



The Pre-Hospital Emergency Department Data Linkage Project

Data linkage across ambulance services and acute trusts: assessing the potential for improving patient care

Principal Investigator (corresponding author)	Sophie Clark Sophie.clark@lond-amb.nhs.uk
Project Team	Martin Brand, LAS Sheila Donovan, Swansea University Holly Dorning, The Nuffield Trust Mary Halter, Kingston University and St George's, University of London Alison Porter, Swansea University
Co-Applicants	Michael Damiani, Rachael Fothergill, Martin McTigue, Helen Snooks, Fenella Wrigley

Summary of Key Findings

Introduction

Ambulance services and emergency departments (EDs) collect data on patient care and store it electronically. However, in English ambulance services, there is no routine link made between the datasets. Each episode of emergency care for one patient will have two records, one held by the ambulance service, another by the ED. The physical handover of a patient and the continuity of clinical care from one organisation to the other is routine, but currently electronic data does not cohesively connect the patient journey. Demand for ambulance services in England is rising at an average year on year increase of 5% whilst they are under pressure to contain costs and improve quality, data systems have a part to play.

The Pre-Hospital Emergency Department Data Linkage project (PHED Data) was a 2 year mixed methods research project funded by the Health Foundation as part of the “Insight 2014” award funding stream. It aimed to assess the feasibility of and potential learning from retrospectively linking ambulance service data to ED data, using no patient identifiable information, and creating a continuous electronic record of the patient journey from ambulance to ED.

PHED Data aimed to answer 3 questions:

1. What are the potential opportunities for and challenges to routinely linking data from the ambulance service to emergency departments?
2. What understanding can be gained from this linked data which could lead to the improvement of health care delivery within the ambulance service and across the wider healthcare economy?
3. What are the challenges to and opportunities for using these data to inform future commissioning of healthcare?

Methods

We conducted the study with one metropolitan ambulance trust and six acute NHS trusts (13 EDs) in England. We sought routine patient data for the period 01/04/12 to 30/06/16 (followed monthly extracts) for all patients conveyed by the ambulance service to an ED within one of the participating acute trusts. This data does not contain patients that were not conveyed to an ED even if an ambulance attended. For patients who died in the ED, we collected additional data on the patient’s observations from ambulance patient report forms. We carried out quantitative analyses as part of Work Packages 2 – 5 below. Admission rate was defined as a patient that was admitted to a hospital ward after their ED care and was used as a proxy measure of being too unwell to be cared for in the community.

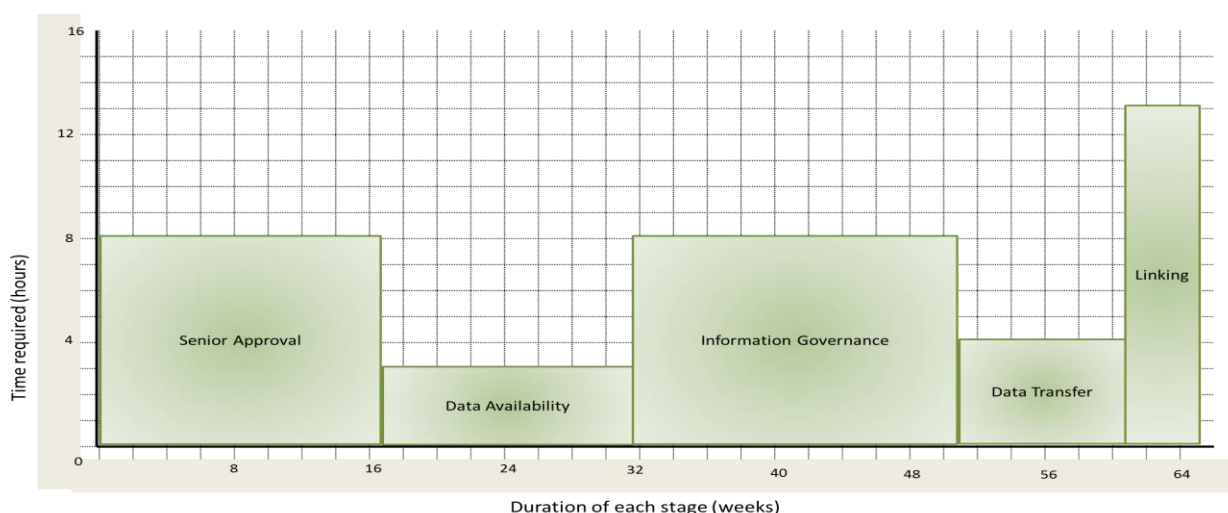
Work package	Focus of potential learning
WP1	Opportunities for and practical challenges to linking data
WP2	Analyses relating to response times and patient outcomes
WP3	Analyses relating to referrals to the ambulance service from healthcare professionals
WP4	Analyses relating to mortality in ED
WP5	Analyses relating to hospital diagnoses given to conveyed patients
WP6	Potential for the analysis developed in WP2-5 to influence patient care developments

In addition, we kept a log of the work involved (on the part of the ambulance service) in making the data linkage happen. We conducted interviews and focus groups with key stakeholders: prehospital clinicians, emergency operations centre staff, general practitioners, ED clinical staff, performance managers and commissioners of the ambulance trust. This qualitative work was designed to seek commentary and explanation of the findings from the analysis of linked data, and to gather views on the feasibility and value of routinely linking patient level data.

Results

Work Package 1: What are the potential opportunities for and challenges to routinely linking data from the ambulance service to emergency departments?

We identified 5 steps to obtaining the linked dataset



- All 6 acute trusts agreed to participate in the project, signed information sharing agreements and transferred data. The time taken and duration of each stage above is the mean.
- On average the whole process took 1 year and 13 weeks, with information governance approval taking the most time to complete.
- All EDs had matchable data, a deterministic matching algorithm yielded an average match-rate of 78% (range 50% - 93%).
- A linked dataset consisting of 775,018 records across 13 EDs was produced.
- The project required input from staff spanning multiple departments and delays in communication/ time lags due to staff capacity were common; information governance was most affected.
- Extensive data cleaning was required before linking and before analysis, this included the deletion of blank or duplicate records and removing incomplete records from some statistical models.
- It is feasible to collect and match ambulance data to ED data across multiple sites, but setting up the data linkage process takes a long time.

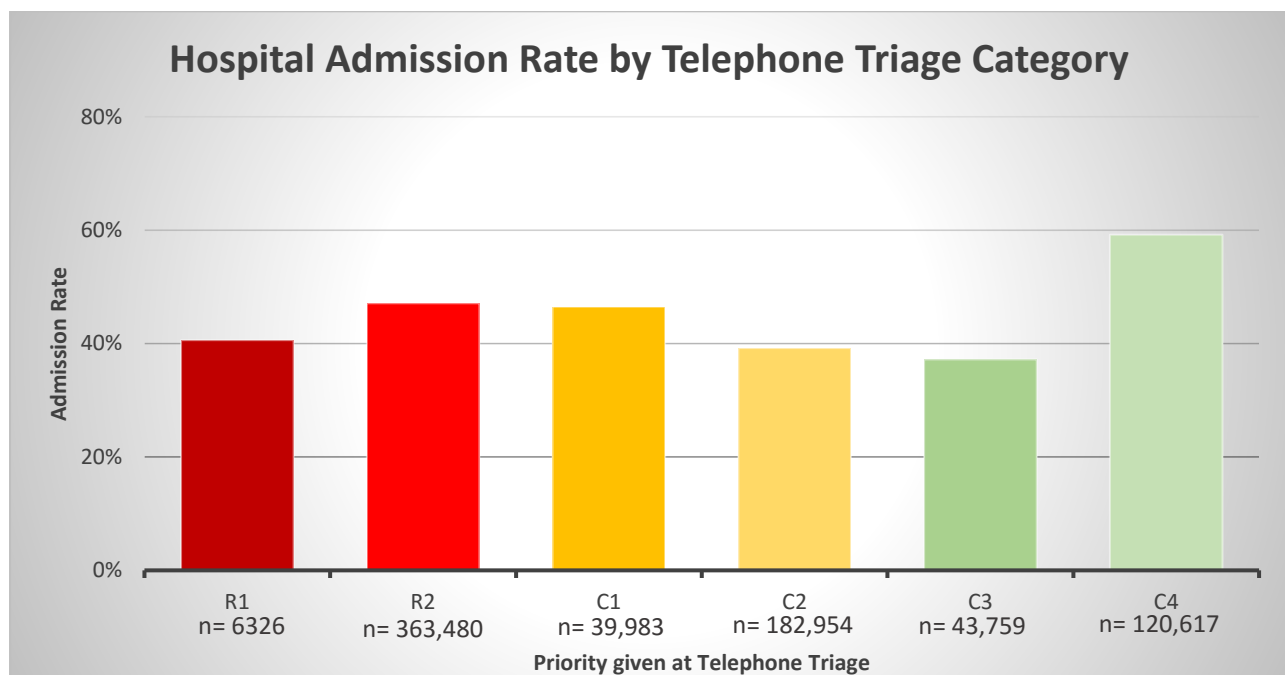
Work Package 2: What understanding can be gained from linked data relating to response times and patient outcomes?

In this work package we explored the relationship between the triage category assigned during the 999 call (which determines how fast the ambulance service will try to reach the patient) and the decision to admit a patient to hospital from the ED.

Priority category	Priority level	Response	Typical patient
R1	Highest	8 min face to face response (blue light)	Cardiac arrests/ choking/ continuous fitting
R2	High	8 min face to face response (blue light)	High speed vehicle collisions/ chest pain/ strokes onset within 4.5 hours
C1	Lower	20 min face to face response (blue light)	Intentional overdose/ stroke onset over 4.5 hours/ diabetic problems
C2	Lower	30 min face to face response (blue light)	Mental health/ lower speed vehicle collisions/ abdominal pain
C3	Lower	Referred to telephone advice*	Minor burns/ headaches/ eye problems
C4	Lowest	Referred to telephone advice*	GP referrals/ mental health/ very low speed vehicle collisions

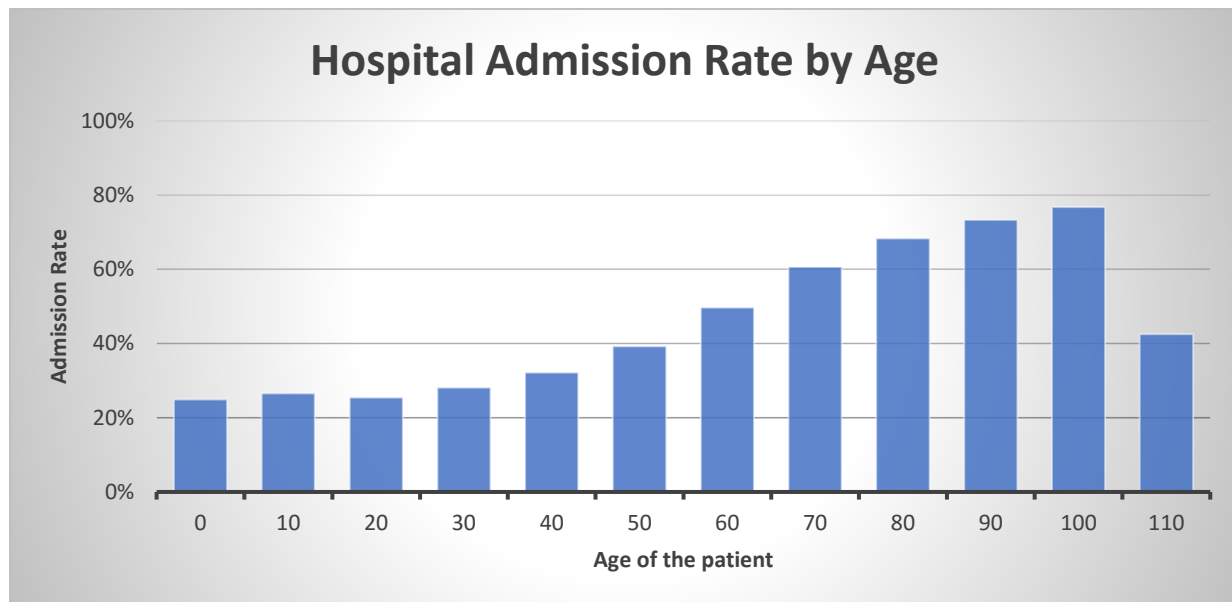
Crude admission rates across triage categories (Figure 1) ranged from 37.65 (C3 category) to 59.4% (C4 category), with a crude admission rate in the highest priority R1 category of 45.6%.

Figure 1 shows the percentage of patients admitted to the hospital after their ED care by their telephone triage priority assigned during the 999 call.



- As shown in Figure 2, the odds of being admitted increased with age. Once age and other factors had been adjusted for, the odds of admission were highest in the R1 category.

Figure 2 shows the percentage of patients admitted to hospital after their ED care by their age to the nearest decade



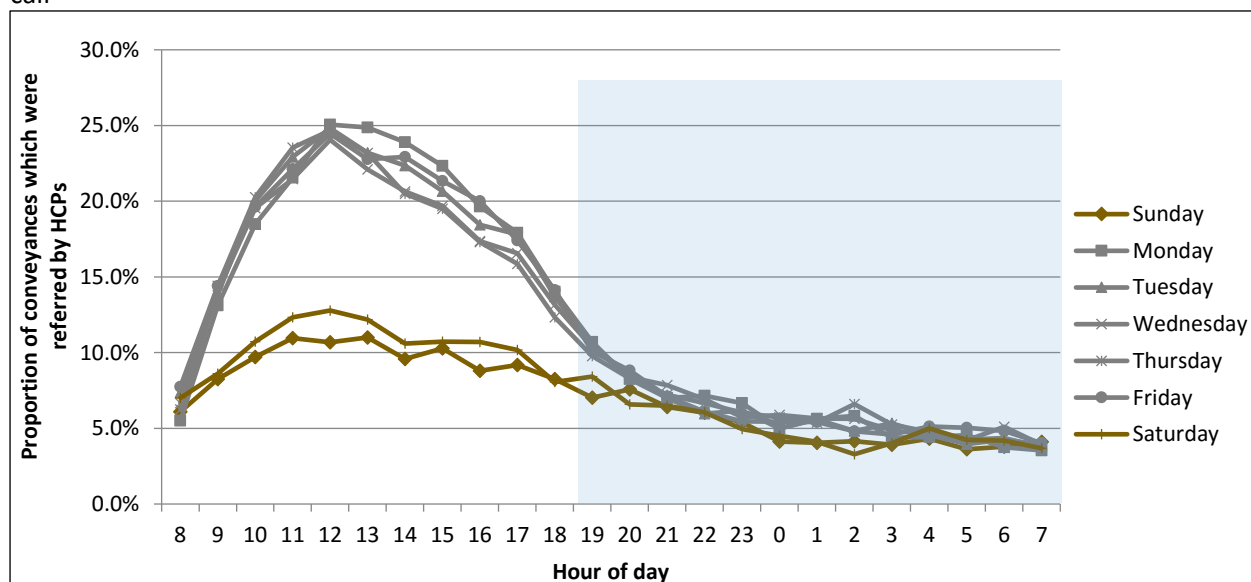
- Patients categorised as C4 (the lowest priority) had the highest admission rate. Age was a key factor in determining whether a patient was admitted and patients in the C4 category tended to be older. An admission to hospital does not necessarily reflect that a patient required a fast response by the ambulance service. It does suggest that older patients with conditions that require considerable care can generate a low priority and will receive a slower response.
- The biggest potential for making efficiency improvements is likely to be in the R2 category, as this was the largest group of conveyances and roughly half were admitted to hospital. This suggests that this group may contain low risk groups that are currently receiving a high priority and a fast response.
- Qualitative work found that participants felt that quality of triage was affected by the exchange of information between the caller and call handler; there were many factors which may limit the fullness and accuracy of the information shared.
- Current telephone priority systems rely mainly on symptoms and may be missing unwell elderly patients with low priority symptoms.

Work Package 3: What understanding can be gained from this linked data relating to referrals to the ambulance service from health care professionals?

We examined referrals to the emergency ambulance service made by health care professionals (HCPs). HCP describes a range of clinical practitioners such as GPs, district nurses and mental health nurses, however the details of their role are not currently collected they are all identified as a HCP. We also looked at conveyances of people who lived in care homes.

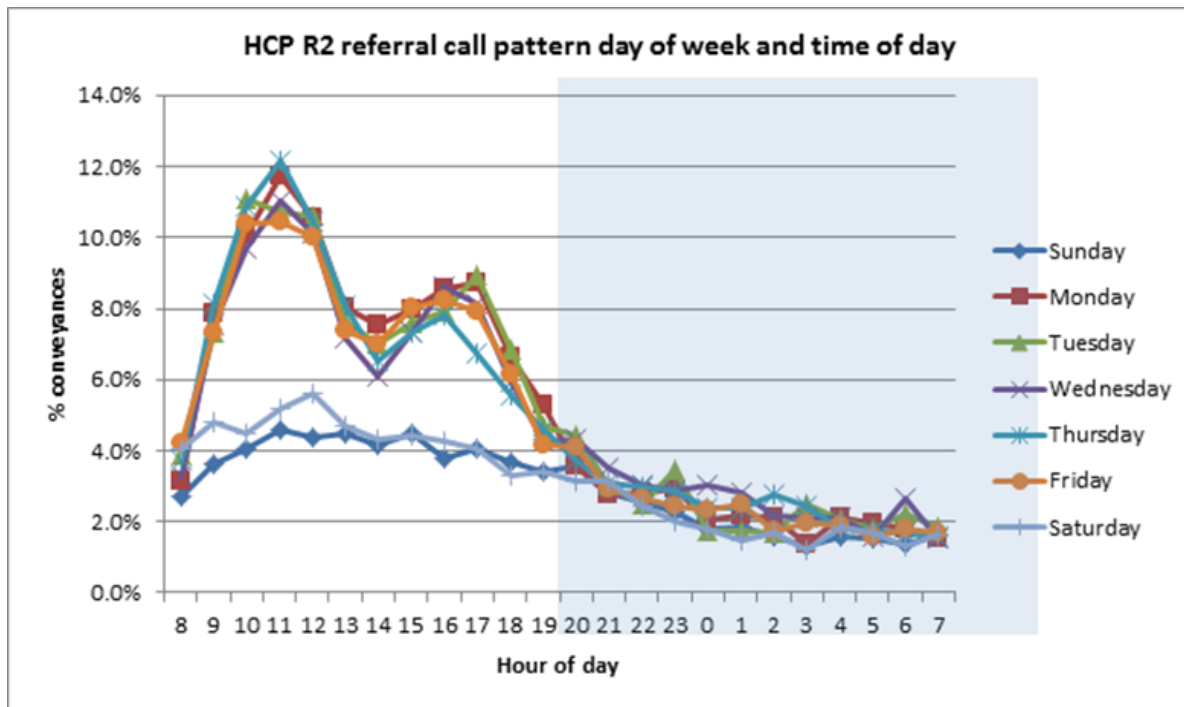
- HCP referrals accounted for 12% of all conveyances in our sample as a whole, this proportion remaining roughly constant over the four years of our dataset.
- Patients referred by HCPs tended to be older than the whole patient group, and a greater proportion (roughly two thirds) were admitted. After adjusting for age, patients referred by HCPs still had a higher odds of admission.
- The telephone triage categories R2 and C4 between them accounted for 99.9% of HCP conveyances, this is due to the response options given to the HCP during the call.
- As shown in Figure 3, HCP conveyances peaked at around mid-day on weekdays, when they accounted for up to a quarter of all conveyances.

Figure 3 shows the proportion of conveyances which were referred by HCPs, by day and time of ambulance call*



- Those HCP calls triaged as R2 showed two distinct peaks, at around 10am and 4pm on weekdays, as shown in Figure 4.

Figure 4 shows the proportion of conveyances triaged as R2 calls by HCPs by day and time of ambulance call*



*The out-of-hours period is from 6.30pm to 8.00am on weekdays and all day at weekends and on bank holidays, weekday out-of-hours period is represented by shaded area. Care homes are defined by the tick box "care home" noted on the patient report form, this could be either a care home or nursing home.

- We did not observe significant variation between GP practices in terms of admission rates of patients who were HCP referrals.
- Calls from care homes accounted for 6% of our dataset. Some patients may be counted as both an HCP admission and originating from a care home.
- After adjusting for age and other factors, patients from care homes were less likely to be admitted than the whole patient group. Conveyances from care homes showed no particular patterns of activity.
- Significant numbers of patients referred by HCPs were allocated very broad condition codes such as 'generally unwell' (7%) and 'unknown' (6%), and these codes were used at a higher rate than with patients who were not referred by HCPs. Just over 2% of HCP referrals were taken to hospital as stroke patients.
- The focus group and interview participants suggested reasons for HCPs to call: care needs outside the scope of practice of the HCP, e.g. FAST positive patients; an identified need for admission, often linked to multi-morbidity/social; situations of uncertainty where a second opinion was needed. They suggested that some calls logged as HCP referrals may actually be made by, for example, a GP receptionist.
- There was sensitivity to the pressures under which colleagues in other parts of the system worked, but scope to improve their understanding of processes and models of service delivery.

Work Package 4: What understanding can be gained from this linked data in regards to patients who die in the ED?

In this work package we looked at the patients who died in the emergency department and their prehospital care.

- The number of patients who died in the ED was small – 1953, or 0.26% of the dataset.
- Patients who died in the ED tended to be older and were more likely to reside in a care home. Comments from senior ED and ambulance service clinicians suggest that this group was likely to be receiving palliative care or otherwise at the end of their life.

Figure 5 shows the number of patients who died in the ED by the telephone triage category assigned by the ambulance service.

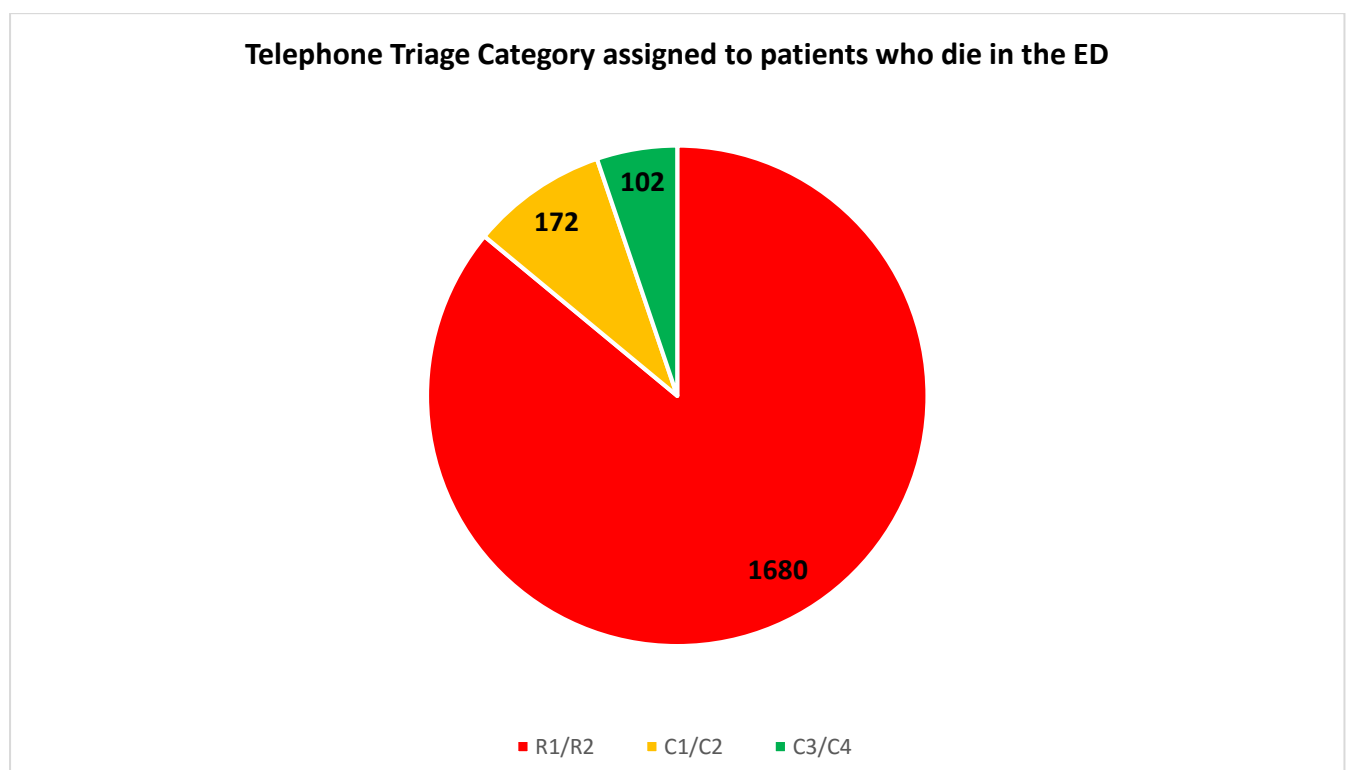
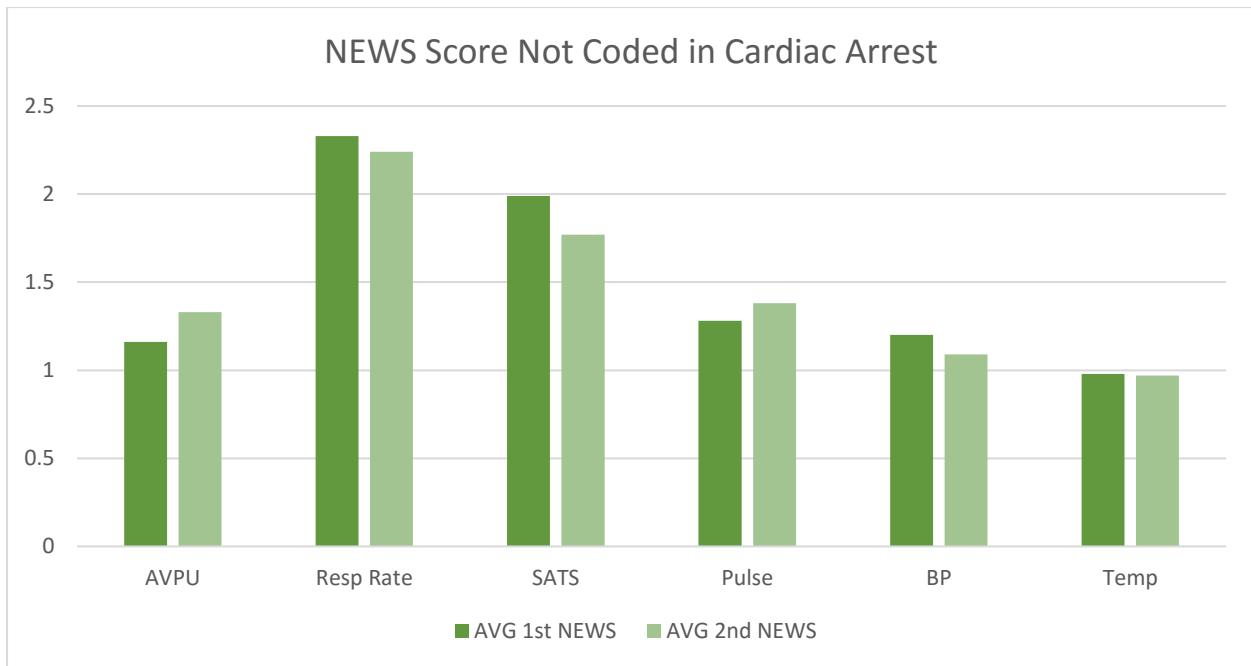


Figure 6 shows the National Early Warning Score by observation for patients not in cardiac arrest. The National Early Warning Score, uses 6 physiological measurements; alertness, respiratory rate, oxygen saturations, pulse, systolic blood pressure and temperature. Each measurement generates a score 0-3 and a cumulative score is generated (0-18). Normal observations in a healthy patient will generate a 0 score with acutely unwell patients generating high scores.



- As shown in Figure 5, the majority of patients who died in the ED had been triaged as R1/R2 (34.3% and 51.7% respectively) and were pre-alerted by prehospital clinicians. This suggests that the ambulance service is recognising and escalating care for this patient cohort.
- The minority of patients who were not recognised and escalated appropriately included: patients that were referred to the ambulance service by health care professionals, patients that were not in cardiac arrest and patients with a low NEWS (<5) during their prehospital care.
- The only observation with an average NEWS of over 2 was respiratory rate, coupled with difficulty in breathing being a common symptom in this cohort, respiratory distress, over other signs and symptoms, could be an early predictor of acute deterioration to death in the prehospital patient.

Work Package 5: What understanding can be gained from this linked data in regards to hospital diagnoses given to ambulance conveyed patients?

We looked at the ED diagnosis given to conveyed patients. We focused in particular on two diagnostic sets – gastrointestinal and urological – which offered us exemplars for analysing the scope for developing pre-hospital interventions and pathways. We also explored this data for a definition of the appropriateness for an ambulance conveyance to ED.

Figure 7 (overleaf) shows the code assigned at 3 points in the pathway, during the 999 call (chief complaint), on scene with pre-hospital clinicians (illness code) and the ED diagnosis for patients with a gastrointestinal ED diagnosis. We are showing only the most common diagnoses, so this visualisation represents 52% of those in this broader ED diagnosis group.

Figure 8 (overleaf) shows the code assigned at 3 points in the pathway, during the 999 call (chief complaint), on scene with pre-hospital clinicians (illness code) and the ED diagnosis for patients with a urological ED diagnosis. We are showing only the most common urological diagnosis in the ED, so this visualisation represents 80.5% of those in this broader diagnosis group. ‘

Figure 7

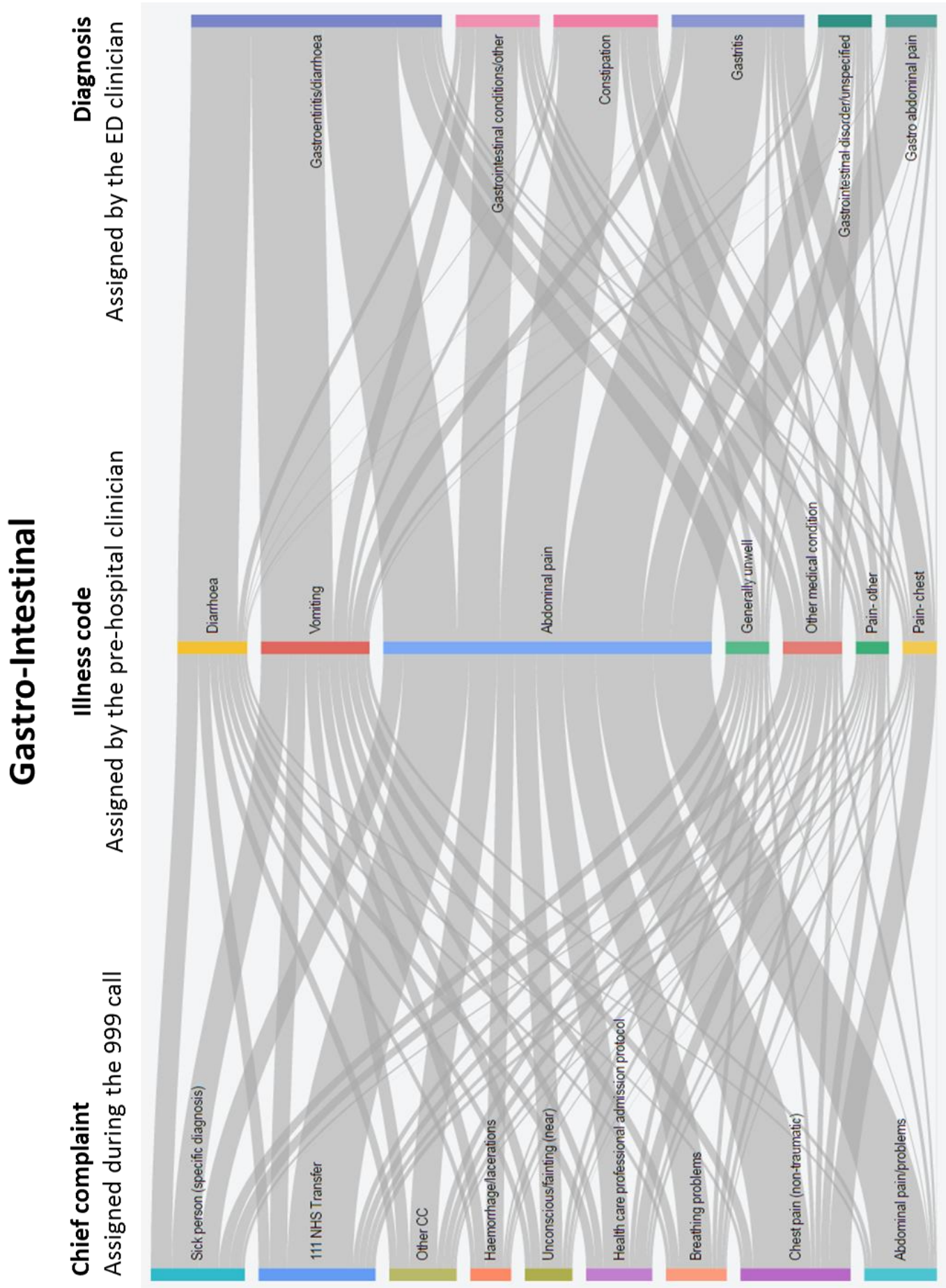
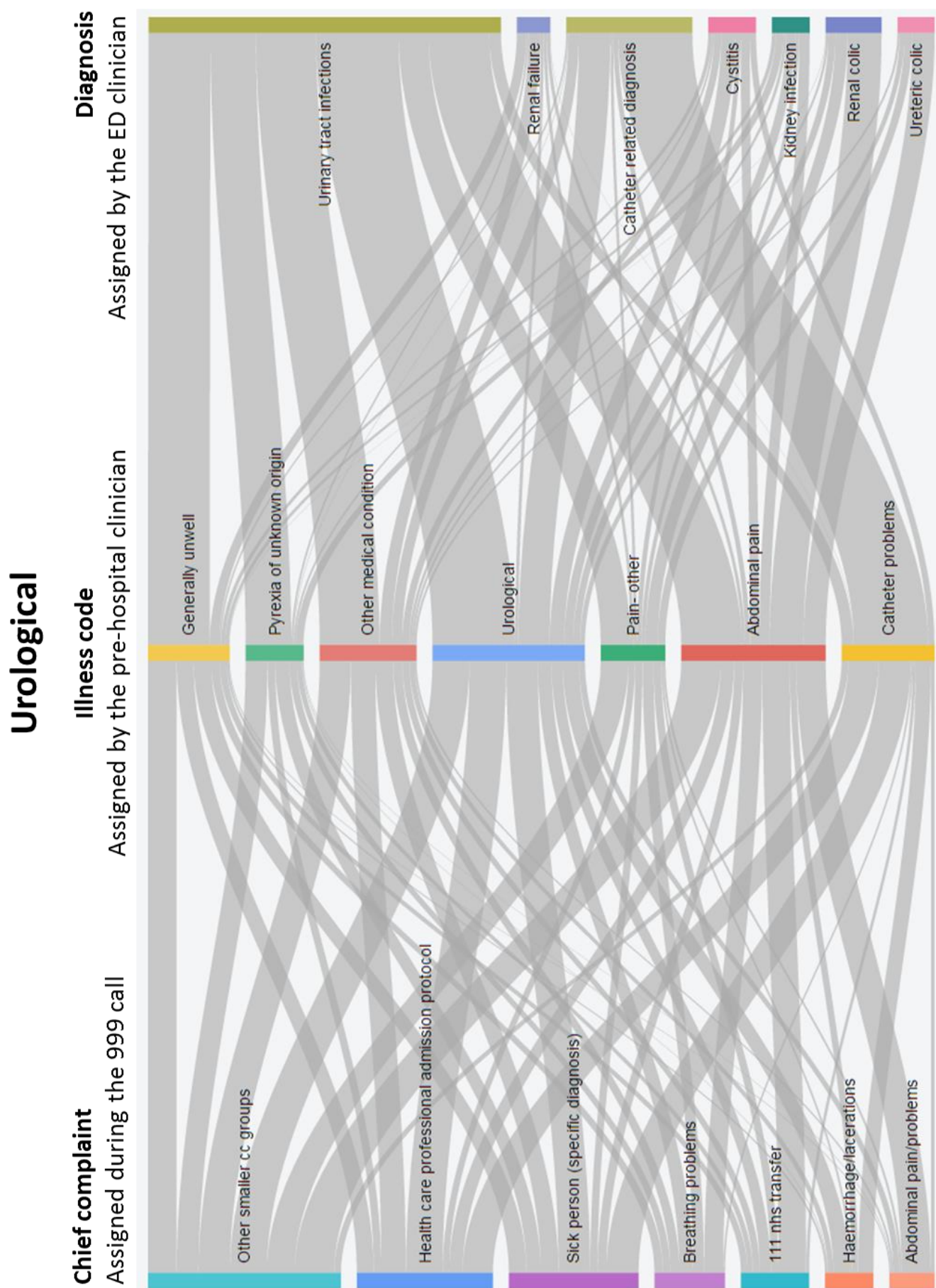


Figure 8



- The 3 coding systems use different codes and were designed for different purposes.
- There was variable data quality in the ED diagnosis field.
- Chief complaints with high admission rates included 'unknown problem (collapse 3rd party)', 'health care professional admission protocol', 'stroke (cva)' and 'hospital transfer'.
- Illness codes assigned by prehospital clinicians with high rates of match with ED diagnostic groups included: 'Stroke FAST positive', 'abdominal pain', 'alcohol related' and 'drug overdose'.
- At focus groups and interviews, participants consistently challenged the assumption that discharge from the ED equates precisely to an opportunity for ED avoidance. Pre-hospital clinicians raised concerns about the risks of overly simplistic analyses.
- Service improvement, particularly around using ED diagnosis to assist in a definition of "appropriate" ambulance conveyance was considered to require more detailed analysis of; time spent in the ED, investigations carried out and the clinical training level of the ED decision maker prior to shifting this decision to the pre-hospital setting. An awareness of non-clinical factors in the decision to admit (such as social care needs) was also expressed. This level of detail was not consistently available in the dataset.

Work Package 6: What are the challenges to and opportunities for using these data to inform future commissioning of healthcare?

We drew on focus groups with ambulance staff, interviews with senior clinical and managerial staff in participating trusts and the ambulance service, and interviews with commissioners to consider the value of the linked data for improvement within the ambulance service, and the commissioning of healthcare.

Opportunities

- The linked data, aggregated to patient trends could be used to inform clinicians of patient outcomes, which they reported would have a host benefits such as opportunities for professional development and improving clinical confidence.
- Linked data could contribute to more informed commissioning and could be part of the commissioning cycle.
- It fits with current work on the Ambulance Response Programme and joint work with CCGs on the development of alternative pathways.
- Implications for commissioning across the wider healthcare system, particularly public health and preventive health interventions.
- Potential for further linkages, such as public health datasets
- Potential to inform decisions made by NHS England and NHS Digital about national data sets collected.
- The dialogue opened by the project and its results could increase integration with the EDs, through shared improvements.
- Potential value of using routine data to create risk algorithms – use of retrospective data for health care resource modelling.
- The linked data could be used to feedback to clinicians at individual patient level.

Challenges

- Data is not useful unless used in the right way.
- Accuracy and reliability of the data, it has the potential be manipulated to achieve performance targets.
- The use of pseudonymised data limits enquiries that require identifiable data such as trends in frequent attenders.
- Risk in misinterpreting the data.
- Difficulties with communication between different NHS IT systems.
- Potentially difficult to manage the professional and personal ramifications of delivering bad news to clinicians.

Despite the challenges and limitations identified, generally linked data was considered a suitable evidence base for informing a variety of future commissioning initiatives.

Conclusion

Linked data is becoming increasingly common, especially as more data is available electronically. In this example, it affords us the opportunity to better understand the patient journey from ambulance to ED. It is possible to link ambulance data to ED data across multiple sites, which would suggest that national implementation would also be feasible using the same method. This would allow ambulance services to use additional ways of measuring performance beyond response times and audits using only ambulance data.

Evaluative approaches to the quality of telephone triage could include an understanding of otherwise unknown risks such as triage codes or patient characteristics with high mortality and high admission rates. Understanding the patient journey from HCP to ambulance to ED is also possible using this dataset. HCPs tend to be good gatekeepers with most patients being admitted after a referral to the ambulance service. Mortality in the ED is very low, with the majority of these patients being recognised and escalated appropriately. Data looking at ED diagnosis and admission rates raises the issue of data quality and an overly simplistic definition of an appropriate ambulance conveyance. This is especially pertinent in strategic and commissioning decisions, highlighting a potential risk of misinterpreting the data.

Despite the risks, overall this linked data provides a meaningful method of contributing to the commissioning cycle and providing evidence for national programmes. It also has the potential to steer the conversation towards integrating more measures of quality in-line with the NHS's Five Year Forward View, providing an equitable quality service to all patients.

Implications

Demand for ambulance services is rising and it is important that data are used to improve the quality and the efficiency of the service. This linked data can contribute to reviewing telephone triage systems, reflecting the growing number of urgent care needs whilst safely identifying and managing the minority of acutely unwell patients. Risk matrices for all chief complaints in the R2 and HCP admission categories in particular, would have the biggest impact on demand and efficiency due to the size of the patient cohorts. This continues into clinical care, with clinicians wanting individual outcome information on their patients, in order to evaluate and improve their own practice.

A wide and varied patient cohort ring 999 and this linked data can have an impact on other services (such as GP and palliative care services) as well as providing a new evidence-based approach to the commissioning and delivery of prehospital and secondary care. The most frequent and most acute patient diagnoses could be identified in the linked data, to better inform training, preparing clinicians for the patients they are most likely to care for. Furthermore, the linked data, could allow demand community services to be better understood at local commissioning or at ED level, with the needs of specific populations in a geographical area being met more efficiently.

Recommendations

- 1) From the findings reported
 - Implement a national information sharing agreement to allow ambulance data to be linked to all EDs in England. The introduction of the national initiative to standardise ED data collection (the

Emergency Care Data Set Programme) beginning in October 2017, provides an opportunity to ensure all EDs collect matchable data.

- More emphasis placed on identifying high risk and low risk patient groups at telephone triage, this may require new processes such including age and pre-existing medical conditions.
- Consider the response profile for patients presenting with difficulty in breathing
- Understand any potential cross-over with the Ambulance Response Programme.
- Evaluate the current procedure for HCP referrals, to ensure the registered clinician is making the phone call.
- Provide an integrated response to the predictable influx of non-urgent conveyances that are likely to result in a hospital admission to promote patient flow.
- Analysis using an overly simplistic set of data fields as a proxy for an “appropriate” ambulance conveyance should be avoided.
- Coding at telephone triage and clinician coding sheets, where possible, should be modified to match the coding system being implemented as part of the Emergency Care Data Set.
- A summary of findings with clear recommendations to be disseminated widely to key stakeholders.

2) Further analysis of the current linked dataset

- Understanding any demographic influences on ambulance/ED use, such as age, gender, social deprivation and ethnicity.
- Evaluating prehospital and ED care of specific patient groups e.g. stroke, trauma, mental health and older people who fall.
- Public health research
- Working with clinicians to develop valid and reliable grouping of data items that allow for further analysis of the appropriateness of conveyance to the ED for those who are not admitted.

3) Commissioning/ Performance

- Identify patient groups that may benefit from alternatives to the ED such as patients that leave before being seen.
- Understanding the effects of long ambulance response times, patient flow from ambulance to ED, the effects of ED closures and collaborative demand modelling.
- Identifying groups/ clinician training that may enable a prehospital contribution to admission avoidance.

4) Other Linkages

- Linkage to other routine health data; in-patient hospital data and GP data.

- Linkage to patient registries; mental health data, trauma (Trauma Audit and Research Network) and stroke (Sentinel Stroke National Audit Programme)
- Linkage with other services such as police, social services, education and county council/public health databases.