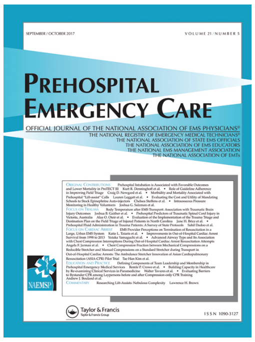

Prehospital Emergency Care

ISSN: 1090-3127 (Print) 1545-0066 (Online) Journal homepage: https://www.tandfonline.com/loi/ipec20

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Abstract

Objectives: Emergency departments (ED) continue to be overburdened, leading to crowding and elevated risk of negative clinical outcomes. Extending clinical services to paramedics may support efforts to improve ED burdens by promoting health care access and capacity during times of patient crisis. The objective of this study was to identify the clinical course and most responsible diagnosis of patients transported by paramedic services to local EDs to then evaluate impact of various augmented 9-1-1/paramedic clinical service models on the need for additional ED services. **Methods**: A retrospective cohort and model-simulation based study. We retrieved clinical data from hospital records for a random selection of 3,000 patients who engaged 9-1-1/paramedic services and were transported to a regional ED to identify their clinical course (interventions, diagnostics) disposition and most responsible admitting/discharge diagnosis. We used this data to establish, simulate and test numerous paramedic service models on the need for ED services. **Results**: A random selection of 3,000 patients was reviewed across 3 hospitals. The majority were female (57.2%) with a mean age of 65 (SD = 21.3). The majority (n = 1954; 65.1%) were discharged directly from ED of which 3.6% (n = 108) received no intervention or diagnostic, 20.4% (n = 611) received only a diagnostic, 4.8% (n = 143) received only an intervention and 36.4% (n = 1092) received both an intervention and diagnostic. The proportion of nonadmitted patients rose to 82.2% and 77.2% when considering lower priority patients and age greater than 65, respectively. Patient types were identified based on frequency and association with discharge directly from ED. Twelve simulated augmented paramedic clinical service models are reported with estimated gains in the number of patients who may no longer require ED services ranging from 7.5% (n = 146) to 35.4% (n = 691). **Conclusions**: This study suggests a reduction in need for ED services may be achieved through innovative models of paramedic services at the time of crisis. Identifying and confirming patient types/events to target and clinical services to include in the model requires ongoing investigation. Future research will be needed to evaluate the accuracy and impact of the models presented. **Keywords**: Paramedic; EMS; Community Paramedicine; Healthcare Service Delivery; ED Crowding; primary care

PREHOSPITAL EMERGENCY CARE 2017;21:652–661

Received August 25, 2016 from Wilson Centre and Post-MD Education, University Health Network/University of Toronto, Department of Medicine, Toronto, Ontario, Canada. (WT); Paramedic and Seniors Services, Community and Health Services Department, Regional Municipality of York, Newmarket, Ontario, Canada (WT, ID, MA, NK, CS, NB); Department of Medicine, Division of Emergency Medicine, McMaster University, Hamilton, Ontario, Canada (WT, KVD, MM); School of Community and Health Studies, Paramedic Program, Centennial College, Toronto, Ontario, Canada (WT, MA); Rescu, Li Ka Shing Knowledge Institute, St. Michaels Hospital, Toronto, Ontario, Canada (ID); Ornge Transport Medicine, Clinical Affairs/Base Hospital, Mississauga, Ontario, Canada (WT); Institute of Medical Sciences, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada (ID). Revision received February 16, 2017; accepted for publication March 15, 2017.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding Statement: This study was supported by the Regional Municipality of York.

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doi: 10.1080/10903127.2017.1311391

Introduction

Health care resources are scarce and as such, it is important that resources be allocated in a way that optimizes health care outcomes. In considering use of resources, some have suggested that it may be more clinically appropriate and resource efficient if many patients who access care directly through the emergency department (ED) were to instead do so through primary or ambulatory care providers.[1] However, many patients who might otherwise be cared for appropriately in these settings continue to access the ED often due to limited options and despite (a) efforts to reduce need through more access to these services, or (b) misuse through patient education.[2] This may result in ED crowding, raising the risk for negative clinical outcomes.[1,3-5] For those who access care (or the ED) using paramedic services, care options are limited and paramedics are obligated to convey patients to the ED regardless of need,[6,7] contributing further to an overburdening of the system. As such, simply increasing the capacity of EDs may not be a sustainable solution and increasing primary and/or ambulatory care resources does not necessarily address the challenge of providing opportunities to obtain care outside of the ED setting at the time of the emergent problem.[8] This suggests alternative strategies are required, which may include reexamining the scope of care available in the system and/or expanding capacity by providing more access to clinical services outside of the ED by using and redesigning paramedic services.[9]

The current scope of care provided by paramedics may be too narrowly focused to support goals of capacity growth and access when considering the spectrum of patients they and EDs encounter. As such, this represents an underutilized health care service especially when considering the opportunity paramedics have to offer more in the community as a function of their context of practice. For instance, until recently,[10,11] paramedicine has traditionally focused on resuscitative, acute and/or emergent care. Early interventions for emergent conditions (e.g., early defibrillation, STEMI care) and rapid transport to more definitive care have been the mainstay and even catalyst for whatever system developments that have emerged. There have been advances, with paramedic services providing more care for acutely ill cardiac, trauma, obstetrical, neurological, and pediatric patients and triaging them directly to specialized centers, not just the nearest ED.[12-14] What can be learned from these enhancements is that paramedics are able to provide increasingly complex levels of care in place, in the community, and more meaningful dispositions for those accessing care in this way, at least for those experiencing high acuity events. These advances are examples of how paramedicine can advance, transform and be leveraged and integrated to optimize care and outcomes safely.[15,16]

In the event that paramedic services can serve as a means of bolstering capacity and access to care and thus mitigate overburdened EDs, changes to what paramedics can offer are required. However, there are uncertainties regarding what other clinical services, dispositions or even specific patient types, conditions or events would be most appropriately targeted toward optimizing services, specifically during times of crisis. An opportunity exists to augment "out of hospital" care by leveraging paramedic services if we can better understand the most appropriate clinical services to offer and for whom (as a method and outcome) as a means of effecting gains in health resource capacity and access.[17] Evidence supporting programs designed to implement care outside of the ED, specifically at the time of the emergent problem, remains limited.

Therefore this study aimed to identify types of patient presentations that might be suitable to take advantage of changes in the scopes of clinical services offered by paramedic services, such that patients not requiring ED services can obtain care in the community (out of hospital). We asked, of patients transported by paramedic services, what is their course of clinical care, disposition and most responsible diagnosis once transported to the ED? Then based on this information, we asked what additional clinical services provided by paramedics (in a 9-1-1 model) may result in the least need for additional ED services? The results may help inform educational and practice models in paramedicine toward supporting larger healthcare policy goals.

Methods

Study Design

Overview

We designed a retrospective cohort and simulation based study. For patients who engaged 911-paramedic services and were transported to a regional ED, we retrieved clinical data from hospital records retrospectively to identify clinical course and disposition. We used this data to (a) describe the patient population transported by paramedic services; (b) identify specific interventions, diagnostics, disease classifications and disposition; and (c) simulate the impact of various paramedic service delivery models on these patient groups and need for additional ED services. This study received ethics approval by McMaster University (REB 0399-C) Southlake Regional Heath Centre (REB 0046-1516), MacKenzie Health and Markham Stouffville Hospital.

Study Setting

We selected a paramedic service located in southern Ontario, Canada for this study. This region has population of 1.1 million with a mix of urban, suburban and rural residential, industrial and commercial communities, and responds to approximately 77,000 emergency/9-1-1 calls per year with 35% of staff at the Advanced Care Paramedic (ACP) level.[18,19] All patient contacts are documented and maintained in an electronic patient care record (ePCR) database. Medical oversight and scope or practice are provided and defined by an external base hospital program.

Study Subjects – Inclusion / Exclusion Criteria

Patients were identified using an ePCR database and were included if they were a resident who contacted 9-1-1 between January 1, 2014 and December 31, 2014, were transported to one of the 3 regional/study hospitals, and were assigned a Canadian Triage Acuity Scale (CTAS)[20] score of 2, 3, 4, or 5 by paramedics. Patients who were less than 18 years old at the time of contacting paramedic services were excluded from the study because of the known low rate of pediatric populations and interest in targeting an adult scope of practice and growing aging population first. We also excluded those patients whose ePCR did not match with hospital records (e.g., those transported out of the region), those who used paramedic services specifically for transport between facilities, and those who were part of a by-pass protocol (e.g., stroke by-pass). This allowed us to identify an adult patient population that self-identified as being in need of 911 services and patient types that were potentially suitable for some sort of out of hospital/ ED based intervention.

Data Collection

We required two different databases, accessed in sequence. First we retrieved all paramedic service ePCRs based on the criteria above and assigned unique identifiers for each. Duplicate records for the same patient (e.g., completed by more than one paramedic crew), were merged. We then screened all records for inclusion criteria and stratified the records by CTAS within hospital destination. We then randomly (using a random number generator) selected 1,000 patients per hospital using the CTAS stratification weights for all data. This ensured our sample was representative of our population in at least CTAS level distributions across 3 hospitals.

Next we abstracted clinical data from each ePCR including identifiers to facilitate matching with hospital records. We used name, date of birth and healthcare number, to match the records then manually abstracted clinical data, removing identifiers at that point. To ensure accuracy we verified all matches and randomly verified all data abstracted for 20% of the records at each of the 3 hospitals. See Supplemental Material Section 1 (Supplementary Material Available Online) for details regarding data abstracted. Not all data listed was relevant to or reported in this study, but was collected as part of a larger program of research.

We were interested in (a) admission status, (b) discharge or admission diagnosis, and (c) diagnostics and interventions performed. Admission status was captured either as admitted (including those transferred to another facility), not admitted, left against medical advice (AMA) or deceased in ED ("transferred" to another hospital was treated as admitted). For each hospital record we abstracted either a discharge or admission diagnosis, which were listed according to the International Statistical Classification of Diseases and Related Health Problems Tenth Ed. Canada (ICD-10-CA) at the four-to-five character category level. Where multiple ICD codes were assigned we retained the first or most responsible code and cross-referenced it with the health record to ensure it was the main reason for the visit. We then organized the raw ICD-10-CA codes into more clinically meaningful categories using an existing Clinical Classifications Software (CCS) (https://www.hcup-us.ahrq.gov/toolssoftware/ccs10/ccs10.jsp). Where exact matches could not be made (e.g., due to small variations is descriptions), members of the research team (MA, WT) met to discuss possible matches. We manually screened all remaining codes and assigned them to the closest most appropriate clinically relevant grouping. We only entered the code into the database once consensus was reached, involving a third (ID) team member only if needed. Finally, for all diagnostics and interventions documented at the individual patient level, we abstracted and entered these verbatim.

Primary Outcomes and Analysis Plan

Our analysis plan aimed to triangulate findings toward identifying patient types / medical conditions whose dispositions may potentially be improved by paramedic intervention. In doing so we avoided any preconceived limitations associated with existing scopes of practice, feasibility or supposed barriers as they might exist in this context at the time of the study (e.g., legislative barriers). Our intention was to be aspirational and suggestive of directions for future study.

First we established a classification system based on clinical services documented and admission status. For instance, following 9-1-1 activation, care and transport by paramedics to an ED, those in group 1 met the following criteria: (a) received no further interventions; (b) received no further diagnostics; and (c) were not admitted. Those in group 2 also received no further interventions and were not admitted, but received further diagnostics. Various combinations led to a total of 10 classifications (reported below). We deduced that those that were not admitted and specifically did not receive any further intervention or diagnostics in ED, as a result of paramedic service innovations, might be a group of patients that potentially could be cared for by paramedics without the need to occupy emergency department resources.

For this cohort of transported but nonadmitted patients, we then explored and listed patient types, diagnostics and interventions for their frequency as well as association with discharge directly from ED. We used this information to conduct a number of simulations manipulating combinations of interventions and diagnostics with a primary outcome of maximizing the number of patients requiring no additional services (i.e., group 1). These simulations involved creating models based on statistical data (frequency x association with discharge rate) to establish an index that could then be ranked. "Frequency" was based on the nonadmission group only, since it was this group that we were interested in. However, for "association with discharge," we considered all patients since it was important to determine for a patient type, their admission and nonadmission rates. This allowed us to ultimately formulate recommendations regarding meaningful shifts in paramedic services that might build capacity in the system.

RESULTS

A total of 76,996 ePCRs were retrieved. After screening for inclusion criteria and cleaning (e.g., removing duplicates) 32,009 eligible records remained (see Figure 1 for details). Our sample distribution by CTAS within hospital resulted in similar distributions to our "population," which meant no further manipulation or stratification was required. Ensuring we distributed the sample equally across the 3 hospitals rather than proportionately to each hospital, meant other factors (e.g., various community demographics) could be represented in our data. Of the 3000 patients, the majority (57.2%) were female (population mean = 57.5%) and the mean age was 65 (SD = 21.3; min = 19, max = 105) (population mean = 64) with 23 of 41 regional communities represented. Paramedics recorded assessments for all 3,000 records and provided treatment (defined as controlled delegated medical acts) for 12% (n = 367) of patients. See Table 1 for a summary of the demographics.

Of the 3,000 patients reviewed, a total of 65.1% of patients (n = 1954) were not admitted. Of the nonadmitted patients this included 3.6% (n = 108) receiving no intervention or diagnostic, 20.4% (n = 611) receiving only a diagnostic, 4.8% (n = 143) receiving only an intervention and 36.4% (n = 1092) receiving both an intervention and diagnostic. The proportion of nonadmitted patients rose to 82.2% and 77.2% when considering lower priority patients (i.e., CTAS 4 and 5 only) and lower priority patients over the age of 65, respectively (see Table 2 for details).

When considering all patients (n = 3000), a total of 675 unique conditions/patient types, 258 unique interventions and 187 unique diagnostics (44 were listed as consultations) were recorded. Of all the ICD-10-CA codes recorded 73% occur within groups 1-4. At the patient level, this represented 87% of all patients, meaning only 13% have unique ICD codes exclusive to groups 5–10 (e.g., ICD Codes A41.9 sepsis-unspecified and K92.2 gastrointestinal hemorrhage exist only in groups 5–10) indicating patient types not suitable for prehospital diversions.

It was at this point that we converted the raw ICD-10 codes using CCS (as described above). Following CCS grouping, the top 10 patient types / conditions based on frequency and association with discharge directly from ED are reported in Table 3. See Supplemental Material Section 2 (Supplementary Material Available Online) for the individual ICD-10 codes that make up each of the "patient types" listed in Table 3.

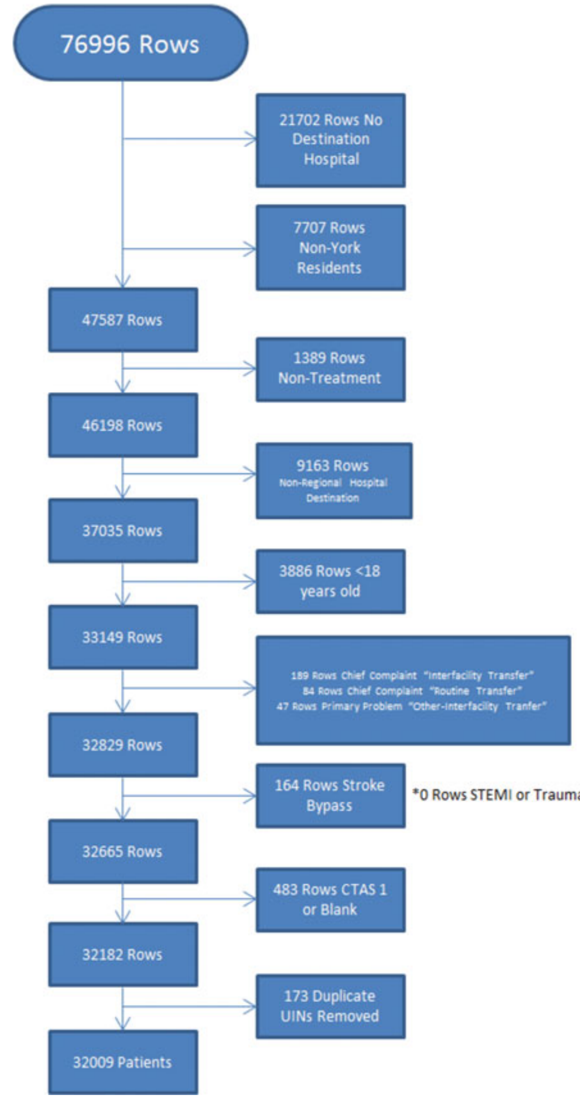

FIGURE 1. Illustration of data cleaning prior to random selection of 3,000 patients for analysis. *Note*: Nonresidents were eliminated because (a) we felt that the population immediately outside of the Region's boundaries was not sufficiently different in any meaningful way as to threaten the representativeness of our sample population; and (b) as a condition of our internal and external research review.

Simulated Paramedic Service Models and Impact on Group Assignment

Next we evaluated group assignment for the cohort of 1954 nonadmitted patients after simulating various paramedic service models. We asked what would happen to group assignment if paramedic services were equipped (e.g., in resources, clinical reasoning) with various clinical services, simulating reductions

TABLE 1. Demographic data comparing sample to "population" data

	Sample $N = 3000$	Population* $N = 76,996$
Gender	57.2% Female; 42.8% Male	57.5% Female; 42.5% Male
Age	65 (SD = 21.3); Min = 19, Max = 105	64
Age Distribution and Discharge Rate (does not include those who left against medical advice)	55.7% discharged directly from ED; Age 18–64 = 1,311; 1,013 or 77.3% discharged directly from ED	n/a (see NACRS ref)
Communities	23	41
Treatment Rendered by Paramedics	$n = 367$; 12.2%	n/a
CTAS Distribution[1]	2 = 28.4%; 3 = 57.5%; 4 = 10.9%; 5 = 3.3%	2 = 29.2%; 3 = 55%; 4 = 10.6%; 5 = 3.6%
CTAS (determined by triage nurse) Distribution by Hospital	MSH – 2 = 26.8%; 3 = 58.3%; 4 = 10.7%; 5 = 4.2% Southlake – 2 = 25.9%; 3 = 58.6%' 4 = 12.3%; 5 = 3.3% MacKenzie – 2 = 31.5%; 3 = 56%; 4 = 9.7%; 5 = 2.8%	Unable to determine hospital distributions.
CTAS (determined by paramedics) and rate of discharge directly from ED	CTAS 2 = 46.76% (397/849) 3 = 69.97% (1207/1725); 4 = 82.57% (270/327); 5 = 80.81% (80/99)	Unable to determine hospital distributions.

*Population values obtained by filtering 76,996 rows with those that had the "response outcome" of "Treatment and/or transport" from January 1, 2014 to December 31, 2014.

in the need for ED services. We used 4 approaches. First, we considered the interventions and diagnostics performed most frequently and with the highest association with nonadmission (creating an index ranking for each, see Supplemental Material Section 3 for details; Supplementary Material Available Online). Next, we removed diagnostics and interventions that exist in broad classification as part of an ACP skill set (e.g., pain medication) and replaced the top 10 list with the next highest-ranking (based on index) diagnostics / interventions. Then we removed the diagnostics/interventions that may be threatened by feasibility (e.g., CT Scans). Lastly we report the statistical and selected combinations (based on a number of simulations) that resulted in the greatest number of patients requiring no further clinical services in ED. See Table 4 for the best performing model and Supplemental Material Sections 3–6 for details (Supplementary Material Available Online) regarding some additional sample models and model results including effects on patient types.

DISCUSSION

Overburdening EDs risks negative clinical outcomes and strategies to mitigate system pressures continue to be explored.[21] Increasingly paramedic services are recognized as well positioned to offer more in clinical contributions to better meet the needs of patients they encounter in the community, potentially reducing the need for ED services.[11] The aim of this study was to identify patient types, conditions, or groups that might benefit from expanded paramedic services as a way of improving health care resource utilization, access, patient disposition, and outcomes. The results of this study suggest that with paramedic service innovations, which are responsive to the population it serves, significant reductions in the need for additional ED services may be reduced. Furthermore, the methods we presented serves both as a needs-analysis for considering efficient service innovations, but also as a mechanism to consider risk in doing so. Re-examining clinical services in paramedicine, including offering and integrating more clinical services in the community (especially at times of crisis) may promote access and capacity in the healthcare system, particularly for nonlife threatening events where primary care may not be positioned to handle urgent care needs. While other studies have explored use of paramedics in other healthcare contexts,[22] this study has implications for those responsible for education and practice changes to 9-1-1 systems in paramedicine..

For care to be further extended from the ED to paramedic services, education, guidelines, and practice models must be aligned with those most appropriately cared for in this context, aiming for safe clinical and socially responsive care.[23] While programs are already in place, evidence in support of them has been limited.[23] One of the challenges continues to be how best to structure these programs/clinical services. Forecasting the types of patients that would be most appropriate for shifts in clinical services during times of crisis, and the clinical services that would be needed to do so, remains fundamental to promoting program success.

This study suggests that focusing on specific patient types and augmenting paramedic clinical services can result in expanded access to and capacity within out of hospital systems, ultimately reducing the need for (some) ED services. Successful ED crowding programs have targeted capacity growth in areas other than the ED. For example, Scandinavian countries with robust systems to manage acute care outside the ED do not report crowding as a major problem.[1] These programs involve engaging a number of "prehospital care systems" before accessing the ED. These include contact with general practitioners, primary care, or outpatient specialty physicians. Ambulance services (as they are referred to) are also engaged for emergency and none-

Table 2. Grouping definitions and descriptive statistics based on group assignment, including interventions, diagnostics, and admission status for 3,000 patients transported by paramedics to local EDs

Group	Interventions Performed	Diagnostics Performed	Admitted	Total ($N = 3000$) (n; %)	Length of Stay in minutes (mean and SD)	Treated* by Paramedics ($N = 367$) (n; %)	Total when screened for CTAS 4 and 5 only ($N = 426$) (n; %)	Total when screened for > 65 and CTAS 4 or 5 only ($N = 224$) (n; %)
1 = Release	No	No	No	108; 3.6	112.1(104.7)	5;4.6	34; 8.0	14; 6.3
2 = Test and Release	No	Yes	No	611; 20.4	260.1 (146.9)	53;8.7	120; 28.2	56; 25.0
3 = Treat and Release	Yes	No	No	143; 4.8	158.0(138.1)	22;.15.4	35; 8.2	11; 4.9
4 = Test, Treat and Release	Yes	Yes	No	1092; 36.4	345.2(218.7)	114;10.4	161; 37.8	92; 41.1
Non Admitted Totals				**1954; 65.1**†	—	**194; 52.9**	**350; 82.2**	**173; 77.2**
5 = ED Required and Admitted	Yes	Yes	Yes	871; 29.0	420.8(207.8)	152;17.5	58; 13.6	45; 20.9
6 = ED Required and Decease	Yes	Yes	Deceased	2; 0.1	228.0(96.2)	0	0	0.0%
7 = Test and Admit	No	Yes	Yes	92; 3.1	395.7(168.0)	10;10.9	4; 0.9	3; 1.3
8 = Treat and Admit	Yes	No	Yes	8; 0.3	258.9(353.6	2;40	2; 0.5	1; 0.5
9 = Admit Only	No	No	Yes	2; 0.1	143.0(42.4)	0	0	0.0%
10 = Left AMA	—	—	Left AMA	71; 2.4	188.4(156.0)	9; 12.7	12	2; 0.9
Admitted / Deceased and Left AMA Totals				1046; 35.2	—	—	—	—

Note: Length of stay, whether patients were treated by paramedics and when considering age greater than 65, and/or only CTAS 4 and 5 by grouping are also reported.

*Treated refers to a controlled medical act (medication or procedure) and included Nitroglycerin, Salbutamol, ASA, Dimenhydrinate, Fentanyl, Fluid Bolus, Diphenhydramine, Morphine, Oral Glucose, D50W, Midazolam, Glucagon, Adenosine, Epinephrine, Naloxone, Cardioversion, CPAP.

†When screened for only CTAS 2 and 3 patients regardless of age ($N = 2574$), the "nonadmitted totals" (including their distribution) were similar ($n = 1604$; 62.3%). When screened for patients older than 65 regardless of CTAS ($N = 1689$), "nonadmitted totals" decreased ($n = 941$; 55.7%).

Table 3. Top 10 patient types (by CCS Grouping) with the highest frequency and correlation with discharge directly from ED

	Group Patient Type (See Supplemental Material Section 2 for conditions that define each group; Supplementary Material Available Online)	Freq.Out of $N = 1954$*	Assoc. with Discharge Directly from ED $N = 2927$†	Index‡	Group Assignment Of 1954 Nonadmitted Patients			
					1 ED Release (n; %)	2 ED Test and Release (n; %)	3 ED Treat and Release (n; %)	4 ED Test, Treat and Release (n; %)
A	Other injuries and conditions due to external causes	184	0.95	174.52	18; 10	60; 33	18; 9	**88; 48**
B	Nonspecific chest pain	145	0.89	128.99	0; 0	71; 33	1; 1	**73; 50**
C	Conditions associated with dizziness or vertigo	91	0.94	85.37	3; 3	34; 49	6; 7	**48; 53**
D	Abdominal pain	88	0.89	78.22	1; 1	23; 26	1; 1	**63; 72**
E	Superficial injury; contusion	74	0.97	72.05	11; 15	**33; 45**	1; 1	29; 39
F	Spondylosis; intervertebral disc disorders; other back problems	65	0.96	62.13	2; 3	7; 11	17; 26	**39; 60**
G	Syncope	76	0.77	58.34	0; 0	**48; 63**	0; 0	28; 37
H	Anxiety disorders	54	0.93	50.28	3; 6	**28; 52**	4; 7	19; 35
I	Open wounds of head; neck; and trunk	44	0.96	42.09	2; 5	3; 7	12; 27	**27; 61**
J	Sprains and strains	43	0.96	41.09	10; 23	11; 26	4; 9	**18; 42**

*1,954 is the number of patients that were not admitted. The values in this column represent the number of times the specified patient type was present in the 1,954 nonadmitted patients. Other patient types (not listed) complete the list.

†3000 patients were analyzed; however 71 left against medical advice, 2 deceased.

‡Calculated by multiplying "frequency" with "association with discharge directly from ED."

TABLE 4. Summary of paramedic service model (intervention and diagnostics) having the greatest impact on reductions for the need for additional services in EDs

All nonadmitted patients (Groups 1–4)	Baseline (Group 1)	Model 12*			
	No Diagnostics in ED	Diagnostics	Model 4	CBC/Differential	Chem7
				Creatine Kinase	Troponin
				Urinalysis	INR
				GEM Consult	PTT
				Crisis Consult	X-ray
	No interventions in ED	Interventions	Model 8	Hydromorphone	Pink Lady
				Zofran	Ativan
				Metoclopramide	Tylenol 3
				Percocet	TD
				Ceftriaxone	Sutures
($N = 1954$)	Baseline $n = 108$ (5.53%)	—	Predicted $n = 691$ in total in Group 1 (35.36%)		

*Model that resulted in the greatest number of patients who would not require additional ED services (i.e., group 1), if available in the prehospital setting and requiring the least amount of diagnostics and interventions (see Supplemental Sections 4 and 5 for additional details regarding all other models; Supplementary Material Available Online).

mergency events but are staffed with nontraditional clinical services when compared to most North American models.[1] These "prehospital" programs facilitate direct admission as well as treat and release programs. Our study contributes to the growing discussion and evolution of "prehospital care systems" by providing specific foundational data by which to structure, but also study further shifts in education, practice, policy, and oversight into an existing service.

Guiding model development, particularly those that involve selected combinations of interventions and diagnostics, were aims to shift patients to instances in which no further ED services would (theoretically) be needed. We developed and tested numerous models using different combinations of interventions and diagnostics while taking into consideration the conditions most associated with discharge directly from ED with variable results. While future research would need to provide support for the models, deriving them involved both empirical (frequency and association with discharge) and analytical approaches (judgment in selecting combinations). Feasibility, training requirements, costs and other local factors should be additionally considered, However, research exploring patient perspectives on related topics, suggests the public is increasingly in favor of these types of changes.[24,25],

Regardless of the model, extending ED clinical services to prehospital settings requires caution. For example, while we assumed that nonadmitted patients represented the most likely to be suitable for care in the community, in exploring these by patient types we found that none of the groupings were exclusively discharged directly from ED. This suggests that while an opportunity exists to support these patients in the community, there is still risk in doing so, particularly if paramedics were to continue to be challenged with decisions on working diagnoses and predictions regarding admission.[26,27] Other conditions were associated with discharge directly form the ED exclusively, but were so infrequent, (leading to a low index score) that shifting policies on these conditions may be ineffectual. Still, service delivery model simulations that assume an existing ACP skill set in addition to legislative freedom to avoid conveyance to the ED and selected diagnostics and interventions for specific patient types, suggest that the proportion of patients that may be cared for in the community by paramedics can be increased significantly.

Appropriate clinical reasoning and quality assurance must support consideration of these models. For example, while the discharge diagnosis (patient types) may appear benign, the clinical reasoning to get there is complicated. Our results and any applicability they may have in practice assumes a level of clinical reasoning and expertise intended to support interaction with any of these patient types and/or the selection, application and interpretation of any of the listed interventions and diagnostics. Also, these results have the benefit of hindsight and confirmed diagnoses. Simply transferring these results into paramedic clinical settings is not likely to be helpful. Further, the heterogeneity that may exist within each patient type or even decisions associated with selection and interpretation of diagnostics and interventions cannot be overstated. As such, these grouped patient conditions, interventions and diagnostics must be carefully interpreted, translated and assembled to support and be responsive to actual clinical encounters, context, practice and feasibility. Our intention is to provide data and a model by which to support decisions toward capacity growth and expansions in the scope of available care in the community. However, doing so must be accompanied by robust education, clinical acumen, policy, quality assurance, and medical oversight, practice guidelines and medical legal considerations where appropriate and further research.

Limitations

There are limitations associated with this study. To avoid being overly granular and facilitate meaningful and clinical relevant analysis and reporting of results, we grouped ICD codes using CCS. Aggregating methods of this kind reduces some of the detail to gain in interpretation. While we provide all raw data for each grouping, the grouping themselves may skew some of the results and lead to difficulty in interpretation. For our grouping and eventual analysis, we used the first and/or most responsible diagnosis. The challenges with using ICD codes are well documented. There may have been other conditions (at times many ICD codes were documented) that may have been clinically relevant and yet were not captured in our analysis. However, in each of the study clinical sites, policy was to use the first ICD code as the most responsible diagnosis. The range of possible service delivery models are not quite infinite, but large. Despite assembling and conducting multiple analyses, we limited our reporting to 12 models. There may be other models that were not considered that may have led to other equally, if not more meaningful, results. Also, while we did take into consideration the clinical relatedness and appropriateness of the interventions and diagnostics in most models, this is not what dictated our models. Instead we looked for models that led to the largest reductions in need for ED services. Other drivers may have yielded different results. Our models are necessarily speculative and it is difficult if not impossible in this study to determine whether our results are over or under estimated. Future prospective research will need to test these predictions and modify models as necessary, but we have been able to provide educators and policy makers with a database by which to make informed decisions for pursuing this issue further. Lastly, we limited our lists to top ten based mainly on factors influencing our composite index scores. Other patient types may be relevant to policy makers and educators, however, including additional diagnostics and interventions led to limited gains or began to reach a point where feasibility may have been significantly threatened.

CONCLUSIONS

As health care resources become increasingly scarce, resources must be optimized in a way that promotes health care outcomes. By exploring the clinical course and disposition of patients transported by paramedic services to local EDs, there may be patient types or groups appropriate for care in the community by paramedics at the time of crisis (i.e., 9-1-1 response). To support doing so, clinical services including diagnostics and interventions that best support these patient types and reduce the need for ED services would need to be made available as part of a new model of paramedic services. Doing so may be a way of correcting an underservicing/underutilization that exists in paramedic services currently while simultaneously reducing the burden on EDs and promoting health care capacity and access. We have proposed a number of service delivery models that may achieve these goals assuming robust education, clinical acumen, policy, quality assurance and medical oversight, practice guidelines, and medical legal considerations where appropriate. Indeed, re-examining and ultimately integrating augmented paramedic clinical services, as part of larger out of hospital programs, should be considered further. Future research will be needed to evaluate the accuracy and impact of the models presented.

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