Detailed project description

Title: Impact of closing Emergency Departments in England **(closED)**

Summary of Research

In recent years a number of Emergency Departments (EDs) have closed, or been replaced by another facility such as an Urgent Care Centre. Currently, there is little research evidence to inform decision making about these closures. Using a controlled interrupted time series design, we plan to establish if local populations and emergency care providers are affected by the closure/downgrading of an ED, focusing on five EDs which closed between 2009 and 2011, and in doing so inform the evidence base. Identifying any impact of closures on an emergency healthcare system will enable National Health Service providers and the public to assess the possible implications of closure on their local system and develop strategies to minimise any potentially adverse impact.

The study aims to identify:

- Any changes in the pattern in mortality in the local population
- Any changes in local emergency care service activity, and performance

The following phases will be undertaken:

1. Documentary analysis

Documentary analysis will a) provide some context regarding the closures, b) establish if there were any other significant changes to emergency and urgent care provision in our chosen provider areas during the time series that will be applied to our quantitative data. Significant re-organisation of emergency and urgent care provision may influence our results, and it is important to establish this before the quantitative analysis begins. Control areas are subject to substitution if documentary analysis suggests there have been major changes to emergency and urgent care provision during our time series.

2. Calculation of resident catchment population

We will identify a resident catchment population for each target ED (both intervention and control). Catchment populations will be identified from Hospital Episode Statistics (HES) Accident & Emergency attendance data using the 'first past the post method'. (Yorkshire and Humber Public Health Observatory 2012)

3. Calculation of population and emergency care indicators

The following indicators will be calculated monthly for each resident catchment population:

Deaths: The population mortality rate for deaths occurring up to 3 days after an emergency for the 16 conditions identified as rich in 'avoidable deaths'. (Coleman 2010)

Risk of death: The 3-day case fatality ratio for the 16 conditions identified as rich in 'avoidable deaths'.

Emergency attendances: a) The total type 1 ED attendances at all hospitals and at 'local' hospitals, and b) separately for patients brought in by ambulance and those identified as having an 'other' mode

of arrival. We will also calculate c) the numbers of 'unnecessary attenders', (Lowy 1994, Nicholl 2011) and d) the proportion of attenders admitted to hospital.

Emergency admissions: The number of emergency hospital admissions by the catchment population a) for any condition, and b) for the 14 conditions identified as rich in 'avoidable admissions'. (Coleman 2010)

Condition severity: For those admitted as emergencies a) the mean length of stay in hospital, and b) the numbers and proportions admitted to critical care.

Ambulance service performance: For 999 calls from the resident catchment area a) mean time from 999 call to ambulance on scene, b) mean time from ambulance arriving on scene to ambulance arriving at hospital, c) mean time to hospital from time of 999 call, d) mean time from ambulance arriving at hospital to ambulance 'clear' time, e) total call volumes, f) non conveyance rates, and g) number of emergency transfers between 'local hospitals'.

Data will be drawn from Office for National Statistics, HES Accident & Emergency attendance, HES Admitted Patient Care, and NHS Ambulance Service Computer Aided Despatch datasets.

For all the indicators, data will be analysed using a time series of monthly values (for a minimum of 48 months spanning the closure or downgrading of the ED). A simple time series will be fitted to the data including a linear time trend, a seasonal effect, step interruptions for any other major changes to the local emergency care system, and a step interruption at the time of the change to the ED.

Background and Rationale

Emergency care in England is under continued pressure. Ambulance service emergency call volumes have risen from 7.23 million in 2007/8 to over 9 million in 2012/13. (Health & Social Care Information Centre 2013) Attendances at Emergency Departments (EDs) follow a similar trend, albeit showing a smaller increase. (Appleby 2013) Emergency admissions to hospital also continue to increase. (National Audit Office 2013) In addition emergency and urgent care services are also under unprecedented scrutiny. The National Health Service (NHS) Commissioning Board is currently reviewing the model of urgent and emergency services in England. The review will set out proposals to re-organise care which best meets the needs of patients, in a sustainable way. The first phase of this review has recently been completed and sets out a vision for re-defining EDs into two types of Emergency Centre: 'Emergency Centres' and 'Major Emergency Centres'. Proposals suggest that Emergency Centres will assess and initiate treatment, with the larger major emergency centres hosting specialist services. (NHS England 2013)

Rising demand for emergency care comes at a time when EDs are facing a staffing shortage. It has been recently reported that EDs are understaffed by an average of 10%. (BBC 2013) Whilst this is in part caused by rising demand, there are also problems in recruiting staff to departments due to the increased pressure of workload, and work intensity. Significant staffing shortages coupled with rising demand may have implications for the safety of patients. One solution to this may be to close some of these EDs, concentrating care in larger EDs. In recent years a small number of EDs in England have closed for all or part of the day, usually for reasons of safety, sustainability or affordability. It is reported that there are more than 20 further EDs that are being considered for closure. Currently, there is no robust evidence to support this decision making.

The evidence base concerning Emergency Department (ED) closures is limited, and conflicting. When an ED closes, patients may have to travel further for emergency care with some evidence that travelling further for care can lead to poorer outcomes. This may be true because travelling further increases time before getting to the ED. Nicholl (a co-applicant) has shown that an increased journey distance to hospital appears to be associated with an increased risk of mortality. (Nicholl 2007) In addition, emergency treatments are usually more effective the earlier they are given. Tranexamic acid

given to bleeding trauma patients reduces deaths from bleeding by 15%, but the same treatment given an hour later is ineffective. (Roberts 2011) Evidence also suggests that patients suffering myocardial infarction have higher mortality if primary angioplasty is delayed, even by short periods, (Rathore 2009) and for patients suffering an acute ischemic stroke, reducing the time to treatment has a positive impact on mortality. (Saver 2013) Added to this, delays in the arrival to the ED may also delay the administration of effective analgesia for patients.

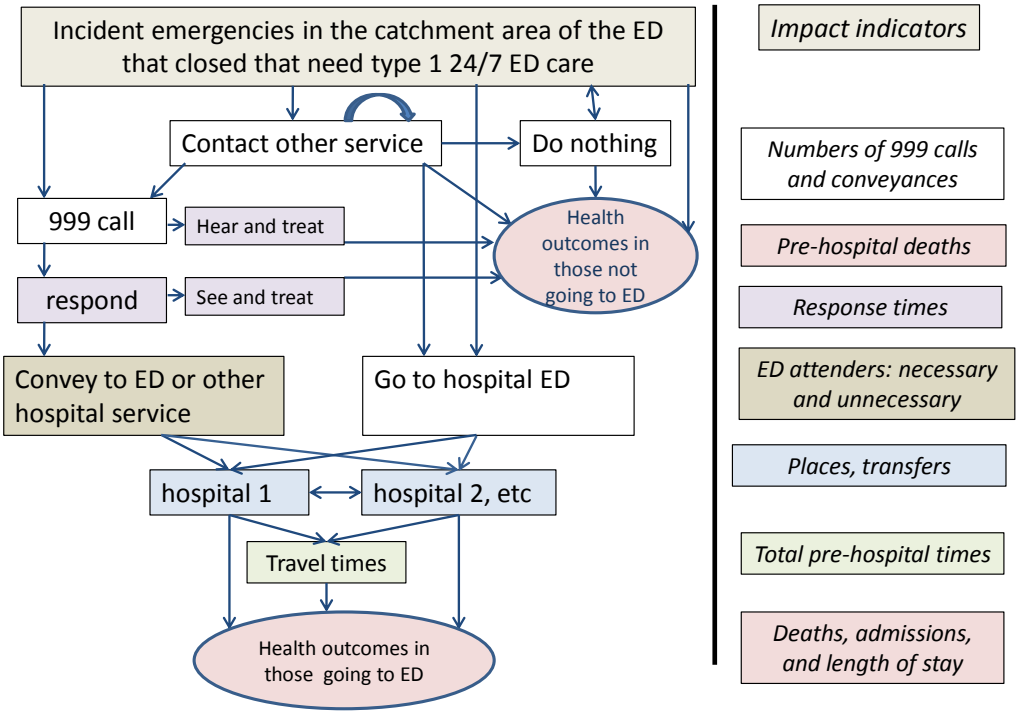
Set against this, there is some evidence that the care received at the hospital you arrive at may determine your outcomes. ED care provided under the supervision of senior doctors is more effective than care provided by less experienced doctors, (White 2010) and that for some conditions, including both heart attacks and strokes, specialist care, not available in all EDs, is more effective than care routinely available. Surprisingly, there is almost no evidence about the impact of closing EDs on patient outcomes. The arguments and counter arguments, and the hints of evidence on both sides, mean that closing an ED is not an evidence informed policy.

Assessing the impact of ED closures

In order to inform our assessment of the impact of the closure or downgrading of an ED, we have developed a simple model of healthcare pathways following an emergency incident needing (ie with the capacity to benefit from) Type 1 24/7 ED care (see Figure). In the model patients having an emergency go direct to ED, phone 999 or contact another emergency service, or delay doing anything. The numbers choosing these options will be affected by the closure or downgrading of local EDs, but in this study we are proposing only to capture the impact on the number of patients who go directly to ED and on the number who call 999. The numbers choosing other options are hard to obtain from routine sources. We have developed survey methods to assess these other impacts (O'Cathain 2010, Knowles 2012) but these methods need before and after studies which we cannot use (as the EDs have already closed).

Those who choose not to go direct to ED may also end up at the ED, but if they don't we assume they either die (in which case we assume they were patients who needed ED) or they have their problem resolved. We plan to capture deaths in those who don't get to ED as well as those who do. For all those who do end up at ED, attendance may have been necessary or not. NHS England has recently claimed that 40% of attendances at ED may not have been needed, (NHS England 2013) and using a similar methodology based on our own work (Nicholl 2011) we plan to look at the effect of ED closures on the numbers of necessary and unnecessary attendances. Closure of an ED affects which hospital patients attend. Which hospital ED patients attend in turn determines a number of things – including how long it took to get there, the number of inter-hospital transfers, and the quality of their hospital (ED and inpatient) care. These effects result in their health outcomes, and we plan to capture both the processes (where they attend, travel times, admissions, and transfers) and the outcomes (deaths, and indicators of the severity of the condition of survivors).

Figure. A model to assess the impact of ED closures



It is important to first establish what impact the closure of an ED has on the local population (in terms of mortality, hospital admissions, and ED attendances), and/or emergency care providers (in terms of performance). If our study finds there are implications for the population and/or emergency care providers, or indeed if there is variation across different areas affected by closure, we will seek to develop further in depth case study research (as a follow up to this study) to explore wider issues such as the impact on patients (behaviours, experiences, satisfaction, etc) and the link between closures and our findings.

Evidence explaining why this research is needed now

This study is both timely, and relevant. We are proposing to conduct a relatively short term study (21 months to completion) to enable the general public, the NHS, and policymakers to have access to robust evidence which can support their decision making. EDs in England have, and will continue to, close or be downgraded. There is little research evidence to support the closure of, or indeed the retention of some of these departments. Currently we know little about the impact that closures may have on the mortality of a local population, or the workload implications on local emergency care providers, or indeed if the hospitals that patients will be re-directed to are sufficiently better than the ones where the ED has closed to compensate for the increased journey times. Closing EDs is not viewed positively by the public and patients, as demonstrated by campaign groups which have formed to prevent these closures. However, closures may not have the negative impact on patient outcomes that campaign groups suggest. With further emergency department closures planned, such evidence is necessary to inform future decision making. Identifying any impact of closures on an emergency healthcare system will enable NHS providers and the public to assess the implications of closure on their local system and develop strategies to minimise any potentially adverse impact.

Aims/Objectives

The aim of this study is to establish the implications of closing, or downgrading, EDs on the population and emergency care providers and in doing so provide the general public, the NHS, and policy makers with the necessary evidence to inform decision making about future ED closures.

Our specific objectives are to:

1) Detect changes in mortality in emergencies in our resident catchment populations for those conditions rich in 'avoidable deaths' following the closure or downgrading of an ED
2) Detect changes in ED attendances in our resident catchment populations following the closure or downgrading of an ED
3) Detect changes in emergency admissions in our resident catchment populations for all conditions, and those conditions rich in avoidable emergency admissions, following the closure or downgrading of an ED
4) Detect changes in mean length of stay and the need for critical care for patients admitted as emergencies in our resident catchment populations following the closure or downgrading of an ED
5) Detect changes in NHS ambulance service call volumes, response times, emergency hospital transfers, and non-conveyance rates in our resident catchment populations following the closure or downgrading of an ED

Research plan/methods

Design

A controlled interrupted time series analysis of a series of indicators will be undertaken to detect the impact of ED closures on the resident catchment populations of five EDs which were closed or downgraded between 2009 and 2011.

Setting

The study will take place in ten geographical areas in England: five intervention areas where an ED closed or was downgraded between 2009 and 2011 and a matched control area for each intervention area. Each intervention area will be defined by the catchment population of the ED that closed (see *data collection: catchment populations*). For each intervention area, a potential control area will be identified. Control areas will be proposed based on sharing similar characteristics with their corresponding intervention area (ie of a similar size and having a similar socio economic demographic), but *not* sharing the same ambulance service. Control areas are subject to substitution if documentary analysis suggests there have been major changes to emergency and urgent care provision during our time series which might affect the indicators such as the relocation of major trauma services or the opening of a coronary care unit.

Data collection

1. Documents

National policy documents published in relation to ED closures/downgrades, and the re-organisation of emergency care will be identified and used to provide some national context to closures.

In addition, documentary analysis will be undertaken in each of the 10 geographical areas identified as the target EDs. In the intervention areas we will identify any local NHS reviews, strategic, and public consultation documents related to the closure/downgrade to describe the processes involved in closing/downgrading, provide some context to the reorganisation, and to identify the expectations held within localities regarding the anticipated impact of the reorganisation within local emergency and urgent care systems. In addition we will identify major NHS emergency and urgent care commissioners and service providers, such as PCTs/CCGs, acute trusts and ambulance services,

within our chosen areas (both intervention and control), collating annual reports published during the data capture period and beyond, to identify and record any significant changes to the emergency and urgent care system and also to provide further context to the closures in our intervention areas. We will also undertake documentary analysis within areas where the substitute ED is based, that is, the ED in which the intervention catchment population now use, following the closure.

Significant reorganisation of emergency and urgent care provision may affect our results, and it is important to establish this before selecting control target EDs and beginning the quantitative analysis.

2. Catchment populations

Resident catchment populations will be identified from HES (Hospital Episode Statistics) Accident & Emergency attendance data using the 'first past the post method'. (Yorkshire and Humber Public Health Observatory 2012)

We will firstly explore the calculation of catchment areas using Lower Super Output Areas (LSOAs). LSOAs have a population range between 1000 and 3000. The HES dataset includes LSOA. However, if the ambulance service CAD system does not record LSOA, we will look into converting the postcode provided on the CAD system into an LSOA. This is subject to the availability of suitable mapping software. If this is not available, we will calculate catchment areas using larger postal districts.

We will define the catchment area of a target ED as 'the set of areas (postal districts or LSOAs) where the *majority* of first attendances by residents of the areas during a defined time period were attendances at the target ED', and the catchment population as the population of the catchment area. To calculate these areas and populations the time period we will use is the period covered by the HES dataset we are planning to obtain, that is from 2007-2014.

The same method will be used for defining the catchment areas and populations of both 'intervention' and 'control' target EDs.

3. Population and Emergency Care indicators

The EDs downgraded or closed at different points between 2009 and 2011, and we intend to collect data for a minimum of 24 months prior to, and 24 months following the closure/downgrade.

We have identified a series of indicators which will detect any impact an ED closure/downgrade has on the local population and emergency care providers. The following indicators will be calculated monthly for each resident catchment population (*the rationale for indicator inclusion and data source is shown in table 1*):

1. *Deaths*. The population mortality rate for deaths occurring up to 3 days after an emergency for 16 'serious' conditions identified as rich in 'avoidable deaths'. (Coleman, 2010) These conditions are: stroke/CVA, meningitis, anaphylaxis, myocardial infarction, fractured neck of femur, asthma, cardiac arrest, pregnancy and birth related, non-superficial head injuries, self-harm, ruptured aortic aneurysm, falls <75 years, road traffic accidents, septic shock, asphyxiation, and acute heart failure.

The time series will use national Office for National Statistics (ONS) mortality data and the linked HES datasets, detailing month of death, cause of death, and place of residence. Deaths will be assigned to the month of incident not the month of death using the month of admission for deaths following admission and month of death for those not admitted.

2. *Risk of death*. The 3-day case fatality ratio for the 16 conditions identified as rich in 'avoidable deaths'. (see above for 16 conditions) The case fatality ratio is the ratio of the number of deaths to the number of cases occurring in the resident catchment population each month. The time series will use the mortality data as above to define fatalities, and the fatalities together with HES Admitted Patient Care data for patients admitted for more than 3 days who survived, to define the cases. The methods

for calculating the case fatality ratios and their reliability have been established by a team led by Professor Nicholl. (Nicholl 2011)

3. *Emergency attendances*. a) The total type 1 ED attendances at 'local' hospitals for residents of the catchment populations, and b) separately for patients brought in by ambulance and those identified as having an 'other' mode of arrival. We will also calculate c) arrivals at EDs discharged without treatment or investigations(s) that required hospital facilities (ie 'unnecessary attendances') using a methodology we have used in our previous work. (Lowy 1994, Nicholl 2011), and d) the proportion of attenders admitted to a hospital inpatient bed.

4. Emergency admissions. The number of emergency hospital admissions by the catchment population a) for any condition, and b) for 14 'urgent' conditions identified as rich in 'avoidable admissions'. (Coleman 2010) These conditions are non-specific chest pains, non-specific abdominal pains, acute mental crisis, falls>75, chronic obstructive pulmonary disease, angina, superficial head injuries, urinary tract infections, deep vein thrombosis, epileptic fit, cellulitis, pyrexial child, blocked urinary catheter, and hypoglycaemia.

The time series will use HES Admitted Patient Care data. Since patients are admitted to hospitals throughout England following incidents occurring outside the catchment area, and which are not therefore affected by changes to the local emergency care system, we will do this analysis looking at admissions to all hospitals and again looking just at admissions to 'local' hospitals. 'Local hospitals' will be defined as hospitals taking a significant proportion (eg more than 5%) of the total catchment population emergency admissions.

5. *Condition severity.* For those admitted as emergencies a) the mean length of stay in hospital, and b) the numbers and proportion admitted to critical care. These indicators may also pick up other effects, such as differences between hospitals in lengths of stay, critical care availability, and any changes in the difficulty of discharging patients to non-local services. However, they are also related to condition severity and matter to patients.

6. *Ambulance service performance*. For 999 calls from the catchment area a) mean time from 999 call to ambulance on scene, b) mean time from ambulance arriving on scene to ambulance arriving at hospital, c) mean time to hospital from time of 999 call, d) mean time from ambulance arriving at hospital to ambulance 'clear' time, e) total call volumes, and f) non conveyance rates. In one of our intervention areas, the local primary care trust envisaged that the downgrading of the ED would result in fewer emergency transfers to other hospitals because patients would be more likely to receive their care in the 'right place, first time'. We will identify g) emergency transfers between 'local hospitals' (as defined in Indicator 4 – emergency admissions) across all study areas to establish if the number of emergency transfers changed following a closure/downgrade.

Sources of data

In order to calculate the indicators we intend to collect routine data from the following sources: ONS mortality data, HES Admitted Patient Care data, HES Accident & Emergency attendance data, HES/ONS linked mortality data, and ambulance service Computer Aided Despatch (CAD) data. (Table 1)

Ambulance service CAD data will be sourced from multiple ambulance services. We will identify the postal districts within our identified catchment population areas and request a defined set of routinely collected data. We will write a specification of the data needed and EK will visit each ambulance service to work with a data manager to ensure the relevant data is extracted consistently across ambulance services. For HES data we will request data for a defined set of variables, including postal district of residence, for all ED attendances and all emergency admissions in England from March 2007 to the most recently available data. We will request the HES-ONS linked mortality data for all deaths occurring during the same period as the HES data (March 2007 to the most recently available data).

HES Admitted Patient Care data, ONS data, and ambulance service CAD data was routinely and consistently collected throughout the entire data capture period (March 2007 to August 2013). HES Accident & Emergency attendance data became available in April 2007 and its completeness has been patchy. Therefore, we will examine the quality of the HES A&E data prior to using it in the time series analysis. In one area the ED attendance rate indicator will be calculated for 23 months prior to the closure, instead of the desired 24 months. All remaining indicators will be calculated using at least 48 months data.

Table 1: Indicator, rationale for inclusion and data source

Indicator – all numbers and proportions, etc relate to residents of the catchment areas	**Rationale for indicator inclusion**	**Data source**
The number of deaths from conditions identified as rich in avoidable deaths	Mortality may be affected by a) where a patient goes (ie the quality of the hospital that the patient attends), and b) when they get there. If a patient delays seeking treatment or has increased travel time to hospital this may impact adversely on mortality.	ONS mortality data and HES-ONS linked mortality data
3-day case fatality ratio for conditions identified as rich in avoidable deaths	The case fatality ratio may be affected by a) where a patient goes (ie the quality of the hospital that the patient attends), and b) when they get there. If a patient delays seeking treatment or has increased travel time to hospital this may impact adversely on case fatality.	ONS mortality data and HES-ONS linked mortality data
Total ED attendances	Ease of access is a prominent determinant of ED attendance rates (Hull 1997). ED attendance may decrease a) by patients choosing not to travel further, or b) by ambulance services increasing their use of non-conveyance.	HES Accident & Emergency attendance
Total ED attendances by mode of arrival (ie by patients brought in by ambulance and those identified as having an 'other' mode of arrival)	Changes in total ED attendances may result either from changes in the numbers self-referring to ED or changes in ambulance service conveyance rates.	HES Accident & Emergency attendance
The number of arrivals at ED discharged without treatment or investigations(s) that required hospital facilities.	Unnecessary ED attendances may decrease if patients choose to seek alternative care, closer to home, rather than travel further to an ED.	HES Accident & Emergency attendance
The proportion of attenders at ED who are admitted to an inpatient bed	The proportion of attenders who are admitted may change as a result of patients going to different EDs, or because discharging patients home from ED may be more difficult as distances from ED to home increase.	HES Accident & Emergency attendance
The number of emergency hospital admissions for any condition	The emergency hospital admissions rate may be affected by a) where a patient goes and b) when they get there. Where they go may affect admissions because of differences between hospitals in admission rates, and because of difficulties in discharging patients home from ED	HES Admitted Patient Care

	who are at a non-local ED. If a patient delays seeking treatment or has increased travel time to hospital this may lead to deterioration in their condition which may necessitate admission.	
The number of emergency hospital admissions for conditions identified as rich in 'avoidable admissions'	A well performing urgent and emergency care system might be expected to avoid some admissions for selected conditions (Nicholl 2011). We know that 'avoidable admission' rates vary between hospitals (O'Cathain 2014) so admission rates could be affected by which hospital a patient goes to and also by delays in the patient arriving at hospital.	HES Admitted Patient Care
Mean length of stay in hospital for those admitted as emergencies	Increases in length of stay may be affected by where patients are admitted, and also be an indicator of a) condition severity or b) difficulties in discharging patients to non-local services.	HES Admitted Patient Care
The numbers and proportions admitted to critical care medicine	Admissions to critical care may be affected by where patients are admitted, and also indicate condition severity. The condition of patients with a delayed presentation may deteriorate and lead to critical care admission.	HES Admitted Patient Care
Mean time from 999 call to ambulance on scene,	Whilst ambulance response times should not be affected by the closure of an ED, there is a possibility that ambulances may be further away from the catchment area after travelling to more distant EDs.	Ambulance service CAD data
Mean time from ambulance arriving on scene to ambulance arriving at hospital	Ambulance journey times are likely to be longer from the catchment area to the 'now nearest' ED	Ambulance service CAD data
Mean time to hospital from time of 999 call	Ambulance journey times are likely to be longer from the catchment area to the 'now nearest' ED	Ambulance service CAD data
Mean time from ambulance arriving at hospital to ambulance 'clear' time	Following ED closures, neighbouring EDs will receive patients. If the receiving EDs are having difficulties in managing this additional demand one consequence may be an increase in the time taken for ambulance crews to handover care to the ED.	Ambulance service CAD data
Total ambulance service call volumes	If an ED is not easily accessible for patients, ambulance call volumes may increase for patients without access to alternative transport. Conversely, ambulance call volumes may decrease if a patient chooses to use an alternative care provider, closer to home, rather than travel by ambulance to an ED further away (and have to find their own transport to return to their home).	Ambulance service CAD data
Non conveyance rates	Ambulance services may increase their use of non-conveyance to minimise the potential impact of increased journey times on service performance	Ambulance service CAD data

	measures.	
The number of emergency hospital transfers between local hospitals	Emergency transfers may decrease if, as anticipated, the patient is taken to the 'right place, first time' (NHS Nottinghamshire County 2010)	Ambulance service CAD data

Sample size

Nationally there are about 80,000 deaths per year for our 16 emergency conditions rich in avoidable deaths. This is about 400 per average type 1 ED catchment population. There are about 25,000 emergency admissions per year, per average ED catchment population. We expect the catchment populations of the closed EDs to be smaller than average. So assuming 200 deaths and 10,000 emergency admissions per year, and ignoring the time series, confidence intervals for the change in the number of deaths per year in individual EDs will be approximately +/-14%; for all EDs together +/-6%; for emergency admissions in individual EDs +/-2%; and for all EDs together +/-1%. There are about four times as many ED attendances as emergency admissions, and estimates of changes in ED attendances will be even more precise than for admissions. For Ambulance Service indicators such as mean times to hospital, there is a roughly similar number of conveyances as emergency admissions, and very small changes in mean times will be detectable. For mean lengths of stay of emergency admissions, changes of less than ½ day will be detectable.

Data analysis

Primary analysis

For all the indicators, data will be analysed using a time series of monthly values (for 48 months spanning the closure or downgrading of the ED). A simple time series will be fitted to the data including a linear time trend, a seasonal effect, step interruptions for any other major changes to the local emergency care system, and a step interruption at the time of the change to the ED. Control series will also be used. The control catchment areas will be for populations in similar areas not expected to be affected by the closures either directly (as a result of ED attendances being diverted) or indirectly (via any impact on the ambulance service). Analyses will estimate the step in the intervention series, and the difference in the step between the intervention series and the control series. We will use the estimate of the size of any step to estimate the impact on the indicators following the closure of the ED. The methods for doing these analyses have been used by the applicants (Nicholl, Knowles) to investigate the introduction of NHS111, and the methods are thoroughly described in the report and corresponding journal publication. (Turner 2012, Turner 2013)

The analysis will be conducted a) separately for each of the five intervention resident catchment populations, and b) by pooling the data for all the intervention resident catchment populations together, to estimate an average effect of closing EDs on local populations.

For the ED attendance data, we will first examine the data to establish whether the monthly counts have been collected consistently over the 48 month study period. We have found previously that data anomalies are not uncommon but are easy to identify. (Nicholl 2011) In any area where the HES ED attendance data is compromised, the ED analysis will be omitted.

For many of the indicators the case mix, such as the mix of diagnostic conditions, may change over the 48 month study period. It is conventional to standardise for the case mix, eg by using SMRs. However, we do not plan to do this. We are not comparing populations but the same population over time. Any changes (eg in population numbers, demographics, diagnostic mix, etc) will be gradual. These changes are therefore allowed for in the time series model by the time trend.

Exploratory analysis - why did indicators change? Some of the hospital indicators may change for two distinct reasons – changes in which hospital patients go to, and changes in how long it took to get to hospital. In our primary analysis described above we are trying to find out what happened which is a combination of both these effects, but in a secondary, exploratory analysis we plan to try to get some insight into why the changes we find occurred. To do this we plan to compare the values of the hospital indicators for patients of the catchment population of the ED that closed with the values for other patients in the hospitals they are now attending. For example, suppose we find that the mean length of stay of emergency admissions for patients in the catchment population of the ED that closed increases from 3 days (when they were going to the hospital whose ED has closed) to 4 days (when after the closure they go to other hospitals). Is this because patients are now attending hospitals where typically the average length of stay is 4 days, or is it because patients are now arriving at hospital in a more serious condition than before? By examining the value that this indicator usually takes in the hospitals patients are now attending we can make some informed assessment of the reasons behind the change. If other patients in the hospitals they are now attending also stay 4 days on average, then it is likely that the change has occurred because of a change in the hospitals patients are admitted to. However, if other patients typically stay 3 days, we would be more inclined to ascribe the change to patients being admitted in a more serious condition.

Research outputs and plans for dissemination

We will disseminate our findings in the following ways:

1. Produce interim reports, for HS&DR, at 6, 12, 18 months, and a full report at the end of the study.
2. Scientific papers derived from this project will be submitted to high profile journals that provide open access and are widely read by those responsible for providing and commissioning emergency care. The research team has a track record in publishing evidence in such journals.
3. Findings will be submitted for presentation at relevant conferences, both national (College of Emergency Medicine and Health Services Research Network), and international (International Conference of Emergency Medicine).
4. We will publicise key outputs by issuing press releases via the University, making research team members available for interview, and using our website. We will undertake further impact activities by sending our report to, and offering attendance at meetings of, relevant colleges and associations such as the College Emergency Medicine and the Association of Ambulance Chief Executives.
5. Following the publication of our final report we plan to hold events, open to the public, disseminating our findings in each of the areas affected by a closure/downgrade within this study. Local commissioners and providers will also be invited to attend these events.

Plan of investigation and timetable

Obtaining NHS ethical and R&D approval can take a number of months and we intend to submit these applications as soon as we hear if this application has been successful. Obtaining HES and ONS data will take a number of months so we will apply for this as soon as we obtain the necessary approvals. The study will begin in January 2015 to allow for contracts to be agreed and signed.

Table 2: Project timetable

Month	**Task**
Pre study (Autumn 2014)	Submit NHS ethics and R&D application Contact appropriate ambulance services

1-6 (January –June 2015)	STUDY START Order HES and ONS data* Identify recently published literature Convene advisory group 1 (introduction to study) Undertake documentary analysis in 10 areas, explore national context, and supplement literature Identify definitive control sites Submit 6 month progress report
7-8 (July – August 2015)	Submit NHS research governance (maximum of 10 ambulance services) Calculate catchment areas (after receipt of HES data)
9-17 (September 2015-May 2016)	Collect ambulance service CAD data Submit annual progress report Calculate indicators Perform time series analysis Convene advisory group 2 (discussion of preliminary findings)
18-21 (June-September 2016)	Submit 18 month progress report Exploratory analysis (see page 11) Preparation of papers for journal submission Preparation of dissemination events Convene advisory group 3 (dissemination discussion) Final report writing
September 2016	Submit final report
Post study	Undertake dissemination events

*allow up to six months for HES/ONS data to arrive

Project management

Dr Emma Knowles will lead the project, ensuring that applicants and staff fulfil their commitments in a timely way. Her 50% wte for the project will ensure she has time for full project management, undertaking the approval processes, undertaking the identification and analysis of documents/literature, assisting the data manager and statistician, and actively engaging with Sheffield Emergency Care Forum in developing the dissemination. The team also consists of two professors (Professors' Nicholl, and Mason) who bring to the study extensive experience of emergency care research.

There will be bi-monthly (every two months) project meetings of all team members. The fact that this project is being undertaken by staff in a single institution who have worked together successfully on numerous projects will facilitate project management.

A Project Advisory Group will be established to include a commissioning manager with experience of emergency services, a clinician from the emergency and urgent care system, an academic with a background in emergency and urgent care, an academic with a background in working with large datasets (such as HES), and a PPI representative, as well as members of the management team. An

independent chair will be appointed. The Group will meet twice a year, that is, three times during the project. The first meeting will introduce the study to the group, the second will convene to discuss preliminary findings, and the final group will focus on plans for dissemination.

Approval by ethics committees

This study involves the use of HES, ONS and ambulance service routine datasets. Patient postal district residences will be sought for each of these datasets to enable us to determine if a patient resides within our defined catchment area. The ethical issues relevant to this proposal are those concerned with the use of routine data which will require attention to anonymity

We will apply for NHS ethics and R&D approval at the start of the study. Our past experience indicates that a NHS Ethics Committee may classify this study as 'service evaluation'. If this applies here, we will then apply for University of Sheffield ethics approval and inform research governance leads in each of the ambulance services identified in our study. This may occur for this study or full NHS approvals may be required. We will also need to obtain R&D governance permissions from all ambulance services that are participating in our study. We have timetabled the study for a NHS ethics application and full research governance procedures.

Patient and Public Involvement

The closure of Emergency Departments has provoked strong reaction from local groups. A co-applicant (JN) has been approached by members of local campaign groups seeking research evidence with regard to the closure of Emergency Departments. This prompted our interest in developing this application. Engaging with these local groups in the development, and conduct, of this research may not be desirable given concerns of impartiality.

In Sheffield we are fortunate to have an active emergency care PPI group: The Sheffield Emergency Care Forum (http://secf.org.uk). The Forum is an independent patient and public representative group that already provides representation to, and engagement with, a number of research projects within ScHARR. Enid Hirst, co-ordinator of the Forum, is a co-applicant and has assisted in the development of, and commented on, the proposal. If the project is funded, Linda Abouzeid (a member of the Forum) will assist Enid, as a PPI developmental opportunity, during this project.

The perspective of patients in the proposed research is vital. As a co-applicant, Enid Hirst will continue to assist with the development of the research. The Sheffield Emergency Care Forum hold quarterly meetings. As part of these meetings, research teams are invited to present their ideas/work. We will share findings with the group, and receive feedback at these meetings. When the study is completed we will ask the Forum to engage with us in preparing plain language dissemination material. There is likely to be considerable public interest in our findings. The advice, and support, of the Forum will be necessary in helping to disseminate our findings to the public in the local areas affected by emergency department closures.

Appropriate costs to support the PPI involvement in the project including fees, travelling expenses and consumables (telephone calls, email) have been included

Expertise and justification of support required

The research team has extensive expertise in developing and undertaking emergency care research. It draws together expertise in emergency care, health service research, and statistics. Members of the research team (EK, JN) completed a programme of work for the DH developing methods for measuring the performance of the emergency and urgent care system. (Nicholl 2011) One strand of this work focussed on using routinely available data to evaluate performance. Our experience of this is a major strength in this study.

Dr Emma Knowles is an experienced health services researcher, with extensive project management experience and significant experience of undertaking research within the emergency and urgent care health system (eg Evaluation of NHS Direct first wave sites, and NHS 111 pilot sites). Emma's main role will be to lead, and manage this study.

Professor Jon Nicholl is a leading health services researcher and statistician who has extensive experience of working on politically sensitive research projects (eg Evaluation of NHS Direct, NHS 111). He has 25 years' experience of conducting health services research in the field of emergency and urgent care. His main role will be to lead the design of the analysis, working closely with Neil Shephard (medical statistician). Professor Nicholl will also offer an advisory role on all other aspects of the study.

Professor Suzanne Mason is an experienced emergency care researcher with over £4 million research funding during the last 5 years. Previously and current commissioned projects include evaluating organisational factors affecting emergency department waiting times (NIHRSDO), impact of paramedic practitioners on older people (Health Foundation), and the role of Emergency Care Practitioners (NIHRSDO). In addition, Suzanne is a Consultant in Emergency Medicine and brings invaluable practical insights of emergency care. Suzanne will offer an advisory role on all aspects of the study.

Mrs Enid Hirst is co-ordinator of the Sheffield Emergency Care Forum. Enid has extensive experience in providing public and patient representation for health service research studies, and played a leading role in establishing the Forum. Enid will play a key role in the dissemination of the findings.

A substantial proportion of the research costs have been allocated to support a) the project manager, so the study is undertaken by an experienced researcher who can devote their attention to ensuring successful completion of the project, b) Neil Shephard, a medical statistician, who is experienced in handling large routine datasets (such as HES and ONS), and assisted Professor Nicholl with the data analysis during the evaluation of NHS 111. (Turner 2012) He will work closely with Dr Knowles and Professor Nicholl. An experienced data manager will also be appointed to manage the data retrieved from ONS, HES, and the ambulance services, and create the datasets for analysis. A research associate will be appointed to assist Dr Knowles with the documentary analysis. A clerical assistant will also be appointed to set up management and project advisory group meetings, follow up data requests, support PPI and dissemination activities, process invoices, and arrange travel for team members. The second main element of funding will be allocated to supporting a proportion of the time of each of the collaborators. This will ensure that their involvement is recognised and that the project is prioritised against their other commitments

We have made a realistic estimate that it will take 21 months to complete the project, based on previous experience. Whilst in project duration terms, this may appear a relatively short period to complete a study, it is achievable with effective planning and management. Given the current lack of research evidence, our team feel that it is necessary to deliver rigorous findings in a timely way that can inform decision making around impending ED closures.

Contribution to research effort

The current evidence base regarding ED closures is lacking. The expected output of this study is to produce robust information about a series of indicators which can measure the effect of an ED closure/downgrade on a local population, and emergency care providers. These indicators may be transferable to other evaluations concerning the emergency and urgent care system. These indicators may be particularly transferable to any evaluation of the re-defining of A&E care, proposed as part of the current review of emergency and urgent care services. (NHS England 2013)

Our analyses will be a) pooled (all five resident catchment populations analysed collectively) and also b) presented separately (each resident catchment population analysed individually). By providing analyses that will be conducted individually for each area, we can establish if there are circumstances

whereby it appears beneficial (or not) to close/downgrade an ED. For example, we may find no impact where the nearest available ED to the closure is within ten miles, but find impact where the nearest hospital is further away.

The expected impact of this study is to inform the re-organisation of emergency care in England by providing the general public, the NHS, and policymakers with the evidence to enable them to make informed decisions.

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