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The appropriateness of cases presenting in the emergency department following secondary telephone triage: A data linkage study.

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Key words: Health Services Misuse; Health Services Needs and Demand; Triage; Telephone; Referral and Consultation

Objective

To investigate the appropriateness of the emergency department (ED) presentation of cases following an ambulance-based secondary telephone triage.

Design

A pragmatic retrospective cohort analysis of all the planned and unplanned ED presentations within 48 hours of a secondary telephone triage.

Setting

The secondary telephone triage service, called the Referral Service (RS), and the hospitals were located in metropolitan Melbourne, Australia and operated 24 hours a day, servicing 4.25 million people. The RS provides an in-depth secondary triage of cases identified as low-acuity when calling the Australian emergency telephone number.

Population

Cases triaged in full by the RS (N=103,768) between September 2009 and June 2012 were linked to ED and hospital admission records. Planned ED presentations were cases referred to the ED following the RS triage, unplanned ED presentations were cases that presented despite being referred to alternate healthcare providers.

Main outcome measures

Appropriateness was measured using an ED suitability tool and hospital admission rates. These were compared to mean population data which consisted of *all* of the ED presentations for the state (termed the 'average ED presentation').

Results

The deterministic linkage process yielded an 80% linkage rate between ambulance and hospital data. Planned ED presentations were more likely to be ED suitable than unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; P<0.001) and the average ED presentation (OR1.85; 95% CI 1.01 to 3.4; P=0.046). They were also more likely to be admitted to the hospital than the unplanned ED presentation (OR 1.5, 95% CI 1.4 to 1.6; P<0.001) and the average ED presentation (OR 2.3, 95% CI 2.24 to 2.33; P<0.001).

Conclusions

This study successfully utilized linked data to analyse the appropriateness of ED presentations following secondary telephone triage, providing a methodological approach for future research. Secondary telephone triage was able to appropriately identify ED suitable cases.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first Australian study to link secondary telephone triage records to emergency department (ED) and hospital records to track a patient's process through the prehospital to hospital healthcare system.
- This is the first large-scale study to investigate the appropriateness of cases presenting in the ED following secondary telephone triage.
- This study did not rely upon expert opinion to measure appropriateness but used a range of independently derived ED outcomes to assess appropriateness.
- Cases referred to services other than the ED could not be linked to their corresponding service records limiting the analysis of these cases.

AUTHOR CONTRIBUTORS

Author contributions were as follows:

Ms Kathryn Eastwood: Study conception, conducted the data-linkage for the Ambulance Victoria data sets, analysed data and wrote the paper.

Professor Karen Smith: Discussed core ideas to study, oversaw the data extraction, consulted on the data analysis and edited the paper.

Dr Amee Morgans: Discussed core ideas, consulted on the data analysis and edited the paper.

Professor Johannes Stoelwinder: Discussed core ideas to study, edited the paper. Professor Stoelwinder is Ms Eastwood's Primary PhD supervisor.

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The staff from the Victorian Data Linkages unit at the Victorian Department of health who conducted the hospital data extraction and linkage to the pre-linked Ambulance Victoria data sets.

TRANSPARENCY DECLARATION

Kathryn Eastwood affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

ETHICAL APPROVALS

Ethics approval was granted by the Monash University Human Research Ethics Committee (CF12/0547-2012000215) and the Ambulance Victoria Research Committee (R11-021).

FUNDING STATEMENT

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INTRODUCTION

An increasing proportion of ambulance service and emergency department (ED) workload involves patients with low-acuity health events that do not require the specific resources provided by these services.[1-19] Responding to these cases with traditional emergency ambulance attendance and transport to a hospital ED negatively impacts on ambulance services' efficiency and efficacy by reducing the availability of these resources for emergency cases and thus potentially compromising patient outcomes.[8,17,20,21] Unnecessary ED users place a similar stress upon the ED and often present with conditions that are best managed in community-based healthcare services rather than the ED.[18,21] For both of these services, their ability to expand resources to meet this increasing demand is limited, and as a result, alternative strategies are being implemented to manage low-acuity cases.[22-31]

Secondary telephone triage has been used by some ambulance services as a demand management strategy for the identification and referral of low-acuity cases to primary health care services and away from the emergency care pathways involving ambulances and the ED.[1,32] Ambulance Victoria (AV) in Melbourne, Australia, operates the Referral Service (RS), which manages nearly 12% of the total emergency ambulance workload by diverting 72.4% of its cases away from emergency ambulances and 32.2% away from the ED.[1] This strategy has had a measurable impact in metropolitan Melbourne and across Victoria on acute ambulance transports.[33]

Despite the impact seen by AV, some cases remain or re-emerge in the emergency care pathways following RS triage.[1,34] These cases may appear to be contrary to the policy intention of removing low-acuity cases from the ambulance workload, and consequently the ED workload. There are, however, two groups of cases that attend the ED after secondary telephone triage -- those that are planned and those that are not. *Planned ED attendances* are cases identified at secondary telephone triage as suitable to remain in the emergency care pathways. These cases may be sent an emergency ambulance, non-emergency ambulance or referred to self-present at the ED.[1] If these cases turn out to be inappropriate for the ED, they may have been incorrectly triaged by the secondary telephone triage service. *Unplanned ED attendances* are cases that present in the ED despite being referred to alternative care pathways. These pathways include a range of alternate service providers (ASPs) used by AV, referral to the patient's own general practitioner (GP) or allied health carer, or where the patient may have been given home-care advice to manage their presenting problem.[1] If these cases are appropriate for the ED they may represent a cohort of cases that are potentially incorrectly triaged by the secondary telephone triage service.

The effectiveness of an ambulance-based secondary telephone triage service is reflected in its ability to provide patients with the most appropriate care for their needs. The appropriateness of the ED presentation of cases following secondary telephone triage has only been investigated in two small trials which found that patients were more likely to be admitted to the hospital if they were identified as being suitable to remain in the emergency care pathways (ie. they were a planned ED attendance).[26-28] No large scale evaluations have been conducted using an established secondary telephone triage service operating within an ambulance service.

The aim of this study was to investigate the appropriateness of the ED presentation of cases following secondary telephone triage by the RS.

METHODS

Design

A pragmatic retrospective cohort analysis was conducted of all the planned and unplanned ED presentations within the emergency care and alternative care pathways within 48 hours of a RS triage.

Setting

Ambulance Victoria is a statewide publicly funded ambulance service operating in the state of Victoria, Australia. In June 2012, 4.25 million people lived in metropolitan Melbourne which covers an area of approximately 10,000km^2.[35] During the study timeframe the RS operated within metropolitan Melbourne 24 hours a day, seven days a week.

The Referral Service has been described extensively elsewhere.[1] Briefly, this service provides a secondary telephone triage, conducted by qualified nurses or paramedics, to cases identified as low-acuity during the call to the emergency services telephone number (in Australia, this is triple zero), based on pre-specified Advanced Medical Priority Dispatch System (AMPDS) codes. RS call-takers use a condition-specific computer-based questioning algorithm (CECC –Care Enhanced Call Centre),[36] to arrive at a disposition with a recommended resource allocation outcome as listed below:

<u>Emergency care pathways</u>

1. Return for emergency ambulance dispatch;
2. Non-emergency ambulance dispatch;
3. Advise the patient to self-present at the ED;

<u>Alternative care pathways</u>

4. Referral to an Alternative Service Provider (ASP); or
5. Self-management advice including home care or to seek further non-urgent medical attention independently (please refer to Figure 1).

**Please insert: Figure 1

Figure 1: Case-flow from the call to the emergency services to RS outcome

The ASPs that the RS utilizes include locum doctor services, home-visiting nurses, hospital outreach programs (that send allied health staff into the community), crisis assessment and treatment team (CATT) for psychiatric cases, poisons telephone advice line, and other services that can assist with

non-medical issues such as lifting patients. The only ASP data available for review was data from the locum doctor services.

Data Sources

Referral Service

RS records between September 2009 and June 2012 were extracted from the Referral Service database. Data items included case date and time, case number, de-identified patient-specific code, date of birth, age, gender, suburb, presenting problem, free text entry with details of the patient triage, and triage disposition.

Electronic Patient Care Records (ePCRs)

Where paramedics attended patients, an electronic patient care record documenting assessment, treatment, demographic and operational information was generated. ePCRs for RS cases were extracted. Data items included case date and time, case number, Medicare suffix (first 3 characters of the patients given name), date of birth, age, gender, suburb, dispatch urgency, treatment, transport outcome, destination hospital (where appropriate), and transport urgency (where appropriate).

ASPs

Locum doctor records between January and December 2011 for RS cases were available for inclusion in this study. These records outlined the management and outcome of the interaction with the locum service. Data items included locum suitability, whether the referral was cancelled, management outcome, presenting symptoms and a free text entry field.

Victorian Emergency Minimum Dataset (VEMD) and the Victorian Admitted Episode Dataset (VAED)

Hospital data was sourced from the Victorian Emergency Minimum Dataset (VEMD) and the Victorian Admitted Episode Dataset (VAED). The VEMD contains de-identified administrative, demographic, treatment and clinical information detailing ED presentations at designated Victorian public hospitals and others as directed by the Victorian Government Department of Health and Human Services (DHHS).[37] Similarly the VAED contains de-identified administrative data for Victorian hospital admissions.[38] VEMD data is not collected from private hospitals (privately owned hospitals running on a user-pays system), and in this study only five (0.2%) of the cases transported to private hospitals had a corresponding VEMD record. Given the small numbers only public hospital data was utilized. Variables extracted included case date and time, de-identified patient-specific code (this is a different code to that used in the RS dataset), ICD-10-AM code (International Classification of Diseases, 10th Edition, Australian Modification), arrival mode, ED triage category, outgoing referral, admission and death.

Mean Population Data

Finally aggregate data pertaining to all Victorian ED attendances between July 2011 and June 2012 was obtained from the Australian Hospital Statistics report.[39] Data collected included hospital admission rates and ED suitability outcome rates (discussed further below).

Data Linkage

Deterministic data-linkage was used to link the RS and AV ePCR data for cases referred to the emergency ambulance pathway.[40] The variables used for linkage included case date, case number, date-of-birth (DOB), age, gender and suburb.

The AV datasets were then linked to the hospital datasets (VEMD and VAED) also using deterministic data linkage methods.[40] For this linkage ambulance case number, Medicare suffix, DOB, address (postal code or locality), and record date within 48 hours of arrival at the ED were used. The algorithm utilized allowed for a single day discrepancy in date of birth, date of AV records and date of VEMD/VAED records.

Insufficient data was available to allow for reliable linkage of the resultant RS-ePCR-VEMD-VAED dataset with the locum doctor service data. A deterministic data-linkage was attempted between the datasets using case date and case number. This returned five linkages for cases seen by the locum service. A further 16 linkages were made, however these were cases where the RS had dispatched an emergency ambulance and attending paramedics subsequently arranged for a locum visit. Given the poor linkage rate (0.2%) linkage was not utilized in the data analysis.

Patient Involvement

Given the retrospective nature of this study and the use of established data sources no patients were involved in this study.

Patient Outcomes

General demographic and patient outcome information was collected during this study. This included patient age, and gender. For cases returned to ambulance dispatch the rate of ambulance transportation was assessed. For cases referred to locum doctors, the management, rate of return to ambulance and recommendations to present at the ED were also assessed.

Indicators of appropriateness

In this study admission to hospital and ED suitability were used as indicators of appropriateness for cases that presented at the ED.

ED suitability

ED suitability was based on a modified version of the 'potentially avoidable GP-type presentation'.[39] Potentially avoidable GP-type presentations are ED presentations that are considered avoidable had an appropriate community-based service been accessed.[39] A 'potentially avoidable GP-type presentation' is defined as cases that present to an ED where the patient:

- Was triaged as a category 4 or 5 according to the Australian Triage Scale;[41]
- Did not arrive by ambulance;

- Was not admitted to the hospital, referred to another hospital, and
- Did not die.[39]

This 'potentially avoidable GP-type presentation' outcome was modified in this study to exclude the criterion involving arrival by ambulance and was referred to as 'ED suitability'.

Hospital admission

Despite hospital admission being used as part of the ED suitability indicator, this indicator has also been used in isolation in other studies[26,28] and was retained as it was provided by both public and private hospitals, therefore allowing for private hospital admission results to be included and for the results to be compared to those of other studies.

Locum appropriateness

For the cases that were seen by the locum doctors, appropriateness was assessed using the managed outcome, and more specifically, whether a case was returned for an emergency ambulance dispatch. The locum services also had the opportunity to report whether they felt the cases were appropriate for them upon handover of the case from the RS.

Average ED Presentation for Victoria

Each year the Australian government report the overall rates of hospital admission and 'potentially avoidable GP-type presentations' for all public hospital ED presentations in each state of Australia.[39] The overall rates are inclusive of all ED attendances, including RS cases referred to the emergency care pathways. The overall rates for Victoria are referred to as 'the average ED presentation' in this paper.

Data Analysis

Data were analysed using descriptive statistics, chi-squared tests of association, independent samples t-tests and logistic regressions to identify relationships with 95% CIs. All tests were considered to be significant at 0.05 level. All data analysis was performed using SPSS Version 20.[42]

RESULTS

Data Linkage

The deterministic data linkage process to link the two AV datasets (RS and ePCRs) had a 94.7% linkage rate. The linkages were verified based on case-time, presenting problem, urgency level set by RS call-takers and free-text analysis where required. This process resulted in seven linkages within the entire linkage process that could not be verified as a true match (0.0003% error rate).

Validation of the probabilistic linkage between the linked AV datasets and the hospital datasets was completed using gender. A mismatch was identified for 2% of linkages and these were discarded (n=856). Linkages where the ED or hospital record occurred before RS triage were also discarded (n=2,300).

Figure 2 depicts the proportion of cases for each of the three emergency care pathways for which an ED record was linked. Cases in the emergency ambulance pathway had the highest rate of linkage to ED records. Some cases in this pathway were found to have been transported to private hospital, meaning no ED record was available in the VEMD, or left at home after paramedic assessment. After accounting for these cases only 15.7% of unlinked cases were unable to be accounted for. Therefore the rate of probabilistic linkage was >80% between the ambulance and hospital datasets.

Over half of the 'non-emergency ambulance' cases (57.3%) and 42.8% of the 'self-present at ED' cases were linked to an ED record or a hospital admission record (Figure 2).

The number of cases with no corresponding ED record increased as emergency care pathway acuity level decreased ($p<0.001$) (Figure 2). A comparison was conducted of the cases within the emergency care pathways based on whether they had an ED record or not (Table One). This was done to identify any potential for systematic bias exerted by the missing cases.

Significance testing was pragmatically unsuitable for this systematic bias evaluation because the large size of the dataset would result in a high level of statistical sensitivity to small distribution differences. This is demonstrated in Table One, where despite some areas of statistical significance, the actual differences for age and gender between the 'ED record' and 'no ED record' groups were unlikely to be clinically significant. When comparing the presenting problems of the cases within each group in Table One there was also little variation in the three most common case types between those with and without an ED record. Therefore age, gender and presenting problem were considered as not imposing any great bias on the results, and the results presented in this paper were considered to be representative of the cases referred to the emergency care pathways by the RS.

**Please insert: Figure 2

Figure 2: linkage outcomes for each of the emergency care pathways

Outcomes

During the study timeframe AV received 1,036,114 calls through the emergency services telephone number. A total of 123,458 (11.9%) were triaged by the RS, and 107,148 case records were available for this study (86.8%). From this, 103,768 (96.8%) cases had undergone a complete RS triage and were either sent to the emergency care pathways and able to be linked to one, or all of the other

datasets available, or were sent to the primary care pathways. There were 72,141 planned ED presentations (cases referred to the emergency care pathways). However, hospital records were only identified for 39,820 (55.2%) of the planned ED presentation cases. Further to this, an additional 4,703 unplanned ED presentations were identified from the alternative care pathways. Therefore the overall linked study population used for analysis involved 44,523 cases.

Care Pathway Outcomes

The distribution of the triage outcomes are shown in Figure 3. Over the study period 69% of cases were referred back to one of the emergency care pathways and 31% were triaged to the alternative care pathways.

**Please insert: Figure 3

Figure 3: Outcome distribution following RS triage (n=103,768)

Within the alternative care pathways, cases that were referred to ASPs included 8,656 (75.6%) cases that went specifically to locum doctors. Cases in the care advice group were expected to self-manage their ongoing care and finally the 'care plan' cohort of cases consisted primarily of frequent callers with psychiatric histories. Care plans were devised to manage these patients outside of the hospital and emergency ambulance setting.[1]

ED presentation

Eleven percent (4,703) of patients that presented in the ED following RS triage were unplanned ED presentations (i.e. triaged to the alternative care pathways). This accounted for 14.9% of the cases triaged to alternative care pathways, and included ED records for 19.3% of cases that were originally referred to locum doctors and 12.5% of the cases given self-care advice.

Patient demographics

The gender distribution for cases presenting to the ED was similar for all groups except those with care plans who were predominantly male (53.4%) (Table Two). Triage outcomes that required the patients to self-source further care, including the 'self-present at the ED' cases and 'self-care advice' cases were younger than those sent further care (Table Two).

Locum doctor cases

During the timeframe the locum doctor records were available, there were 3,134 referrals to this

pathway, and records for 83.4% (2,615) of cases were identified. Twenty-five percent of cases referred to the locum doctors were cancelled either prior to, or on arrival of the doctor. The most common reasons for this were that the patient felt they no longer required the doctor (42.4%), that the patient refused their services (17.9%), and finally that the locum service were not able to service the location in which the case was located (16.8%).

Over half of the cases referred to a locum doctor presented in the ED within 48 hours of their original RS triage (1,668; 53.2%). Due to the inability to link the data it was not possible to identify which of these cases had cancelled the locum service, which had been referred to the ED by the locum doctor and which presented after being given other advice or treatment by the locum doctor.

When reviewing the cases that the doctors attended (1,954 cases), they only referred 123 (6.3%) cases back to either emergency ambulance (15 cases; 0.8%), non-emergency ambulance (53 cases; 2.7%) or to self-present at the ED (55 cases; 2.8%). None of the cases returned to emergency ambulance were coded as potential high-acuity. No further information was available about the rationale for the referral of these cases back into the emergency care pathways. None of the cases available for review were highlighted by the locum service as inappropriate upon their handover from the RS.

ED suitability

For the cases that attended the ED, the planned ED presentations were more likely to be classified as ED suitable than the unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; p<0.001). The planned ED presentations were also more likely to meet the ED suitability criteria than the average ED presentation (OR 1.85; 95% CI 1.01 to 3.4; p=0.046). When the small number of care plan cases were excluded from the unplanned ED presentations, there was no significant difference in the rates of ED suitability between the unplanned ED presentations and the average ED presentation (OR 1.14; 95% CI 0.6 to 2.0; p=0.66).

Hospital Admission

Planned ED presentations were significantly more likely to be admitted to hospital than unplanned ED presentations (OR 1.5, 95% CI 1.4 to 1.6; p<0.001). Hospital admission was highest amongst the cases transported by emergency or non-emergency ambulance. (Table Two). Due to the inability to link ASP data with the other datasets, it cannot be determined what proportion of cases were admitted following ASP referral to ED, however overall 11.4% of cases referred to locums were admitted to hospital within 48 hours of the RS triage.

The planned ED presentations, and the unplanned ASP ED presentations displayed higher absolute risks of admission, 53.8% and 51.3% respectively, than the average ED presentation (36.0%). Overall both the planned ED presentations (OR 2.3, 95% CI 2.24 to 2.33; p<0.001), and the unplanned ED presentations (OR 1.6, 95% CI 1.5 to 1.73; p<0.001) were more likely to be admitted than the average ED presentation. As with ED suitability, cases advised to self-care who subsequently presented to the ED had absolute risks of admission lower than the cases that RS arranged or advised further medical assessment for (Table Two).

DISCUSSION

Previous research has identified that whilst the primary goals of ambulance-based secondary telephone triage systems are similar, no two systems are alike.[26,28,34,43]

The research into the appropriateness of these systems has utilized many different criteria and methodologies.[20] Many of these methodologies have been based on expert opinion, leaving the analysis open to personal bias which often resulted in a lack of consensus amongst the experts used.[44] The heterogeneity of the systems (and the ambulance services within which they are embedded), along with the limitations in previous research designs, means comparison of findings is often limited if possible at all. Whilst the variation in secondary telephone triage system structure and functionality could not be addressed in this study, the research variables used were specifically selected to allow for similar methodological approaches, less vulnerable to personal opinion, to be utilized in future work.

The variables used in this study allowed for an unbiased retrospective analysis of appropriateness, based upon decisions made by healthcare professionals during the patient care phase. These variables are also likely to be recorded in most emergency departments and the decisions associated with these variables were made independently of any consideration of whether the particular visit was appropriate.

This was the first large-scale study to link ambulance service data and hospital data to investigate the outcomes of both planned and unplanned ED presentations following an ambulance-based secondary telephone triage. The linkage processes used in this study produced adequate linkages, however there were still many cases unaccounted for. There are several possible reasons for a failure of an appropriate linkage, or for records to not have been available for linkage. These include private hospital attendance, transcription errors in case numbers and dates-of-birth during data acquisition and handovers, usage of a written paper PCR rather than an ePCR, ambulance cancellation prior to arrival and patient non-compliance.[45] This highlights a need for consistent patient identifiers and a means of transcribing data at the various transitions of care that reduces errors, such as electronic transfer.

The outcomes of this study support the research indicating that ambulance-based secondary telephone triage is a feasible and effective demand management tool for ambulance services, with 28.5% of cases being diverted away from emergency ambulance resources and 69% of cases ultimately being referred to the ED.[26,28,29] Like the previous research, our study has identified that planned ED presentation cases were more likely to be admitted to the hospital.[26,28] The planned ED presentations in this study were also more suitable for the ED and were admitted at a higher rate than the average ED presentation. The decision to send cases to the alternative care pathways appears sound with over 85% not emerging in the emergency care system within 48 hours. However the unplanned ED presentations that had a locum doctor triage outcome demonstrated higher rates of ED suitability and admission than the state-wide average ED presentation. This is not necessarily a failure of the triage process to refer the case to the locum service as no cases were identified as unsuitable during case transfer. The inability to link the locum data to the other datasets meant that no further analysis could be conducted. Given the rates of ED suitability and admission, further investigation is warranted to determine if more sensitivity can be introduced to identify which ASP cases may result in an ED presentation.

The cases that the RS arranged or advised further medical assessment for (the emergency care pathways and cases referred to ASPs), returned ED suitability rates above that of the average ED presentation for the state. Cases given self-care advice or managed as per their care plan, who went on to present in the ED had rates below that of the average population. This indicated that the RS was able to effectively delineate between the cases that were appropriate for further assessment and those that were not.

Whilst these results indicate that the RS was appropriate in filtering the cases ultimately destined for the ED, more can potentially be done to increase the sensitivity and specificity of the triage process. The unplanned ED presentation cases need to be further investigated to determine whether their condition evolved within the potential 48 hour window between RS triage and ED presentation, whether they should have been triaged to the emergency care pathway, or whether other services, not within the suite of ASPs used by the RS, would have been able to manage these cases in the primary care setting.

Similarly cases from the planned ED presentation pathway that were not ED suitable, or not admitted need to be further investigated to determine if a primary care alternative is available to manage these cases out of the hospital setting. Optimizing the suite of pathways available to the RS call-takers may lead to increased specificity of cases for emergency ambulance and the emergency department, therefore increasing the effectiveness of the RS.

This study was limited by the inability to link the ASP data to the remaining datasets. This inhibited the investigation of particular sub-cohorts for patterns as they progressed through their care. Emergency care pathway groups who did and did not have an ED record were compared to identify any major differences that may affect the results, and whilst no clinically significant difference between the group demographics and presenting problems were found, the lack of this volume of cases from each pathway has the potential to exert a systematic bias on the results.

Further outcome identification of cases in the non-emergency ambulance or self-presentation pathways was not possible as no further documentation (in the setting of the non-emergency ambulance) was available to inform the researchers about transportation status or destination ED. As stated in the method section, most private hospitals do not release ED data to the VEMD so records for cases presenting to these hospitals were therefore not included in the analysis.

The mean population data for the average ED presentation included all of the patient presentations for the time period. Therefore the data pertaining to cases returned from the RS to the emergency care pathways was also present within the 'average ED presentation' data. This will impact upon the ED suitability indicator by increasing the overall rates of ED suitability for the 'average ED presentation' group. Finally the ED suitability measure was directly compared to the 'potentially avoidable GP-type presentations' despite their slight difference.

CONCLUSION

This study successfully utilized linked ambulance and hospital data to analyse the appropriateness of the referral of cases for ED presentation following secondary telephone triage and provided a methodological approach that can be applied in future research. Overall secondary telephone triage was able to appropriately identify cases that were suitable for the ED and that would be admitted, at

a rate higher than that of the average ED presentation. It was able to delineate between cases suitable for the emergency care pathways or the alternative care pathways. Further investigation is required to optimize the suite of alternate pathways to emergency ambulance and ED presentation to ensure the right patient is being triaged to the right service.

DATA SHARING STATEMENT

Data sharing: no additional data available.

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	ED record			No ED record found				Significance test	
	Age	Female (%)	Main presenting problem with RS (%)	Age	Female (%)	Main presenting problem with RS (%)	Missing cases (%)	Age	Gender
Emergency ambulance	56	54.3	Abdominal pain (17.0) Back pain (9.8) Dizziness & vertigo (5.7)	56	56.1	Abdominal pain (14.9) Back pain (9.2) Dizziness & vertigo (7.1)	37.2	t(21820.5) = -1.82, p=0.068	Chi-square = 9.14, df=1, p<0.002
Non-emergency ambulance	65	53.2	Abdominal pain (24.6) Back pain (7.2) Urinary symptoms (6.9)	66	53.9	Abdominal pain (24.6) Back pain (6.4) Urinary symptoms (6.0)	47.8	t(19432.2) =4.26, p<0.001	Chi-square = 1.04, df=1, p=0.31
Self-present at ED	44	55.5	Abdominal pain (21.0) Back pain (7.1) Flank pain (5.8)	41	56.4	Abdominal pain (21.4) Back pain (6.7) Nausea and vomiting (4.9)	59.6	t(22754) =-7.34, p<0.001	Chi-square = 1.72, df=1, p=0.2

Table One: Comparison of emergency care pathways cases that were matched to an ED record

				ED suitability			Hospital admission		
		Female %	Median age	Absolute Risk (%) for RS cases that attended ED	Absolute Risk (%) for All Victorian ED attendances	OR (95% CI; P value)	Absolute Risk (%) for RS cases that attended ED	Absolute Risk (%) for All Victorian ED attendances	OR (95% CI; P value)
Planned ED presentations (Emergency care pathways)	**Emergency ambulance** (N=18,578)	54.3	60	77.8	61.0	2.0 (95% CI 1.9 to 2.0; p<0.0001)	55.0	36.0	2.4 (95% CI 2.3 to 2.5; p<0.0001)
	Non-emergency ambulance (compared to all cases transported by emergency ambulance (N=10,348)	53.2	70	71.3		1.4 (95% CI 1.3 to 1.5; p<0.0001)	58.3		2.7 (95% CI 2.6 to 2.9; p<0.0001)
	Referred to self-present at ED (compared to all cases transported by emergency ambulance) (N=9,184)	55.5	41	70.6		1.3 (95% CI 1.3 to 1.4; p<0.0001)	46.4		1.7 (95% CI 1.6 to 1.8; p<0.0001)
Unplanned ED presentations from the Alternative care pathways	**Cases referred to an ASP** (N=2,207)	53.2	59	68.8		1.2 (95% CI 1.1 to 1.4; p<0.0001)	51.3		2.1 (95% CI 1.9 to 2.2; p<0.0001)
	Cases referred to locum doctor services (N=1,668)	54.5	57	68.7		1.2 (95% CI 1.1 to 1.4; p<0.0001)	51.7		2.1 (95% CI 1.9 to 2.3; p<0.0001)
	Cases given self-care advice (N=2,285)	52.6	47	60.3		0.9 (95% CI 0.8 to 0.9; p<0.0001)	39.4		1.3 (95% CI 1.2 to 1.4; p<0.0001)
	Cases managed as per their care plan (N=211)	46.6	52.2	56.9		0.7 (95% CI 0.6 to 0.97; p=0.029)	5.7		0.1 (95% CI 0.1 to 0.2; p<0.0001)

Table Two: Hospital management of cases that presented at ED following RS triage.

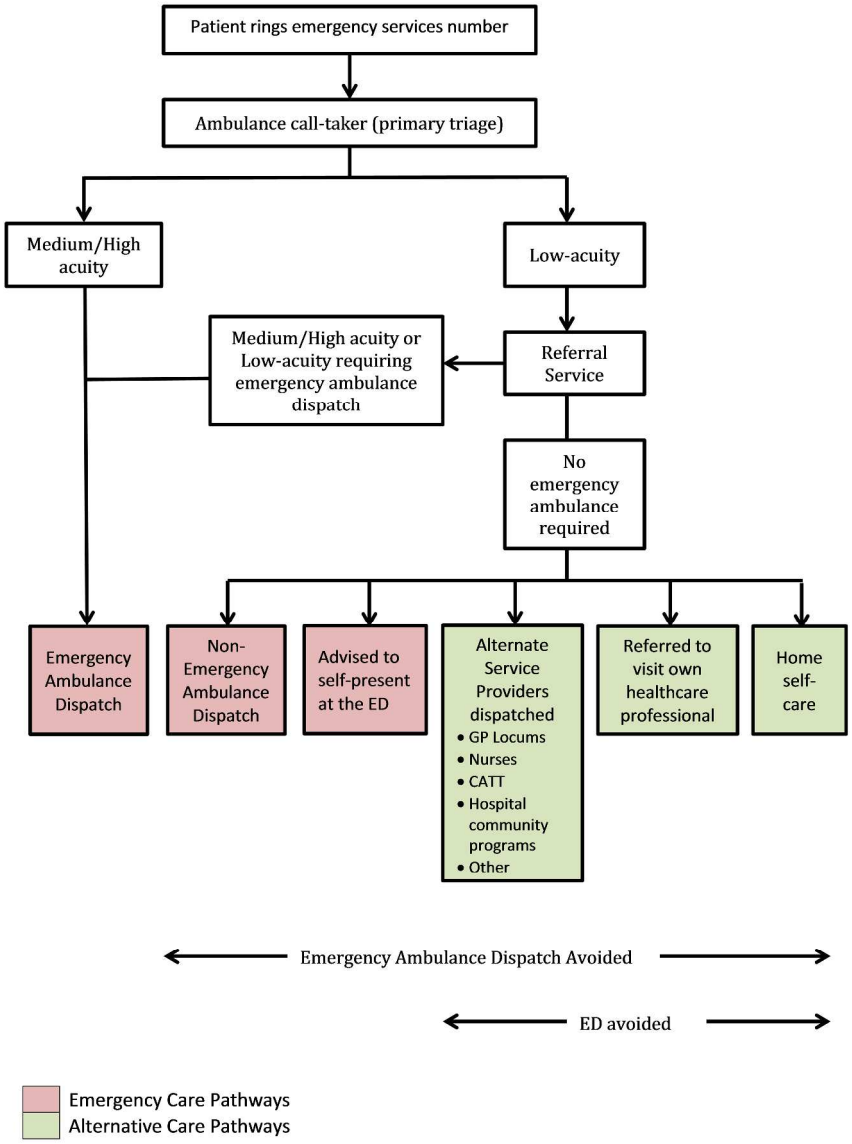

Figure 1: Case-flow from the call to the emergency services to RS outcome

943x1229mm (120 x 120 DPI)

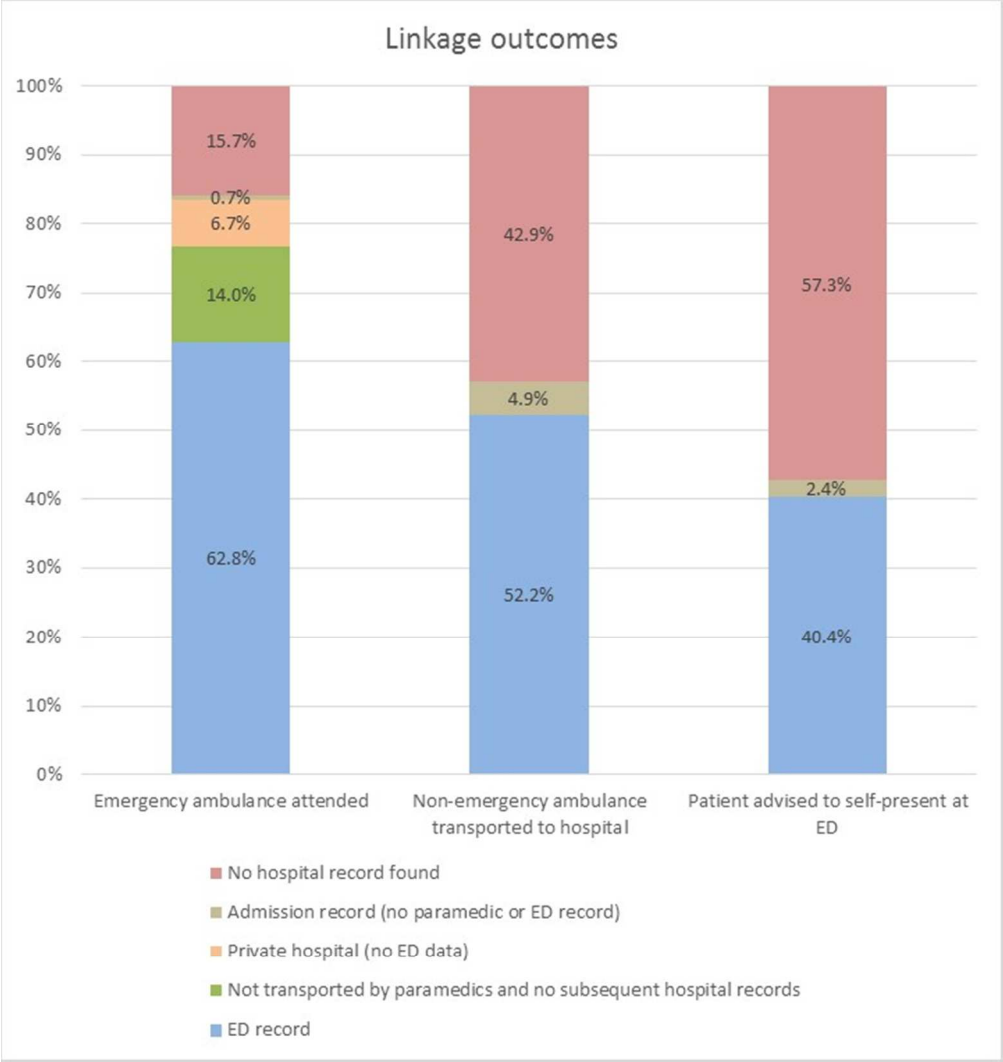

Figure 2: linkage outcomes for each of the emergency care pathways

152x161mm (120 x 120 DPI)

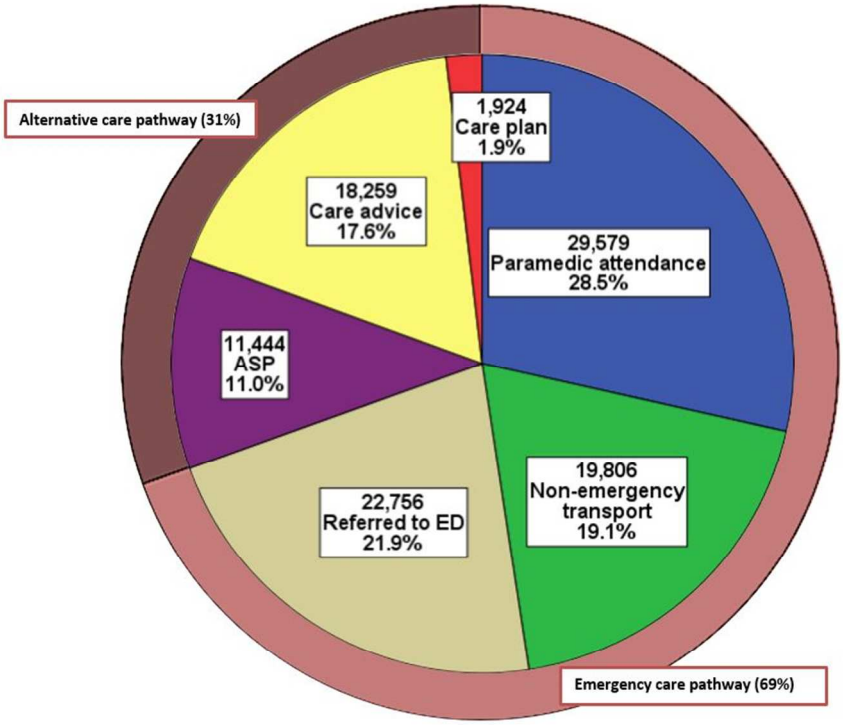

Figure 3: Outcome distribution following RS triage (n=103,768)

208x158mm (120 x 120 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	*7-8*	5-6
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	10-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	10-11
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-10
		(b) Give reasons for non-participation at each stage	9-10
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-12, 19-20
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage

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The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage.

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Word count: 4241

Key words: Health Services Misuse; Health Services Needs and Demand; Triage; Telephone; Referral and Consultation

Objective

To investigate the appropriateness of cases presenting to the emergency department (ED) following ambulance-based secondary telephone triage.

Design

A pragmatic retrospective cohort analysis of all the planned and unplanned ED presentations within 48 hours of a secondary telephone triage.

Setting

The secondary telephone triage service, called the Referral Service, and the hospitals were located in metropolitan Melbourne, Australia and operated 24 hours a day, servicing 4.25 million people. The Referral Service provides an in-depth secondary triage of cases classified as low-acuity when calling the Australian emergency telephone number.

Population

Cases triaged by the Referral Service between September 2009 and June 2012 were linked to ED and hospital admission records (N=44,523). Planned ED presentations were cases referred to the ED following the secondary triage, unplanned ED presentations were cases that presented despite being referred to alternative care pathways.

Main outcome measures

Appropriateness was measured using an ED suitability definition and hospital admission rates. These were compared to mean population data which consisted of *all* of the ED presentations for the state (termed the 'average Victorian ED presentation').

Results

Planned ED presentations were more likely to be ED suitable than unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; P<0.001) and the average Victorian ED presentation (OR1.85; 95% CI 1.01 to 3.4; P=0.046). They were also more likely to be admitted to the hospital than the unplanned ED presentation (OR 1.5, 95% CI 1.4 to 1.6; P<0.001) and the average Victorian ED presentation (OR 2.3, 95% CI 2.24 to 2.33; P<0.001). Just under 15% of cases diverted away from the emergency care pathways presented in the ED (unplanned ED attendances), and 9.5% of all the alternative care pathway cases were classified as ED suitable and 6.5% were admitted to hospital.

Conclusions

Secondary telephone triage was able to appropriately identify many ED suitable cases, and whilst most cases referred to alternative care pathways did not present in the ED, further research is required to establish that these were not inappropriately triaged away from the emergency care pathways.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first Australian study to link secondary telephone triage records to emergency department (ED) and hospital records to track a patient's process through the prehospital to hospital healthcare system.
- This is the first large-scale study to investigate the appropriateness of cases presenting in the ED following secondary telephone triage.
- This study did not rely upon retrospective expert opinion to measure appropriateness but used a range of independently derived ED outcomes to assess appropriateness.
- Due to the heterogeneity of ambulance services and secondary telephone triage services the generalisability of the results may be limited, however the methodology can be replicated to generate locally reproducible results.

AUTHOR CONTRIBUTORS

Author contributions were as follows:

Ms Kathryn Eastwood: Study conception, conducted the data-linkage for the Ambulance Victoria data sets, analysed data and wrote the paper.

Professor Karen Smith: Discussed core ideas, oversaw the data extraction, consulted on the data analysis and edited the paper.

Dr Amee Morgans: Discussed core ideas, consulted on the data analysis and edited the paper.

Professor Johannes Stoelwinder: Discussed core ideas, edited the paper. Professor Stoelwinder was Ms Eastwood's Primary PhD supervisor.

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The staff from the Victorian Data Linkages unit at the Victorian Department of health who conducted the hospital data extraction and linkage to the pre-linked Ambulance Victoria data sets.

TRANSPARENCY DECLARATION

Kathryn Eastwood affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

ETHICAL APPROVALS

Ethics approval was granted by the Monash University Human Research Ethics Committee (CF12/0547-2012000215) and the Ambulance Victoria Research Committee (R11-021).

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

COMPETING INTERESTS

Kathryn Eastwood is an intensive care paramedic has previously worked as a call-taker with the Ambulance Victoria Referral Service (secondary telephone triage service). Also Professor Johannes Stoelwinder was the Chair of the Board of Ambulance Victoria. Professor Karen Smith is the Manager of Research and Evaluation for Ambulance Victoria.

INTRODUCTION

An increasing proportion of ambulance service workload involves patients with low-acuity health events that do not require the specific resources provided by ambulance services or emergency departments (ED).[1-19] Responding to these cases with a traditional emergency ambulance attendance and transport to a hospital ED negatively impacts on ambulance services' efficiency and efficacy by reducing the availability of these resources for emergency cases and thus potentially compromising patient outcomes.[8,14,20,21] The notion of whether these unnecessary ED users place a similar stress upon the ED is one of contention, with some research suggesting that the number and the impact of these patients is much lower than the high levels reported in other literature.[22-24] Depending on the study, these figures range from as little as 5% up to 82% of all ED presentations.[22,24,25] Despite this, there appears to be some level of consensus that these patients often present with conditions that can be suitability managed in community-based healthcare services rather than the ED.[15,21] The ability of ambulance services and EDs to expand resources to meet their increasing demand is limited, and as a result, alternative strategies are being implemented to manage low-acuity cases.[26-37]

Secondary telephone triage has been used by some ambulance services as a demand management strategy for the identification and referral of low-acuity cases to alternative health care services and away from the emergency care pathways involving ambulances and the ED.[1,38] As its name implies, secondary telephone triage occurs after a primary triage has taken place when a patient contacts the emergency dispatch centre. Cases classified as low-acuity during primary triage are then triaged by qualified nurses or paramedics to further elucidate the patients presenting problem. Where appropriate these cases are diverted to other means of transportation to hospital, alternative service providers for management outside of the emergency care pathways, or they are given self-care advice for management in the home. Ambulance Victoria in Victoria, Australia, operates the Referral Service, a secondary telephone triage service that managed nearly 12% of the total emergency ambulance workload in the capital city of Melbourne between 2009-2012. The Referral Service diverted 72.4% of the triaged low-acuity cases away from emergency ambulances and 32.2% away from the ED.[1] This strategy has had a measurable impact in metropolitan Melbourne and across Victoria with a 10% decrease in growth of demand for emergency ambulance transports upon its implementation.[39]

Despite the policy intention of reducing low-acuity cases from the emergency ambulance and from ED workloads, some cases remain or re-emerge in the emergency care pathways following secondary triage.[1,40] These can be categorised into two groups of cases -- those that are planned ED attendances and those that are unplanned ED attendances. *Planned ED attendances* are cases identified at secondary telephone triage as suitable to remain in the emergency care pathways. These cases may be sent an emergency ambulance, non-emergency ambulance or referred to self-present at the ED.[1] If these cases are later identified as inappropriate for the ED, then the question is raised about whether they were incorrectly triaged by the Referral Service to these care pathways. *Unplanned ED attendances* are cases that present in the ED despite being referred to alternative care pathways. These pathways include advice to allow the patient to manage their presenting problem at home (self-care advice), referral to the patient's own general practitioner (GP) or allied healthcare worker, or referral to one of a range of alternate service providers contracted by Ambulance Victoria, who will attend the patient's home.[1] If these cases subsequently and

appropriately attend the ED they may represent a cohort of cases that were incorrectly triaged by the Referral Service as suitable for alternative care pathways.

The effectiveness of an ambulance-based secondary telephone triage service is reflected in its ability to provide patients with the most appropriate care for their needs. The appropriateness of the ED presentation of cases following secondary telephone triage has only been investigated in two small trials which found that patients were more likely to be admitted to the hospital if they were identified as being suitable to remain in the emergency care pathways (ie. they were a planned ED attendance).[30-32] No large scale evaluations have been conducted using an established secondary telephone triage service operating within an ambulance service.

The aim of this study was to investigate the appropriateness of the ED presentation of cases following secondary telephone triage by the Referral Service.

METHODS

Design

A pragmatic retrospective cohort analysis was conducted of all the planned and unplanned ED presentations within the emergency care and alternative care pathways within 48 hours of a Referral Service triage.

Setting

Ambulance Victoria is a statewide publicly funded ambulance service operating in the state of Victoria, Australia. In June 2012, 4.25 million people lived in metropolitan Melbourne which covers an area of approximately 10,000km^2.[41] During the study timeframe the Referral Service operated within metropolitan Melbourne 24 hours a day, seven days a week.

The Referral Service has been described extensively elsewhere.[1] Briefly, cases identified as low-acuity during the call to the emergency services telephone number (in Australia, this is triple zero), using the Advanced Medical Priority Dispatch System (AMPDS), are transferred for secondary triage. Case-types designated as low-acuity have been specifically identified by Ambulance Victoria as having low paramedic treatment and transportation rates and are unlikely to represent to the ambulance service within a 24 hour timeframe. Referral Service call-takers use a condition-specific computer-based questioning algorithm (CECC –Care Enhanced Call Centre)[42] during secondary telephone triage to arrive at a disposition with a recommended resource allocation outcome as listed below:

<u>Emergency care pathways</u>

1. Return for emergency ambulance dispatch;
2. Non-emergency ambulance dispatch;
3. Advise the patient to self-present at the ED;

<u>Alternative care pathways</u>

4. Referral to an Alternative Service Provider; or

5. Self-care advice including home care or to seek further non-urgent medical attention independently (please refer to Figure One).

The alternative service providers that the Referral Service utilizes include out-of-hours home-visiting doctor services, home-visiting nurses, hospital outreach programs (that send allied health staff into the community), crisis assessment and treatment teams (CATT) for psychiatric cases, poisons telephone advice line, and other services that can assist with non-medical issues such as lifting patients.

Data Sources

Data were collected between September 2009 and June 2012 for the datasets below unless otherwise stated.

Referral Service

Referral Service records were extracted from the Referral Service database. Data items included case date and time, case number, de-identified patient-specific code, date-of-birth, age, gender, suburb, presenting problem, free text entry with details of the patient triage, and triage disposition.

Paramedic Records

Cases referred for an emergency ambulance dispatch had an electronic patient care record (paramedic record) generated documenting assessment, treatment, demographic and operational information. Paramedic records included case date and time, case number, Medicare suffix (first 3 characters of the patients given name), date-of-birth, age, gender, suburb, dispatch urgency, treatment, transport outcome, destination hospital (where appropriate), and transport urgency (where appropriate).

Hospital datasets (ED and admission records)

Hospital data was sourced from the Victorian Emergency Minimum Dataset (ED records) and the Victorian Admitted Episode Dataset (admission records). The ED records contains de-identified administrative, demographic, treatment and clinical information detailing ED presentations at designated Victorian public hospitals and others as directed by the Victorian Government Department of Health.[43] Similarly the admission records contains de-identified administrative data for Victorian hospital admissions.[44] The Department of Health does not routinely collect ED data from private hospitals (privately owned hospitals running on a user-pays system), which on average received about 8.1% of all Victorian ED presentations.[25,45] Private hospitals do provide their admission records to the Department of Health and this was the only indicator of whether a patient attended a private hospital ED. If, however a patient was not admitted following their ED presentation at a private hospital, then no record of their ED presentation could be obtained. Variables extracted included case date and time, de-identified patient-specific code (this is a different code to that used in the Referral Service dataset), ICD-10-AM code (International

Classification of Diseases, 10th Edition, Australian Modification), arrival mode, ED triage category, outgoing referral, admission and death.

Data Linkage

Deterministic data-linkage was used to link the Referral Service and paramedic records for cases referred to the emergency ambulance pathway (the ambulance datasets).[46] The variables used for linkage included case date, case number, date-of-birth, age, gender and suburb. Nearly all of the paramedic records (94.7%) were linked to Referral Service records, and these linkages were verified using case-time, presenting problem, urgency level set by Referral Service call-takers and free-text analysis where required. This process resulted in seven linkages that could not be verified as a true match (0.0003% error rate).

These ambulance datasets were then linked to the hospital datasets (the ED and admission records) also using deterministic data linkage methods.[46] For this linkage ambulance case number, Medicare suffix, date-of-birth, address (postal code or locality), and record date within 48 hours of arrival at the ED were used. The algorithm utilized allowed for a single day discrepancy in date-of-birth, date of ambulance records and date of hospital records. Validation of the deterministic linkage between the linked ambulance datasets and the hospital datasets was completed using gender. A mismatch was identified for 2% of linkages and these were discarded (n=856). Linkages where the hospital record occurred before Referral Service triage were also discarded (n=2,300).

Data linkage outcomes for planned ED presentations

During the study timeframe, 27.5% of all metropolitan Ambulance Victoria cases that had an ambulance attendance were not transported to hospital. This, combined with the fact that the private hospitals do not supply their ED records, meant a linkage rate of 100% between ambulance and hospital records was not expected.

Figure Two depicts the proportion of Referral Service cases for each of the three emergency care pathways for which an ED record was linked. Cases in the emergency ambulance pathway had the highest rate of linkage to ED records (62.8%). Some cases in this pathway were found to have been transported to private hospital (6.7%), meaning no ED record was available, or left at home after paramedic assessment (14.0%). The remaining 15.7% of cases for which an ED record was expected were unable to be accounted for.

Over half of the 'non-emergency ambulance' pathway cases (57.3%) and 42.8% of the 'self-present at ED' pathway cases were linked to an ED record or an admission record (Figure Two). Some of these cases may have been transported to a private hospital. The proportion of private hospital ED presentations is 8.1% of all Victorian ED presentations, and assuming a similar proportion of this population attended a private hospital ED, a large number of cases would remain unaccounted for.

The lack of an ED record for 37.0% of the planned ED attendances does not necessarily mean these patients did not attend the ED. The linkage process may have failed to identify a corresponding ED

record, or they may have attended a private hospital ED. When comparing the number of cases Ambulance Victoria reported as being transported to hospital, to the number of ambulance presentations reported in the Australian government reports,[25,47,48] there is only a 2.2% discrepancy in the numbers. This suggests that there may be a number of missed linkages rather than simply no presentation at the ED, however a level of non-compliance was expected.[49]

A systematic bias evaluation was conducted, comparing age, gender and main presenting problems between the cases with a linked ED record and those with no linked ED record. Significance testing was pragmatically unsuitable because the large size of the dataset would result in a high level of statistical sensitivity to small distribution differences. This is demonstrated in Table One, where despite some areas of statistical significance, the actual differences for age and gender between the 'ED record' and 'no ED record' groups were unlikely to be clinically significant. When comparing the presenting problems of the cases within each group in Table One there was also little variation in the three most common case types between those with and without an ED record. Therefore age, gender and presenting problem were considered as not imposing any clinically significant bias on the results, and the results presented in this paper were considered to be representative of the cases referred to the emergency care pathways by the Referral Service.

**Please insert: Table One

Table One: Comparison of emergency care pathways cases that were matched to an ED record (RS – Referral Service)

Patient Involvement

This was a retrospective study of established data sources, as such no patients were involved in this study.

Patient Outcomes

General demographic, triage outcome and main presenting problem information was collected during this study.

Indicators of appropriateness

ED suitability and admission to hospital were used as indicators of appropriateness for cases that presented at the ED. Planned and unplanned ED presentation were analysed using these measures and then compared to the average Victorian ED presentation.

ED suitability

ED suitability was based on a modified version of the 'potentially avoidable GP-type presentation' measure used by the Australian Government for ED presentations that are considered avoidable had an appropriate community-based service been accessed.[50] A 'potentially avoidable GP-type presentation' is defined as cases that present to an ED where the patient:

- Was triaged as a category 4 or 5 according to the Australian Triage Scale;[51]
- Did not arrive by ambulance;
- Was not admitted to the hospital, referred to another hospital, and
- Did not die.[50]

This 'potentially avoidable GP-type presentation' outcome was modified in this study to exclude the criterion involving arrival by ambulance and was referred to as 'ED suitability'.

Hospital admission

Despite hospital admission being used as part of the ED suitability indicator, this indicator has also been used in isolation in other studies[30,32] and was therefore retained to allow for comparison. Also, hospital admission was provided by both public and private hospitals, therefore allowing for cases transported to private hospitals to be included in the analysis.

Average Victorian ED Presentation for Victoria

Each year the Australian government report the overall rates of hospital admission and 'potentially avoidable GP-type presentations' for all public hospital ED presentations in each state of Australia.[50] The overall rates are inclusive of all ED attendances, including Referral Service cases that present at the ED. The rates of ED suitability and hospital admission were compared to the overall rates for Victoria, which were referred to as 'the average Victorian ED presentation' in this paper. The rates from the 2011/2012 report were utilized in this study.[50]

Data Analysis

Data were analysed using descriptive statistics, chi-squared tests of association, independent samples t-tests and logistic regressions to identify relationships with 95% CIs. All tests were considered to be significant at 0.05 level. All data analysis was performed using SPSS Version 20.[52]

RESULTS

Outcomes

During the study timeframe Ambulance Victoria received just over one million calls for assistance, of which 11.9% were triaged by the Referral Service. At the end of this triage, 69.5% of cases were referred to care pathways other than the emergency ambulance dispatch pathway, and 30.5% were referred away from an ED presentation (the emergency care pathways). Figure Three outlines the selection of cases eligible for inclusion in this study, resulting in 44,523 cases undergoing further analysis.

Patient demographics

The gender distribution for cases presenting to the ED was similar for all care pathway groups (Table Two). Triage outcomes that required the patients to self-source further care, including the 'self-present at the ED' cases and 'self-care advice' cases, were younger than those sent further care (Table Two).

Five main presenting problems made up 80% of the most common problems for each of the care pathways (Table Two). These were abdominal pain, back pain, nausea and vomiting, urinary symptoms and dizziness and vertigo. Abdominal pain and back pain featured in the top five main presenting problems for every care pathway.

**Please insert: Table Two

Table Two: Hospital management of cases that presented at ED following Referral Service (RS) triage.

ED suitability

The planned ED presentations were more likely to be classified as ED suitable than the unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; p<0.001). The ED suitability for planned ED presentations ranged from 70.6% to 77.8% for each of the emergency care pathways, which was significantly higher than the ED suitability for the average Victorian ED presentations of 61.0% (OR 1.85; 95% CI 1.01 to 3.4; p=0.046) (Table Two).

Of the alternative care pathway cases, the unplanned ED presentations that were originally referred to alternative service providers had an ED suitability rate higher than the average Victorian ED presentation (68.8%), and the cases originally given self-care advice had an ED suitability rate almost the same as the average Victorian ED presentation (60.3%) (Table Two). These unplanned ED presentations were therefore at least as 'ED suitable' as the average Victorian ED presentation. It should be noted however, that only 19.3% of all the cases referred to the alternative service providers and 12.5% of all the cases given self-care advice presented in the ED. Overall, only 9.5% of the total alternative care pathway cases were identified as ED suitable (14.7% of all the alternative service provider cases and 8.2% of all the self-care advice cases).

Hospital Admission

Planned ED presentations were significantly more likely to be admitted to hospital than unplanned ED presentations (53.8% versus 43.5%; OR 1.5, 95% CI 1.4 to 1.6; p<0.001). Both the planned ED presentations (OR 2.3, 95% CI 2.24 to 2.33; p<0.001), and the unplanned ED presentations (OR 1.6, 95% CI 1.5 to 1.73; p<0.001) were more likely to be admitted than the average Victorian ED presentation (36.0%) (Table Two). Overall only 6.5% of all the alternative care pathway cases were admitted to hospital (11.3% of all the alternative service provider pathway cases and 5.1% of all the self-care advice pathway cases).

DISCUSSION

This was the first large-scale study to link ambulance service data and hospital data to investigate the outcomes of both planned and unplanned ED presentations following an ambulance-based secondary telephone triage. Overall the cases referred to the emergency care pathways, (the planned ED presentations), appeared to be appropriate with ED suitability and hospital admission rates being higher than both the unplanned ED presentation group and the average Victorian ED presentation.

The decision to send cases to the alternative care pathways appears sound with over 85% not emerging in the emergency care system within 48 hours. The overall rates of ED suitability and admission for the cases sent to the alternative care pathways were well below that of the average Victorian ED presentation predominantly because so few went on to present at the ED. When only the unplanned ED presentations were considered, the ED suitability and admission rates were the same, if not higher, that those for the average Victorian ED presentation. These results suggest that whilst the overall numbers of unplanned ED presentations were relatively small, they may have been appropriate for the ED and further investigation of these cases needs to be done to ensure they are not being incorrectly triaged to the alternative care pathways.

The results of this study are consistent with previous research whereby cases classified as requiring an emergency ambulance were more likely to be admitted to the hospital than those classified as not requiring an emergency ambulance.[30,32] The admission rate of cases in the alternative care pathways (unplanned ED presentations) of 6.5% was below that found in these other studies, which had rates of 9.2% and 15.8%.[30,32] This lower rate of admission may indicate that the secondary telephone triage process used by Ambulance Victoria, is more effective in identifying which cases are suitable for the alternative care pathways. While the previous research have accepted these admission rates and suggested the secondary telephone triage process is a safe and feasible means of managing ambulance demand,[30,32] further investigation of the unplanned ED attendances is warranted.

This evaluation of ED suitability casts a broader net than simply basing the appropriateness of an ED presentation on whether a patient was admitted or not. The 'ED suitability' outcome measure increased the sensitivity, whereas the 'admissions only' outcome measure was felt to be more specific and prone to excluding appropriate cases. The ED suitability measure used a range of variables to eliminate the potential bias imposed by the decisions made by individual healthcare professionals during the patient care phase. Also, given that these variables are likely to be recorded in most emergency departments and are collected independent of any assessment of appropriateness, the ED suitability measure used in this study offers future researchers the opportunity to generate locally generalizable results that are also reproducible. ED treatment itself was not included in this outcome measure as it was the researcher's view that the ED healthcare workers will naturally instigate at a minimum, investigative procedures that could have been conducted in the primary care setting, which would have been viewed as a positive result for ED treatment. In this study, the ED suitability and admission outcome measures, also allowed for a comparison with the greater population of cases that present at the ED in Victoria.

Whilst the results from this study suggest that the Referral Service was appropriate in filtering the cases ultimately destined for the ED, more can potentially be done to increase the sensitivity and specificity of the triage process. The unplanned ED presentation cases need to be further

investigated to determine whether their condition evolved within the potential 48 hour window between Referral Service triage and ED presentation, whether they should have been triaged to the emergency care pathway, or whether other services, not within the suite of alternative service providers used by the Referral Service, would have been able to manage these cases in the primary care setting. Similarly cases from the planned ED presentation pathway that were not ED suitable, or not admitted, need to be further investigated to determine if a primary care alternative is available to manage these cases out of the hospital setting.

Optimizing the suite of pathways available to the Referral Service call-takers may lead to increased specificity of cases for emergency ambulance and the emergency department, therefore increasing the effectiveness of the Referral Service. In doing this, care should be taken to ensure that more than just physiological or clinical indicators are considered when decisions are made, particularly when these decisions result in the omission of a face-to-face assessment within a particular timeframe. Nonclinical situations have been identified where it would be considered appropriate for a low-acuity patient to be assessed and transported by paramedics, or present in the ED.[53] An example of this is where there may be a perceived risk of physical harm to the patient, either through the threat of violence, an unattended minor or a patient who may appear physically or psychologically incompetent.[53] Any secondary telephone triage process should ensure that the patients overall wellbeing is taken into consideration.

This study was limited by the inability to link some of the cases between the datasets. There are several possible reasons for a failure of an appropriate linkage, or for records to not have been available for linkage. These include private hospital attendance (therefore no ED records were available), transcription errors in case numbers and dates-of-birth during data acquisition and handovers, usage of a written paramedic record rather than an electronic paramedic record, ambulance cancellation prior to arrival and patient non-compliance.[49] This highlights a need for consistent patient identifiers and a means of transcribing data at the various transitions of care that reduces errors, such as electronic transfer.

Whilst no clinically significant systematic bias was detected, the potential for this bias remained given the volume of unlinked cases in each of the emergency care pathways.

The mean population data for the average Victorian ED presentation included all of the patient presentations for the respective time period, including those from the Referral Service who were sent to the emergency care pathways and presented in the ED. The presence of these cases in the 'average ED presentation' group will increase the overall ED suitability rate for this group. The impact would be negligible however with all Referral Service cases referred to the emergency care pathways only constituting 1.6% of the total ED workload if they had all presented at the ED during the study timeframe. Finally, the ED suitability measure was directly compared to the 'potentially avoidable GP-type presentations' despite their slight difference.

Whilst the variation in secondary telephone triage system structure and functionality could not be addressed in this study, the research variables used were specifically selected to allow for similar methodological approaches, less vulnerable to personal opinion, to be utilized in future work. Using these methodological approaches, the findings may be somewhat limited in their broader generalisability, however they should be locally reproducible.

CONCLUSION

This study utilized linked ambulance and hospital data to analyse the appropriateness of the referral of cases for ED presentation following secondary telephone triage and provided a methodological approach that can be applied in future research. Overall secondary telephone triage was able to appropriately identify many cases that were suitable for the ED and that would be admitted, at a rate higher than that of the average Victorian ED presentation. A small cohort of cases identified as suitable for alternative care pathways presented in the ED and were ED suitable. Further investigation is required beyond this study beyond this study to ensure cases were not incorrectly triaged to the alternative care pathways and to optimize the suite of alternate pathways to ensure the right patient is being triaged to the right service.

DATA SHARING STATEMENT

Data sharing: no additional data available.

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		Linked ED record			No ED record found			Statistical comparison		
									Significance test	
		Age	Female (%)	Main presenting problem with RS (%)	Age	Female (%)	Main presenting problem with RS (%)	Missing cases (%)	Age	Gender
Emergency care pathway cases (Planned ED attendances)	**Emergency ambulance**	56	54.3	Abdominal pain (17.0) Back pain (9.8) Dizziness & vertigo (5.7)	56	56.1	Abdominal pain (14.9) Back pain (9.2) Dizziness & vertigo (7.1)	37.2	t(21820.5) = -1.82, p=0.068	Chi-square = 9.14, df=1, p<0.002
	Non-emergency ambulance	65	53.2	Abdominal pain (24.6) Back pain (7.2) Urinary symptoms (6.9)	66	53.9	Abdominal pain (24.6) Back pain (6.4) Urinary symptoms (6.0)	47.8	t(19432.2) =4.26, p<0.001	Chi-square = 1.04, df=1, p=0.31
	Self-present at ED	44	55.5	Abdominal pain (21.0) Back pain (7.1) Flank pain (5.8)	41	56.4	Abdominal pain (21.4) Back pain (6.7) Nausea and vomiting (4.9)	59.6	t(22754) = -7.34, p<0.001	Chi-square = 1.72, df=1, p=0.2

Table One: Comparison of emergency care pathways cases that were matched to an ED record (RS –Referral Service)

	Planned ED presentations (Emergency care pathways)			Unplanned ED presentations (from the Alternative care pathways)	
	Emergency ambulance	**Non-emergency ambulance**	**Referred to self-present at ED**	**Cases referred to an Alternative service provider**	**Cases given self-care advice**
ED record (% of total cases referred to that pathway)	18,578 (62.8)	10,348 (52.2)	9,184 (40.4)	2,207 (19.3)	2,496 (12.5)
Female (%)	54.3	53.2	55.5	53.2	52.6
Median age (years)	60	70	41	59	47
Most common main presenting problems (of ED presentation cases)	1. Abdominal pain (17.0%) 2. Back pain (9.8%) 3. Dizziness/ vertigo (5.7%) 4. Nausea/ vomiting (5.0%) 5. Fever (4.1%)	1. Back pain (24.6%) 2. Abdominal pain (7.2%) 3. Urinary symptoms (5.2%) 4. Weakness/ paralysis (4.8%) 5. Lower leg non-injury (4.8%)	1. Abdominal pain (21.0%) 2. Back pain (7.1%) 3. Flank pain (5.8%) 4. Nausea/ vomiting (4.8%) 5. Urinary symptoms (3.0%)	1. Back pain (16.1%) 2. Nausea/ vomiting (8.4%) 3. Dizziness/ vertigo (7.5%) 4. Urinary symptoms (5.3%) 5. Abdominal pain (4.4%)	1. Back pain (10.6%) 2. Abdominal pain (8.1%) 3. Nausea/ vomiting (7.0%) 4. Dizziness/ vertigo (5.9%) 5. Constipation/rectal symptoms (3.6%)
ED suitability of RS cases that attended ED (Absolute Risk (%))	77.8	71.3	70.6	68.8	60.3
Overall ED suitability for RS cases with an ED record (Absolute Risk (%))	74.3			64.1	
Hospital admission for RS cases with an ED record (Absolute Risk (%))	55.0	58.3	46.4	51.3	39.4
Overall hospital admission for RS cases with an ED record (Absolute Risk (%))	53.8			43.5	

Table Two: Hospital management of cases that presented at ED following Referral Service (RS) triage.

FIGURE LEGENDS

Figure One: Case-flow from the call to the emergency services to Referral Service outcome

Figure Two: linkage outcomes for each of the emergency care pathways

Figure Three: Selection planned and unplanned ED presentation cases for inclusion in this study

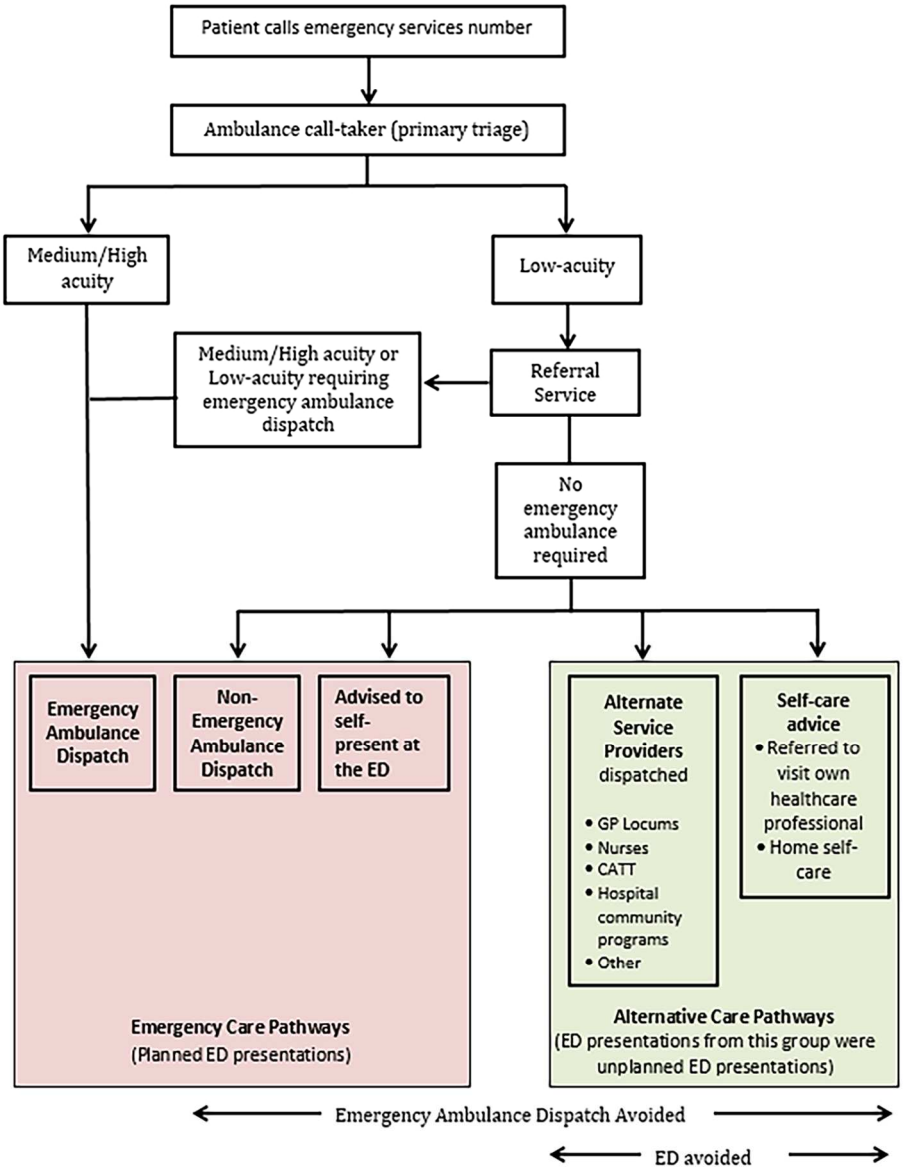

Figure One: Case-flow from the call to the emergency services to Referral Service outcome

115x152mm (300 x 300 DPI)

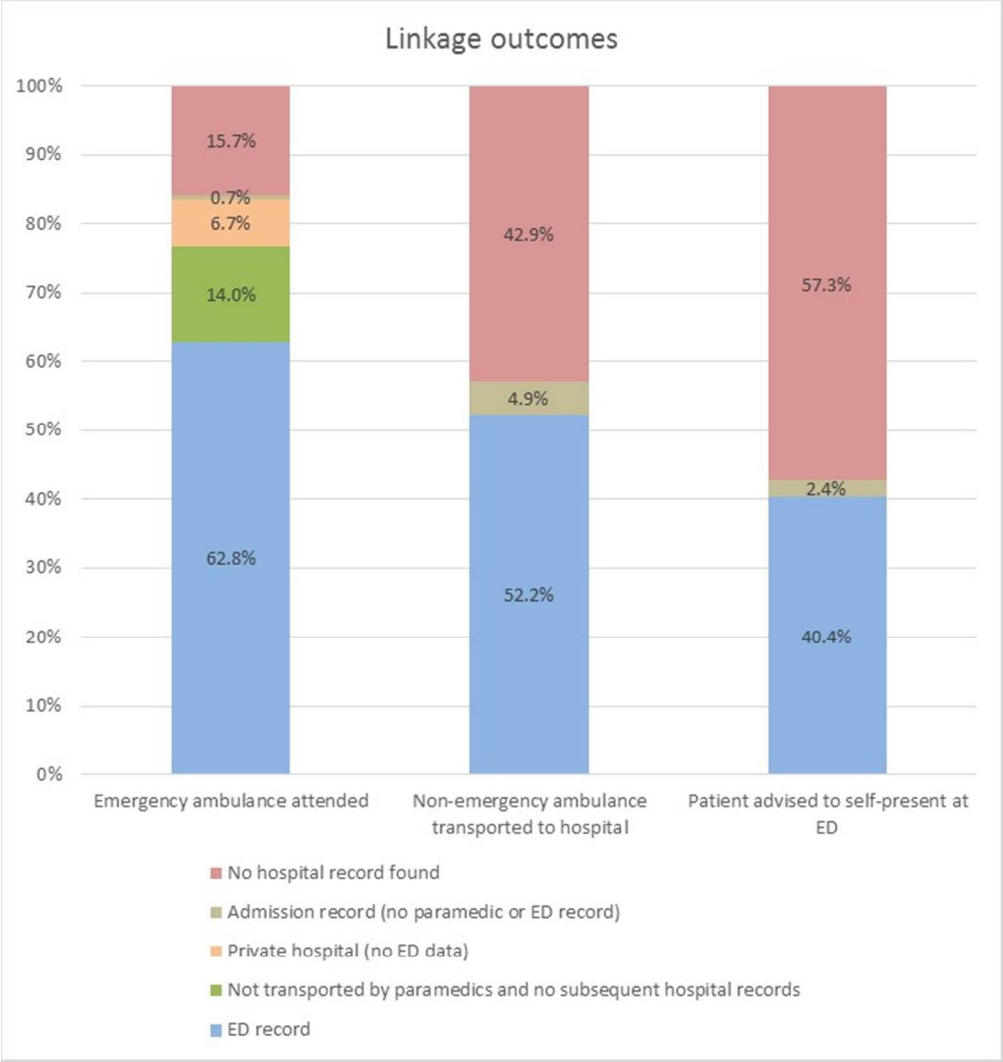

Figure Two: linkage outcomes for each of the emergency care pathways

60x64mm (300 x 300 DPI)

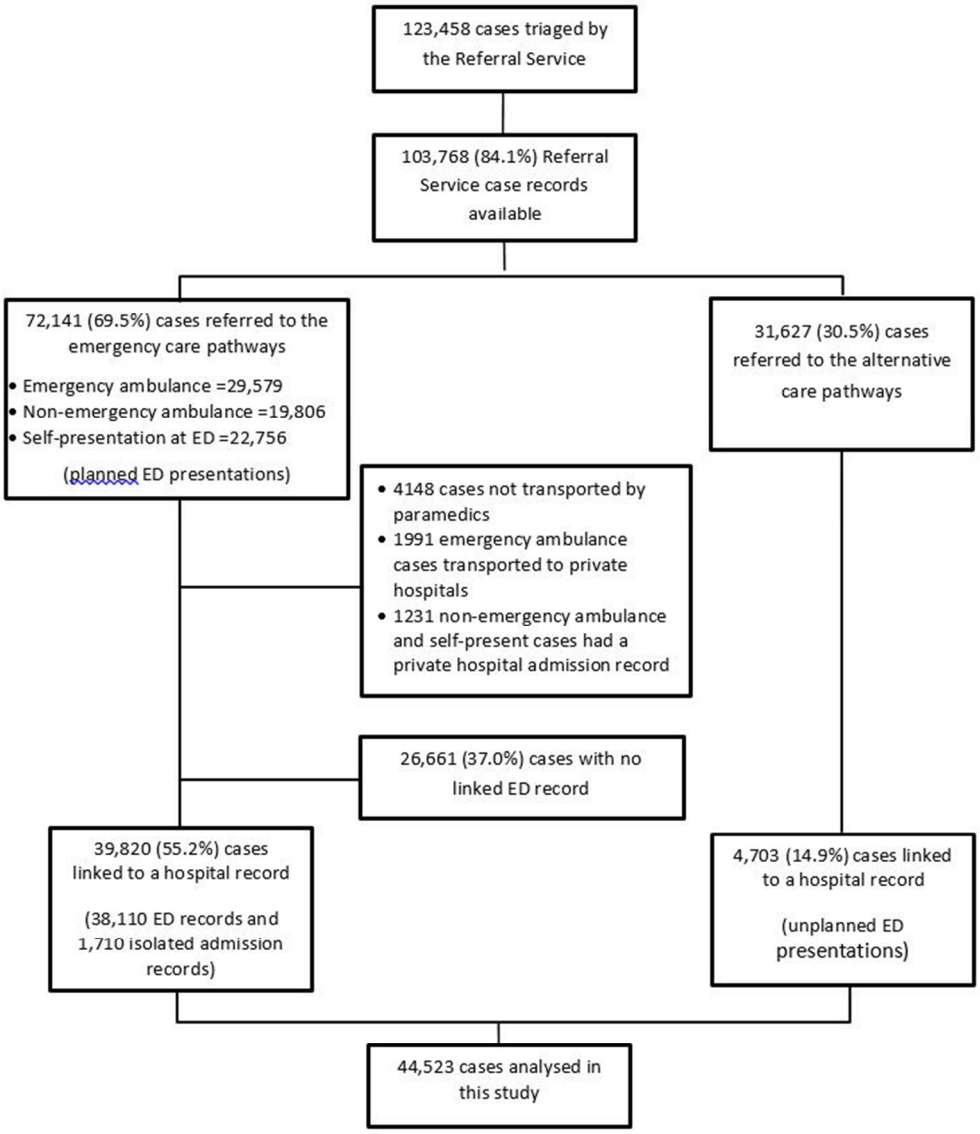

Figure Three: Selection planned and unplanned ED presentation cases for inclusion in this study

63x72mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-9
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10
Data sources/ measurement	8*	*7-8*	7-8
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	9-10
		(*c*) Explain how missing data were addressed	9; 18
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	9-10
		(c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11, 19
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: a retrospective cohort study.

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Keywords:	Health services needs and demand, Telephone, Triage, Referral and consultation, Health services misuse

The appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: a retrospective cohort study.

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Key words: Health Services Misuse; Health Services Needs and Demand; Triage; Telephone; Referral and Consultation

Objective

To investigate the appropriateness of cases presenting to the emergency department (ED) following ambulance-based secondary telephone triage.

Design

A pragmatic retrospective cohort analysis of all the planned and unplanned ED presentations within 48 hours of a secondary telephone triage.

Setting

The secondary telephone triage service, called the Referral Service, and the hospitals were located in metropolitan Melbourne, Australia and operated 24 hours a day, servicing 4.25 million people. The Referral Service provides an in-depth secondary triage of cases classified as low-acuity when calling the Australian emergency telephone number.

Population

Cases triaged by the Referral Service between September 2009 and June 2012 were linked to ED and hospital admission records (N=44,523). Planned ED presentations were cases referred to the ED following the secondary triage, unplanned ED presentations were cases that presented despite being referred to alternative care pathways.

Main outcome measures

Appropriateness was measured using an ED suitability definition and hospital admission rates. These were compared to mean population data which consisted of *all* of the ED presentations for the state (termed the 'average Victorian ED presentation').

Results

Planned ED presentations were more likely to be ED suitable than unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; P<0.001) and the average Victorian ED presentation (OR1.85; 95% CI 1.01 to 3.4; P=0.046). They were also more likely to be admitted to the hospital than the unplanned ED presentation (OR 1.5, 95% CI 1.4 to 1.6; P<0.001) and the average Victorian ED presentation (OR 2.3, 95% CI 2.24 to 2.33; P<0.001). Just under 15% of cases diverted away from the emergency care pathways presented in the ED (unplanned ED attendances), and 9.5% of all the alternative care pathway cases were classified as ED suitable and 6.5% were admitted to hospital.

Conclusions

Secondary telephone triage was able to appropriately identify many ED suitable cases, and whilst most cases referred to alternative care pathways did not present in the ED, further research is required to establish that these were not inappropriately triaged away from the emergency care pathways.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first Australian study to link secondary telephone triage records to emergency department (ED) and hospital records to track a patient's process through the prehospital to hospital healthcare system.
- This is the first large-scale study to investigate the appropriateness of cases presenting in the ED following secondary telephone triage.
- This study did not rely upon retrospective expert opinion to measure appropriateness but used a range of independently derived ED outcomes to assess appropriateness.
- Due to the heterogeneity of ambulance services and secondary telephone triage services the generalisability of the results may be limited, however the methodology can be replicated to generate locally reproducible results.

AUTHOR CONTRIBUTORS

Author contributions were as follows:

Ms Kathryn Eastwood: Study conception, conducted the data-linkage for the Ambulance Victoria data sets, analysed data and wrote the paper.

Professor Karen Smith: Discussed core ideas, oversaw the data extraction, consulted on the data analysis and edited the paper.

Dr Amee Morgans: Discussed core ideas, consulted on the data analysis and edited the paper.

Professor Johannes Stoelwinder: Discussed core ideas, edited the paper. Professor Stoelwinder was Ms Eastwood's Primary PhD supervisor.

ACKNOWLEDGEMENTS

The staff from the Victorian Data Linkages unit at the Victorian Department of health who conducted the hospital data extraction and linkage to the pre-linked Ambulance Victoria data sets.

TRANSPARENCY DECLARATION

Kathryn Eastwood affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

ETHICAL APPROVALS

Ethics approval was granted by the Monash University Human Research Ethics Committee (CF12/0547-2012000215) and the Ambulance Victoria Research Committee (R11-021).

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

COMPETING INTERESTS

Kathryn Eastwood is an intensive care paramedic has previously worked as a call-taker with the Ambulance Victoria Referral Service (secondary telephone triage service). Also Professor Johannes Stoelwinder was the Chair of the Board of Ambulance Victoria. Professor Karen Smith is the Manager of Research and Evaluation for Ambulance Victoria.

INTRODUCTION

An increasing proportion of ambulance service workload involves patients with low-acuity health events that do not require the specific resources provided by ambulance services or emergency departments (ED).[1-19] Responding to these cases with a traditional emergency ambulance attendance and transport to a hospital ED negatively impacts on ambulance services' efficiency and efficacy by reducing the availability of these resources for emergency cases and thus potentially compromising patient outcomes.[8,14,20,21] The notion of whether these unnecessary ED users place a similar stress upon the ED is one of contention, with some research suggesting that the number and the impact of these patients is much lower than the high levels reported in other literature.[22-24] Depending on the study, these figures range from as little as 5% up to 82% of all ED presentations.[22,24,25] Despite this, there appears to be some level of consensus that these patients often present with conditions that can be suitability managed in community-based healthcare services rather than the ED.[15,21] The ability of ambulance services and EDs to expand resources to meet their increasing demand is limited, and as a result, alternative strategies are being implemented to manage low-acuity cases.[26-37]

Secondary telephone triage has been used by some ambulance services as a demand management strategy for the identification and referral of low-acuity cases to alternative health care services and away from the emergency care pathways involving ambulances and the ED.[1,38] As its name implies, secondary telephone triage occurs after a primary triage has taken place when a patient contacts the emergency dispatch centre. Cases classified as low-acuity during primary triage are then triaged by qualified nurses or paramedics to further elucidate the patients presenting problem. Where appropriate these cases are diverted to other means of transportation to hospital, alternative service providers for management outside of the emergency care pathways, or they are given self-care advice for management in the home. Ambulance Victoria in Victoria, Australia, operates the Referral Service, a secondary telephone triage service that managed nearly 12% of the total emergency ambulance workload in the capital city of Melbourne between 2009-2012. The Referral Service diverted 72.4% of the triaged low-acuity cases away from emergency ambulances and 32.2% away from the ED.[1] This strategy has had a measurable impact in metropolitan Melbourne and across Victoria with a 10% decrease in growth of demand for emergency ambulance transports upon its implementation.[39]

Despite the policy intention of reducing low-acuity cases from the emergency ambulance and from ED workloads, some cases remain or re-emerge in the emergency care pathways following secondary triage.[1,40] These can be categorised into two groups of cases -- those that are planned ED attendances and those that are unplanned ED attendances. *Planned ED attendances* are cases identified at secondary telephone triage as suitable to remain in the emergency care pathways. These cases may be sent an emergency ambulance, non-emergency ambulance or referred to self-present at the ED.[1] If these cases are later identified as inappropriate for the ED, then the question is raised about whether they were incorrectly triaged by the Referral Service to these care pathways. *Unplanned ED attendances* are cases that present in the ED despite being referred to alternative care pathways. These pathways include advice to allow the patient to manage their presenting problem at home (self-care advice), referral to the patient's own general practitioner (GP) or allied healthcare worker, or referral to one of a range of alternate service providers contracted by Ambulance Victoria, who will attend the patient's home.[1] If these cases subsequently and

appropriately attend the ED they may represent a cohort of cases that were incorrectly triaged by the Referral Service as suitable for alternative care pathways.

The effectiveness of an ambulance-based secondary telephone triage service is reflected in its ability to provide patients with the most appropriate care for their needs. The appropriateness of the ED presentation of cases following secondary telephone triage has only been investigated in two small trials which found that patients were more likely to be admitted to the hospital if they were identified as being suitable to remain in the emergency care pathways (ie. they were a planned ED attendance).[30-32] No large scale evaluations have been conducted using an established secondary telephone triage service operating within an ambulance service.

The aim of this study was to investigate the appropriateness of the ED presentation of cases following secondary telephone triage by the Referral Service.

METHODS

Design

A pragmatic retrospective cohort analysis was conducted of all the planned and unplanned ED presentations within the emergency care and alternative care pathways within 48 hours of a Referral Service triage.

Setting

Ambulance Victoria is a statewide publicly funded ambulance service operating in the state of Victoria, Australia. In June 2012, 4.25 million people lived in metropolitan Melbourne which covers an area of approximately 10,000km^2.[41] During the study timeframe the Referral Service operated within metropolitan Melbourne 24 hours a day, seven days a week.

The Referral Service has been described extensively elsewhere.[1] Briefly, cases identified as low-acuity during the call to the emergency services telephone number (in Australia, this is triple zero), using the Advanced Medical Priority Dispatch System (AMPDS), are transferred for secondary triage. Case-types designated as low-acuity have been specifically identified by Ambulance Victoria as having low paramedic treatment and transportation rates and are unlikely to represent to the ambulance service within a 24 hour timeframe. Referral Service call-takers use a condition-specific computer-based questioning algorithm (CECC –Care Enhanced Call Centre)[42] during secondary telephone triage to arrive at a disposition with a recommended resource allocation outcome as listed below:

<u>Emergency care pathways</u>

1. Return for emergency ambulance dispatch;
2. Non-emergency ambulance dispatch;
3. Advise the patient to self-present at the ED;

<u>Alternative care pathways</u>

4. Referral to an Alternative Service Provider; or

5. Self-care advice including home care or to seek further non-urgent medical attention independently (please refer to Figure One).

The alternative service providers that the Referral Service utilizes include out-of-hours home-visiting doctor services, home-visiting nurses, hospital outreach programs (that send allied health staff into the community), crisis assessment and treatment teams (CATT) for psychiatric cases, poisons telephone advice line, and other services that can assist with non-medical issues such as lifting patients.

Data Sources

Data were collected between September 2009 and June 2012 for the datasets below unless otherwise stated.

Referral Service

Referral Service records were extracted from the Referral Service database. Data items included case date and time, case number, de-identified patient-specific code, date-of-birth, age, gender, suburb, presenting problem, free text entry with details of the patient triage, and triage disposition.

Paramedic Records

Cases referred for an emergency ambulance dispatch had an electronic patient care record (paramedic record) generated documenting assessment, treatment, demographic and operational information. Paramedic records included case date and time, case number, Medicare suffix (first 3 characters of the patients given name), date-of-birth, age, gender, suburb, dispatch urgency, treatment, transport outcome, destination hospital (where appropriate), and transport urgency (where appropriate).

Hospital datasets (ED and admission records)

Hospital data was sourced from the Victorian Emergency Minimum Dataset (ED records) and the Victorian Admitted Episode Dataset (admission records). The ED records contains de-identified administrative, demographic, treatment and clinical information detailing ED presentations at designated Victorian public hospitals and others as directed by the Victorian Government Department of Health.[43] Similarly the admission records contains de-identified administrative data for Victorian hospital admissions.[44] The Department of Health does not routinely collect ED data from private hospitals (privately owned hospitals running on a user-pays system), which on average received about 8.1% of all Victorian ED presentations.[25,45] Private hospitals do provide their admission records to the Department of Health and this was the only indicator of whether a patient attended a private hospital ED. If, however a patient was not admitted following their ED presentation at a private hospital, then no record of their ED presentation could be obtained. Variables extracted included case date and time, de-identified patient-specific code (this is a different code to that used in the Referral Service dataset), ICD-10-AM code (International

Classification of Diseases, 10th Edition, Australian Modification), arrival mode, ED triage category, outgoing referral, admission and death.

Data Linkage

Deterministic data-linkage was used to link the Referral Service and paramedic records for cases referred to the emergency ambulance pathway (the ambulance datasets).[46] The variables used for linkage included case date, case number, date-of-birth, age, gender and suburb. Nearly all of the paramedic records (94.7%) were linked to Referral Service records, and these linkages were verified using case-time, presenting problem, urgency level set by Referral Service call-takers and free-text analysis where required. This process resulted in seven linkages that could not be verified as a true match (0.0003% error rate).

These ambulance datasets were then linked to the hospital datasets (the ED and admission records) also using deterministic data linkage methods.[46] For this linkage ambulance case number, Medicare suffix, date-of-birth, address (postal code or locality), and record date within 48 hours of arrival at the ED were used. The algorithm utilized allowed for a single day discrepancy in date-of-birth, date of ambulance records and date of hospital records. Validation of the deterministic linkage between the linked ambulance datasets and the hospital datasets was completed using gender. A mismatch was identified for 2% of linkages and these were discarded (n=856). Linkages where the hospital record occurred before Referral Service triage were also discarded (n=2,300).

Data linkage outcomes for planned ED presentations

During the study timeframe, 27.5% of all metropolitan Ambulance Victoria cases that had an ambulance attendance were not transported to hospital. This, combined with the fact that the private hospitals do not supply their ED records, meant a linkage rate of 100% between ambulance and hospital records was not expected.

Figure Two depicts the proportion of Referral Service cases for each of the three emergency care pathways for which an ED record was linked. Cases in the emergency ambulance pathway had the highest rate of linkage to ED records (62.8%). Some cases in this pathway were found to have been transported to private hospital (6.7%), meaning no ED record was available, or left at home after paramedic assessment (14.0%). The remaining 15.7% of cases for which an ED record was expected were unable to be accounted for.

Over half of the 'non-emergency ambulance' pathway cases (57.3%) and 42.8% of the 'self-present at ED' pathway cases were linked to an ED record or an admission record (Figure Two). Some of these cases may have been transported to a private hospital. The proportion of private hospital ED presentations is 8.1% of all Victorian ED presentations, and assuming a similar proportion of this population attended a private hospital ED, a large number of cases would remain unaccounted for.

The lack of an ED record for 37.0% of the planned ED attendances does not necessarily mean these patients did not attend the ED. The linkage process may have failed to identify a corresponding ED

record, or they may have attended a private hospital ED. When comparing the number of cases Ambulance Victoria reported as being transported to hospital, to the number of ambulance presentations reported in the Australian government reports,[25,47,48] there is only a 2.2% discrepancy in the numbers. This suggests that there may be a number of missed linkages rather than simply no presentation at the ED, however a level of non-compliance was expected.[49]

A systematic bias evaluation was conducted, comparing age, gender and main presenting problems between the cases with a linked ED record and those with no linked ED record. Significance testing was pragmatically unsuitable because the large size of the dataset would result in a high level of statistical sensitivity to small distribution differences. This is demonstrated in Table One, where the gender distribution for the 'ED record' and 'no ED record' group was minimal (54.3% versus 56.1%), and the mean age for the non-emergency ambulance records only varied by one year, yet the significance testing found these to be significant differences between these groups. When comparing the presenting problems of the cases within each group in Table One there was little variation in the three most common case types between those with and without an ED record. Therefore, age, gender and presenting problem were considered as not imposing any clinically significant bias on the results, and the results presented in this paper were considered to be representative of the cases referred to the emergency care pathways by the Referral Service.

**Please insert: Table One

Table One: Comparison of emergency care pathways cases that were matched to an ED record (RS – Referral Service)

Patient Involvement

This was a retrospective study of established data sources, as such no patients were involved in this study.

Patient Outcomes

General demographic, triage outcome and main presenting problem information was collected during this study.

Indicators of appropriateness

ED suitability and admission to hospital were used as indicators of appropriateness for cases that presented at the ED. Planned and unplanned ED presentation were analysed using these measures and then compared to the average Victorian ED presentation.

ED suitability

ED suitability was based on a modified version of the 'potentially avoidable GP-type presentation' measure used by the Australian Government for ED presentations that are considered avoidable had

an appropriate community-based service been accessed.[50] A 'potentially avoidable GP-type presentation' is defined as cases that present to an ED where the patient:

- Was triaged as a category 4 or 5 according to the Australian Triage Scale;[51]
- Did not arrive by ambulance;
- Was not admitted to the hospital, referred to another hospital, and
- Did not die.[50]

This 'potentially avoidable GP-type presentation' outcome was modified in this study to exclude the criterion involving arrival by ambulance and was referred to as 'ED suitability'.

Hospital admission

Despite hospital admission being used as part of the ED suitability indicator, this indicator has also been used in isolation in other studies[30,32] and was therefore retained to allow for comparison. Also, hospital admission was provided by both public and private hospitals, therefore allowing for cases transported to private hospitals to be included in the analysis.

Average Victorian ED Presentation for Victoria

Each year the Australian government report the overall rates of hospital admission and 'potentially avoidable GP-type presentations' for all public hospital ED presentations in each state of Australia.[50] The overall rates are inclusive of all ED attendances, including Referral Service cases that present at the ED. The rates of ED suitability and hospital admission were compared to the overall rates for Victoria, which were referred to as 'the average Victorian ED presentation' in this paper. The rates from the 2011/2012 report were utilized in this study.[50]

Data Analysis

Data were analysed using descriptive statistics, chi-squared tests of association, independent samples t-tests and logistic regressions to identify relationships with 95% CIs. All tests were considered to be significant at 0.05 level. All data analysis was performed using SPSS Version 20.[52]

RESULTS

Outcomes

During the study timeframe Ambulance Victoria received just over one million calls for assistance, of which 11.9% were triaged by the Referral Service. At the end of this triage, 69.5% of cases were referred to care pathways other than the emergency ambulance dispatch pathway, and 30.5% were referred away from an ED presentation (the emergency care pathways). Figure Three outlines the selection of cases eligible for inclusion in this study, resulting in 44,523 cases undergoing further analysis.

Patient demographics

The gender distribution for cases presenting to the ED was similar for all care pathway groups (Table Two). Triage outcomes that required the patients to self-source further care, including the 'self-present at the ED' cases and 'self-care advice' cases, were younger than those sent further care (Table Two).

Five main presenting problems made up 80% of the most common problems for each of the care pathways (Table Two). These were abdominal pain, back pain, nausea and vomiting, urinary symptoms and dizziness and vertigo. Abdominal pain and back pain featured in the top five main presenting problems for every care pathway.

**Please insert: Table Two

Table Two: Hospital management of cases that presented at ED following Referral Service (RS) triage.

ED suitability

The planned ED presentations were more likely to be classified as ED suitable than the unplanned ED presentations (OR 1.62; 95% CI 1.5 to 1.7; p<0.001). The ED suitability for planned ED presentations ranged from 70.6% to 77.8% for each of the emergency care pathways, which was significantly higher than the ED suitability for the average Victorian ED presentations of 61.0% (OR 1.85; 95% CI 1.01 to 3.4; p=0.046) (Table Two).

Of the alternative care pathway cases, the unplanned ED presentations that were originally referred to alternative service providers had an ED suitability rate higher than the average Victorian ED presentation (68.8%), and the cases originally given self-care advice had an ED suitability rate almost the same as the average Victorian ED presentation (60.3%) (Table Two). These unplanned ED presentations were therefore at least as 'ED suitable' as the average Victorian ED presentation. It should be noted however, that only 19.3% of all the cases referred to the alternative service providers and 12.5% of all the cases given self-care advice presented in the ED. Overall, only 9.5% of the total alternative care pathway cases were identified as ED suitable (14.7% of all the alternative service provider cases and 8.2% of all the self-care advice cases).

Hospital Admission

Planned ED presentations were significantly more likely to be admitted to hospital than unplanned ED presentations (53.8% versus 43.5%; OR 1.5, 95% CI 1.4 to 1.6; p<0.001). Both the planned ED presentations (OR 2.3, 95% CI 2.24 to 2.33; p<0.001), and the unplanned ED presentations (OR 1.6, 95% CI 1.5 to 1.73; p<0.001) were more likely to be admitted than the average Victorian ED presentation (36.0%) (Table Two). Overall only 6.5% of all the alternative care pathway cases were admitted to hospital (11.3% of all the alternative service provider pathway cases and 5.1% of all the self-care advice pathway cases).

DISCUSSION

This was the first large-scale study to link ambulance service data and hospital data to investigate the outcomes of both planned and unplanned ED presentations following an ambulance-based secondary telephone triage. Overall the cases referred to the emergency care pathways, (the planned ED presentations), appeared to be appropriate with ED suitability and hospital admission rates being higher than both the unplanned ED presentation group and the average Victorian ED presentation.

The decision to send cases to the alternative care pathways appears sound with over 85% not emerging in the emergency care system within 48 hours. The overall rates of ED suitability and admission for the cases sent to the alternative care pathways were well below that of the average Victorian ED presentation predominantly because so few went on to present at the ED. When only the unplanned ED presentations were considered, the ED suitability and admission rates were the same, if not higher, that those for the average Victorian ED presentation. These results suggest that whilst the overall numbers of unplanned ED presentations were relatively small, they may have been appropriate for the ED and further investigation of these cases needs to be done to ensure they are not being incorrectly triaged to the alternative care pathways.

The results of this study are consistent with previous research whereby cases classified as requiring an emergency ambulance were more likely to be admitted to the hospital than those classified as not requiring an emergency ambulance.[30,32] The admission rate of cases in the alternative care pathways (unplanned ED presentations) of 6.5% was below that found in these other studies, which had rates of 9.2% and 15.8%.[30,32] This lower rate of admission may indicate that the secondary telephone triage process used by Ambulance Victoria, is more effective in identifying which cases are suitable for the alternative care pathways. While the previous research have accepted these admission rates and suggested the secondary telephone triage process is a safe and feasible means of managing ambulance demand,[30,32] further investigation of the unplanned ED attendances is warranted.

This evaluation of ED suitability casts a broader net than simply basing the appropriateness of an ED presentation on whether a patient was admitted or not. The 'ED suitability' outcome measure increased the sensitivity, whereas the 'admissions only' outcome measure was felt to be more specific and prone to excluding appropriate cases. The ED suitability measure used a range of variables to eliminate the potential bias imposed by the decisions made by individual healthcare professionals during the patient care phase. Also, given that these variables are likely to be recorded in most emergency departments and are collected independent of any assessment of appropriateness, the ED suitability measure used in this study offers future researchers the opportunity to generate locally generalizable results that are also reproducible. ED treatment itself was not included in this outcome measure as it was the researcher's view that the ED healthcare workers will naturally instigate at a minimum, investigative procedures that could have been conducted in the primary care setting, which would have been viewed as a positive result for ED treatment. In this study, the ED suitability and admission outcome measures, also allowed for a comparison with the greater population of cases that present at the ED in Victoria.

Whilst the results from this study suggest that the Referral Service was appropriate in filtering the cases ultimately destined for the ED, more can potentially be done to increase the sensitivity and specificity of the triage process. The unplanned ED presentation cases need to be further investigated to determine whether their condition evolved within the potential 48 hour window between Referral Service triage and ED presentation, whether they should have been triaged to the emergency care pathway, or whether other services, not within the suite of alternative service providers used by the Referral Service, would have been able to manage these cases in the primary care setting. Similarly cases from the planned ED presentation pathway that were not ED suitable, or not admitted, need to be further investigated to determine if a primary care alternative is available to manage these cases out of the hospital setting.

Optimizing the suite of pathways available to the Referral Service call-takers may lead to increased specificity of cases for emergency ambulance and the emergency department, therefore increasing the effectiveness of the Referral Service. In doing this, care should be taken to ensure that more than just physiological or clinical indicators are considered when decisions are made, particularly when these decisions result in the omission of a face-to-face assessment within a particular timeframe. Nonclinical situations have been identified where it would be considered appropriate for a low-acuity patient to be assessed and transported by paramedics, or present in the ED.[53] An example of this is where there may be a perceived risk of physical harm to the patient, either through the threat of violence, an unattended minor or a patient who may appear physically or psychologically incompetent.[53] Any secondary telephone triage process should ensure that the patients overall wellbeing is taken into consideration.

This study was limited by the inability to link some of the cases between the datasets. There are several possible reasons for a failure of an appropriate linkage, or for records to not have been available for linkage. These include private hospital attendance (therefore no ED records were available), transcription errors in case numbers and dates-of-birth during data acquisition and handovers, usage of a written paramedic record rather than an electronic paramedic record, ambulance cancellation prior to arrival and patient non-compliance.[49] This highlights a need for consistent patient identifiers and a means of transcribing data at the various transitions of care that reduces errors, such as electronic transfer.

Whilst no clinically significant systematic bias was detected, the potential for this bias remained given the volume of unlinked cases in each of the emergency care pathways.

The mean population data for the average Victorian ED presentation included all of the patient presentations for the respective time period, including those from the Referral Service who were sent to the emergency care pathways and presented in the ED. The presence of these cases in the 'average ED presentation' group will increase the overall ED suitability rate for this group. The impact would be negligible however with all Referral Service cases referred to the emergency care pathways only constituting 1.6% of the total ED workload if they had all presented at the ED during the study timeframe. Finally, the ED suitability measure was directly compared to the 'potentially avoidable GP-type presentations' despite their slight difference.

Whilst the variation in secondary telephone triage system structure and functionality could not be addressed in this study, the research variables used were specifically selected to allow for similar methodological approaches, less vulnerable to personal opinion, to be utilized in future work. Using

these methodological approaches, the findings may be somewhat limited in their broader generalisability, however they should be locally reproducible.

CONCLUSION

This study utilized linked ambulance and hospital data to analyse the appropriateness of the referral of cases for ED presentation following secondary telephone triage and provided a methodological approach that can be applied in future research. Overall secondary telephone triage was able to appropriately identify many cases that were suitable for the ED and that would be admitted, at a rate higher than that of the average Victorian ED presentation. A small cohort of cases identified as suitable for alternative care pathways presented in the ED and were ED suitable. Further investigation is required beyond this study beyond this study to ensure cases were not incorrectly triaged to the alternative care pathways and to optimize the suite of alternate pathways to ensure the right patient is being triaged to the right service.

DATA SHARING STATEMENT

Data sharing: no additional data available.

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Emergency care pathway cases (Planned ED attendances)		Linked ED record	No ED record found	Statistical comparison
Emergency ambulance	**Missing cases (%)**		37.2	
	age	56.0	56.0	t(21820.5) = -1.82, p=0.068
	Gender (% female)	54.3	56.1	Chi-square = 9.14, df=1, p<0.002
	Main presenting problem with RS (%)	Abdominal pain (17.0) Back pain (9.8) Dizziness & vertigo (5.7)	Abdominal pain (14.9) Back pain (9.2) Dizziness & vertigo (7.1)	
Non-emergency ambulance	**Missing cases (%)**		47.8	
	age	65.0	66.0	t(19432.2) =4.26, p<0.001
	Gender (% female)	53.2	53.9	Chi-square = 1.04, df=1, p=0.31
	Main presenting problem with RS (%)	Abdominal pain (24.6) Back pain (7.2) Urinary symptoms (6.9)	Abdominal pain (24.6) Back pain (6.4) Urinary symptoms (6.0)	
Self-present at ED	**Missing cases (%)**		59.6	
	age	44.0	41.0	t(22754) = -7.34, p<0.001
	Gender (% female)	55.5	56.4	Chi-square = 1.72, df=1, p=0.2
	Main presenting problem with RS (%)	Abdominal pain (21.0) Back pain (7.1) Flank pain (5.8)	Abdominal pain (21.4) Back pain (6.7) Nausea and vomiting (4.9)	

Table One: Comparison of emergency care pathways cases that were matched to an ED record (RS –Referral Service)

	Planned ED presentations (Emergency care pathways)			Unplanned ED presentations (from the Alternative care pathways)	
	Emergency ambulance	**Non-emergency ambulance**	**Referred to self-present at ED**	**Cases referred to an Alternative service provider**	**Cases given self-care advice**
ED record (% of total cases referred to that pathway)	18,578 (62.8)	10,348 (52.2)	9,184 (40.4)	2,207 (19.3)	2,496 (12.5)
Female (%)	54.3	53.2	55.5	53.2	52.6
Median age (years)	60	70	41	59	47
Most common main presenting problems (of ED presentation cases)	1. Abdominal pain (17.0%) 2. Back pain (9.8%) 3. Dizziness/ vertigo (5.7%) 4. Nausea/ vomiting (5.0%) 5. Fever (4.1%)	1. Back pain (24.6%) 2. Abdominal pain (7.2%) 3. Urinary symptoms (5.2%) 4. Weakness/ paralysis (4.8%) 5. Lower leg non-injury (4.8%)	1. Abdominal pain (21.0%) 2. Back pain (7.1%) 3. Flank pain (5.8%) 4. Nausea/ vomiting (4.8%) 5. Urinary symptoms (3.0%)	1. Back pain (16.1%) 2. Nausea/ vomiting (8.4%) 3. Dizziness/ vertigo (7.5%) 4. Urinary symptoms (5.3%) 5. Abdominal pain (4.4%)	1. Back pain (10.6%) 2. Abdominal pain (8.1%) 3. Nausea/ vomiting (7.0%) 4. Dizziness/ vertigo (5.9%) 5. Constipation/rectal symptoms (3.6%)
ED suitability of RS cases that attended ED (Absolute Risk (%))	77.8	71.3	70.6	68.8	60.3
Overall ED suitability for RS cases with an ED record (Absolute Risk (%))	74.3			64.1	
Hospital admission for RS cases with an ED record (Absolute Risk (%))	55.0	58.3	46.4	51.3	39.4
Overall hospital admission for RS cases with an ED record (Absolute Risk (%))	53.8			43.5	

Table Two: Hospital management of cases that presented at ED following Referral Service (RS) triage.

FIGURE LEGENDS

Figure One: Case-flow from the call to the emergency services to Referral Service outcome

Figure Two: linkage outcomes for each of the emergency care pathways

Figure Three: Selection planned and unplanned ED presentation cases for inclusion in this study

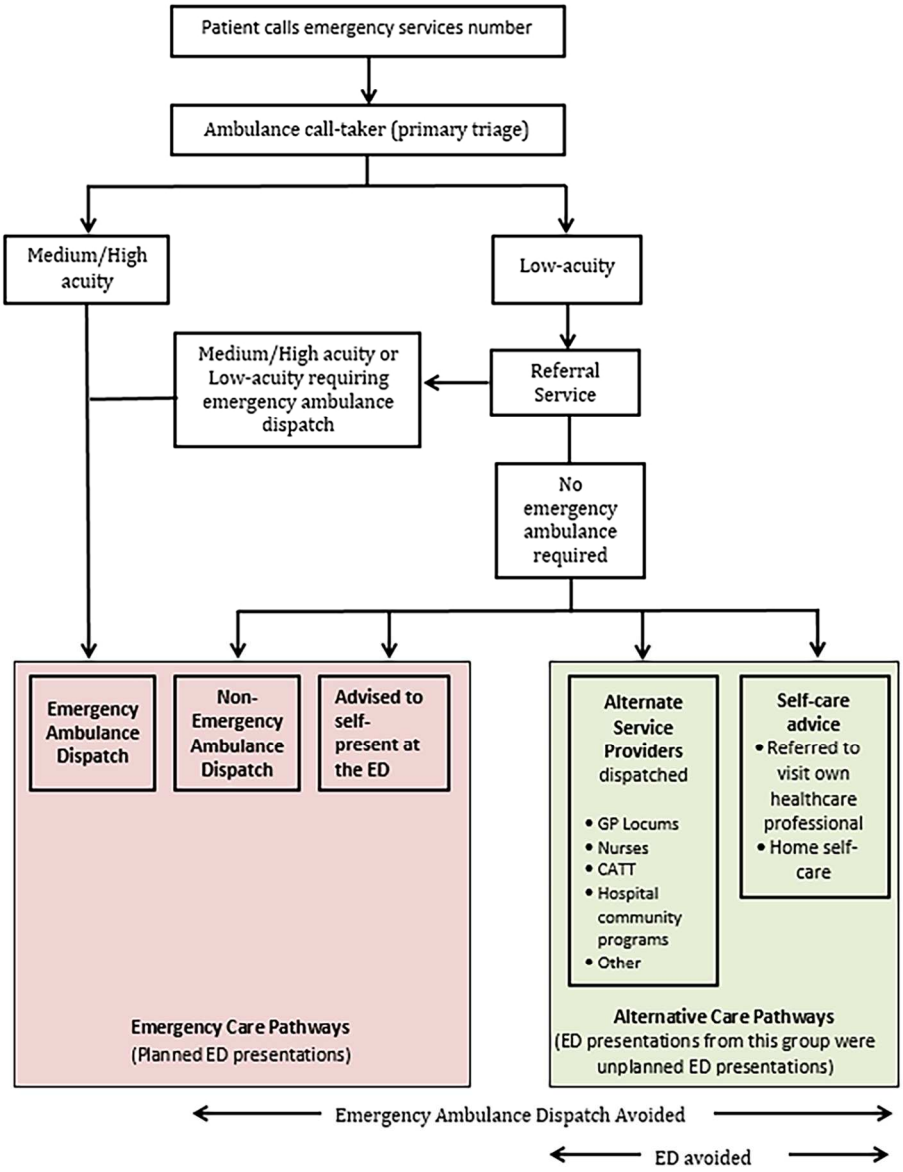

Figure One: Case-flow from the call to the emergency services to Referral Service outcome

115x152mm (300 x 300 DPI)

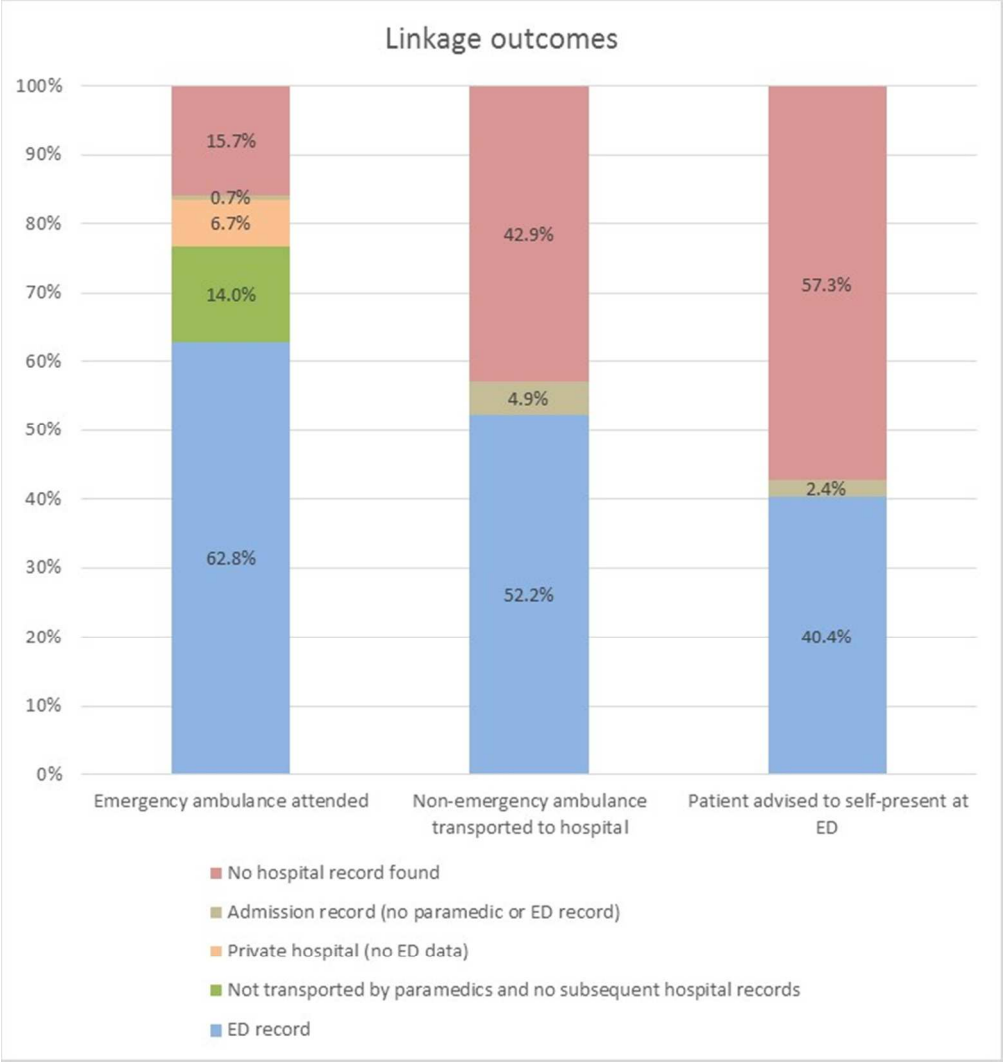

Figure Two: linkage outcomes for each of the emergency care pathways

60x64mm (300 x 300 DPI)

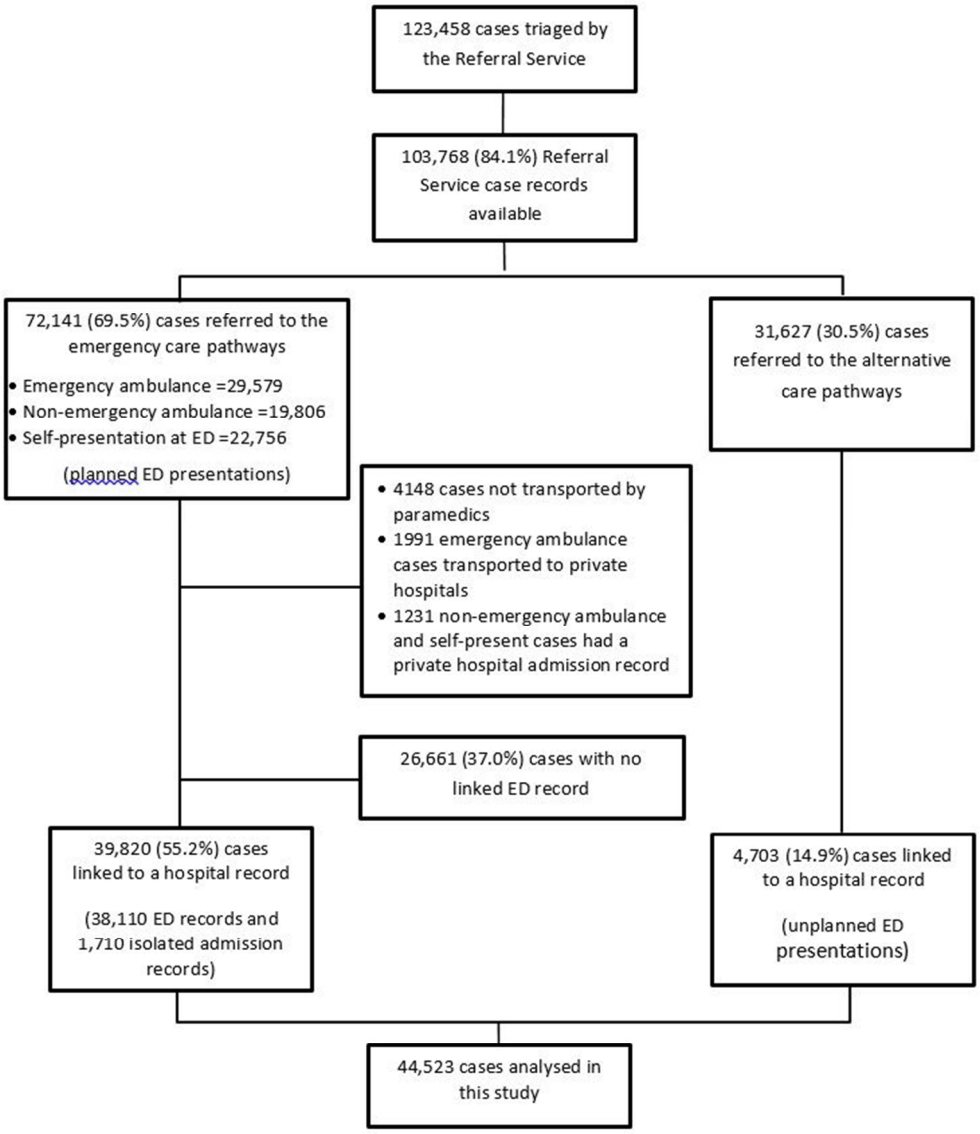

Figure Three: Selection planned and unplanned ED presentation cases for inclusion in this study

63x72mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-9
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10
Data sources/ measurement	8*	*7-8*	7-8
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	9-10
		(*c*) Explain how missing data were addressed	9; 18
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	9-10
		(c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11, 19
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.