Introduction

Kootenay Emergency Response Physicians Association (KERPA) is a registered Canadian Charity that operates in the Kootenay Region of British Columbia (BC), Canada. KERPA equips and supports a volunteer Emergency Response Physician (ERP) to respond directly to the scene of critically ill and injured patients in the community, with the goal of saving lives and supporting the Emergency Services. KERPA began in 2014 as a pilot project that was initially self-funded and operated out of the ERP's personal vehicle. In 2016, KERPA was officially created as a non-profit organization. By 2018, KERPA acquired charity designation and began carrying additional trauma equipment, medications, and roadside ultrasound. With further budget increases throughout 2019, KERPA purchased a dedicated rapid response vehicle (RRV) enabling lights-and-sirens response to 9-1-1 emergencies. While KERPA's volunteer physician-staffed emergency medical services (p-EMS) is a unique model in BC and Canada, similar charity based services in the United Kingdom have been operational since the 1960's. [1]

In January 2020, KERPA's Quality Management Committee decided to undertake a quality improvement project with the overall aim of improving the care provided by KERPA. This paper details the steps taken to analyze the service utilization, key performance metrics and patient care since the p-EMS began as a small pilot project back in 2014. Over the scope of this study (six years) the p-EMS has been dispatched to 451 immediate threat to life 9-1-1 emergency calls. Of these calls, 398 calls (88%) the physician attended the scene and assisted the patient, and 53 calls (12% or 1 in 8) the ERP was cancelled en route.

In an effort to improve KERPA's quality of care and to add to the limited base of literature on p-EMS systems in rural settings, this paper on our quality improvement (QI) project presents data on a rural, p-EMS that operates in the Kootenay region of BC, Canada.

The EMS system in the Kootenay region of BC consists primarily of First Responder Firefighters and British Columbia Ambulance Services (BCAS) Basic Life Support (BLS) paramedics. By understanding how the KERPA p-EMS supports these existing Emergency Services, this QI paper will help inform the future role that p-EMS systems can play in rural settings in BC, Canada, and elsewhere.

Recent research has suggested that p-EMS systems can improve patient outcomes. [2,3] For instance, a recent overview of 10 review studies published in 2019 found that physicians are particularly beneficial for out-of-hospital cardiac arrests (OHCA), critically ill or injured patients requiring intubation, and trauma patients. [4] While the benefit of p-EMS systems is generally supported in urban settings, much less is known about their efficacy in a rural environment. A scoping review of the literature on the efficacy of rural p-EMS systems revealed very limited results.

The purpose of our study is not to determine how the KERPA p-EMS directly affects patient outcomes, instead we hope to characterize the ways in which the KERPA p-EMS is utilized by the regional Emergency Services. As such, the objective of this paper is to report high-quality data on the KERPA p-EMS, in accordance with consensus templates in order to ensure KERPA maintains a high quality of data tracking and patient care. [5]

Methods

We describe the system, operations, and utilization of the KERPA p-EMS through variables that are consistent with the Tønsager et al. template for documenting and reporting data in physician-staffed pre-hospital services. [5] This quality assurance project was approved by the KERPA Board of Directors and did not require ethical review because, as stated under Article 2.5 of the Tri Council Policy Statement, Quality Assurance/Quality Improvement activities are not subject to institutional ethical review. [6]

Variables of Analysis

Of the categories of data reporting outlined by Tønsager et al., we focus on fixed system variables, event operational descriptors, and process mapping variables. Fixed system variables refer to variables describing how a p-EMS is organized, competence in a p-EMS team, and its operational capacities. Since these variables are relatively constant throughout time, they are considered fixed. Event operational descriptors refers to variables characterizing service missions, such as dispatch codes and mission types. Lastly, process mapping variables are variables documenting diagnostic and therapeutic procedures performed during the period of p-EMS care. [5]

These categories were the focus of our paper for two primary reasons. Firstly, these three categories encompassed all the data that the KERPA p-EMS collected during the study period. Secondly, by focusing on the p-EMS's system variables, operational descriptors, and processes, we were able to best meet our objective of describing the utilization of KERPA's p-EMS within its operational context.

Data Tracking

To track the variables under investigation, we first analyzed all call data that were inputted into KERPA's database by the ERP within the time period between May 1, 2014 to April 30, 2020. Two investigators cross-checked the collected data on the variables under investigation with the original call data for accuracy and completeness. Identifying information, including patient name, age, and address were removed from all calls by the ERP prior to the analysis to protect patient confidentiality. Using the main database as a reference, we created quarterly, yearly, and total variable tracking files.

Data Presentation

We presented our fixed systems variables, event operational descriptors, and process mapping variables in tables. To best align our data reporting with the Tønsager et al. template for documenting and reporting data in physician-staffed pre-hospital service, we coded all applicable variables with their respective data variable number used in the data-reporting template[5]. We defined 'primary mission' as any mission where the p-EMS is activated and arrives on scene. We then calculated percentages and frequency of variables based on the number of primary missions per calendar year and in total across all calendar years. Percentages and frequencies were rounded to the nearest whole number.

Results

Fixed Systems Variables

In Table 1 we report our fixed systems variables, their corresponding data-template number, and their definitions.

Event Operational Descriptors

In Table 2 we report our event operational descriptors, their corresponding data-template number, and their definitions and/or descriptions.

Process Mapping Variables

In Table 3 we report the KERPA p-EMS process mapping variables. The purpose of the composite metrics for KERPA p-EMS utilization was to track and present how frequently the KERPA p-EMS was utilized by the EMS System. As such, the utilization of medical expertise and/or equipment variable demonstrates the frequency at which the KERPA p-EMS provided any type of expertise and/or equipment, regardless of whether the expertise and/or equipment provided was above or below what the existing EMS system was capable of. Conversely, the advanced procedures and/or equipment variable demonstrates the frequency at which the KERPA p-EMS provided services and/or equipment that were beyond the scope of the EMS System and thus would not have otherwise been available to patients.

The variables under diagnosis and monitoring procedures also require further explanation. Since the program's beginning in 2014, the KERPA p-EMS has used a LifePack 12 (LP12) as its primary automated external defibrillator and cardiac monitor. The LP12 was used

at a total of 144 (36%, 1 in 3) primary missions. However, as the KERPA p-EMS transitioned from a self-funded pilot program to a charity funded model, the equipment capabilities of the program rapidly increased. For instance, pre-hospital ultrasound capabilities became available in January 2018. Due to the fact that the KERPA p-EMS began using ultrasound equipment in 2018, the number of primary missions in which this equipment could have been utilized is all primary missions between January 1, 2018 and April 30, 2020 (n=166). As such, since 2018, the focused assessment with sonography in trauma (FAST) scan was used at 15 (9%, 1 in 11) primary missions, and specific cardiac ultrasound was used at 8 (5%,1 in 21) primary missions.

Discussion

Our data demonstrate the extensive utilization of the KERPA p-EMS to support Emergency Services in the Kootenay region of BC. In this section we highlight a number of data points that warrant further discussion.

Scene Response

The KERPA p-EMS is only dispatched to or requested at immediate life-threatening or time-critical 9-1-1 calls, as determined by the BCEHS medical priority dispatch system. [7] The KERPA p-EMS is automatically paged via text message at the time of the 911 calls. If the physician is available and not on service at the hospital, they will contact ambulance dispatch, confirm the call details, and respond from their location.

Our results indicate that, on average, the KERPA p-EMS arrived on scene before the ambulance service at roughly 1 in 5 of all primary missions (17%). By arriving safely and quickly to the scene, the KERPA p-EMS was able begin treatment earlier and reduce overall pre-hospital rescue times, which has been demonstrated in other jurisdictions to improve patient outcomes. [8-11] As such, our data suggests that the KERPA p-EMS was able to provide medical care before it would otherwise have been available and reduce rescue times for 1 in 5 serious or critically ill or injured patients in the Kootenay region.

Further, it is of note that the frequency at which the KERPA p-EMS arrived on scene before the ambulance service increased since the p-EMS has begun responding in a RRV. For instance, between the calendar years of 2015 to 2018, the p-EMS arrived on scene prior to the ambulance service at, on average, 14% (1 in 7) of primary missions. In January of 2019, the p-EMS began responding with its dedicated RRV. Between January 1, 2019 and April 30th 2020, the percentage of primary missions in which the p-EMS arrived on scene prior to ambulance service increased to 27% (1 in 4) of primary missions. This data highlights the potential impact the RRV had on response times. While our study design does not allow for causal inferences, the usage of a RRV could have greatly increased the p-EMS's capacity to arrive on scene in a more timely manner.

The Severity of Primary Missions

In addition to serving as an extra response unit that can arrive on scene and provide patient care potentially prior to other Emergency Services, the KERPA p-EMS is also utilized by the EMS system at the most critical calls in the Kootenay region. Our data shows that the five most common primary missions to which the p-EMS responded included unconscious/fainting

(20%), high-mechanism traffic incidents (16%), seizure (10%), cardiac arrest (10%), and overdose (8%). Taken together, these primary missions account for almost three out of four of the total number of primary missions (72%). For comparison, in Germany, EMS physicians responded to approximately 44% of all EMS calls, but responded to a high percentage in rural areas.[12] In addition, approximately 95% of severely injured trauma patients in Germany were cared for by EMS physicians.[13] While our study does not allow for direct comparison with these statistics due to lack of data on the total number of EMS calls in the Kootenay region, it seems reasonable to conclude that that the p-EMS is being utilized at a high percentage of critical calls.

In addition, the types of primary missions to which the KERPA p-EMS frequently responds, such as cardiac arrest and trauma from high-mechanism traffic incidents, correspond to the types of patients for which prehospital physician treatment has resulted in improved outcomes. [2,3,4] As such, the p-EMS serves the Emergency Services as an extra pair of hands at the critical calls where they are most effective and those that often require additional resources.

Patient Care

In order to understand how the p-EMS was utilized while delivering patient care, we tracked 33 process mapping variables. We created two specific composite variables in an effort to capture the frequency at which the p-EMS was used by the EMS system at primary missions. We found that p-EMS expertise and/or equipment was utilized at 76% of all primary missions. In addition, we also tracked the frequency at which the p-EMS performed procedures and/or provided equipment that was beyond the scope of the EMS system. We found that the p-EMS provided advanced procedures and/or used advanced equipment at 93 (23%, 1 in 4) primary missions.

These composite measures suggest that the p-EMS is of use to the Emergency Services at the vast majority (3 in 4) of primary missions to which they respond. In addition, the p-EMS is further utilized by the Emergency Services at more serious calls, at a frequency of roughly 1 in 4 primary missions, to perform advanced procedures and/or use advanced equipment that is beyond the scope of practice of the EMS system. While comparative literature does exist with which to contextualize these statistics, we speculate that providing assistance through either medical expertise or equipment at three in four primary missions is a relatively high frequency, and constitutes frequent use by the Emergency Services.

Our data also highlights several of the p-EMS's advanced procedures and equipment that were required to treat critically ill and injured patients. For instance, The p-EMS secured a definitive airway via endotracheal intubation at five (1 in 80) primary missions. Though not without its risks, endotracheal intubation can significantly improve outcomes for certain groups of patients, including severely injured trauma patients, non-traumatic cardiac arrests, and critically ill patients. [14] At these primary missions, the KERPA p-EMS was clearly an asset to the Emergency Services team in helping to secure the airway of critically ill patients.

The KERPA p-EMS was also utilized to help manage breathing-related emergencies with various advanced procedures. For instance, the KERPA p-EMS performed two needle chest decompressions and six finger thoracostomies, at a frequency of 1 in 200 and 1 in 66 primary missions respectively. Both of these procedures are potentially life-saving, [15,16] and demonstrate the use of the KERPA p-EMS to support the EMS system.

Furthermore, an integral part of the management of patients with circulation compromise is rapidly acquiring intravenous (IV) or intraosseous (IO) access in order to effectively administer medications and fluids.[17,18] The p-EMS secured IV and IO access at 6% and 10% of primary missions, respectively. The high frequency of IO insertion is related to the severity of patients

attended, such as cardiac arrests or significant multi-traumas[19]. Although IV line insertion is within the scope of practice of the EMS system, these statistics demonstrate instances where the p-EMS inserted an IV line prior to EMS arrival, or assisted inserting an IV line. This data highlights another instance where the p-EMS was able to support the Emergency Services to provide patient care.

Lasty, the p-EMS administered a number of different advanced medications to patients at primary missions. For instance, analgesia medications, including fentanyl and ketamine, were administered at 6% of primary missions. Our data can be compared to rates of analgesia administration by other p-EMS systems. For instance, in a retrospective study conducted in Denmark, the EMS system, which includes pre-hospital physicians, administered intravenous fentanyl to 7.9% of pre-hospital patients over a 1.5 year period. [20] According to another study from a rural EMS system in Germany, opioid analgesics were administered to 1.8% of patients over a 1.5 year period. [21] Although these comparisons are limited by their heterogeneity in patient population, emergency service structure, and geographic setting, they suggest that a proportion of patients receive analgesia in the pre-hospital setting, and that this fraction is fairly similar to that of our p-EMS. Furthermore, the need for pain control in the pre-hospital setting has been well studied and widely accepted[22]. In that sense, delivering analgesia to 24 of 398 primary missions for acute pain is an important utilization of the p-EMS in the Kootenay region of BC.

In addition to analgesia, seizure medications such as midazolam and diazepam, helped manage 14 (4% or 1 in 28) patients who were critically ill and actively seizing. The p-EMS also assisted the Emergency Services with managing combative patients by providing sedation (using midazolam or ketamine) at 10 (3% or 1 in 40) of primary missions. Lastly, medications to facilitate endotracheal intubation were administered at 5 primary missions (1% or 1 in 80) .

Initially the pilot project did not provide rapid sequence induction with paralytics, but as the programs progressed this was offered in the later years.

Due to the importance of correctly managing generalized status epilepticus, [23] combative patients, [24,25] and those requiring intubation in the pre-hospital setting, [26] these medications provided by the p-EMS likely significantly helped the Emergency Services care for this small category of critical ill or injured patients.

Patient Transport

The final aspect of the KERPA p-EMS utilization is with respect to patient transport. The KERPA p-EMS aided the EMS system in assisting with transport at 171 (43%) of all primary missions. At 101 (25%, 1 in 4) of primary missions, the KERPA p-EMS transported the patient in the ambulance with the paramedics. This enabled the KERPA p-EMS to monitor the patient and provide care while enroute to definitive care. Additionally, the KERPA p-EMS supported the EMS system by following behind the ambulance in a RRV vehicle to the hospital at 70 primary missions (18%, 1 in 5) for patients who were in a stable condition. In the remaining cases the KERPA p-EMS was not required to assist in the treatment, or transport of the patient.

It is difficult to determine the significance of this data with regards to the overall utilization of the KERPA p-EMS. In comparison to published data on patient transport by other p-EMS systems, physician-staffed EMS services in Norway over a 6 week period transported 81% of patients with a physician attending in ground ambulance and 2% in helicopter ambulance. As such, the p-EMS were involved in transport at 83% of their primary missions. In the same study, however, p-EMS in Finland only transported 27% of patients with a physician attending in ground ambulance and 63% in helicopter ambulance, supporting patient transport at 90% of

primary mission[27]. Neither p-EMS system recorded patient transport in ground ambulance with a physician following in a RRV.

These two p-EMS systems highlight the significant variability in frequency of different modes of patient transportation. They also demonstrate the high frequency in which their respective p-EMS systems were involved in patient transport. In comparison, the KERPA p-EMS was involved in patient transport at only 44% of primary missions. While it is difficult to make meaningful comparisons between these unique p-EMS systems, a number of explanations could account for this significant discrepancy. For instance, the p-EMS in Norway and Finland could be responding to a higher proportion of critical patients that require transportation. Conversely, Norway and Finland p-EMS systems may simply support the transport of more stable patients, whereas the KERPA p-EMS only transports the most critically ill and/or injured patients. While it is difficult to draw any confident conclusions, it is nevertheless reasonable to suggest that by supporting the Emergency Services at nearly half of all primary missions, patient transport represents another aspect of care in which the KERPA p-EMS is widely used.

Conclusion

In this paper we describe the utilization of a unique volunteer p-EMS system that operates in the rural Kootenay region of BC, Canada. Over a six year period (between 2014 and 2020) KERPA p-EMS was dispatched 451 times and attended the scene of 398 emergency calls (88%). KERPA p-EMS responded to the most critical emergency calls in the region and used expertise and/or equipment at 304 (76%) of all primary missions. This suggests that the p-EMS is of use to the Emergency Services at the vast majority (3 in 4) of primary missions to which they respond. In addition, the p-EMS is further utilized by the Emergency Services at

more serious calls, at a frequency of roughly 1 in 4 primary missions, to perform advanced procedures and/or use advanced equipment that is beyond the scope of practice of the EMS system. As such, critically ill or injured patients in the Kootenay region had access to physician care and advanced procedures that would otherwise not have been available. KERPA p-EMS was able to support the Emergency Services by providing an additional set of hands at difficult calls, supporting patient care and patient transport, and serving as an additional response unit. Although p-EMS systems are not widely operational across Canada, we have shown that a p-EMS can be effectively utilized by a rural EMS system. By rigorously describing this unique emergency medical service, this quality improvement project helps shed light on the utilization of the service and ensures KERPA maintains a high standard of quality data tracking. Our hope is this project will assist in forming the basis for further research to determine if this model improves patients outcomes.

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