A spatiotemporal analysis of emergency medical services use for palliative situations in Cape Town, South Africa

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Background. Approximately 56.8 million people worldwide require palliative care annually, while only 14% receive such care. Within low- to middle-income countries (LMICs), this imbalance is prominent, as these countries contain up to 80% of patients requiring palliative care. To correct this imbalance, palliative care integration with other disciplines has been recommended. One developing area of integration in the South African (SA) LMIC context involves emergency medical services (EMS).
Objectives. To describe the geographical and temporal distribution of the EMS and palliative situation intersection in Cape Town, SA.
Methods. A descriptive, retrospective patient record review was employed at two hospitals in Cape Town. Records of patients who received palliative care at hospitals after EMS transport between 1 January 2020 and 31 December 2020 were included. EMS intersection with palliative situations according to the time of day, working hours, day of the week and month of the year were subjected to χ^2 testing for temporal analysis. Geospatial data were investigated using cluster and proximity analyses.
Results. Overall, 494 instances of EMS palliative situation transport were identified. Most occurred in peri-urban areas (78%, *n*=385), during the daytime (52%, *n*=257), out of office hours (53%, *n*=261) and on weekdays (76%, *n*=375). Statistically significant variation in distribution was found according to time of day ($p<0.001$), with 38% (*n*=188) of cases occurring between 13h00 and 19h00, and month of year ($p<0.001$), with 54% (*n*=267) occurring from June to October. Proximity analysis revealed a mean driving time of 6.69 minutes and distance of 3.65 km to palliative care facilities.
Conclusion. EMS are frequently used for access to palliative care at any time of the day, week or year, particularly in peri-urban areas. EMS may further improve access through integration with palliative care. This efficient use of constrained resources should be pursued in SA, focusing on areas of increased demand.

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Palliative care is an approach that improves the quality of life of patients and their family members experiencing problems associated with life-threatening illness, through the prevention and relief of suffering.[1] Approximately 56.8 million people worldwide require palliative care annually, while only 14% receive such care.[1] Within low- to middle-income countries (LMICs), which have greater disease burdens relative to high-income countries (HICs), this disparity is prominent, as these countries contain up to 80% of the patients requiring palliative care.[1,2] Despite the disproportionate need for palliative care within LMICs, access to such care is limited owing to scarce resources and underdeveloped palliative care services.[1,2] An example of this imbalance between palliative care supply and demand is found in the LMIC context of South Africa (SA). SA suffers a 'quadruple burden of disease' comprising communicable diseases, non-communicable diseases, elevated maternal and paediatric mortality rates and injury.[3] Subsequent life-limiting illnesses have resulted in increased palliative care needs.[4] Mortality data alone indicate that 0.52% (*n*=286 000) of the SA population require palliative care annually.[5] To meet these high demands, the World Health Organization (WHO) has recommended palliative care integration with other healthcare disciplines.[6]

One developing area of palliative care integration involves emergency medical services (EMS).[7,8] It has been demonstrated within HICs that EMS and palliative care integration improves palliative care access, particularly in rural areas.[9,10] While much progress has recently been made in integrating palliative care in SA within various health and allied health sectors, palliative care access challenges remain, and EMS segregation persists.[5,11-13] However, positive conditions for integration are present in the country, as palliative care has been included as an essential service in the National Health Insurance (NHI) Bill.[4] Furthermore, access to palliative care is recognised as a human right in SA.[4]

To benefit from these positive conditions, SA-specific research, *vis à vis* palliative care and EMS, is essential. One area requiring investigation is the spatiotemporal distribution of EMS intersection with palliative situations. Given their limited resources, LMICs require targeted, efficient interventions. Within various areas of SA, identifying locations of high EMS and palliative situation intersection may allow the development of such interventions within the context of local resources. Furthermore, these analyses may identify methods by which EMS can improve palliative care access. The aim of this study, therefore, was to describe the geographic and temporal distribution of EMS and palliative situation intersection in

Cape Town, SA. The term 'palliative situation' refers to any incident involving the care of a patient with palliative needs.

Methods

Design

A descriptive, retrospective patient record review was employed to gather clinical, spatial and temporal data. The clinical data were published previously,[13] and the current study presents the spatiotemporal analysis of the dataset. This report has been compiled according to the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) extension of the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist.[14]

Setting

The Western Cape Province (WC) of SA, in which Cape Town is situated, has a population of ~7.3 million,[15] representing 12% of the SA population.[16] Around 64% of the WC population reside in Cape Town.[15] As in the rest of SA, the WC maintains two healthcare sectors: private and state. State healthcare is supplied by the government to all citizens, while private healthcare is restricted to those with medical insurance or adequate financial means. Currently, only 17% of the SA population (24% in the WC) holds medical insurance.[17] State hospitals are categorised into three levels: district, regional and tertiary.[18] District hospitals are frequently the entry point into the healthcare system, offering 24-hour emergency departments (EDs), and basic outpatient and inpatient care. Patients requiring advanced care are referred to larger regional or tertiary hospitals, which are capable of more complex, specialist interventions. Patient records from two state hospitals within Cape Town, one district and one tertiary, were used in this study. Each of these facilities provides a palliative care service.

In both private and state EMS sectors, out-of-hospital emergency care is provided using a paramedic-led rather than physician-led model.[12] Formal training at a higher education (HE) institute is required to register as an EMS provider; however, this requirement was only introduced recently, and many providers with vocational training remain registered and practising.[19] HE courses range from 1 (assistant) to 4 years (practitioner) in duration.

Sample and sampling

Patient records of those who arrived at the two hospitals between 1 January 2020 and 31 December 2020 using EMS transport leading to palliative care provision were included. Patients who received palliative care at the hospitals were, therefore, equated with having palliative needs at the time of EMS interaction. Thus for the purposes of this study, palliative care needs were viewed broadly, and included any situation for which palliative care was deemed necessary by the hospital palliative care providers: emergencies, non-emergencies, end-of-life care, pre-existing or newly identified palliative care situations. Illegible patient records, duplicates and those missing data relating to the mode of hospital conveyance were excluded.

Variables were extracted from a combination of hospital palliative service, ED and EMS records, which were all included within individual patient files. District hospital patient files were available on a digital database, to which CG was given access. Tertiary hospital patient files were physically stored in the facility; however, the ED and palliative service maintained digital databases. BS and KC were given access to both physical and digital records at the tertiary facility, and linked patients across the platforms with a heuristic inclusive of unique hospital numbers, folder numbers, patient names and birth dates.

Data were collected from November 2022 to February 2023. To ensure accuracy and minimise inconsistencies, the recommendations of Gilbert *et al*.[20] were followed: data collectors were trained beforehand in the study aims and data extraction tool. Carefully defined protocols and inclusion and exclusion criteria were developed and applied to all patient records. Analysed variables were precisely defined. A standardised extraction tool was used to uniformly handle missing, conflicting or unclear data. Throughout data collection, frequent meetings were held to ensure consistency in approach. LG, WS and CG monitored data-extracting performance. CG re-extracted data from a random sample (10%) of tertiary hospital patient care records, blinded to the extracted data of BS and KC. An inter-rater reliability of 1.0, calculated using Cohen's kappa (κ), was achieved. The data extraction tool was piloted by CG and BS prior to the study.

Missing data techniques were not employed. Data were recorded and cleaned using Excel (Microsoft, USA).

Data analysis

An *a priori* data extraction tool, based on previous international studies,[9,21] was used to extract the following spatiotemporal variables: area, time of day, working hours, day of week, month of year.

Area referred to the location where EMS were called to a patient. This was divided into urban and peri-urban based on socioeconomic status, economic activity, infrastructure and geography. For the purposes of this study, urban refers to cities and towns with extensive infrastructure, and large-scale economic activities including trade, finance and commerce.[22] Peri-urban refers to adjacent areas that mark the interface between urban and rural environments, though, given the unique layout of the City of Cape Town, some areas with peri-urban characteristics may appear interspersed among various urban areas.[22,23] Despite their urban locales, peri-urban areas are characterised by poor infrastructure, decreased socioeconomic status relative to urban areas, and mixed urban and rural economic activity, including small-scale agriculture and industry.[22,23] Day time was defined as 06h00 to 18h00. Office hours were defined as 08h00 to 17h00. Weekday was defined as Monday - Friday.

Summary descriptive statistics were used to describe frequencies, proportions, distances and times. X^2 goodness of fit testing, assuming equal distributions, was used to analyse the temporal data: distribution of EMS calls to palliative situations by time of day, day of week and month of year. $P<0.05$ was set for statistical significance. Data were analysed using IBM SPSS Statistics for Windows version 29.0 (IBM Corp., USA).

Geospatial data were analysed with the Esri World Geocoder from ArcGIS (Esri, USA). Data were geocoded and aggregated at suburb level to preserve patient confidentiality. To correct for potential biases in data distribution due to the varying sizes of Cape Town suburbs, a cluster analysis was performed to identify areas of statistically significant higher or lower incidence.

Proximity analysis was performed to identify projected driving times and distances from cases of EMS and palliative situation intersection to the closest palliative care-capable facility. The facilities included for proximity analysis were WC Department of Health clinics within the City of Cape Town, and hospitals that offer palliative services. The clinics offer generalist palliative care services, and may refer patients to hospitals for specialist palliative care where necessary. ArcGIS proximity analysis uses typical traffic trends determined by averaging historic driving speeds in 5-minute intervals over the period of 1 week for each road.

Ethical approval

Ethical approval, including a waiver of informed consent, was granted by the University of Cape Town Faculty of Health Sciences Human Research Ethics Committee (ref. no. 589/2021). Institutional approvals were granted from each hospital.

Results

From 1 January 2020 to 31 December 2020, a combined 1 207 patients received palliative care from the two hospitals. Of these, 395 (33%) used EMS for hospital conveyance on 494 occasions. This resulted in an average of 41 EMS transports of patients with palliative needs per month. The majority (78%, *n*=385) of transports occurred from peri-urban areas. Most occurred during the daytime (52%, *n*=257), out of office hours (53%, *n*=261) and on weekdays (76%, *n*=375). Table 1 provides a summary of the spatiotemporal characteristics.

Figs 1 - 3 demonstrate the distribution of EMS palliative situations according to time of day (Fig. 1), day of week (Fig. 2) and month of year (Fig. 3). Statistically significant variation in distribution was found according to time of day (χ^2=105.792; df=23; p<0.001), with 38% (*n*=188) of cases occurring between 13h00 and 19h00, and month of year (χ^2=44.251; df=11; p<0.001), with 54% (*n*=267) of cases occurring from June to October 2020. No significant variation was found according to day of week (χ^2=7.393; df=6; p=0.286).

Fig. 4 demonstrates the geospatial distribution of EMS palliative situation intersection and available palliative care facilities. No statistically significant variations in distribution were found after cluster analysis. Distribution was explained by suburb size, with larger suburbs containing greater case numbers. Proximity analysis revealed a mean (range, standard deviation) driving time of 6.69 (1.12 - 29.75, 4.69) minutes, and distance of 3.65 (0.23 - 26.45, 4.47) km from cases of EMS and palliative situation intersection to palliative care-capable facilities.

Discussion

The aim of this study was to describe the geographical and temporal distributions of EMS and palliative situation intersection in Cape Town, SA for the purposes of developing targeted, efficient interventions within the context of locally available resources, and to identify areas in which EMS may contribute to palliative care access. To our knowledge, this is the first spatiotemporal analysis globally concerning EMS and palliative care.

The majority (78%, *n*=385) of EMS intersections with palliative situations occurred in peri-urban areas. Despite its location in an urban environment, most (63%, *n*=184) EMS transports to the tertiary hospital were likewise from peri-urban areas. As explained above, these areas are adjacent to urban centres but maintain rural characteristics such as poor infrastructure and decreased socioeconomic status.[22-24] As a result, they frequently suffer from difficulties accessing even basic healthcare.[24] Within SA, it has been noted that many such areas developed not as a consequence of urban sprawl, as documented elsewhere in the world,[25] but of historical discrimination.[26,27] After the abolition of apartheid, urban economic centres, previously reserved for 'whites', were opened to all South Africans, resulting in a massive influx of the population from outlying rural areas to these urban centres in search of better opportunities.[26,27] The peri-urban areas surrounding these centres sustained the primary impact of this rapid population increase, resulting in uncontrolled growth and service delivery challenges.[26] Despite these negative historical consequences and ongoing challenges, peri-urban areas contain tremendous potential for development. Discussing the historical context of this rural-urban integration in SA, Sadiki and Ramutsind[27] state that 'the acknowledgement of the rural-urban divide should be the first step towards meaningful peri-urban transformation.' We suggest that EMS and palliative care integration would form a valuable part of this transformation.

Our findings indicate a heightened reliance on EMS in peri-urban environments for patients with palliative needs, despite the close proximity of palliative care-capable facilities in most cases (mean distance 3.65 km). This may be due to the frequently high burdens of illness in such areas, and lack of alternative transport options. However, regardless of alternative transport availability, patients with palliative needs may remain reliant upon EMS because their conditions frequently render them immobile, precluding typical vehicular transport. Furthermore, these findings may indicate a lack of access to palliative home-care services, which would prevent the need for medical facility transport. Findings from the clinical data support this, as home palliative services were the primary source of care in only 1% (*n*=4) of cases in this study.[13]

Within HICs, EMS have been successfully deployed not only to meet palliative care transport needs, but also home-care needs, through community paramedic models in which dedicated EMS providers function as part of a broader palliative care team.[28,29] One

Table 1. Spatiotemporal characteristics (*N*=494)

Characteristic	District, *n*=201, *n* (%)	Tertiary, *n*=293, *n* (%)	Total, *N*=494, *n* (%)
Area			
Peri-urban	201 (100)	184 (63)	385 (78)
Urban	0 (0)	85 (29)	85 (17)
Missing data	0 (0)	24 (8)	24 (5)
Time of day			
Day	112 (56)	145 (49)	257 (52)
Night	89 (44)	131 (45)	220 (45)
Missing data	0 (0)	17 (6)	17 (3)
Working hours			
Office hours	99 (49)	117 (40)	216 (44)
Out of office hours	102 (51)	159 (54)	261 (53)
Missing data	0 (0)	17 (6)	17 (3)
Time of week			
Weekday	152 (76)	223 (76)	375 (76)
Weekend	49 (24)	70 (24)	119 (24)

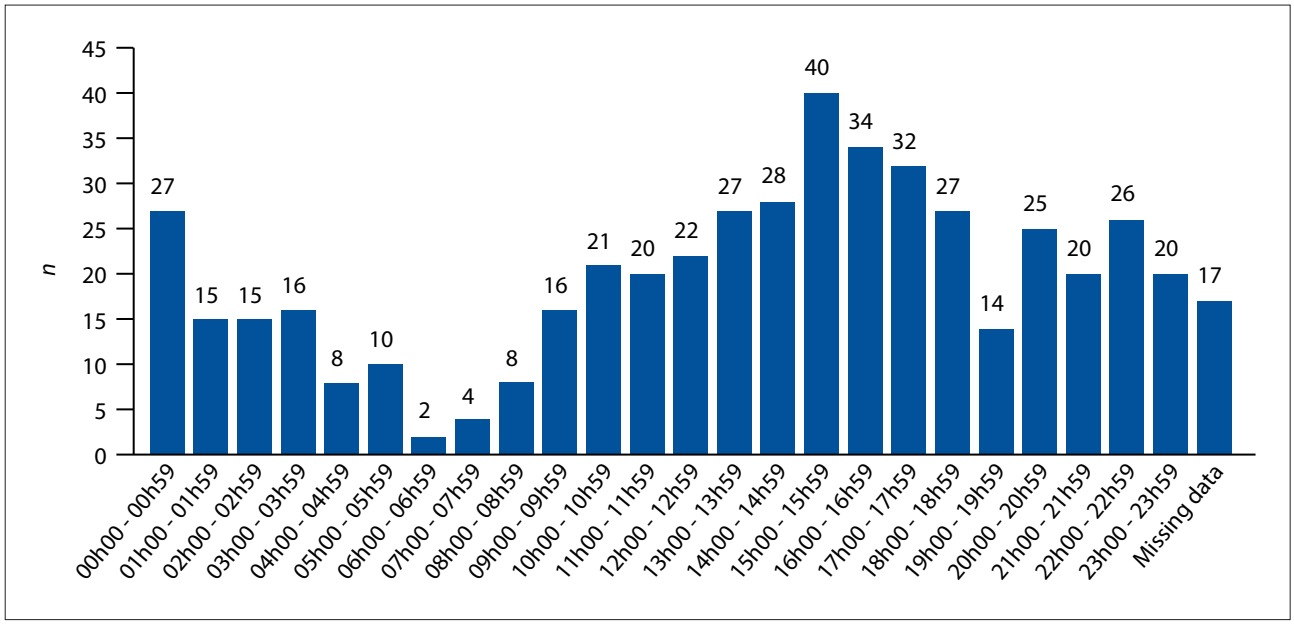

Fig. 1. Distribution of emergency medical services palliative situations by time of day.

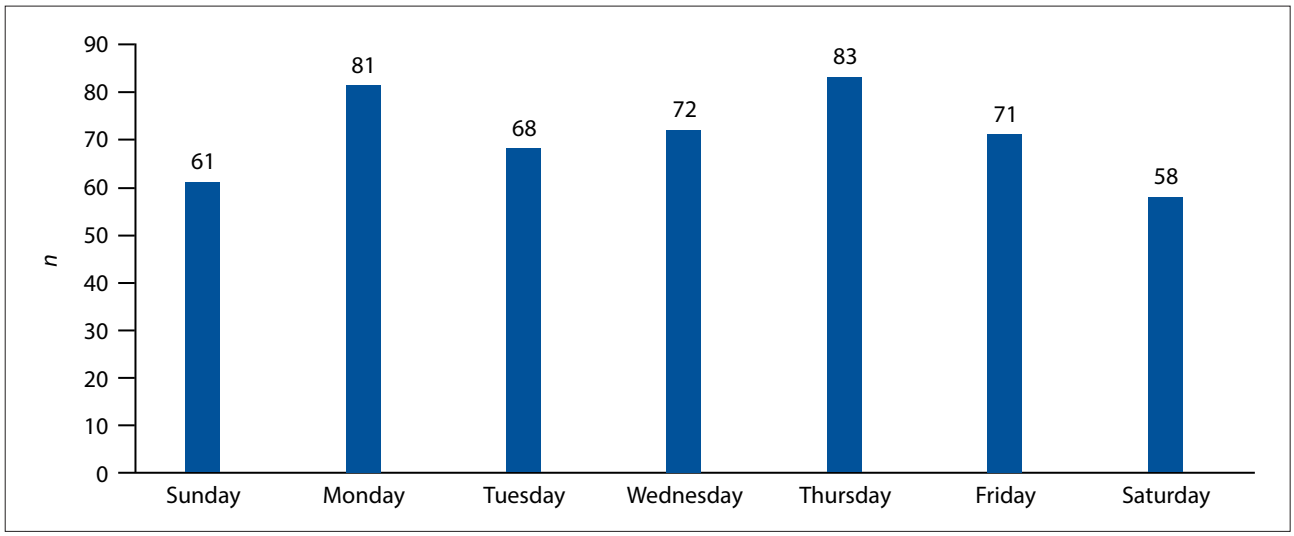

Fig. 2. Distribution of emergency medical services palliative situations by time of week.

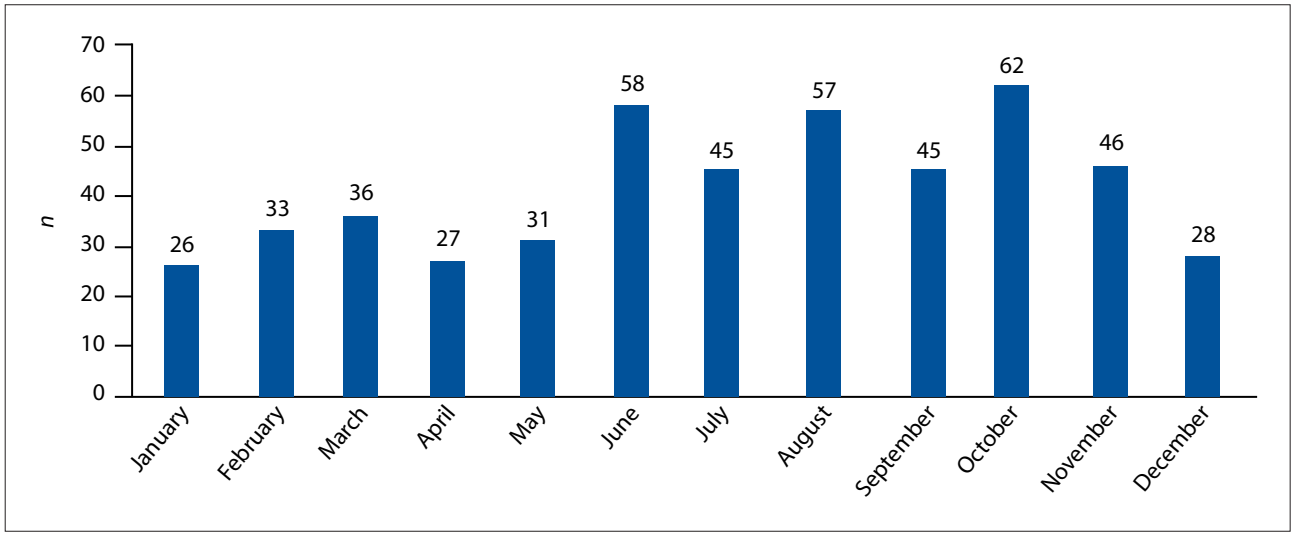

Fig. 3. Distribution of emergency medical services palliative situations by time of year.

potential benefit of palliative home care is decreased healthcare system costs through avoidance of unnecessary hospital admissions.[30,31] As previously reported in the clinical dataset, most hospital transports in the current study ultimately resulted in discharge home (60%, *n*=295), many after only a brief 0 - 3-day hospital stay (27%, *n*=129), potentially indicating unnecessary hospital transports.[13] While the cost-effectiveness of EMS use for this purpose remains an area for investigation, particularly in SA, several studies have postulated this benefit.[9,32-34] Given the resource limitations of SA and other LMICs, novel system development, such as specialist out-of-hospital palliative care teams, may be costly, and the integration of two existing systems (EMS and palliative) may represent more judicious use of constrained resources.[13] Community paramedic models, in particular, may be of substantial cost benefit,[32] and should be explored in SA.

While EMS use for palliative situations may prove cost-effective, their safety in some peri-urban areas represents a challenge. High crime rates are strongly associated with areas of increased socioeconomic inequality,[35-37] which, in turn, may negatively impact EMS ability to perform their various functions. Within Cape Town itself, attacks on EMS have been frequently reported, resulting in certain areas requiring an escort by the SA Police Services before entering these areas.[38] In addition to negatively affecting EMS care provision, this may likewise contribute to a lack of palliative home-care services, as nurses, who frequently travel alone, are not permitted to travel in these areas owing to safety concerns. Should EMS be integrated with palliative care in SA for its provision in patient homes, mechanisms for safety will be required.

Some studies have noted that, due to their 24/7 availability, EMS are frequently called to patients with palliative needs out of office hours, during the night or at other times when palliative services are unavailable.[9,39] We found that while most (53%, *n*=261) cases of EMS intersection with palliative situations did occur out of office hours, these occurrences were more evenly distributed across office and out-of-office hours when compared with international literature, and variance was not explained by day of week. While cases during the night were frequent, daytime hours were slightly more common (52%, *n*=257). The more even distribution of our findings across office and out-of-office hours, day and night, when compared with the literature, may be explained by a relative lack of home-care services in SA, including during office hours.

Statistically significant variance was found regarding hour of the day, with 38% (*n*=188) of cases occurring between 13h00 and 19h00. Case numbers appeared to rise throughout the morning and into the afternoon, which may be explained by worsening patient symptoms or caregiver distress as a day progressed. Peak case numbers occurred between 15h00 and 18h00. As the majority of primary caregivers in this study were family members,[13] this may also be explained by caregivers returning home from work and finding their loved ones in distress. Furthermore, statistically significant variance was noted according to month of the year, with 54% (*n*=267) of cases occurring from June to October. These represent cooler winter and spring months, which, in addition to seasonal viral infections, may exacerbate the conditions of those with palliative needs, many of whom are immunocompromised.

Although numerous facilities offering palliative care services exist within Cape Town, it appears that access to these facilities requires assistance. EMS were frequently used for this purpose, particularly in areas of decreased socioeconomic status and during any time of the day, week or year. Penchansky and Thomas[40] describe five dimensions of access to healthcare: (*i*) availability: the supply of services in relation to demand; (*ii*) accessibility: the location of services in relation to clients, accounting for transportation resources; (*iii*) accommodation: the manner in which available services facilitate clients; (*iv*) affordability: the cost of services in relation to clients' purchasing power; and (*v*) acceptability: clients' attitudes concerning available services and healthcare workers, and healthcare worker attitudes towards clients.[40] Currently, in palliative situations, patients and their caregivers make use of EMS for improved accessibility, provided by EMS conveyance, and accommodation, as EMS are available 24/7.

Through integration with palliative care, EMS may improve access in all dimensions. Equipping EMS to recognise palliative care needs and provide this care in patient homes would improve both the availability and acceptability of palliative care. This has been demonstrated in Canada, where palliative home care provided by EMS improved patient and family satisfaction.[21] While the limited existing evidence suggests that EMS and palliative care integration may be cost-effective from a healthcare system perspective, improvements in affordability from a patient standpoint may also result. EMS use for palliative home care without conveyance may avoid unnecessary personal transport and other costs associated with hospital admissions. This would not only improve the affordability of immediate care needs, but also increase patient purchasing power for future needs through relief of high opportunity costs associated with hospital admission. Affordability improvements would mostly benefit those within areas of decreased socioeconomic status (i.e. peri-urban areas) who lack resources and concomitantly suffer the greatest disease burdens.[41] In this manner, EMS and palliative care integration may play a role in decreasing healthcare access inequalities, which is the overarching goal of the NHI in SA. Therefore, EMS and palliative care integration should be considered within the NHI framework.

Limitations

This study is limited by its retrospective design. Due to the keeping of physical records at the tertiary facility, some data were missing (<5%). However, this small proportion is unlikely to significantly affect the results. The true intersection between EMS and palliative situations is likely under-reported in this study, as only two state hospitals, involving primarily state EMS, were used for sampling. The private sector, patients not transported by EMS and patients with unmet palliative needs were not observed. In addition, as this study was performed at only two state hospitals within Cape Town, the geographical findings are restricted primarily to the drainage areas of these hospitals. Nevertheless, the reliance of patients upon EMS for access to palliative care in these areas is worthy of attention. This study reveals the need for larger scale spatial analyses within SA to compare more diverse areas.

As areas were aggregated at suburb level rather than specific addresses, some accuracy in proximity analysis may have been lost; however, this effect is likely minimal. Due to the COVID-19 pandemic, data collected in the year 2020 may be atypical. The pandemic may have increased the frequency of EMS and palliative situation intersection owing to greater patient numbers and preferential use of EMS over public transport. However, it is more likely that the enforced national lockdowns resulted in decreased frequency of use, as many patients avoided medical facilities and were encouraged to remain home. Furthermore, only 10% of cases in this study involved a COVID-19 diagnosis.[13] Concerning the temporal data, hospital arrival times were used in lieu of EMS call times, as these were largely missing from patient hospital files. As large discrepancies may exist between these times, findings of this

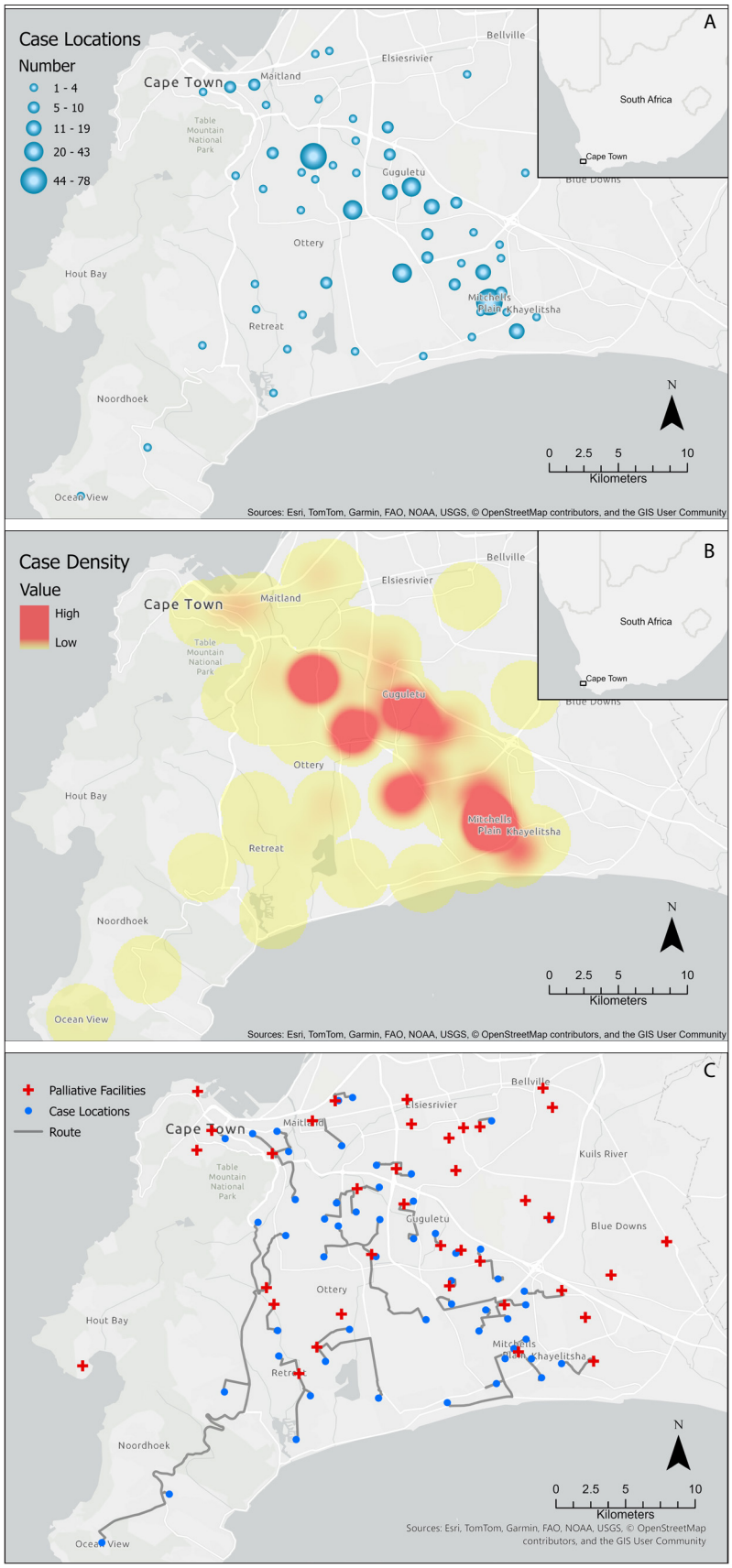

Fig. 4A - C. Geospatial distribution of emergency medical services (EMS) and palliative situation cases. A: A graduated symbol map indicating locations of EMS intersection with palliative situations. B: A heat map indicating EMS and palliative situation case density. C: Visualisation of proximity analysis. Palliative facilities refer to Western Cape government clinics and hospitals with palliative care capabilities. The path to the nearest palliative care facility is indicated by the route.

study may be more reflective of EMS interaction with palliative situations than patient need in some cases. However, these findings remain important and likely do not affect the relatively even distribution of times across office and out-of-office hours, day and night, nor the 24/7 use of EMS in palliative situations.

Conclusion

While numerous facilities within Cape Town, SA, offer palliative care services, it appears that assistance in accessing these facilities is required. From our findings, EMS are frequently used for this purpose at any time of the day, week or year, particularly in areas of decreased socioeconomic status and during the colder winter months, despite the close proximity of patients to palliative care facilities. EMS currently provide access to palliative care through their 24/7 availability and patient conveyance. Should EMS and palliative care integration occur, EMS may further improve access through the provision of home care, thereby enhancing availability, acceptability and affordability of care. Moreover, this integration would represent an efficient intervention because it would synergise existing EMS and palliative care resources. As an efficient use of constrained resources, with the potential to greatly improve palliative care access among those most in need, EMS and palliative care integration should be pursued, particularly in areas of increased demand, such as peri-urban environments, and during times of greater need.

Data availability. The data used in this study are available from the corresponding author on reasonable request.

Declaration. This study was performed as part of CG's PhD in Emergency Medicine at the University of Cape Town.

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Author contributions. CG conceptualised the study, collected and analysed data and drafted the manuscript. BS and KC collected data and contributed to data interpretation. TS contributed to data analysis and interpretation and provided geospatial analysis expertise. LG contributed to study design and data interpretation and acted as a co-supervisor for the project. WS conceptualised the study, contributed to data analysis and interpretation and acted as primary supervisor for the study. All authors critically reviewed the study and approved the final published version.

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Conflicts of interest. None.

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