A national retrospective descriptive analysis of critical care transfers in the private sector in South Africa

M Venter, BTech Emerg Med Care, MPhil EM; **W Stassen,** BTech Emerg Med Care, PhD

Division of Emergency Medicine, Faculty of Health Sciences, University of Cape Town, South Africa

Corresponding author: *W Stassen (willem.stassen@uct.ac.za)*

Background. Critical care transfers (CCTs) are necessitated by the growing prevalence of high-acuity patients who require upgrade of care to multidisciplinary teams from less-equipped referring facilities. Owing to the high acuity of the critical care patient, specialised teams with advanced training and equipment are called upon to undertake these transfers. The inherent understanding of the potential effects, and therefore the needs of the critical care patient during transfer, are affected owing to the paucity of international, but more specifically, local data relating to CCTs.
Objectives. To describe a cohort of patients who underwent CCT by dedicated critical care retrieval services (CCRS) in the private sector in South Africa (SA).
Methods. This retrospective, descriptive study sampled all paediatric and adult CCTs completed over a 1-year period (1 January 2017 - 31 December 2017) from the dedicated CCRS of two national emergency medical services in SA. All neonatal patients were excluded. Data were extracted from patient report forms by trained data extractors and subjected to descriptive analysis.
Results. A total of 1 839 patients were transferred between the two services. A total of 3 143 diagnoses were recorded, yielding an average of ~2 diagnoses per patient. The most prevalent primary diagnosis was cardiovascular disease (*n*=457, 25%), followed by infection (*n*=180, 10%) and head injury (*n*=133, 7%). Patients had an average of ~3 attachments, with the most prevalent being patient monitoring (*n*=2 856, 155%), peripheral intravenous access (*n*=794, 43%) and mechanical ventilation (*n*=445, 24%). A total of 2 152 instances of medication infusion or administration were required during transport, yielding an average of ~1 medication or infusion per patient transported. The most common medications recorded were central nervous system depressants (*n*=588, 32%), followed by analgesics (*n*=482, 26%) and inotropic or vasoactive agents (*n*=320, 17%).
Conclusion. This study provides insight into the demographics, most prevalent diagnoses and interfacility transfer monitoring needs of patients being transported in SA by two private dedicated CCRS. The results of this study may be used to inform future specialised critical care transport courses and qualifications, equipment procurement and scopes of practice for providers undertaking critical care transfers.

S Afr Med J 2023;113(8):e672. https://doi.org/10.7196/SAMJ.2023.v113i8.672

The growing need for critical care transfers (CCTs) has been necessitated by the growing population of critically ill or injured patients requiring upgrade of care from resource-limited facilities to centralised facilities with multidisciplinary teams. Additional demand for CCTs has also been found to be a result of a lack of access to appropriate healthcare facilities, a growing patient population and an insufficient number of medical specialists, along with an outgrowing demand for intensive care unit and high-care beds.[1,2] Internationally, specialised critical care retrieval services (CCRS) have been developed to undertake these transfers, owing to the high acuity of patients, the need for specialised training and equipment, and the high rates of adverse events during transport.[1,3,4]

As a result of increased capabilities, training, and more specialised equipment, several international studies have shown that dedicated and specialised CCRS decrease the potential for adverse events during transfers.[5-7] In South Africa (SA), limited training opportunities are available for prehospital providers who undertake these transfers, resulting in them feeling poorly prepared and lacking confidence.[8] There is also limited regulation or standardisation that may support safe CCT.[8,9] Furthermore, very few data have been published to show the specific population of patients requiring transfer, and their care needs during transport.[1,4,10,11] These data are essential to ensure that training and equipment are matched to patient needs. Training and dedicated equipment are essential components of a CCRS.[12]

The SA emergency medical services (EMS)' qualifications and scopes of practice have undergone significant restructuring over the past decade. All advanced life support (ALS) providers are licensed to undertake CCTs, with some exceptions such as endotracheal intubation and the initiation of certain medications for haemodynamic support.[13] Importantly, there is considerable variation in the baseline training and experience of these ALS providers, which comprises three different qualifications (1-year certificate, 2-year diploma, or 4-year degree).

In higher-income countries, specialised physicians, nurses and paramedics undertake these high-acuity transfers.[5-7,14] Locally, EMS are responsible for all interfacility (IFT) and CCTs, regardless of patient acuity. This is unlikely to change, as SA has a severe shortage of physicians, and offers no opportunities for specialisation for prehospital providers currently undertaking these transfers.[2,15] Consequently, a number of critical patients may undergo CCT by non-dedicated services that do not have specialised training, equipment and resources. This may lead to increased rates of adverse events, and affect patient outcome.[4,10,11,15,16]

In an effort to mitigate this risk, SA has initiated the process of developing CCRS.[9,12] This process has been done, however, with few standardised protocols or guidelines, and without formalised training.[8,9] Furthermore, the shortage of CCRS at this time means that many critically ill or injured patients may not have access to CCRS, which are mostly contained in the private sector.

As a necessary step towards standardisation and the development of bespoke training and procurement programmes, it is important to understand the patient population undergoing CCT. The aim of this study was therefore to describe a sample of patients who underwent CCT transfer by dedicated CCT services in the private sector of SA.

Methodology

This retrospective descriptive study sampled all paediatric and adult CCTs between 1 January 2017 and 31 December 2017, undertaken by dedicated CCRS of two private EMS that operate nationally. Data were extracted from patient report forms by trained data extractors and subjected to descriptive analysis. A similar descriptive analysis of the neonatal CCTs undertaken during this period is published elsewhere.[17]

Study setting

There are very few CCRS in SA, especially in the public sector.[18] To our knowledge, only the Western Cape and Gauteng Departments of Health operate such services. Although both services sampled in this study are from the private EMS, each does serve a certain percentage of public sector patients – either funded through the patients themselves, or through dedicated funding agreements between the relevant Department of Health and the service. Both services have dedicated CCRS that operate in various geographic locations within SA, including the Western Cape, Gauteng and KwaZulu-Natal provinces. The Gauteng CCRS also transfers patients from the North West, Mpumalanga, Limpopo and Free State provinces. Services are typically crewed by one ALS and one intermediate life-support provider. Combined, these transfer services perform an estimate of over 2 000 CCTs per annum.

Sample and sampling

CCTs were identified in two ways, corresponding with the archiving systems of the EMS. For the first EMS, which utilises electronic patient report forms (PRFs), all cases performed by the aeromedical (helicopter and fixed-wing) and ground CCT services were identified and extracted into an Excel (Microsoft Corp., USA) spreadsheet. Data were anonymised upon extraction. Only transfers of patients undertaken by the dedicated services were included. All primary (emergency) cases, cases undertaken by non-dedicated units and instances where critical data variables were missing were excluded. Return trips of the same patient (such as for diagnostic purposes) were also excluded.

For the second EMS, anonymised scanned copies of hand-written PRFs from the dedicated ground CCRS were obtained and screened according to the inclusion and exclusion criteria. After specific training in the research aims, objectives, data variables and the contents of the PRFs, the data from eligible cases were extracted according to a dedicated, standard data abstraction form, by a clinical data capturer – a senior paramedic student. Regular meetings between the data capturer and investigators were held to ensure credibility of the extraction process. This approach is in keeping with the guidance on retrospective chart reviews in emergency care, as outlined by Gilbert *et al.*[19]

Data related to demographics, patient contact times, patient diagnosis and attachments and medications were extracted and analysed.

Data analysis

Regardless of the data source, data were extracted onto a spreadsheet and subjected to simple descriptive analysis. Categorical data are presented as frequency and proportions (%), and continuous variables as means. In all instances, >1 diagnosis, attachment or medication is possible per patient. Additionally, proportions are expressed in terms of number of patients.

Ethics

Ethical approval was obtained from the Human Research Ethics Committee of the University of Cape Town (ref. no. 754/2018), and from the private EMS organisations.

Results

For the period of 1 January 2017 - 31 December 2017, 1 839 patients (excluding the neonatal cases) were transferred between the two services. The majority of patients were male (*n*=1 083; 58.9%), and the average age (range) was 44.9 (1 - 97) years, after removing two extreme outliers (107 and 111). The mean (standard deviation (SD)) time spent (minutes:seconds) at the receiving facility to prepare the patient for transfer was 41:36 (26:24), and the mean (SD) duration of transport after departure was 35:51 (36.43).

Table 1 outlines the predominant diagnoses of patients transferred. A total of 3 143 diagnoses were recorded, yielding an average of ~2 diagnoses per patient. The most prevalent diagnosis was cardiovascular disease (*n*=457, 25%), followed by infection (*n*=180, 10%) and head injury (*n*=133, 7%).

Table 2 describes the indwelling devices and attachments. Patients had an average of ~3 attachments, with the most prevalent being patient monitoring (*n*=2 856, 155%). The second most prevalent attachment was peripheral intravenous lines (*n*=794, 43%), followed by mechanical ventilation (*n*=445, 24%). Patients may have >1 indwelling device or attachment.

Table 3 describes the medications running or requiring administration during transport. A total of 3 584 medications were required during transport, yielding an average of ~1 medication or infusion per patient transported. The most common medications recorded, other than fluids, were central nervous system depressants (*n*=588, 32%), followed by analgesics (*n*=482, 26%) and inotropic or vasoactive agents (*n*=320, 17%).

Discussion

This study aimed to describe paediatric and adult patients who underwent CCT by two dedicated CCRS within the private sector in SA. The most common diagnoses were related to cardiovascular disease, infection or trauma. All patients had some monitoring, with pulse oximetry being the most common. Just over half of patients had intravenous access that required monitoring, while almost one in three patients required ventilatory support. Sedatives and analgesics were the most common medications administered, while just under one in five patients required inotropic support. The multitude of diagnoses, indwelling attachments and medications in this sample illustrates the complexity and acuity of patients undergoing CCTs within the SA context. The complexity of these patients and an apparent lack of a standardised approach indicate a need for treating practitioners with specialised training, who have the necessary specialised equipment available to adequately monitor, initiate and continue critical care interventions.

SA is currently undergoing an epidemiological transition from that of predominantly communicable diseases to that of non-communicable, cardiovascular disease.[20] Given the general shortage and inaccessibility of cardiac centres in SA, it is unsurprising that these patients were transported often.[21] Similarly, trauma and injury accounted for a large share of patients requiring CCT in this sample. This is expected, as SA faces a massive trauma burden due to road traffic collision and interpersonal violence.[22]

A previous study that explored the use of an air ambulance service over a 5-year period in the KwaZulu-Natal area in SA found that 88.4% of all calls serviced during this period were transfers.[23] This is significant, as the percentage of transfers is significantly higher than that of international air ambulance services. This may be due to the limited availability of specialised road ambulances and equipment, along with the reported scarcity of multidisciplinary teams and treating facilities.[24] The study also reported that 398 (34.5%) patients transported were for obstetric emergencies, paediatrics accounting for 322 (27.9%) patients, and 183 (15.9%) trauma patients.[23] In contrast, our study found that cardiovascular disease accounted for majority of patients transported (*n*=456, 25%), followed by trauma (*n*=382, 21%) and infection (*n*=180, 10%).

It is encouraging to note that most patients undergoing CCTs within the context of this study had continuous monitoring attached, with pulse oximetry as the most common modality. Second to this, 50% of patients in this group had electrocardiography monitoring, and 31% had capnography monitoring attached. The low percentage of patients with capnography monitoring was noted as a concern, as previous studies have shown that respiratory-related adverse events during transfer of high-acuity patients are common.[4] Routine capnography monitoring of high-acuity patients during transport would allow for improved recognition and response to various adverse events relating to ventilation, oxygenation and perfusion. Patient monitoring has been shown to be an important factor in adverse events during transport. Pulse oximetry, electrocardiography and capnography are of vital importance in an effort to mitigate and treat potential hypoxaemia, dysrhythmias and hypotension, and respiratory insufficiencies – all of which are common adverse events during transport.[4] Yet variation in either rates of monitoring or actual reporting points to a lack of standardised guidelines or training.

A previous study found that patients who were ventilated with peak end expiratory pressures of >6 cmH_2O, sedation before transport and fluid loading carried an increased risk of adverse events occurring

Table 1. Diagnosis of patients undergoing critical care transfers (*N*=1 839)

Diagnosis	*n* (%)
Cardiovascular disease	456 (25)
Infection	180 (10)
Head injury	133 (7)
Central nervous system disorder	73 (4)
Diagnosis unspecified	64 (3)
Central nervous system disease	63 (3)
Conduction disorder	56 (3)
Polytrauma	55 (3)
Spinal injury	49 (3)
Extremity fracture	46 (3)
Neoplasm	44 (2)
Respiratory disease	39 (2)
Burns	38 (2)
Endocrine disorder	36 (2)
Gunshot injury	30 (2)
Mental and behavioural disorders	26 (1)
Overdose	26 (1)
Post-surgery	22 (1)
Congenital defect	20 (1)
Trunk fracture	19 (1)
Acute pain	17 (1)
Gastrointestinal bleed	17 (1)
Respiratory disorder	17 (1)
Renal failure	15 (1)
Poisoning	13 (1)
Pulmonary embolism	13 (1)
Bowel obstruction	11 (1)
Post-cardiac arrest	11 (1)
Preterm Labour	11 (1)
Submersion injury	11 (1)
Pelvic fracture	10 (1)
Soft-tissue injury	10 (1)
Other, *n*<10	208 (11.3)
Total	1 839 (100)

Table 2. Indwelling devices and attachments of patients undergoing critical care transfers (*N*=6 847)

Description	*n* (%)
Patient monitoring	2 856 (155)
SpO_2 monitoring	1 356 (74)
Electrocardiography	925 (50)
Capnography	575 (31)
Vascular access	1 031 (56)
Peripheral intravenous line	794 (43)
Central venous line	167 (9)
Arterial line	63 (3)
Other, *n*<10	7 (<1)
Ventilation	539 (29)
Mechanical ventilation (unspecified)	445 (24)
NIPPV	51 (3)
BVM ventilation	23 (1)
BVT ventilation	18 (1)
ECMO	2 (<1)
Indwelling attachments	728 (40)
Urinary catheter	487 (26)
Nasogastric tube	116 (6)
Orogastric tube	29 (2)
IC drain	43 (2)
PEG tube	25 (1)
Other, *n*<10	28 (2)
Medication infusion devices	773 (42)
Syringe driver	299 (16)
Infusion pump	161 (9)
Dial-a-flow	11 (1)
Other, *n*<10	3 (<1)
Supplemental oxygen (not ventilated)	373 (20)
Artificial airways	472 (26)
ET tube	398 (22)
Oropharyngeal airway	31 (2)
Tracheostomy tube	29 (2)
Other, *n*<10	14 (1)
Nebulisers	24 (1)
Incubators	16 (1)
Other, *n*<10	35 (2)
Total	6 847 (100)

NIPPV = non-invasive positive pressure ventilation; BVM = bag-valve mask; BVT = bag-valve tube; ECMO = extracorporeal membrane oxygenation; IC = intercostal; PEG = percutaneous endoscopic gastrostomy; ET = endotracheal.

Table 3. Medications infused or administered during critical care transfer (*N*=2 152)

Medications	*n* (%)
Analgesics	482 (26)
Morphine	407 (22)
Paracetamol	30 (2)
Tramadol	16 (1)
Remifentanil	12 (1)
Other, *n*<10	17 (1)
CNS depressants	588 (32)
Midazolam	291 (16)
Ketamine	157 (9)
Lorazepam	30 (2)
Propofol	30 (2)
Dexmedetomidine	18 (1)
Etomidate	17 (1)
Diazepam	13 (1)
Other, *n*<10	32 (2)
Vasoactives/inotropes	342 (19)
Adrenaline	114 (6)
Dobutamine	96 (5)
Glyceral trinitrate	62 (3)
Isosorbide dinitrate	33 (2)
Dopamine	13 (1)
Phenylephrine	10 (1)
Other, *n*<10	14 (1)
Anti-Coagulants/thrombolytics	142 (8)
Heparin	47 (3)
Tirofiban	33 (2)
Aspirin	2 (1)
Clopidogrel	18 (1)
Tenectaplase	11 (1)
Other, *n*<10	8 (<1)
Electrolytes	57 (3)
Potassium chloride	27 (1)
Sodium bicarbonate	19 (1)
Magnesium sulphate	9 (<1)
Other, *n*<10	2 (<)1
Anti-Emetics	51 (3)
Metoclopramide	34 (2)
Ondansetron	12 (1)
Other, *n* = <10	5 (<1)
Maintenance, fluids and feeding	1 528 (83)
Isotonic crystalloids	1 432 (78)
Dextrose 5%	72 (4)
Other, *n*<10	24 (1)
Neuromuscular blockers	63 (3)
Rocuronium	51 (3)
Suxamethonium	10 (1)
Other, *n*<10	2 (<1)
Anti-arrhythmics	45 (2)
Amiodarone	39 (2)
Other, *n*<10	6 (<1)
Antibiotics	35 (2)
Blood products	15 (1)

(continued)

Table 3. (continued) Medications infused or administered during critical care transfer (*N*=2 152)

Bronchodilators	47 (3)
B2 adrenergic stimulants	27 (1)
Ipratropium bromide	13 (1)
Other, *n*<10	7 (<1)
Furosemide	34 (2)
Proton pump inhibitors	23 (1)
Insulin	22 (1)
Dextrose, other	14 (1)
Other, *n*<10	96 (5)
Total	3 584 (100)

during transport.[24] These findings might have particular relevance to our results given that a large proportion of patients requiring ventilation were given crystalloids or had sedation administered.

Many of the administered medications recorded are currently within the scope of practice of ALS paramedics under continuation of care only, and not initiation of care. Resultantly, ALS providers have limited to no training during undergraduate studies for medications such as remifentanil, propofol, antibiotics and a large variety of others found to have been administered during transportation. The onus of further training falls onto the practitioner, and no standardised training requirements for CCTs are found other than the scope of practice limitations of practitioners.[13] A Delphi study published in 2016 aimed to gain expert consensus on training and scope of practice requirements for CCTs to be undertaken safely in SA.[25] Positive consensus was gained on many of the medications reported in the current study. This once again highlights the unmet need for structured further training for providers undertaking CCT.

Although there is no standardised approach to the level of training required for practitioners undertaking CCTs, consensus exists regarding the need for more advanced training and equipment availability for the critically ill or injured patient.[9,11,12,14,16,26,27] Currently, within SA, there are few limitations relating to who can undertake CCTs, with all ALS paramedics qualifying under current scope of practice.[13] The qualifications of ALS paramedics in SA who may undertake CCTs are varied, consisting of either a 1-year certificate, 2-year diploma or 4-year degree. It is unclear whether approaches and training are standardised or benchmarked between these qualifications, nor are there clear criteria that may guide a service on when to send which provider. Encouragingly, however, a recent study found good overlap between the course content taught across a variety of SA universities offering the degree.[28] Whether this content is aligned to patient need is yet to be determined, but it is unlikely, given that prehospital providers consistently feel underprepared to undertake CCTs.[8,29]

In an answer to this, there is considerable effort by the authors and others to develop evidence-based curricula for CCRS in SA. However, this is happening slowly, and requires significant collaboration, political will and buy-in from services, funders and regulators. In the interim, these gaps may be filled through well-designed and accessible continuous professional development initiatives.

Limitations

The present study has some important limitations. The study followed a retrospective approach, using clinical records that are not designed for research purposes. This has inherent limitations, and as such, diagnoses and clinical data presented herein are based on what transferring providers documented – these results were not verified. Furthermore, a total of 243 patient records were excluded, of which

213 had no age listed, and 30 records had no correlating patient care record attached for verification. Lastly, this study only described patients transported by two dedicated private services. While results are similar to those expected given the SA burden of disease, this limits the external validity of our findings. Future studies should also describe the patient case mix of public service transfers.

Conclusion

This study provides insight into the demographics, most prevalent diagnoses and transfer monitoring needs of paediatric and adult patients being transported in SA by two private CCRS. The results of this study may inform educational interventions for CCT, equipment needed for procurement and scopes of practice of providers undertaking CCTs. Future studies should seek to describe patient demographics in the public sector, rates of adverse events and training curricula to ensure optimal continuation of care during CCT. Furthermore, there is a need for the development of clinical criteria that may guide the dispatch of particular ALS cadres (and CCRS) given patient need and complexity.

Declaration. This study was undertaken in partial fulfilment of MV's degree of MPhil Emergency Medicine.

Acknowledgements. The authors would like to acknowledge Jordan Le Roux for their assistance in data collection.

Author contributions. MV conceptualised the study, collected and analysed data and made critical revisions to the final manuscript. WS conceptualised the study, analysed data and drafted, revised and approved the final manuscript.

Funding. The study was self-funded by MV.

Conflicts of interest. None.

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Accepted 12 June 2023.