (38). Emergency medicine (EM) is a new speciality internationally and 2007 saw SA's first specialist graduates (38). These numbers have continued to grow and an increasing number of EM specialists are now distributed across the country, with the aim of improving EM care on a national scale (38). Nursing staff, who play a pivotal role in healthcare, including EM, are divided into four categories (39). These categories are based on level of training and are described below in Table 2 (39).

Table 2: Description of level of nursing care

Level of Care	Description
Enrolled nursing auxiliary/assistant (ENA)	Trained for 1 year in basic care
Enrolled Nurse/ staff nurse (EN)	Trained as a nurse for 2 years
Registered Nurse (RN)	Trained for 4 years
Specialist registered nurses	RNs with specialist training like critical care or Trauma

In 2006, SA had a ratio of 3:2:1 for ENA:EN:RN, which means that the work force was comprised of predominantly junior staff (39). EC triage has mostly been nurse-based (4). Although nurse-based triage is the norm internationally, in SA, this is largely because of a shortage of doctors (13). Due to the lack of experienced nurses, more junior staff tend to be assigned to triage duties (13). The doctor-to-nurse ratio in SA in 2010 was around 1:8 with there being 56.3 doctors per 100 000 population per year (13). This is compared to first world countries where the number of doctors is well over 100 per 100 000 population per year (13).

The last role player is that of the emergency medical services (EMS). Experience of personnel varies in EMS (38, 40). Ambulance service staff education can range from having as little as a four week course to qualify as a basic ambulance assistant (BAA) to a four year bachelor's degree to qualify as an emergency care practitioner (ECP) (40). In 2017, there were 102 ECPs versus 11 291 BAAs registered in the country, which shows that the prehospital workforce in

SA is largely based on EMS providers with limited training and education (40). It is noted that 64% of ECPs work in the private sector, with EMS services in the public sector being understaffed and poorly equipped to deal with the areas that they cover (38, 40). There is a loss of skills owing to emigration overseas which contributes to this problem (38).

South Africa's healthcare system is divided into two sectors: private and public (38). The private sector caters to patients with access to health insurance or medical aid, and those that can pay for the entirety of their care out-of-pocket (41). The public sector serves the remainder of the population at little-to-no cost (around 45 million people in 2016) (41, 42). In 2001 it was estimated that around 16% of the population were on a medical aid scheme, whereas 55% were unable to access such services (41). The rest were considered potentials that may access either service (41). This is also complicated by the fact that most of the population's access to healthcare is in the form of traditional healers, which is not considered to be part of initial care (41). The number of patients accessing public sector healthcare is continuing to grow, and total numbers were shown to have increased by as much as 1% per annum from 2008-2016 (43). The public system is considered to be in a state of crisis due to neglect, mismanagement and underfunding (44).

In 2012, around 30% of South African doctors provided care in the public system, while the rest were employed in the private sector (44). Given that the majority of the SA population uses public care, this means that there is a significant shortage of doctors in this sector, bearing in mind that SA already has too few doctors (per 100 000 population) compared to international systems (13, 42). Although the number of medical students has increased over the years, the number of physicians per 1 000 of the population remains largely unchanged, and emigration of skills may be playing a role (44). It has been shown that there are increasing numbers of doctors leaving SA to work in countries like the UK and New Zealand (44). Although reasonable numbers of doctors are being trained, these resources are being lost overseas, at huge cost to the country (44).

As it stands South Africa aims to introduce a National Health Insurance (NHI) in the future (43). This concept is based on beliefs that one system could begin to address the inequalities by ensuring accessible healthcare for all (43). Although the details are not yet entirely clear, the NHI aims to provide universal health coverage for South Africans, combining the private and public sectors in such a way to improve access to care as well as better distribution of resources (43, 45). Private hospitals will be contracted into the NHI and assist with providing what are deemed to be necessary services (45). This system will be funded through the country's general tax system, with medical schemes changing roles to cover the gap for services which are not covered by the NHI, such as cosmetic surgery for breast enlargement (45).

The private sector is comprised of three main companies (Netcare, Mediclinic and Life Healthcare) as well as many self-employed general practitioners (46). Netcare is an investment holding company that operates through a number of subsidiaries (47). It has been listed on the Johannesburg Stock Exchange (JSE) since 1996 (47). It operates the largest section of the private healthcare network in SA which includes hospitals, primary healthcare, renal dialysis units and emergency medical services (46, 47). It also has partnerships with the national government to supply some of its services to the public sector (47). Along with providing healthcare, they also have substantial corporate social investment, which includes improving service delivery for poorer communities through increased access to emergency services, increased accessibility to specialised surgery and free sexual assault services at 36 different facilities (47).

Mediclinic is another group that provides private healthcare both in South Africa and Namibia (46, 48). Mediclinic Southern Africa is part of Mediclinic International, which also provides services in Switzerland and the United Arab Emirates (48). It is listed on both the JSE and international stock exchanges (48). Mediclinic owns numerous hospitals throughout the country and it is affiliated with ER24 prehospital service providers (46, 48).

The third dominant group in private healthcare in SA is Life Healthcare (49). It provides healthcare to both SA and Botswana, and has more than 50 hospitals between the two countries (49). It is comprised of hospitals, rehabilitation centres, mental healthcare facilities, and renal dialysis units (49). Life Healthcare are also significantly involved in corporate social development, providing educational opportunities as well as healthcare to those in need (49).

Triage in South Africa

South African Triage Scale (SATS)

South Africa had no standardised means of triaging patients for many years – it was either done subjectively or using international scales (50, 51). Prehospital personnel used to triage patients based on vital signs and clinical experience (51). Within ECs, both private and public, the patient burden was increasing, especially with critically ill patients (51). The Cape Triage Score (CTS) was therefore initially created to fulfil the local needs of the Western Cape (51). It was designed to be used in both the prehospital and in-hospital environments to address increasing patient burden (51). The CTS was devised using a combination of elements from other systems, taking into account the local need and available resources (51). Colour coded systems were also chosen as they were considered easy to identify on patient folders (51).

University of Stellenbosch and University of Cape Town Divisions of Emergency Medicine established the South African Triage Group (52). In 2004, this group revised the CTS into what is now known as the SATS (52). The SATS score was purpose-designed to address the needs of resource-limited countries (53).

The SATS is based on two elements: discriminators and vital signs (13) (Figure 1).

1) Discriminators: More serious mechanisms of injury, certain clinical presentations like decreased level of consciousness, pain score and the senior physician's clinical opinion are all taken into consideration when assessing for higher urgency (51).

2) Vital Signs: Physiological derangement is assessed based on the Triage Early Warning Score (TEWS), which takes into account both medical and trauma parameters. The TEWS is based on the Modified Early Warning Signs (MEWS) and was adapted to the South African context (50).

Figure 1: *TEWS chart from adult SATS, version 3*

OLDER THAN 12 YEARS / TALLER THAN 150 cm tall)	ADULT TEWS						
	3	2	1	0	1	2	3
Mobility				Walking	With Help	Stretcher/ Immobile	
RR		less than 9		9 - 14	15 - 20	21 - 29	more than 29
HR		less than 41	41 - 50	51 - 100	101 - 110	111 - 129	more than 129
SBP	Less than 71	71 - 80	81-100	101 -199		more than 199	
Temp		Cold OR Under 35˚		35˚ - 38.4˚		Hot OR Over 38.4˚	
AVPU		Confused		Alert	Reacts to Voice	Reacts to Pain	Unres-ponsive
Trauma				No	Yes		

The SATS uses a five-step approach (Figure 2, below) based on the above two elements in order to determine urgency (13). If a patient exhibits any emergent or very urgent signs, he or she automatically receives a red or an orange allocation (depending on which signs), without the need for TEWS to be calculated (13). If none of these urgent signs is found, then the algorithm is followed accordingly (13). The TEWS is calculated and any necessary investigations are performed (13). A triage category is then assigned based on all the above information (13).

Figure 2: *SATS 5-step approach to triaging a patient, from SATS, version 3*

2.1 The five step approach

Step 1:	**Look for emergency signs and ask for the presenting complaint**
Step 2:	**Look for very urgent OR urgent signs**
Step 3:	**Measure the vital signs and calculate the TEWS**
Step 4:	**Check key additional investigations**
Step 5:	**Assign final triage priority level**

The SATS has five categories: red, orange, green, yellow and blue (13). The blue category is for patients that are already deceased, which is unique to this score (13). It aims to have patients assessed by a doctor within a certain time period (Table 1) (13). The SATS has two versions: one for adults and one for paediatrics (13). The paediatric version requires that the healthcare provider assess the child using a primary survey approach in order to detect any potential clinical discriminators (Figure 3) (13). If none of these signs is present, TEWS is then calculated (13). Different TEWS charts are used based on the age and height of the patient (13).

Figure 3: *Primary survey approach to a paediatric patient, from SATS, version 3*

EMERGENCY	
Airway and Breathing	Not breathing or reported apnoea Obstructed breathing Central cyanosis or SpO_2 less than 92% Respiratory distress (severe)
Circulation	Cold hands + 2 or more of the following: (i) pulse weak and fast (ii) capillary refill time 3 sec or more (iii) lethargic Uncontrolled bleeding (not nosebleed)
Coma	AVPU: Responds only to Pain (P) OR Unresponsive (U) Confusion
Convulsions	Convulsing or immediately post-ictal and not alert
Dehydration	Diarrhoea or vomiting + 2 or more of the following: (i) Lethargy/floppy infant (ii) Very sunken eyes (iii) Skin pinch very slow - 2 sec or more
Other	Facial /inhalation burn Hypoglycaemia recorded at any time - glucose less than 3 mmol/L Purpuric rash

Triage is most commonly performed by nurses in SA, as is common practice around the world; in SA however, this usually means the most junior nurse (5, 13). A unique feature of the SATS is that it allows for the senior healthcare provider to override any triage score, providing a safety net for incorrectly-triaged patients (29).

The SATS has been implemented in a variety of settings (both public and private) within SA, as well as in many other low-income settings internationally (54). For example, a study done at Zithulele Hospital in rural Eastern Cape (2018) confirmed that the SATS is easy to use: even for personnel with minimal training, reliability is minimally affected, allowing it to be applied to different settings (29). Soogun et al. (2017) showed that it had also been successfully implemented in a more urban setting; however, this study highlighted a few problems, like incorrect choice of discriminators or poor documentation of triage times, which affected its use and accuracy (54). Furthermore, a study by Dalwai et al. (2017), showed that the SATS could also be successfully implemented in multiple non-sub-Saharan African low-income settings like Sierra Leone and Haiti (55). However, whilst shown to be useful, this study brought into question the need to adapt the scale to make it more specific for the population it serves, especially in the cities where paediatric malaria was prevalent (55). From the literature, the use of the SATS in high-income countries appear limited, although it has been modified and used in the paediatric setting in Norway (56). In this setting, it was shown to provide moderate sensitivity and specificity for predicting the need to hospitalise patients as well as the number of resources required to treat patients (56).

SATS has been found to have an under-triage rate of 9% in the more urgent categories (red and orange) and an over-triage rate of around 49%; these rates are above acceptable mis-triage rates (25, 29). In a study in Kenya (2019), similar under-triage rates of around 7% and over-triage rates of around 60% were found when using the SATS (57). However, in rural SA, where there is delay to care and possible transfers, under-triage has a more deleterious effect than it would in a more urban hospital (29). This is also of concern because waiting times in SA are significantly longer than expected times of triage due to limited resources and overcrowding, and so consequences of under-triage may be worse for patients as a result (29). In the study done in Norway (2018), where the paediatric SATS was modified and used, under-triage rates were 26% which is considerably higher than in other studies (56). The reason for this was suggested to be multifactorial: their good referral systems, the fact that some children may have already received management at primary facilities, and the context-specific modifications made to the scale (56).

In rural SA, the distribution of categories of patients over one year was 2% red, 15% orange, 37% yellow and 47% green (29). Due to limited transport and EMS services, access to healthcare in these areas is poor. The EC often provides the only way of accessing a doctor in many areas and is the reason patients present with non-emergent conditions (29). The high rate of green patients was therefore considered to be related more to the fact that access to medical care is poor rather than an issue with the triage system itself (29).

Burden of disease

The HIV/AIDS epidemic is the greatest contributor to SA's burden of disease: SA's HIV/AIDs infections account for 17% of its global burden (44). Leading causes of premature death in SA include HIV/AIDS, tuberculosis, diarrhoeal diseases, non-communicable diseases and trauma (43, 44). SA's health issues are strongly affected by social factors (43), including poverty (due to unemployment), behavioural challenges (for example, lack of breast feeding), poor working conditions, and inequality in accessing services (43). These determinants are an important part of the health agenda for SA (43).

Research hospital

The hospital chosen for this study is one of the largest private hospitals in the Pretoria area, with over 300 beds and multiple intensive care units (ICUs). It has a 24-hour EC and percutaneous coronary intervention (PCI) unit available. The hospital is an accredited Level 2 trauma facility, which is based on the Trauma Society of South Africa's criterion (58). The Trauma Society sets the standards for accreditation for both private and public facilities (58). The accreditation is based on the American College of Surgeons Trauma Centre Criteria but has been adapted to the South African context (58). In 2007, this trauma accreditation for hospitals was accepted by the College of Medicine South Africa as well as the Health Professional Council of South Africa (HPCSA) (58). This means that the facility is capable of providing all initial definitive trauma treatment, regardless of the pathology (58). There are essential criteria that must be met in order to achieve that particular level (58). A level 2 trauma facility is expected to have 24-hour emergency and medical cover with properly trained personnel, theatre availability as well as comprehensive ICUs (58). Currently, the study hospital lacks a 24-hour trauma surgeon as well as emergency medicine consultants; these are the additional requirements in order to meet Level 1 major trauma centre criteria (58).

This hospital's EC has 20 beds with four resuscitation bays. Typically, between 07h00 and 18h00, the EC is staffed with three emergency medical officers. From 18h00 to midnight, there are two medical officers. After midnight, one doctor remains; this is normally the only doctor available in the whole hospital for any emergencies both in the EC and the wards or ICUs. This hospital's doctors are expected to have qualifications in advanced cardiac life support (ACLS), advanced trauma life support (ATLS) and advanced paediatric life support (APLS). Some doctors also have a Diploma in Primary Emergency Care (DipPEC). Normally, there are around 12-13 nursing staff in the EC per 12-hour shift. The shift leader is typically a trauma-trained RN, with 5-6 RNs on the floor. The rest is made up of staff nurses or BAAs. Typically, triage is run by ENs, nursing assistants or BAAs. This EC sees 100 to 120 patients a day, approximately 3 000 per month. The SATS is used to triage patients in accordance with national guidelines and recommendations from the Emergency Medicine Society of South Africa (EMSSA). Types of patients seen include both medical and trauma from all age groups.

Severity of illness can range from minor illness such as otitis media to something as severe as polytrauma or myocardial infarctions. Patients are either triaged at entry if they walk in, or at the bedside if brought in by ambulance.

Motivation for this study

Findings of this literature review show that triage is an essential part of emergency care. By identifying critically ill patients quickly, these patients are seen and treated earlier; this ultimately improves outcomes. Triage assists in how efficiently the EC functions by determining who needs to be seen first, especially in times of overcrowding. Under-triage is a substantial issue with most well-known scales, particularly in higher acuity categories where critically ill patients may not be seen in a time.

The EC that this study will focus on is often overcrowded and manages a high volume of patients with a wide variety of pathology. It is unclear as to whether patients are being seen in a timely manner as mis-triage rates in this setting are not known. It is also not known whether the time in which a patient is seen is in accordance with local standards. The distribution of pathology seen in this EC has not been identified and so it is unclear if the available resources are appropriate for the types of patients seen and whether or not this may vary depending on the time of day.

A study was designed to address these gaps in knowledge in order to determine if the SATS is appropriate for use in this hospital. Results may advise if triage is working effectively in this setting and if changes are required with how the EC currently operates.

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Part B: Manuscript in article format

This article is written in accordance with SAMJ author guidelines (Addendum 1).

Title Page

Title

A descriptive study of demographics, triage allocations and patient outcomes at a private emergency centre in Pretoria for 2018.

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Word count

4033

Table count

6

Figure count

1

Abstract

Background

Triage aims to detect critically ill patients and to prioritise those with time-sensitive needs. It also contributes to the overall efficiency of an emergency centre (EC). International systems have been relatively well researched; however, no data exists on the use of the SATS score in private healthcare settings in SA.

Objectives

This study aimed to describe the demographics, triage allocations, time spent in EC and disposition of all patients presenting to a private hospital EC in Pretoria, South Africa in 2018.

Methods

A retrospective descriptive study was undertaken. Data relating to demographics, triage, and hospital disposition were collected on all patients presenting to the EC during the 2018 calendar year. Descriptive data analyses were conducted in Microsoft Excel.

Results

A total of 29 055 patients were included in this study. More than half (57.6%) were adults aged 18 to 60 years and approximately one-fourth (27.5%) were paediatrics (<18 years). The majority of patients were triaged yellow (73.5%); 17.4% were triaged as red and orange. It took, on average, 28 minutes to be seen by a provider and patients spent an average of 2 hours and 20 minutes in the EC. Delays to be seen exceeded standards for red and orange patients at 8 and 18 minutes respectively, and the mean time these patients spent in the EC was higher (2h 51 minutes and 2h 47 minutes respectively). Most patients (76.1%) were discharged; 5.6% were admitted to ICU/high care, 14.4% to the general ward, and 3.9% either absconded or refused hospital treatment. Of patients triaged red and orange, 11.1% and 49.3% were discharged respectively, and these patients used the most resources .

Conclusion

This study found that most of the patients were triaged into low acuity categories (yellow and green) and discharged home. High acuity patients were usually admitted to ICU or high care; however, these patients experienced delays in being treated and admitted. Causes of these issues, and implications on patient outcomes remain unknown. Large numbers of high acuity patients were ultimately discharged home. Further studies are needed to understand the influence of triage accuracy on these patients' outcomes.

Manuscript

Background

Triage, which stems from the word ‘trier’, meaning to sort, is most commonly known for its use in medical settings [1-3]. The triage process was originally developed during World War I, when the limited resources on the battlefield made it necessary to determine who to prioritize for both care and resources [2, 4]. Today, triage is used to prioritise patients based on their urgency with the goals of ensuring that critically ill patients get timely care and preventing unnecessary mortality [4]. It is most often seen at points of entry into healthcare facilities, such as emergency centres (ECs). Such a system is particularly useful in times of overcrowding, when EC resources are strained [4]. A good triage system is able to distinguish correctly between urgent and non-urgent patients, with reproducible results regardless of who is performing the triage [4-6]. A triage system should ideally have low mis-triage rates: Over-triage rates below 35% and under-triage rates below 5% are considered acceptable in most settings [7]. Well-known systems, such as the Manchester Triage Scale (MTS), the Canadian triage and acuity scale (CTAS) and the Emergency Severity Index (ESI), were developed in high-income countries. The South African Triage Scale (SATS) is one of the few triage systems purposed-designed for use in low- and middle-income countries (LMICs) [4, 8-10].

In South Africa (SA), the SATS is used to triage patients [3]. It has five categories to help providers prioritize time and resources. From most urgent to least, they are: red, orange, yellow, green and blue (already deceased) [3]. Triage is commonly performed by a nurse in SA; however, this is usually a less-experienced junior nurse [3, 11]. A study done in rural SA (2018) showed that the SATS is easy to use and that reliability is not affected when it is used by an untrained healthcare provider [11]. The SATS has been shown to have under-triage rates of around 9% in more urgent categories (red and orange) and overall over-triage rates of 49% [11, 12]. A study in Kenya confirmed similar rates, finding an under-triage rate of 7% and over-triage rate of 60%) [13]. These rates are above acceptable mis-triage rates as set out by international standards [7]. Under-triage rates can have deleterious effects for patients in rural settings where resources are few and waiting times longer, but it is unknown how this compares to more urban areas or ECs in private hospitals [11]. In rural SA, the distribution of patients per category was shown to be the following: red, 2%; orange, 15%; yellow, 37%; and green, 47% [11]. It is not understood if this distribution is true of all ECs using the SATS or if it is dependent on patient population, and therefore differs in private healthcare settings.

The chosen study hospital is a frequently-overcrowded Level 2 Trauma private hospital in Pretoria [14]. It is not clear if patients are being seen timeously or if the SATS is performing in accordance with the standards for this given population. Prior to this study, the SATS had not been evaluated in this setting. It is also not known what the most common presenting pathology is and whether available resources are appropriate for treating this.

To address these gaps in knowledge, this study aimed to describe the demographics of this patient population, their triage allocations and time spent in the EC, and the disposition for each triage category for the year 2018.

Methods

Design and Setting

A retrospective descriptive study was undertaken in the EC of a Level 2 Trauma accredited private hospital in Pretoria. Data relating to demographics, triage, and hospital disposition were collected on all patients presenting to the EC during the 2018 calendar year. A one-year period was chosen so as to cover all potential seasonal variation.

Data collection and analysis

All data were originally collected at the time of patient presentation to the EC and stored in an online medical records system. The data required for this study were extracted by a gatekeeper chosen by the hospital (SM). Data were then checked and anonymised by a hospital data manager (GR) and entered into Microsoft Excel before being given to the research team for analysis. To meet the study aim, only data relating to demographics (age and sex), application of triage (triage category, presenting complaint, and resources used), times and disposition of patient (discharge or admission) were collected. All patient records were considered for inclusion. Patient records with missing data (no triage category or no triage time) and patients given a random, non-SATS triage category ('silver' or 'follow-up') were excluded from analysis. When looking at the objective of time to be seen by a physician, patients who were triaged but left were excluded from this calculation. Due to a lot of inaccurate data capture when looking at the objectives addressing time, if less than 5% of patient data points were missing/incorrect for a specific calculation, then only those patients were excluded; if it was more than 5%, that calculation was not done. Similar presenting complaints were grouped together where appropriate by one of the researchers (a physician). To reduce bias, if there was any uncertainty, they were left as separate. In terms of resources used, these were divided into laboratory (blood test/s), electrocardiogram (ECG), urine test, radiology (x-rays, scans, ultrasounds). Each of these categories counted as one resource. Descriptive analyses were performed using central tendencies such as means. Data were analysed using Microsoft Excel.

Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee of the University of Cape Town (UCT) (HREC REF: 340/2019). Patient consent is given to the hospital to use their data anonymously on arrival in EC. Consent to study these data was obtained from the hospital manager and the hospital Research Committee. A non-disclosure agreement was signed between the researchers and the hospital to ensure data protection.

Results

Patient demographics

A total of 32 328 patients were seen at this hospital's EC in 2018. Of these, 3 272 (10%) were excluded either due to a non-SATS triage category being assigned ('silver' or 'follow-up) or missing data. This left 29 055 patients eligible for inclusion (Table 1). A mean 2 421 (8.3%) patients were seen each month. This proportion was generally stable, with the highest number of patients seen in March (n = 2 759, 9.5%) and the lowest number of patients seen in November (n= 2123, 7.3%) .

Triage Categories

The most frequently allocated triage category was yellow (n = 21 351, 73.5%). No patients were triaged as blue (Table 2). The elderly was most frequently classified as high acuity (red or orange) (n = 1 429, 32.9%), followed by adults aged 19-60 years (n = 2 562, 15.3%) and paediatric patients (n = 1 052, 13.2%).

Table 1: *Patient demographics of a private emergency centre in Pretoria for the year 2018*

Gender	**n**	**(%)**
Male	14 409	(49.6)
Female	14 646	(50.4)
Age Groups (years)		
Paediatrics (0-18)	7 985	(27.5)
<1	2 014	(25.2)
1-12	4 077	(51.1)
12-18	1 894	(23.7)
Adults (19-60)	16 723	(57.6)
19-40	10 385	(62.1)
41-60	6 338	(37.9)
Elderly (>60)	4 347	(14.9)
61-79	3 194	(73.5)
>80	1 153	(26.5)

Table 2: *Triage category allocations for age, disposition and presenting complaints in a private emergency centre in Pretoria in 2018*

	Green	**Yellow**	**Orange**	**Red**
Total patients	2661 (9.1%)	21351 (73.5%)	4519 (15.6%)	524 (1.8%)
Most common age group	Adults (59.6%)	Adults (59.9%)	Adults (51.8%)	Elderly (45.6%)
Most common disposition	Home (89.0%)	Home (81.7%)	Home (49.3%)	ICU/High care (54.4%)
Top presenting complaints	Respiratory (15.3%)	Fall (12.1%)	Chest pain (21.7%)	Neurological (24.0%)

**Blue category not included as no patients were triaged into this category*

Presenting complaints

The most common presenting complaint overall in the EC was abdominal pain (n = 2 613, 8.9%) (Table 3). The most common paediatric complaint was fever (n = 1 277, 16%), adults was abdominal pain (n = 1 778, 10.6%) and the elderly was pain NFS (n = 479, 11.0%). Trauma-related complaints accounted for 12 909 (44.4%) of all presentations.

Table 3: *Top ten presenting complaints in a private emergency centre in Pretoria (South Africa) in 2018*

#	**Overall PC**	**n** (%)	**Paediatrics PC**	**n** (%)	**Adults PC**	**n** (%)	**Elderly PC**	**n** (%)
1	Abdominal Pain	**2613** (8.9)	Fever	**1277** (16)	Abdominal pain	**1778** (10.6)	Pain NFS	**479** (11.0)
2	N/V/D	**2495** (8.5)	N/V/D	**919** (11.5)	Pain NFS	**1569** (9.4)	Respiratory	**422** (9.7)
3	Pain NFS	**2459** (8.4)	Respiratory	**827** (10.4)	MBA/MVC	**1285** (7.7)	Abdominal pain	**314** (7.2)
4	Respiratory	**2088** (7.2)	Sport injury	**523** (6.5)	N/V/D	**963** (5.8)	Fall same level	**307** (7.1)
5	MBA/MVC	**1516** (5.2)	Abdominal pain	**510** (6.4)	Chest pain	**745** (4.5)	N/V/D	**292** (6.7)
6	Fever	**1486** (5.1)	Fall NFS	**476** (6.0)	Headache	**646** (3.9)	Chest pain	**231** (5.3)
7	Fall NFS	**1086** (3.7)	Pain NFS	**412** (5.2)	Back pain	**554** (3.3)	Fall NFS	**211** (4.9)
8	Fall same level	**924** (3.2)	Fall same level	**219** (2.7)	Crush injury NFS	**538** (3.2)	Malaise	**133** (3.1)
9	Headache	**879** (3.0)	Follow up	**162** (2.0)	Fall NFS	**494** (3.0)	Dizziness	**131** (3.0)
10	Sport injury	**846** (2.9)	Headache	**158** (1.9)	Fall same level	**398** (2.4)	Back pain	**130** (2.9)

PC, presenting complaint; N/V/D, Nausea/vomiting/diarrhoea; NFS, Not further specified; MBA/MVC, motor bike accident/motor vehicle collision

Resources used

There were four types of resources used. High acuity patients used the greatest number of resources. Most low acuity patients used no resources at all (Table 4).

Table 4: *Number of patients using zero resources per triage category and number of patients using three or more resources per triage category in a private emergency centre in Pretoria in 2018*

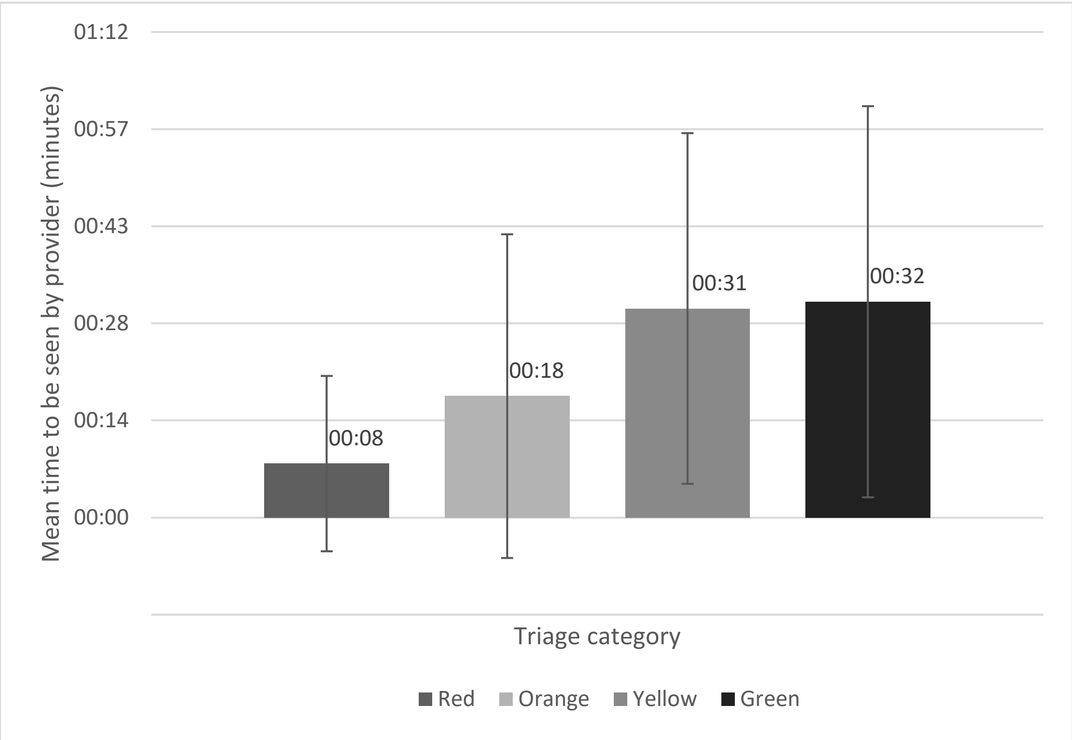
	Zero resources used		**3+ resources used**	
	No. of patients	**(%)**	**No. of patients**	**(%)**
Red	196	(34.7)	92	(16.3)
Orange	2 488	(53.0)	355	(7.6)
Yellow	15 098	(70.7)	5	(0.02)
Green	1 921	(71.5)	0	(0)

**No patients were triaged blue*

Time to be seen in the EC

A total of 603 (2.1% of total) patients were excluded from this calculation as they were triaged but not seen by a practitioner (total 28 452 patients). The mean time to be seen in the EC was 28 minutes. The mean time to be seen per triage category has been illustrated in a chart below (Figure 2).

Figure 1: *Mean times (with standard deviation) for patients to be seen by provider per triage category in a private emergency centre in South Africa in 2018*



Time spent in the EC

A further 163 (0.6%) of patients were excluded due to incorrect capture of time, making the total number of patients for this calculation 28 289 (total excluded 766 (2.6%)). Of the 28 289 patients included in this analysis, the mean time spent in the EC was 2 hours 20 minutes and the mean time spent after treatment was 1 hour and 54 minutes (Table 5).

Table 5: *Mean times spent in the emergency centre per triage category (with standard deviations) in a private hospital in South Africa in 2018*

	Mean (SD) time spent in the EC	Mean (SD) time to be seen	Mean (SD) time after consult
Green	1h 45 min (01h 42 min)	32 min (29 min)	1h 16 min (1h 58 min)
Yellow	2h 18 min (2h 01 min)	31 min (26 min)	1h 49 min (1h 59 min)
Orange	2h 47 min (1h 47 min)	18 min (24 min)	2h 30 min (1h 46 min)
Red	2h 51 min (1h 52 min)	8 min (13 min)	2h 43 min (1h 51 min)
Overall mean	2h 20 min (1h 58 min)	28 min (26 min)	1h 54 min (1h 57 min)

Area of Disposition

Approximately three-quarters (n = 22 113, 76.1%) of patients seen in the EC were discharged home. A small proportion were triaged and cancelled their files before being seen, absconded or they were seen and refused hospital treatment (n = 682, 2.3%). Of the 38 (0.1%) patients that died in the EC, five were classified as dead on arrival but triaged red. Of those admitted to the study hospital, 4 187 (71.9 %) were admitted to a general ward and 1 637 (28.1%) were admitted to high care or ICU (Table 5).

Table 6: *Distribution of disposition per triage category in a private emergency centre in Pretoria in 2018*

	Red		**Orange**		**Yellow**		**Green**		**Total**	
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
ICU/HC	285	(54.4)	1 045	(23.1)	302	(1.4)	5	(0.2)	1 637	(5.6)
Ward	108	(20.6)	995	(22.0)	2 957	(13.8)	127	(4.8)	4 187	(14.4)
Transferred	37	(7.1)	193	(4.2)	197	(0.9)	9	(0.3)	436	(1.5)
Discharged	58	(11.1)	2 230	(49.3)	17 440	(81.7)	2 385	(89.6)	22 113	(76.1)
Other	36	(5.3)	56	(8.2)	455	(66.7)	135	(19.8)	682	(2.4)

**ICU, Intensive Care Unit; HC, High Care;*
†Other, Died/Refused hospital treatment/Assessed & not seen/Absconded;
‡No blue patients were assigned from this population

Discussion

This study gives insight into the demographics, distributions of triage categories, and triage outcomes within this private hospital's EC. The majority of patients presenting to the EC were considered by the SATS to be low acuity (yellow and green patients), and a small proportion were high acuity (red and orange). The distribution of high and low acuity patients was comparable to that seen in a 2018 study in rural SA [11]; however, there were differences in specific categories. This study's private EC saw far more yellow patients (73.5% in this study vs 37%), whereas the rural hospital saw far more green patients (46% vs 9.2% in this study) [11]. The reason for this discrepancy could be as a result this study's population having access to general practitioners in the community: these patients may seek care from those providers and, thus, not use the EC for non-urgent illnesses. In rural SA, the EC might be the closest or most available point of care for certain patients, even if inappropriate.

The finding of no patients triaged as blue (deceased) on arrival was also in keeping with the study in rural SA [11]. An unexpected finding in this study was that five of the patients who died in the EC were noted as 'dead on arrival', but triaged red. If these patients were, indeed, deceased upon arrival, they should have been triaged blue by SATS definition. This may reflect an ethical dilemma on the difficulties in giving no treatment to an unknown patient (especially younger patients) versus giving futile treatment to a patient with no signs of life. Classifying a patient as red motivates for additional aggressive care but classifying a patient as blue leads to halting of potentially life-saving interventions. Further research is warranted to determine whether or not this reflects an ethical dilemma or whether the patients were simply incorrectly triaged. This dilemma may also be more unique to this private healthcare setting. Interventions such as extra-corporeal membrane oxygenation (ECMO) has often been used in this facility to save patients in cardiac arrest, 'buying' time until definitive treatment can be established. In these circumstances, resuscitation efforts are extended beyond that of other hospitals and so triaging red may give the benefit of the doubt to such potential patients.

Trauma-related complaints formed almost half (44.4%) of total presenting complaints in this study. This is more than a study done in Paarl, SA (a government hospital), which showed that only 36% of patients presented with trauma-related conditions, although the sample size in this study was considerably smaller [15]. A reason that this proportion could be higher is because many private institutions, including the one in this study, also treat patients for the Worker's Compensation Assistance (WCA) fund. These are patients who generally have minor injuries that could be treated at primary care facilities. However, as the WCA fund has designated places for care, this forces more patients to seek treatment at a facility that is inappropriate. SA is known to have one of the highest rates of violence and trauma in the world [15]. This finding in this private hospital study is consequently very much in-keeping with SA's national statistics, where trauma is one of the leading causes of morbidity [15].

Red and orange categories were found to use the greatest number of resources, which is consistent with more critical diagnoses where a patient may have multiple pathologies. This is in keeping with the ESI findings where higher acuity categories require more resources [16]. Of note was the fact that over 30% of red and orange patients used no resources at all. Whilst high acuity patients are usually expected to be the sickest by definition, they can likewise be triaged as more urgent based on a time-sensitive need. For example, patients with a simple dislocated shoulder get placed into the SATS orange triage category; however, diagnosis can be made clinically. Nevertheless, given that litigation is common in private healthcare, one would expect all high acuity patients to use at least one resource to err on the side of caution. In the dislocated shoulder example, the minimum would be to use x-rays to confirm a successful reduction. Therefore, this finding of using no resources for some critical patients does not make sense in this setting. Another possible explanation for this finding is that if a patient is so critical, the focus is on providing life-saving treatment. Notes are sometimes then written retrospectively, and resources may accidently be left out of clinical notes, resulting in inaccurate data capture.

Further research is required to see if these findings are as a result of a clinical reasons or inadequate data capture.

In this study, the majority of high acuity patients were elderly, and given that they usually have less typical symptoms, one would anticipate more investigations in all patients to reach a definitive diagnosis [17]. This may explain why the other 60% plus patients used more than the average number of resources. These may have been the sickest patients, or they might have had multiple pathologies requiring a more extensive work-up, of which the final diagnoses may help answer this theory. This finding could also be explained by the fact that the EC uses protocols driven by the hospital's specialists. This means that even if the diagnosis is relatively clear, more resources may get used to comply with protocols. Furthermore, the radiology department is right next to the EC in this hospital. Therefore, for convenience specialists sometimes request certain scans, which would normally be done from the ward, to be done from the EC. This would falsely elevate the use of resources by some patients in the EC.

High acuity patients (red and orange) in this study were noted to wait the longest to be seen by a doctor and these times were outside the recommended standards set by SATS. The orange and red patients at Zithulele Rural Hospital in the Eastern Cape were also above recommended time frames [11]. The difference in time to see red patients between studies was on average only 3 minutes (11 minutes vs 8 minutes) [11]. However, no confidence intervals were available to determine if these findings are statistically significant. As these are usually the sickest patients, this raises concerns. This is because triage aims to identify critically ill patients early in order to provide rapid treatment to reduce morbidity and mortality. Whilst hospitals in rural SA may have good reason to explain these delays, such as fewer available staff, it is unclear why this was also the case in a better-resourced EC. This is especially concerning because, typically, the doctor is given the orange or red file in their hand immediately upon the patient's arrival. One major contributing factor could be that, when the unit is busy, there is often an access block to beds for patients. Therefore, even if the doctor is ready, the patient may not yet be in a bed, increasing the time to be seen. Another possible reason for these delays could be as a result of the way in which the EC is designed. The different sections can be far from each other and so the doctor is not aware of a new red patient if they are otherwise occupied. Until such a patient is brought to a doctor's attention, there will be delays in them receiving treatment. Whilst re-building the EC is not necessarily practical, a system such as the ringing of a bell throughout the EC to indicate a red arrival could be implemented. This would alert the doctor immediately and possibly improve these times. Exact reasons for major delays at this EC are not known and warrant further exploration, as these delays may have adverse outcomes for patients and go against the purpose of triage. This study did not follow patients to understand if these delays affected outcomes, a topic that warrants further analyses.

The mean time spent in the EC was greater than two hours, and, the higher the acuity of the patient, the more time was spent. This finding is in keeping with the study by Hocker *et al.* (2011) which showed that, when using the ESI, higher acuity patients also spent longer in the EC [16]. It was suggested that more resources and investigations were used for these patients, but whether that was the main reason for the prolonged stay is not clear [16]. One possible explanation is that a polytrauma patient may require reduction and casting of fractures and a head-to-pelvis scan to determine the extent of the injuries. The scans are done in another department and, alongside procedure times, can increase patient stays in the EC. However, for less complicated critically ill patients, this still seems to be too long. In this EC, if a patient presents with a ST-segment elevation myocardial infarction (STEMI), they can be in the percutaneous catherization intervention (PCI) unit within 15-30 minutes. Furthermore, for all red patients, bloods can be run urgently, with results completed 30 minutes faster than for non-urgent patients. This implies that the time to final diagnosis should be sooner. These long EC wait times are cause for concern because they result in definitive treatment being delayed. Definitive treatment will naturally vary from patient to patient. For some, it may mean theatre or ICU care; for others, it may be simply antibiotics. If this EC is full, the staff-to-patient ratio is skewed, meaning that items are more likely to be missed or forgotten. This can impact on general patient care for both patients requiring admission and new patients presenting to the EC. It also potentially increases risk for a major adverse outcome in critically ill patients. Patients who require more one-on-one care, such as ventilated patients, could easily deteriorate unnoticed in a chaotic environment. Reasons for these delays are not clearly understood and would need to be investigated to determine if they can be reduced.

In terms of disposition, this study found that the majority of patients were discharged home; the discharge rate was 20% higher than that of Meyer *et al.'s* (2018) study in rural SA [11]. One explanation for this may be that patients in this study have better access to care and can follow up more easily and are therefore discharged more easily. However, there is also a possibility that the burden of disease may differ greatly and that could explain the difference in findings. Final diagnoses of this study's population may provide a clearer idea of why patients were admitted or discharged. Furthermore, if the majority of patients are yellow and being discharged, this raises the question of whether the current EC is optimally set up for the patients it sees. With these results, it may be worth considering having a larger area for yellows with more dedicated staff, so that these patients can be fast-tracked, preventing access block or drawing away of resources from more critical patients.

Most red patients in this study were admitted, with the majority being admitted to high care or ICU. These findings are in line with international studies done on the ESI and MTS which showed that high acuity patients were more likely to be admitted [17, 18]. The ESI showed that 48% of red category patients were admitted to ICU, whilst the rest were admitted to the wards [18] .This study in a private hospital in SA showed high numbers of orange patients discharged home with equal numbers admitted to the ward or high care/ICU. Some red patients in this study were also discharged home. This is in contrast to the ESI which saw no red patients discharged and only 22% of orange patients discharged [18]. In Meyer *et al.'s* 2018 study in rural SA, high discharge rates for red and orange patients were also noted, but with higher admission rates for green patients (9.4% versus 5%) [11]. Another study done assessing the use of SATS in various low-income countries by Dalwai *et al.*, showed that the majority of red patients seen were also discharged (exceeding 50%) [19]. The fact that so many high acuity patients were discharged when using the SATS may imply that either triage is being incorrectly performed or the system itself has a tendency to over-triage. Given that many studies using the SATS in a variety of settings are showing consistent results, it would suggest the latter as a reason for these findings. This would need to be investigated to determine the real implications of these findings, however.

Limitations and recommendations

This study had several limitations. Data were captured online by different people. This meant that some data had to be excluded due to times being inaccurately recorded (some were captured using 24-hour clock, others not), reducing this study's sample size and potentially skewing results. Although this affected calculations regarding time the most, inaccurate data capture could have affected all variables in some manner. Next, was the allocation of the silver category to some patients. This is not a formal SATS category. It is not clear on what criteria this is based, who made that decision, or at what point in the process this was decided (i.e. at triage or when captured online by hospital staff). As it is possible that these patients could have been categorised into a formal SATS category, excluding these patients may have impacted overall numbers per triage category. Furthermore, presenting complaints were grouped together by researcher who is a physician (e.g. abdominal pain and GIT-abdominal pain). Although any ambiguities were left in original categories to reduce bias, this was still a subjective process and so may have impacted the results. This study was only conducted at one hospital and thus may not hold external validity as it is not representative of all private institutions. Repeating this study across multiple facilities to see whether results are reproducible would be of use for those considering SATS implementation in similar settings.

Conclusion

This study shows that the majority of patients attending this private hospital EC were triaged into low acuity categories, which is in-keeping with the high discharge rate seen. This does not appear to be unique to a private healthcare setting, although the reasons for discharge may be different due to better access to healthcare and the ability to follow up more easily. Even though most patients are being seen in a timely manner, high acuity patients are waiting slightly longer than recommended times, and this is unexpected in a private healthcare setting, where staff and resources are more readily available. Reasons for these delays are not apparent and requires further exploration as this issue can impact patient outcomes substantially. Additionally, high acuity patients were shown to use the greatest number of resources and to spend the longest time in the EC. There may be a correlation between these two results, but further research to confirm and correct this is needed. A fair proportion of high acuity patients was also noted to use no resources which was unexpected as these patients are usually the sickest. With more readily available resources in private healthcare as well as high risk of litigation, one would have presumed that all high acuity patients would have had an investigation of some kind. Moreover, whilst a large number of high acuity patients are admitted to high care or ICU, a great number were also discharged home. This raises concerns about the accuracy of triage in this private facility.

Conflict of interests

The researchers declare no conflicts of interest

Acknowledgements

The authors thank all those involved in making this possible, from both the University and the hospital itself.

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Part C: Addenda

Addendum 1: Journal Instruction to Authors

The chosen journal is the South African Medical Journal.

Author guidelines are available on the following link:

http://www.samj.org.za/index.php/samj/about/submissions#Anonymity

Addendum 2: Research Protocol

A descriptive study of demographics, triage allocations and patient outcomes for 2018 in a private Emergency Centre in Pretoria

Student Kirsty Hedding
MPhil (UCT)
HDDKIR001

Supervisors Dr Enrico Dippenaar (UCT)

Professor Lee Wallis (UCT)

Plagiarism Declaration

I, Kirsty Hedding (HDDKIR001), 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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Date: ……June 2019……………

Background

Triage originates from the French word ‘trier’ which directly translates as “to sort” (1). This process aims to do as much as possible for the most number of people, using the tools and resources available at the time (1). Triage is the most critical process in an Emergency Centre (EC) (2). Due to long waits and over-crowding, triage determines the level and urgency of care needed for each patient (2). The key principle of triage is to determine who requires immediate attention, prioritising those who will be disadvantaged by waiting (3). An ideal triage system is easy to use and able to identify those with life-threatening conditions quickly (4). It should also be able to process patients efficiently (4). Scales and scores have been designed to try and standardise the process around the world; however, there isn’t one that suits every healthcare systems’ needs (3). This is due to each area’s demographics, disease patterns and available resources, which play a role in determining the number of patients that present in each acuity level (5). Whilst disease patterns are well-known, it is unpredictable when the individual will present (5). Therefore, it is difficult to standardise a process that is variable (3). South Africa developed its own triage system- the South African Triage scale (SATS), which was designed to improve efficiency in the EC (1). In essence, it combines vital signs (based on the Triage Early Warning Signs (TEWS) score) with that of clinical signs. This produces an overall colour of either red (which is seen immediately), orange (which is seen within 10 minutes), yellow or green (which is seen with in one to four hours respectively) (1).

Triage is a dynamic process and decisions are often made in a time-sensitive environment with limited information (3, 6). The concept of urgency is an important part of understanding how to apply the process (3). Urgency does not denote severity, and relates rather to the time in which a patient needs to be seen (3). Clinical and environmental factors determine the urgency of a patient: a dislocated joint requires urgent relocation for pain relief and reducing complications, even though it is not life-threatening (3). When the initial triage process is applied, three things can occur: the patient can be triaged correctly (the allocation is correct for their medical need) or they can be under- or over-triaged (inappropriate allocation for their medical need) (6). Under-triage is more likely to cause direct harm, whereas over-triage is likely to affect other patients who now wait longer (6).

Motivation

The hospital to be used for this study is one of the larger private hospitals in the Pretoria area, with over 400 beds and multiple Intensive Care Units (ICU). The hospital is an accredited

Level 2 Trauma facility, which is based on the Trauma Society of South Africa's criterion (7). This means that the facility is capable of providing all initial definitive trauma treatment, regardless of the pathology (7). A level 2 Trauma facility is expected to have 24-hour emergency medicine cover with properly trained personnel, theatre availability as well as comprehensive ICUs (7). Currently, this hospital lacks a 24-hour trauma surgeon as well as Emergency Medicine specialists, which is required in order to be accredited as a Level 1 Major Trauma referral centre (7). The EC sees on a mean of around 100 to 120 patients a day, equating to around 3000 per month. The SATS is used to triage patients. Types of patients seen include both medical and trauma from all age groups. Severity of illness can range from something as minor as otitis media to something as severe as polytrauma, or myocardial infarctions. Patients are either triaged as they walk in or at the bedside if brought in by ambulance. Due to the high volumes of patients, it is imperative that patients are seen at the appropriate times.

Triage is critical to how the EC functions and contributes to patient outcomes, and this study wishes to understand how this system is currently working at and to see if it is appropriate for the population it serves. To do this, we need to understand the population by looking at the demographics of patients. By looking at presenting complaints, we can better understand the burden of disease. Also, through analysing the triage categories and the amount of time spent in the unit, it may be possible to see if the triage system is working appropriately (i.e. under-triaging or over-triaging patients). We want to understand the system better so that it can be improved as needed.

Aim

The aim of this study is to describe the demographics, triage allocations and outcome of patients presenting to this private EC during 2018

Objectives

1) To describe the demographics of all patients presenting to EC during 2018.
2) To describe the triage allocations of patients and their time spent in the EC.
3) To describe the disposition of patients for each triage category (i.e. ward, ICU or discharge).

Methodology

Design

A retrospective descriptive study design will be used. The study will collect data form the hospitals online triage and data capture system surrounding multiple aspects of the triage process. Data will be collected on the patients seen in the EC to meet the above objectives as follows:

1) Demographics: age, sex
2) Application of triage: number in each triage category, vital signs, presenting complaint, resources used (laboratory/x-rays)
3) Times: triage time, time to be seen by doctor, time bloods etc done, time to discharge from unit
4) Disposition: admitted (ICU, high care, ward) or discharged

Population and Sampling

The study will extract data from a population of patients that attend the EC at this hospital. The sample for this study will be all those who presented to the EC from the period of 1st January 2018- 31st December 2018- an all-inclusive sample. This will include data from paediatrics (age 0-18 years), adults (age 18-60 years), and elderly (age greater than 60 years). On average, around 3000 patients are seen per month. This equates to approximately 36000 in a 12-month period. This 12-month period was chosen to cover all seasonal variations of illnesses and disease profiles, and all school holidays and terms which may affect health-seeking behaviour. This hospital sees a variety of patients from all ages, races and backgrounds. This includes patients with medical aid, those that pay cash and those covered by workers compensation fund. This study will include all vulnerable populations when and if they present for care.

Inclusion and Exclusion Criteria

This study will have an all-inclusive sample. It is difficult to predict which part of the data set may be missing for each participant, as the information captured online is done by a different person every day. If less than 10% of participants overall has missing data, then they will be completely excluded from the sample. However, if each participant has a missing data set, the aim will then be to adjust the sample for each variable accordingly (e.g. If 80% triage categories are captured, the sample will then be all those captured for this variable). The exact criteria can only be decided on once the data has been captured.

Research procedures and data collection methods

All of the above data is captured on an electronic system used by the hospital at the time the patient is in the unit. This data is then stored on the Hospital's Servers and is protected by hospital. All data is pre-collected and will be based on what is available on the system. Patient files will not be used in this study. Only data relevant to the above objectives will be captured and kept for the duration of the research (see data extraction sheet for more details). This will include all patients that presented to the hospital EC from 01 January 2018- 31st December 2018. Once all permissions are in place the study will commence. The researcher will not have access to the database. The data will be extracted by a gatekeeper chosen by hospital research committee. For this study, this person will be SM He will extract data at the hospital base and will anonymise it into an excel format for the researcher, removing all identifying features by coding it. This document will then be transferred directly to the researcher. A form will be signed to ensure that the transfer of this data occurs directly between the two above individuals. During the data capture process, a second gatekeeper will evaluate a small portion of the data captured, to ensure it is correct.

Data safety and monitoring

All data will be anonymised using codes once collected from online system, thereby protecting confidentiality. This server is protected as part of the hospital's servers and so no one other than designated staff has access to the information stored here. The researcher will be the only one to have access to this information once it has left the system. Once the data has reached the researcher, it will not be shared with anyone and will be discarded after the dissertation has been marked/published. The data will be kept both on a password-protected computer and a back-up hard drive which will be locked in a safe in the researcher's property at all times, unless in use. When using and accessing the data, this will be done in a private space. A non-disclosure agreement will be signed with the hospital as well to ensure data protection.

Data analysis

Data will be captured and recorded in Excel, and statistics then calculated using Excel. Analysis of data will be descriptive, using tables and figures to represent the results graphically (e.g. Histograms and pie charts etc) .

Types of variables:

1) Demographics: age group: ordinal variable; gender: categorical variable
2) Triage category: ordinal variable i.e.. Green (least serious), yellow, orange (more serious) etc
3) Presenting complaint: categorical variable i.e. Chest pain, abdominal pain etc
4) Disposition: categorical variable e.g. Ward, high care, home etc
5) Time to be seen: continuous variable
6) Resources used: categorical variable
7) Distribution of patients: categorical variable
8) Vital signs: continuous variables (blood pressure, temperature, heart rate etc).

1) Demographics: the mean for each age group and gender will be calculated. Age will be divided into the categories mentioned earlier.

2) Triage category: the frequency of each category will be calculated to see which is most common. This data will also be used to determine the distribution of age of patients in these categories i.e. are the older or younger patients more commonly triaged orange.

3) Presenting complaint: The most common presenting complaint will be determined. The most common presenting complaint for each age group and triage category will also be determined.

4) Disposition: this will be analysed according to the most frequent area of disposition. Each area of disposition will then be compared to triage category to see what percentage of each category was admitted or discharged.

5) Time to be seen: the mean time to be seen will be determined. The mean time for each triage category to be seen will also be calculated. This will then be compared with

expected time as set out by triage score to see if performing within expected norms of the SATS.

6) Resources used: this will be looked at for each triage category to determine which category uses the most amount of resources. It will also be compared to presenting complaints to see which complaint uses the most/least resources i.e. does abdominal pain require more resources to make a definitive diagnoses compared to injury right wrist.

7) Time spent in the unit: the mean time spent in the unit will be calculated as well as the mean time for each triage category. Of the patients who stay for long periods of time in the unit, the percentage of them that were discharged or admitted will be calculated.

8) Distribution of patients: this will aim to look at the distribution of patients throughout the day as well seasonal variation. This will give an idea of which parts of the day are busiest and which months are the busiest, like school holidays for example.

   The times will be broken down as follows:

   - Morning: 7am-1pm
   - Afternoon: 1pm-7pm
   - Evening: 7pm- Midnight
   - Early morning: Midnight-7am

   Seasonal variation will be defined as follows:

   - Summer: 1st December-28th February
   - Autumn: 1st March to 31st May
   - Winter: 1st June- 31 August
   - Spring: 1st September- 30th November

     This will then be compared to public school holidays to see if there is a possible relationship between numbers of patients and season.

Logistic regression analysis will be used to analyse the above data set. It will be used, for example, to try and determine whether age and the presenting complaint have an effect on the triage category allocated or whether resources in the EC and presenting complaint have an effect on the time spent in the unit or disposition of the patient. Also, based on the above data set, a confusion matrix will be used to determine what the probability is of a presenting complaint being discharged or admitted. This will also be used to determine the probability of an orange triage category being admitted or discharged.

Description of risks and benefits

The participants are not directly involved in the study, so there is minimal risk to them. In order to minimise this further, the above safety measures (as described) will be taken to avoid leakage of data and loss of anonymity.

The participants receive no direct benefit from this study. This study aims to improve the system by identifying possible problematic areas. If, for example, time to be seen is outside of expected norms, this can then be addressed to improve efficiency for patients in the future. Through understanding the disease pattern presenting to the EC, we will know where to target future health education to better suit our populations needs.

Consent

Participants are not directly involved, so informed consent will not be taken. Consent is given to the hospital group to use the data anonymously when the patient signs into the unit (see Appendix A). Consent to use this data will be obtained from the hospital CEO and Research Committee.

Conflicts of interest

There are no conflicts of interest for the principle investigator or personnel involved in the study.

Limitations

This study will be done in one facility (and one facility within the region), and so findings may not be representative of the population. This study will also not be looking at the quality of triage performed which may be a confounder when interpreting results.

Project timeline

	Jan	Feb	March	April	May	June	July-Sept	Sept-Dec	Dec- Feb
Proposal									
EMDRC approval									
HREC Approval									
Netcare Approval									
Data Collection									
Data Analysis									
Write-up									

Resource Utilisation

The resources used are all electronically captured information which is available from Netcare. The principle investigator will use own car for transport as well as own computer. The costs will be covered by the principal investigator.

Budget

This study will require a small budget to be conducted (see below). Transport is required to go to site to collect the data. Gifts are required to thank the personnel involved in assisting with collecting data and other processes.

Budget	
Stationary (pens and paper used for scrap notes, printing)	R1500
Petrol (To and from site)	R1000
Gifts (to thank those who have assisted)	R2000
Total	R4500

Dissemination of findings

The findings of this study will be presented to those involved in running the EC. This includes the directors of the EC (the doctors) as well as the unit manager (nurses). This will be so that further research or adaptations within the unit can be made based on the findings. The findings will also be presented to the hospital's Research Committee. This study will also aim to publish the results in a journal if possible.

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Addendum 3: UCT Ethics Approval & Research committee approval

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

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

15 November 2019

HREC REF: 340/2019

Dr E Dippenaar
Division of Emergency Medicine
c/o Ms Vathiswa Mzamo
F51, OMB

Dear Dr Dippenaar

PROJECT TITLE: A DESCRIPTIVE STUDY OF DEMOGRAPHICS, TRIAGE ALLOCATIONS AND PATIENT OUTCOMES FOR A PROVATE EMERGENCY CENTRE IN PRETORIA-JULY 2019 (MPHIL CANDIDATE - DR K HEDDING)

Thank you for your letter to the Human Research Ethics Committee (HREC) dated 31 October 2019.

Thank you for providing the reasons for the amendments.

Please note that the amendment is approved as per the Chair's signature on the 03 August 2019.

Please quote the HREC reference no in all your correspondence

Yours sincerely

Signature Removed

PROFESSOR MARC BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

HREC/ref: 340/2019

RESEARCH OPERATIONS COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: UNIV-2019-0051

Ms Kirsty Hedding

E mail: kirst3638@gmail.com

Dear Ms Hedding

RE: A DESCRIPTIVE STUDY OF DEMOGRAPHICS, TRIAGE ALLOCATIONS AND PATIENT OUTCOMES FOR 2018 IN A PRIVATE EMERGENCY CENTRE IN PRETORIA

The above-mentioned research was reviewed by the Research Operations Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at private Hospital, has been approved, subject to the following:

i) Research may now commence with this FINAL APPROVAL from the Committee.

ii) All information regarding the Company will be treated as legally privileged and confidential.

iii) The Company's name will not be mentioned without written consent from the Committee.

iv) All legal requirements regarding patient / participant's rights and confidentiality will be complied with.

v) All data extracted may only be used in an anonymised, aggregated format and for the purposes of this specific study as specified in the proposal. The data may under no circumstances be used for any other purpose whatsoever.

vi) The research will be conducted in compliance with the GUIDELINES FOR GOOD CLINICAL PRACTICE IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2016).

vii) The Company must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from the Committee as well as a FINAL REPORT with reference to intention to publish and probable journals for publication, on completion of the study.

Signature Removed

viii) A copy of the research report will be provided to the Committee once it is finally approved by the relevant primary party or tertiary institution, or once complete or if discontinued for any reason whatsoever prior to the expected completion date.

ix) The Company has the right to implement any recommendations from the research.

x) The Company reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects/ Company or should the researcher not comply with the conditions of approval.

xi) APPROVAL IS VALID FOR A PERIOD OF 36 MONTHS FROM DATE OF THIS LETTER OR COMPLETION OR DISCONTINUATION OF THE TRIAL, WHICHEVER IS THE FIRST.

We wish you success in your research.

Yours fa Signature Removed

7/10/2019

Prof Dio~~n du Plessis~~
Full member: Research Operations Committee & Medical Practitioner evaluating research applications as per Management and Governance Policy

Signature Removed

Shannon Nell
Chairperson: Research Operations Committee
Date: 16/10/2019

This letter has been anonymised to ensure confidentiality in the research report. The original letter is available with author of research

Addendum 4: Consent form – anonymised (as provided by hospital group)

TERMS AND CONDITIONS OF ADMISSION

The Guarantor	Means any person who signs the terms and conditions, independently from the patient, parent(s) or guardian, and who by signing accepts full responsibility for payment of invoice and shall be deemed to be "the guarantor" for purposes hereof. The guarantor remains jointly and severally, the one paying the other, to be absolved liable in solidum as co-principle debtor for the full outstanding balance/s, unless settled in full by the patient, parent/guardian, main member, medical scheme or any other party.
	Ltd, its holding, subsidiary and associated companies and all of those companies' directors, officers, employees and/or agents, as well as any hospital, clinic or medical facility owned and/or operate
Signatories	Includes the patient, guarantor, parent(s) and guardian where the patient is a minor, together or separately where the person has signed in that capacity.
Third Parties	"Third parties", include but are not limited to medical practitioners, doctor's, radiologists, physiotherapists, pathologists, specialists, medical schemes and other service providers who are not employed by .. but are involved in the provision of various services to the patient.
Payment of account	I/we, the undersigned, will be responsible for and agree to make payment of the ("the fee") for the use of the and health services rendered, as charged by from time to time. Details of the fee structure as applicable from time to time are available in writing on request, and form part of this
Recovery of costs	In the event where you have failed to pay the fee mentioned above, has the right to institute legal proceedings to recover the amount due, including a claim for attorney and own client costs; collection commission and all related legal costs incurred.
Signatories personally responsible	I/we, the undersigned, signatory(ies), will be personally responsible for payment of the fee, whether the invoice has been submitted to my medical scheme or any other party for payment. The person who signed these terms and conditions, as the person responsible for payment of the fee, will remain responsible for the full outstanding amount.
Deposit / Guarantee	may request a deposit or guarantee from you, which must be provided immediately. Acceptable payment methods will be provided to you with the request.
Refundable deposits	A deposit paid is refundable to the person or entity that paid the deposit however, the deposit will be automatically set-off against a patient account upon admission.
Duplicate payments	Full or partial duplicate payments shall be refunded only to the person or entity that made the duplicate payment. Refunds shall be effected by way of Electronic Funds Transfer ("EFT") or a credit card reimbursement only.
Credit balances	Where a credit amount is refundable to a patient it may be set off against any outstanding hospital accounts for that patient beforebeing refunded. Where a credit amount is refundable to the medical scheme, such credit amount will be set off against future payments due by the medical scheme. Where a credit amount is refundable to a guarantor who is not the patient, the credit amount shall be reimbursed to the creditor without any set off against any outstanding accounts of the patient.
Invoice due and payable	The fee becomes due and payable immediately upon presentation of a final invoice. After expiration of thirty (30) days from presentation of the account, reserves the right to charge interest on such overdue account at the rate of two (2) percent (%) above the prime lending rate applicable.
Consent to access credit information	I/we, the undersigned, consent to obtaining from any credit bureau, or any other institution with whom I/we, the undersigned, may have financial dealings any information concerning our credit profile and payment history.
Patient's consent	I acknowledge that in providing health and/or medical services ("services") to me, it is necessary for and third parties that are involved in the provision of services, to process my personal information. I provide my express consent to to process my personal information as defined in law for purposes of providing the services and to share such personal information with "third parties" in order to provide various medical and related services to me.
Consent to Magistrates Court Jurisdiction	I/we, the undersigned hereby consent and submit in terms of section 45 of the Magistrates' Courts Act to the jurisdiction of the appropriate Magistrate's Court in respect of all actions or other proceedings which might be brought against me/us by or on behalf of arising out of my/our failure to pay the fee or other breach of the , irrespective of the value of the claim against me/us.
South African Jurisdiction and Law	This and the use of any facility and any service/s provided by to the patient shall be governed by and construed in accordance with the laws of the Republic of South Africa.
Address for Notices	The addresses provided in the details section above are the chosen domicillium addresses for all purposes, including the serving of any court documents such as summonses or notices, the payment of any amount and any communication between the parties in terms of this agreement. A party may change their chosen address by providing 30 (thirty) days written notice to the other party.
Verification of Address & Employment	reserves the right to verify address and employment details of the signatory.
Notice	Every notice, consent, invoice or other communication required or permitted in terms of this contract, must be in writing. Notices may be delivered: • by hand to the address referred to in the details section or any other address chosen in writing: • by telefax or e-mail to the addressees telefax number or e-mail address: OR • by prepaid registered post to the address referred to in the details section or any other address chosen in writing.
Disclosure	I/we, the undersigned, authorise , or any attending doctor, or any other attending healthcare professional to disclose the nature of the patient's diagnosis and/or any health services rendered to the patient and all and any records or copies of records in relation thereto to the patient's medical scheme, and I/we confirm that I/we are duly authorised to disclose such information and in the event of any disclosure, hold harmless from any claims whatsoever.
Disclaimer	Notwithstanding any refusal and/or inability on the part of the patient to provide consent to the disclosure of any information, confidential or otherwise to the guarantor, by , the guarantor accepts by signature hereto, that he/she shall remain jointly and severally liable in solidum for the amounts so claimed in any invoice by
Medical Practitioners	I/we, the undersigned, understand and accept that the medical practitioners, doctors, radiologists, physiotherapists, specialists and other such practitioners who treat the patient are independent contractors who are not employed by and that is not responsible for their invoices or treatment, and agree to hold harmless in respect thereof.
Disclaimer in respect of property	I/we, the undersigned, understand, accept and agree that will not be liable or responsible for any loss of, damage or destruction to, any property, including money and valuables, belonging to the patient, or in possession of the patient, or given to for safekeeping, even if is/was negligent in any way and no matter how the loss, damage or destruction was caused.
Minor Patients	Where the patient is a minor, that is unmarried and below the age of 18 years, both the minor's parents and/or guardians sign these terms and conditions in both their personal and representative capacities and in so doing accept responsibility for payment of the fee in full. In the event that only one parent/ guardian signs these terms both parents shall be held jointly and severally liable for services rendered to such minor patient.
Accounts and invoices	I/we, the undersigned, hereby confirm that may use the email addresses and contact numbers as indicated in the patient/guarantor details for communication purposes on accounts and/or invoices, or submission thereof. may use my personal information for purposes of collecting and recovering any amounts owed by myself to .
Terms & Conditions Read, understood	**I/we, the undersigned warrant that I/we, the undersigned, have read, understood and agree to these terms and conditions, and the Disclaimer in respect of property set out herein.**
Health data	**I/we the undersigned understand that any health data pertaining to us/myself will only be disseminated in a de-identified manner if and when required.**

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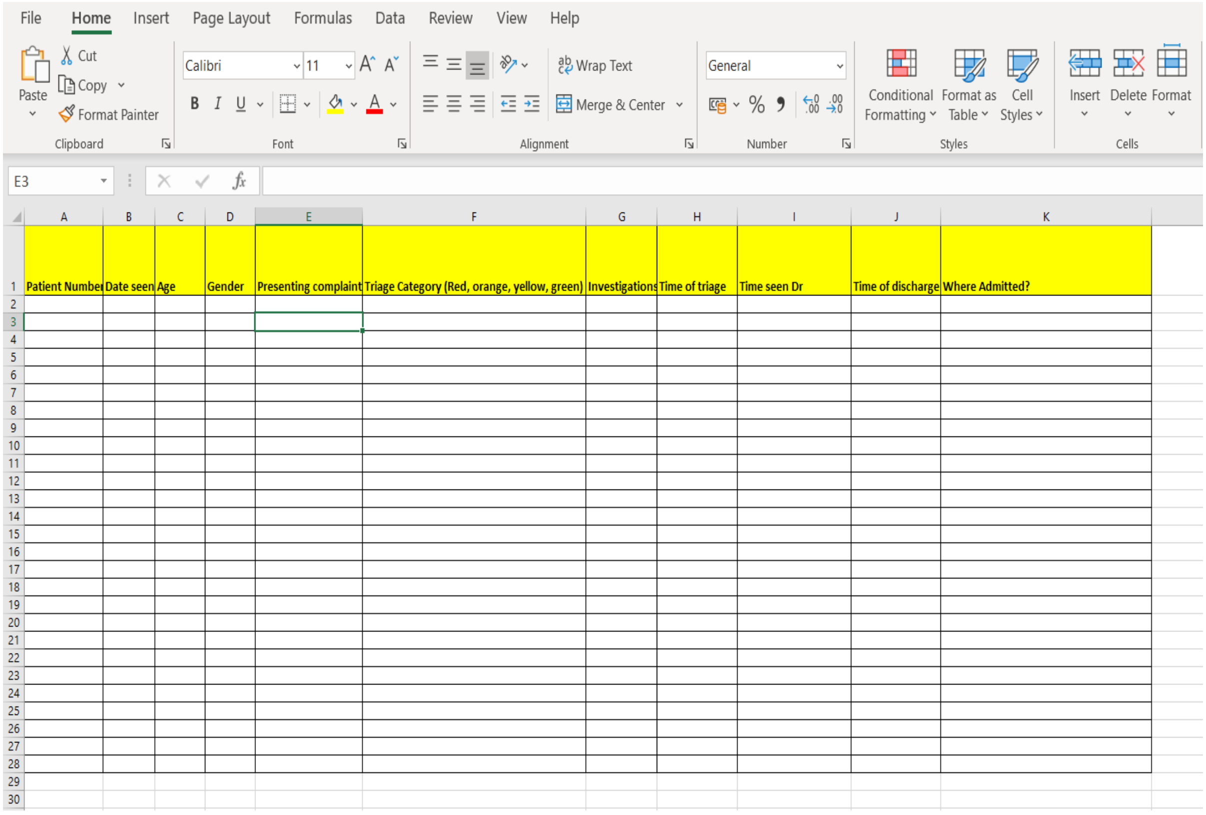
Addendum 5: Data Capture Instrument



Patient Number	Date seen	Age	Gender	Presenting complaint	Triage Category (Red, orange, yellow, green)	Investigations	Time of triage	Time seen Dr	Time of discharge	Where Admitted?