Identifying and profiling prearrival characteristics of avoidable emergency department visits transported by paramedics: a cohort study using linked prehospital and hospital data

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ABSTRACT

Background Increasing demand and crowding in emergency departments (EDs) remain persistent challenges for healthcare systems worldwide. A portion of these visits is avoidable, indicating they could have been effectively managed in non-ED care settings. There has been increased attention on paramedics redirecting avoidable visits to community-based care before ED transport. However, limited evidence exists to identify which patients might be suitable for non-ED care models, particularly based on prehospital clinical presentations. This study aimed to examine the patient characteristics associated with avoidable and potentially avoidable ED visits prior to ED transport.

Methods We conducted a cohort study using linked data from Hamilton Paramedic Services and a Canadian academic hospital between January 2022 and January 2024. ED visit records were classified using the Emergency Department Avoidability Classification into three classes: avoidable, potentially avoidable and not avoidable, and matched with their paramedic care reports. We used Firth's binary logistic regression to identify primary concerns associated with avoidable or potentially avoidable ED visits, reported as ORs with 95% CIs controlling for multiple comparisons using a false discovery rate of 0.10.

Results Among the 23 891 ED visits analysed, 4.9% were classified as avoidable, 16.8% as potentially avoidable and 21.7% as either avoidable or potentially avoidable. Patients were primarily young-to-middle aged, presenting with a low medical acuity, taking fewer prescribed medications regularly and having stable vital signs within normal ranges. Primary concerns associated with these ED transports included social problems (OR 16.7, 4.5–95.5), anxiety (OR 15.0, 4.0–75.1), cough or congestion (OR 12.5, 3.2–65.4), lacerations (OR 11.0, 3.3–62.0) and minor problems (OR 7.8, 2.2–39.3).

Conclusion Our findings highlight key patient characteristics and primary concerns that could inform paramedics to identify patients suitable for non-ED care models. Incorporating evidence-based criteria into paramedic decision-making could support the safe and effective implementation of alternative care models, which could potentially reduce ED visitation and promote optimal healthcare resource distribution.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Avoidable emergency department (ED) visits can often be effectively managed in non-ED settings. Most existing research characterises these patients using data collected during the ED encounter. Paramedics have the potential to redirect some of these visits before ED transport, but limited research exists to define which patients may be suitable before arrival.

WHAT THIS STUDY ADDS

⇒ This study demonstrated that specific prehospital patient characteristics, such as vital signs and primary concerns, are strongly associated with avoidable ED visits before ED arrival.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND POLICY

⇒ Integrating prehospital patient characteristics strongly associated with avoidable ED visits could provide a basis for developing evidence-informed paramedic redirection protocols. These protocols could enable paramedics to safely triage, screen and identify patients for transport to non-ED settings, such as urgent care centres or community health centres.

BACKGROUND

Emergency department (ED) overutilisation is a significant and growing challenge for healthcare systems worldwide.[1–3] For example, annual ED visits in the USA have increased by 15% between the early 2010s and 2019, with similar trends observed in other countries including Canada and England.[4–6] This surge in demand has contributed to several significant consequences, including prolonged patient wait times, diminished quality of care and higher rates of adverse medical events, with studies estimating a 10–15% increase in mortality among admitted patients when EDs are crowded.[7–9] As demand for ED utilisation continues to rise, healthcare stakeholders are prioritising the development of care models and interventions aimed at safely reducing ED visits and reserving resources for patients requiring life-saving care.[7]

Avoidable ED visits, defined as those that could have been effectively managed in non-ED settings, have garnered attention as a key target for intervention.[10] Avoidable visits contribute to ED crowding, increase staff workloads and can impose substantial

financial burdens on healthcare systems.[11] In the USA, avoidable visits are estimated to cost the healthcare system between US$8 and US$32 billion annually,[12 13] with costs exceeding US$400 million in Canada.[14] Redirecting patients likely to have avoidable ED visits to community-based care settings before reaching the ED could help alleviate some overcrowding pressures while potentially reducing costs.[13]

Paramedics are uniquely positioned to reduce avoidable ED visits, given their role as first responders interacting with patients in the community before ED arrival. Paramedics transported ED visits account between 16% and 20% of all ED visits in Ontario, with approximately 60% triaged as non-emergent.[15] Furthermore, an estimated 30% of all paramedic transports are considered avoidable.[16 17] Paramedic alternative care models, such as transporting patients to non-ED facilities, have shown potential to address avoidable ED visit attendance but remain underused due to limited evidence that can guide paramedics to identify which patients could be suitable for non-ED pathways.[7]

Most studies that describe patients of avoidable ED visits rely on data collected during the ED encounter, which may not be applicable to the prehospital context.[11] There is an evident gap in the literature regarding patient characteristics and clinical presentations prior to arrival for avoidable ED visits.[11 16 18] Leveraging prehospital data to examine avoidable ED visits before arrival could be transformative, providing paramedics with crucial insights to differentiate between patients suitable for alternative care settings and those requiring ED-level care. A deeper understanding of prehospital patient characteristics with avoidable ED visits is essential to inform paramedic decision-making and develop evidence-based strategies to reduce ED utilisation safely and effectively.

Our objective was to describe and analyse the patient and clinical characteristics of paramedic-transported avoidable ED visits in the community prior to their ED transport.

MATERIALS AND METHODS

Study design

We conducted a cohort study using linked data between an academic hospital in Hamilton, Canada, and Hamilton Paramedic Services (HPS). The Strengthening the Reporting of Observational Studies in Epidemiology statement was followed for the reporting of results.[19]

Population and setting

We included all patients transported by HPS to the academic hospital by paramedics following a 911 emergency call between 1 January 2022 and 31 January 2024. Interfacility transfers (eg, hospital-to-hospital transports) were excluded, as these cases do not involve paramedic interaction in the community and already have an admission determination. Nearly all transported patients were taken to the academic hospital, as there are no established pathways for paramedics to transport patients to non-ED centres, and transports to other EDs within the jurisdiction were minimal. In late 2023, a new care model allowed paramedics to discharge select patients with resolved issues back to the community. However, its uptake was minimal, and these cases were excluded due to the absence of an ED visit classification. Each patient encounter was considered an independent ED visit, regardless of repeat visits for the same or different conditions during the study period.

HPS is a municipally and provincially funded paramedic service in Hamilton, Ontario, Canada, serving a population of approximately 570 000 across 1120 square kilometres. The service employs around 400 paramedics, certified at two levels: primary and advanced care. Paramedics operate within Ontario's universal healthcare system.

Data source and linkage

Data for this study were obtained from two secondary resources: the academic hospital's administrative patient database and HPSs electronic patient care record (ePCR) database. The hospital's database provided detailed patient data of paramedic-transported ED visits, while the ePCR database supplied paramedic-collected patient, clinical and administrative information for all patients transported to the academic hospital. Both databases are securely maintained and updated in real time after each patient interaction. Both databases contain prestructured and coded data, eliminating the need for additional data cleaning. The study's date range was determined based on the earliest and most recently available data from both secondary sources for research analysis.

ED visits were categorised using the Emergency Department Avoidability Classification (EDAC), a validated epidemiological classification that determines whether ED visits could have been appropriately managed in non-ED community care settings into three classes of avoidable, potentially avoidable and not avoidable.[10] To meet the classification criteria, patients had to have been between 18 and 70 years, discharged from ED without admission, had no specialist physician consultation, had a primary care-like intervention as their main physician intervention and be triaged with a non-emergent acuity (less urgent or non-urgent for avoidable; urgent for potentially avoidable).[10 20] The EDAC criteria and the list of primary care-like interventions were developed through two independent consensus studies involving emergency and primary care physicians in Canada.[20 21] The EDAC is now a standard variable in secondary ED data sets that categorising each visit into one of the three classes. ED visits of each class were linked to paramedic records using key identifiers such as date of birth, visit date and health card number. Records with missing or inaccurate identifiers that could not be linked were reported directly and were excluded from the analysis.

Variables

We included all variables collected by paramedics in the community prior to ED transport. Patient characteristics included details of the specific incident (primary concern, medical acuity), patient baseline characteristics (age, sex, number of medications taken routinely), administrative information regarding the incident (location type, paramedic certification) and the initial set of patient vital signs. The primary concern represented the principal condition prompting the emergency 911 call, as determined by the paramedics on scene following a thorough patient assessment and examination. Medical acuity was measured using the Canadian Triage and Acuity Scale (CTAS), an ordinal scale ranging from 1 (resuscitation) to 5 (non-urgent).[22] Paramedic certification (primary or advanced care) reflected the highest level of paramedic care that could be provided at the incident, categorised based on paramedic scope of practice and medically delegated acts.[23] Vital signs included heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), blood oxygen saturation on room air, Glasgow Coma Scale (GCS) and blood glucose level (BGL). The paramedic cardiac monitor determined the HR, SBP and oxygen saturation on room air, while paramedics determined the RR and GCS using clinical judgement. Patient BGL was determined using a peripheral blood glucometer. GCS is an ordinal scale from 3 (unconscious) to 15 (fully alert) indicating

a patient's level of consciousness.[24] Vital signs were grouped into clinically meaningful categories to reduce non-linearity and improve interpretability of normal ranges. Missing data for each variable were minimal (<0.5%, except for BGL) and directly stated where applicable.

Statistical analysis

We reported descriptive statistics of variables collected by paramedics for each of the three ED visits groups using measures of central tendency and dispersion. Box plots illustrated the distribution of continuous vital sign variables HR, RR, SBP and blood oxygen saturation. To evaluate the association between primary concerns and the likelihood of an ED visit being classified as either avoidable or potentially avoidable, we conducted a Firth's binary logistic regression analysis. We computed ORs, 95% CIs and p values (significance of 0.05) for each primary concern to assess the relative odds of an ED visit being categorised as avoidable or potentially avoidable versus not avoidable, while adjusting for the other variables in this study (age, sex, medical acuity). The avoidable and potentially avoidable classes were combined for this analysis to address the small cell sizes in the avoidable class (<5%), which can result in overfitting and wide CIs when being compared with large groups. Firth's correction, a standard approach for logistic regression when the outcome is binary and the analysis can contain relatively small strata, was applied to mitigate bias.[25] We applied a false discovery rate (FDR) correction to control for a false positive rate of 0.10 (q value), and reported the adjusted p value.[26] Regression results were presented for the 20 most common primary concerns (out of 153), ranked by total incidence. These concerns represent the most frequently encountered cases and provide practical insights to guide care model development. All data were managed and analysed in R software (V.4.2) using the *logistf* package for Firth's binary logistic regression.[27]

Patient and public involvement

Patients or members of the public were not involved in the conception, design or dissemination of results of this study.

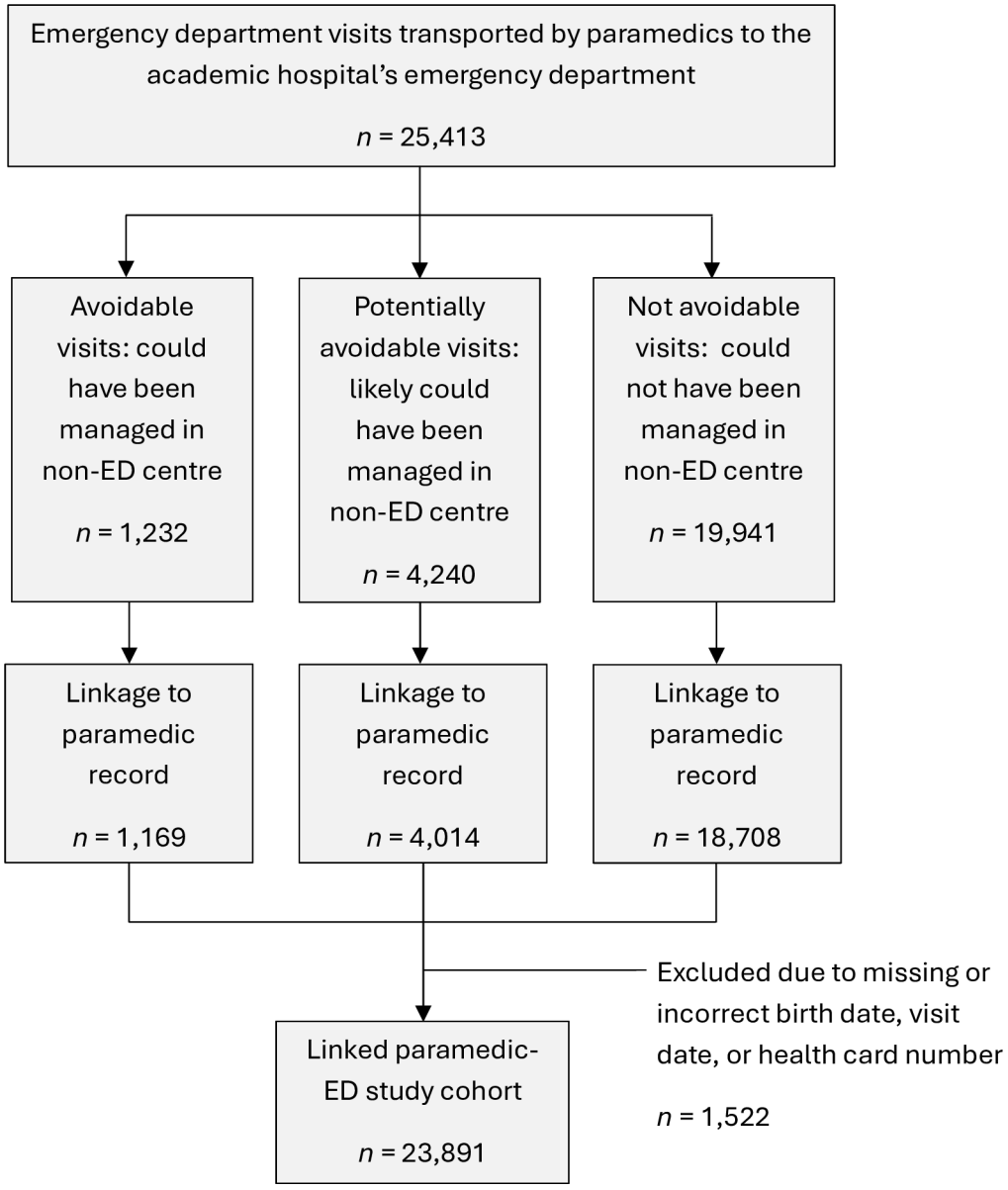

Figure 1 Cohort construction of included emergency department visits with linkage to paramedic care reports. ED, emergency department.

Table 1 Descriptive statistics of paramedic transported patients to an academic hospital's emergency department based on classification of visit

		ED visit classification, n (%)		
Prearrival characteristics	**All visits, n (%)**	**Avoidable**	**Potentially avoidable**	**Not avoidable**
Total visits transported by paramedics	23 891	1169	4014	18 708
Proportion of all visits, %	–	4.9	16.8	78.3
Age, years				
Mean (SD)	59.8 (21.9)	42.9 (15.1)	43.8 (16.1)	64.2 (21.3)
0–17	39 (0.2)	0 (0.0)	5 (0.1)	34 (0.2)
18–34	4448 (18.6)	438 (37.5)	1414 (35.2)	2596 (13.9)
35–49	3256 (13.6)	305 (26.1)	950 (23.7)	2001 (10.7)
50–64	4774 (20.0)	303 (25.9)	1143 (28.5)	3328 (17.8)
65–79	6177 (25.9)	123 (10.5)	497 (12.4)	5557 (29.7)
≥80	5197 (21.8)	0 (0.0)	5 (0.1)	5192 (27.8)
Sex				
Male	12 343 (51.7)	484 (41.4)	2063 (51.4)	9796 (52.4)
Female	11 476 (48.0)	681 (58.3)	1934 (48.2)	8861 (47.4)
Other	41 (0.2)	4 (0.3)	11 (0.3)	26 (0.1)
Acuity, CTAS				
1—Resuscitation	391 (1.6)	0 (0.0)	1 (0.0)	382 (2.0)
2—Emergent	4575 (19.1)	18 (1.6)	284 (7.1)	4281 (22.9)
3—Urgent	15 991 (66.9)	591 (50.6)	2952 (73.5)	12 448 (66.5)
4—Less urgent	2270 (9.5)	354 (30.3)	617 (15.4)	1299 (6.9)
5—Non-urgent	558 (2.3)	203 (17.4)	142 (3.5)	213 (1.1)
Missing	106 (0.4)	3 (0.3)	18 (0.4)	85 (0.5)
Number of medications				
Mean (SD)	4.8 (4.6)	2.3 (3.0)	3.2 (3.8)	5.2 (4.7)
Median (Q1,Q3)	3 (1,7)	1 (1,3)	1 (1,4)	4 (1,8)
0	2102 (8.8)	208 (17.8)	558 (13.9)	1336 (7.1)
1	6726 (28.2)	558 (47.7)	1456 (36.3)	4712 (25.2)
2	1952 (8.2)	107 (9.2)	446 (11.1)	1399 (7.5)
3	1566 (6.6)	66 (5.6)	309 (7.7)	1191 (6.4)
4	1483 (6.2)	48 (4.1)	234 (5.8)	1201 (6.4)
5	1451 (6.1)	42 (3.6)	198 (4.9)	1211 (6.5)
≥6	8611 (36.0)	140 (12.0)	813 (20.3)	7658 (40.9)
Location at contact				
Apartment/condo building	5741 (24.0)	258 (22.1)	996 (24.8)	4487 (24.0)
House/town house	8978 (37.6)	260 (22.2)	1349 (33.6)	7369 (39.4)
Street/highway/road	2009 (8.4)	283 (24.2)	566 (14.1)	1160 (6.2)
Store	390 (1.6)	64 (5.5)	111 (2.8)	215 (1.1)
Other	6437 (26.9)	284 (24.3)	928 (23.1)	5225 (27.9)
Primary concern				
Abdominal pain	2013 (8.4)	63 (5.4)	260 (6.5)	1690 (9.0)
Anxiety/situational crisis	742 (3.1)	102 (8.7)	396 (9.9)	244 (1.3)
Altered level of consciousness	871 (3.6)	9 (0.8)	46 (1.1)	816 (4.4)
Back pain	809 (3.4)	47 (4.0)	177 (4.4)	585 (3.1)
Chest pain—Cardiac features	407 (1.7)	1 (0.1)	25 (0.6)	381 (2.0)
Chest pain—Non-cardiac features	716 (3.0)	45 (3.8)	197 (4.9)	474 (2.5)
Depression/suicidal/ deliberate self-harm	1499 (6.3)	34 (2.9)	445 (11.1)	1020 (5.5)
General weakness	2053 (8.6)	55 (4.7)	157 (3.9)	1841 (9.8)
Lower extremity injury	585 (2.4)	42 (3.6)	102 (2.5)	441 (2.4)
Lower extremity pain	969 (4.1)	91 (7.8)	199 (5.0)	679 (3.6)
Minor issues	713 (3.0)	136 (11.6)	120 (3.0)	457 (2.4)
Nausea and/or vomiting	586 (2.5)	33 (2.8)	90 (2.2)	463 (2.5)
Overdose ingestion	548 (2.3)	2 (0.2)	64 (1.6)	482 (2.6)
Shortness of breath	2861 (12.0)	46 (3.9)	327 (8.1)	2488 (13.3)
Social problem	114 (0.5)	50 (4.3)	32 (0.8)	32 (0.2)
Substance misuse/intoxication	369 (1.5)	27 (2.3)	97 (2.4)	245 (1.3)
Syncope/presyncope	358 (1.5)	9 (0.8)	40 (1.0)	309 (1.7)

Continued

Table 1 Continued

Prearrival characteristics	All visits, n (%)	ED visit classification, n (%)		
		Avoidable	Potentially avoidable	Not avoidable
Upper extremity injury	364 (1.5)	29 (2.5)	93 (2.3)	242 (1.3)
Upper extremity pain	286 (1.2)	28 (2.4)	80 (2.0)	178 (1.0)
Other	7028 (29.4)	320 (27.4)	1067 (26.6)	5641 (30.2)
Heart rate, beats per minute*				
Mean (SD)	90.5 (21.8)	83.3 (13.7)	90.5 (22.7)	92.4 (18.6)
<60	968 (4.1)	16 (1.4)	96 (2.4)	856 (4.6)
60–100	16 112 (67.4)	1025 (87.7)	2695 (67.1)	12 392 (66.2)
101–119	4674 (19.6)	95 (8.1)	898 (22.4)	3681 (19.7)
≥120	1992 (8.3)	11 (0.9)	296 (7.4)	1685 (9.0)
Respiratory rate, breaths per minute*				
Mean (SD)	19.0 (5.6)	17.3 (2.5)	18.3 (4.7)	19.3 (5.9)
<12	366 (1.5)	8 (0.7)	32 (0.8)	326 (1.7)
12–20	19 087 (79.9)	1111 (95.0)	3507 (87.4)	14 469 (77.3)
21–27	3139 (13.1)	31 (2.7)	374 (9.3)	2734 (14.6)
≥28	1172 (4.9)	5 (0.4)	76 (1.9)	1091 (5.8)
Systolic blood pressure, mm Hg*				
Mean (SD)	134.3 (27.5)	132.3 (20.9)	133.0 (21.8)	135.6 (28.9)
<90	784 (3.3)	4 (0.3)	25 (0.6)	755 (4.0)
90–109	3108 (13.0)	670 (57.3)	2188 (54.5)	7948 (42.5)
110–139	10 806 (45.2)	118 (10.1)	472 (11.8)	2518 (13.5)
≥140	8911 (37.3)	340 (29.1)	1287 (32.1)	7284 (38.9)
Blood oxygen saturation, per cent bound Haemoglobin*				
Mean (SD)	96.2 (5.1)	98.0 (2.0)	97.5 (3.1)	95.8 (5.5)
<90	1060 (4.4)	1 (0.1)	33 (0.8)	1026 (5.5)
90–95	5768 (24.1)	103 (8.8)	596 (14.8)	5069 (27.1)
≥96	16 741 (70.1)	1035 (88.5)	3334 (83.1)	12 372 (66.1)
Glasgow Coma Scale*				
Mean (SD)	14.6 (1.7)	14.9 (0.8)	14.9 (0.8)	14.5 (1.9)
≤11	924 (3.9)	6 (0.5)	33 (0.8)	885 (4.7)
12	140 (0.6)	3 (0.3)	16 (0.4)	121 (0.6)
13	328 (1.4)	3 (0.3)	22 (0.5)	303 (1.6)
14	1939 (8.1)	19 (1.6)	139 (3.5)	1781 (9.5)
15	20 408 (85.4)	1124 (96.2)	3779 (94.1)	15 505 (82.9)
Blood glucose levels, mmol per litre*				
Total measured	468 (2.0)	12 (1.0)	52 (1.3)	404 (2.2)
Mean (SD)	8.1 (4.0)	6.5 (2.0)	7.4 (3.7)	8.2 (4.1)
<4	6 (0.0)	0 (0.0)	0 (0.0)	6 (0.0)
4–8	295 (1.2)	11 (0.9)	40 (1.0)	244 (1.3)
9–15	140 (0.6)	1 (0.1)	10 (0.2)	129 (0.7)
≥15	27 (0.1)	0 (0.0)	2 (0.0)	25 (0.1)

*First vital sign recorded by paramedics at the scene, prior to ED transport.
CTAS, Canadian Triage and Acuity Scale; ED, emergency department; Q1, first quartile; Q3, third quartile.

RESULTS

Figure 1 shows the cohort construction and linkage. Among 25 413 ED visits transported by paramedics and categorised using the EDAC, 23 891 (94.0%) were successfully linked to a paramedic ePCR. Of these, 1169 visits (4.9%) were classified as avoidable, 4014 (16.8%) as potentially avoidable and 18 708 (78.3%) as not avoidable.

Table 1 summarises the patient, clinical and administrative characteristics collected by paramedics prior to ED transport, categorised by ED visit grouping. Patients in the avoidable and potentially avoidable categories were predominantly aged 18–64 years, whereas the not avoidable group was characterised by a higher proportion of patients aged 65 and older. Gender was relatively balanced across all groups. While the majority of patients in all categories were classified under the urgent medical acuity level (CTAS 3), the not avoidable group exhibited significantly higher proportions of patients with resuscitation (CTAS 1) and emergent (CTAS 2) acuity levels. The average number of medications taken by patients increased progressively across groupings from 2.3 (SD 3.0) in avoidable to 3.2 (SD 3.8) in potentially avoidable to 5.2 (SD 4.7) in not avoidable. Certain clinical presentations were more prevalent in the avoidable and potentially avoidable groups. Anxiety and situational crises accounted for 8.7% and 9.9% of visits in these groups, respectively. Social problems (4.3%) and minor issues (11.6%) were notably more common in the avoidable class. Regarding vital

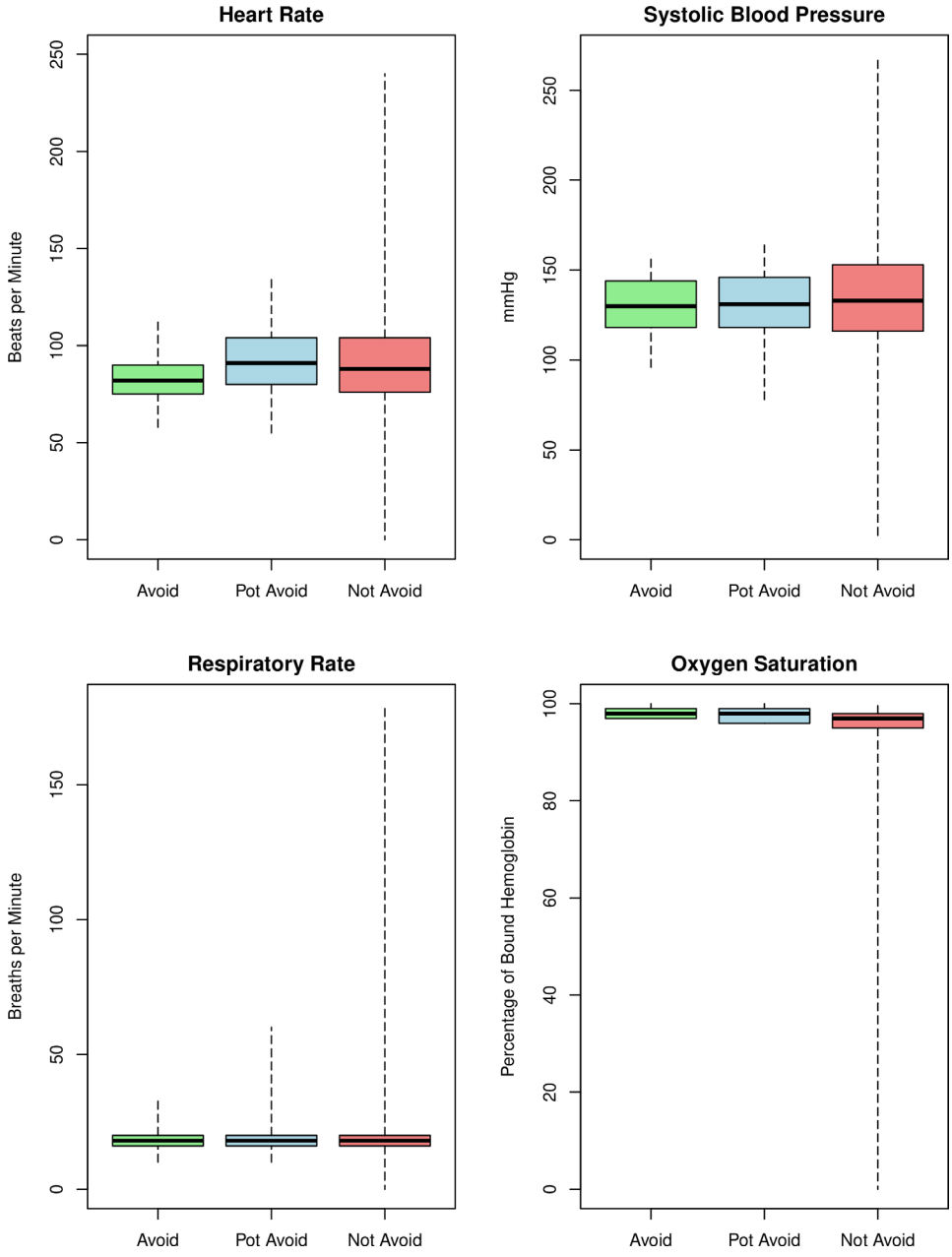

Figure 2 Box plots of first recorded vital signs by paramedics for each group of ED visit. ED, emergency department.

signs, avoidable visits showed fewer patients at the extremes of vital sign ranges, whereas the not avoidable group had a higher proportion of patients with vital signs outside normal limits. Mean HR, RR and SBP increased progressively across the ED visit groups, while mean blood oxygen saturation decreased. BGLs were measured minimally as an initial vital sign across all groups.

Figure 2 displays the box plots of the first recorded vital signs for HR, RR, SBP and blood oxygen saturation. Notable differences were observed between the avoidable and potentially avoidable groups compared with the not avoidable group, particularly in the variability and ranges of these vital signs. For HR, the IQR, a measure of variability calculated as the difference between the first and third quartiles (Q1, Q3), increased across the classes, with avoidable of 15 (Q1=75, Q3=90), potentially avoidable of 24 (Q1=80, Q3=104) and not avoidable of 28 (Q1=76, Q3=104). The HR range was also substantially wider for not avoidable visits (minimum 0, maximum 240), compared with avoidable (minimum 54, maximum 128) and potentially avoidable (minimum 50, maximum 138). SBP followed a similar trend as HR. For RR, the IQR and medians were nearly identical across all classes, but the overall range for the not avoidable group was significantly wider (minimum 0, maximum 180) compared with avoidable (minimum 10, maximum 34) and potentially avoidable (minimum 10, maximum 60). Oxygen saturation also showed a similar trend to RR, with comparable IQRs and medians across classes, but the not avoidable class had a minimum value of 0, while the avoidable and potentially avoidable categories had minimum values of 88 and 84, respectively.

Table 2 presents Firth's binary logistic regression results for the top 20 most frequently recorded primary concerns, ranked by total incidence, comparing avoidable and potentially avoidable ED visits to not avoidable visits. Paramedic transports for social problems had the strongest association (OR 16.7, 95% CI

Table 2 Top 20 most frequently recorded primary concerns for avoidable and potentially avoidable ED visits, with their associated odds

Primary concerns	Paramedic transports	OR (95% CI)*	P value	Adjusted p value (FDR)	Significant (q=0.10)
Anxiety/situational crisis	498	15.0 (4.0 to 75.1)	<0.05	<0.05	Yes
Depression/suicidal/deliberate self-harm	479	3.3 (0.9 to 14.8)	0.07	0.09	No
Shortness of breath	373	7.5 (2.1 to 34.9)	<0.05	<0.05	Yes
Abdominal pain	323	2.2 (0.6 to 10.8)	0.27	0.28	No
Lower extremity pain	290	9.0 (2.5 to 45.2)	<0.05	<0.05	Yes
Minor issues	256	7.8 (2.2 to 39.3)	<0.05	<0.05	Yes
Chest pain, non-cardiac features	242	6.5 (1.9 to 34.6)	<0.05	<0.05	Yes
Back pain	224	5.8 (1.6 to 32.1)	<0.05	<0.05	Yes
General weakness	212	3.7 (0.9 to 17.3)	0.07	0.09	No
Bizarre behaviour	210	5.6 (1.7 to 29.8)	<0.05	<0.05	Yes
Lower extremity injury	144	6.2 (1.7 to 33.7)	<0.05	<0.05	Yes
Hallucinations/delusions	138	7.0 (2.0 to 37.5)	<0.05	<0.05	Yes
Substance misuse/intoxication	124	5.2 (1.4 to 28.8)	<0.05	<0.05	Yes
Nausea and/or vomiting	123	3.8 (0.8 to 17.9)	0.10	0.12	No
Upper extremity injury	122	8.1 (2.2 to 24.1)	<0.05	<0.05	Yes
Upper extremity pain	108	10.3 (2.9 to 55.2)	<0.05	<0.05	Yes
Laceration/puncture	93	11.0 (3.3 to 62.0)	<0.05	<0.05	Yes
Social problem	82	16.7 (4.5 to 95.5)	<0.05	<0.05	Yes
Head injury	66	3.9 (0.7 to 17.3)	0.26	0.29	No
Cough/congestion	66	12.5 (3.2 to 65.4)	<0.05	<0.05	Yes

*Comparison to reference group Not Avoidable emergency department visits.
ED, emergency department; FDR, false discovery rate; q, q value.

4.5 to 95.5) with avoidable and potentially avoidable visits, with other strongly associated issues including anxiety or situational crisis (OR 15.0, 95% CI 4.0 to 75.1) and cough or congestion (OR 12.5, 95% CI 3.2 to 65.4). Other notable problems included laceration or puncture (OR 11.0, 95% CI 3.3 to 62.0), upper extremity pain (OR 10.3, 95% CI 2.9 to 55.2), lower extremity pain (OR 9.0, 95% CI 2.5 to 45.2), minor issues (OR 7.8, 95% CI 2.2 to 39.3) and chest pain with non-cardiac features (OR 6.5, 95% CI 1.9 to 34.6). Overall, the top 20 primary concerns accounted for 80.5% (4173 of 5183) of all avoidable and potentially avoidable ED visits. None of the top 20 primary concerns that were found to be significant in Firth's logistic regression became insignificant after adjusting for a 10% FDR.

DISCUSSION

Our study indicated that certain patient cohorts met by paramedics in the community, particularly middle-aged individuals with low medical acuities, non-emergency issues and normal vital signs, could be strong candidates for paramedic transport to non-ED healthcare centres. By identifying specific primary concerns associated with avoidable and potentially avoidable ED visits before arrival, this research provides valuable evidence to inform paramedic guidelines surrounding patient identification in the community to reduce some ED utilisation and strain.

Our findings align with existing research showing that young-to-middle aged adults with lower-acuity conditions frequently visit EDs for issues manageable outside of the ED.[28–30] Prior studies have similarly highlighted age and acuity as key factors in primary care-like ED utilisation, suggesting that these characteristics could inform decisions to divert patients to alternative care pathways.[29 31] However, most previous research on avoidable ED visits focuses on data collected during the ED encounter, offering limited insight into prehospital factors such as vital signs and issues assessed before ED transport. By addressing this gap, our study contributes a unique perspective on patient profiles that may benefit from alternative care models.

Patients in the avoidable and potentially avoidable categories shared common characteristics, with only minimal subtle differences. Avoidable ED visits were predominantly associated with younger to middle-aged adults presenting with low-acuity triage scores (30.3% CTAS 4, 17.4% CTAS 5), normal vital signs and fewer prescribed medications, suggesting fewer chronic medical conditions. Patients in the potentially avoidable group exhibited slightly higher acuity levels (73.5% CTAS 3), slightly wider ranges of vital signs (though generally within normal limits) and more varied problems, including anxiety, minor injuries and situational crises. When analysed collectively, several primary concerns emerged as strong predictors of avoidable or potentially avoidable ED visits. We have strong evidence that our primary concerns are robust, as none lost significance after adjusting for multiple comparisons using the FDR. These included social problems, anxiety or situational crises, cough or congestion, lacerations or punctures and extremity pain. Some problems exhibited relatively wider CIs due to increased variability around the point estimate; however, their directionality for determining meaningful associations was important when the lower bound exceeded one. Such problems, combined with clinical factors of normal vital signs and non-emergent medical acuities, could guide paramedics to identify patients suitable for non-ED care settings, such as urgent care centres or community clinics. For example, a middle-aged patient who called 911 for a minor arm laceration accompanied by upper extremity pain, with normal vital signs, could be assessed by paramedics as a candidate for transport to an urgent care centre or a community health clinic instead of an ED.

In contrast, the not avoidable group displayed considerable heterogeneity in clinical characteristics and a broad range of vital sign parameters. This variability may offer useful insights for paramedics when determining which patients to exclude at the scene for non-ED care models. Specifically, if a patient's vital signs fall outside defined minimum or maximum vital sign thresholds, they may be considered unsuitable for redirection.

As a result, these patients are best managed in the ED, where a broader range of diagnostic and treatment resources is available.

Integrating clear evidence-based criteria into paramedic assessments—such as specific primary concerns, vital sign ranges and acuity levels—could support informed decisions about which patients might be safe to redirect to non-ED care, and which require ED-level intervention. These criteria could form the basis for standardised protocols that enhance the safety and effectiveness of alternative care models for paramedics.

Redirecting specific patients to appropriate healthcare models that avoid transport to crowded EDs could yield several benefits. First, it could reduce the strain on EDs by decreasing the volume of low-acuity patients, potentially improving ED efficiency, department flow and resource allocation, although evidence on the magnitude of this impact has been mixed.[32] Second, for patients, being transported to facilities with potentially shorter wait times may enhance their overall experience, satisfaction and, in some cases, health outcomes. Third, for paramedic services, this approach could facilitate quicker offloading of patients, addressing a critical challenge of delayed ED transfers that reduce paramedic availability for emergency responses in the community.[33] Finally, for the healthcare system, providing care for low-acuity patients in non-ED settings may lead to significant cost savings, an essential consideration in resource-limited universal healthcare systems.[14]

Future research is needed to build on these findings by developing and validating predictive models that assess the effectiveness of the variables identified in this study to forecast avoidable ED visits. Additionally, practical barriers to implementation, such as paramedic training, quality assurance and operational constraints, should be explored to ensure the successful integration of prehospital triage and redirection protocols in real-world settings.

LIMITATIONS

This study used linked data between a single academic hospital and paramedic service, which may limit the generalisability of the findings to other settings with different healthcare systems or patient populations. Clustering of primary concerns could not be performed or analysed due to the absence of a standardised codification system for paramedics, unlike the structured classification systems used in ED diagnostics. Differences in paramedic training, healthcare policies and the availability of community-based care services may influence the applicability of these results in other settings.

CONCLUSION

By identifying key patient characteristics and problems that contribute to avoidable and potentially avoidable ED utilisation, our findings provide a foundation for developing predictive models and triage protocols that could support paramedics to redirect some specific patients to appropriate non-ED care settings. Implementing such evidence-based care models has the potential to reduce ED congestion, optimise healthcare resources and contribute to a more efficient and patient-centred healthcare system.

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