



Clinical paper

Can ambulance telephone triage using NHS Pathways accurately identify paediatric cardiac arrest?[☆]Charles D. Deakin^{a,b,*}, Simon England^b, Debbie Diffey^b, Ian Maconochie^c^a NIHR Southampton Respiratory Biomedical Research Unit, University Hospital Southampton, UK^b South Central Ambulance Service NHS Foundation Trust, Otterbourne, UK^c Imperial College London, UK

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ABSTRACT

Background: Most out-of-hospital paediatric cardiac arrests (CA) are not identified until a call is made to the emergency medical services. Accurate identification increases overall survival by enabling immediate ambulance dispatch and delivery of bystander CPR. European ambulance services use a variety of didactic telephone scripts to interrogate the caller and rapidly identify paediatric CA. The performance of these scripts has not been reported. This study aims to evaluate the diagnostic accuracy of the NHS Pathways as a telephone triage tool to identify patients less than 16 years age in cardiac arrest.

Methods: All emergency calls to South Central Ambulance Service (SCAS) over a 12-month period screened by 'NHS Pathways' v9.04 were identified. All actual or presumed paediatric CAs (<16 years age) identified by the emergency call taker were cross-referenced with the ambulance crew's Patient Report Form to identify all confirmed CAs.

Results: Over a 12-month period from March 2015, a total of 540,715 emergency calls were received by SCAS, of which 53,213 related to children, 2052 (3.86%) being categorised by 'NHS Pathways' as paediatric CA. On arrival of the ambulance crew, only 87/2052 (4.24%) patients were in CA. Sensitivity = 71.3%; specificity = 96.3%; positive predictive value = 4.2%. NHS Pathways missed the CA in 28.7% cases.

Conclusions: This is the first reported evaluation of any currently used European paediatric telephone triage system for identifying CA. Further work is required to refine telephone triage pathways for paediatric cardiac arrest.

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Introduction

Paediatric cardiac arrest in the community is an increasingly rare event, as infant, child and adolescent death rates in European and North American countries have declined steadily for many years and continue to fall. Death rates in the UK are similar to those reported from all these regions, with the majority (60%) of paediatric deaths occurring in the first year of life due to perinatal and congenital conditions.^{1,2} In older age groups, trauma accounts for the majority of deaths, in addition to epilepsy, asthma and cancer-related conditions.^{1,2} Survival from paediatric out-of-

hospital cardiac arrest (OHCA) however, remains poor, with a reported 8.3% overall survival to hospital discharge.³

Almost by definition in children, out-of-hospital cardiac arrest requiring an ambulance response is unexpected and unlike adult cardiac arrest, where resuscitation attempts are only deemed appropriate in approximately half of cases, paediatric resuscitation is attempted in all but the most futile of cardiac arrests.⁴ Because paediatric cardiac arrests are usually related to an underlying mechanism causing hypoxia, the child's physiological state at the time of cardiac arrest is often more deranged than in adults, where the mostly primary cardiac nature of the event results in a non-hypoxic event with some oxygen reserves remaining in the central circulation. The rare nature of the event and the critical condition of the child at the time make the identification and response to the cardiac arrest a particular challenge for all emergency medical services (EMS).

Early identification and call for help are fundamental factors needed to improve prognosis in children, enabling rapid activation of the EMS response and encouragement to perform bystander

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CPR.⁵ Time to initiation of CPR by any responder has been shown to be a factor in overall mortality⁵ and call to EMS CPR time is a contributing factor to neurologically intact survival after OHCA in children.⁶ Recognition of cardiac arrest by the ambulance call taker facilitates encouragement to perform bystander CPR which, regardless of dispatcher assistance (DA), is associated with improved survival outcomes after OHCA in the paediatric population. When dispatch-assisted CPR instructions are given, the odds ratio for survival is generally doubled, with even greater benefits from bystander CPR when DA instructions are not necessary, suggesting that the caller is trained in CPR.⁷ These beneficial effects are even more pronounced in children of older age groups.⁶

The rapid dispatch of an ambulance and the encouragement of bystanders to perform CPR depend on the accurate identification by the ambulance call taker of the cardiac arrest. Using a didactic telephone script for triage of emergency ambulance calls increases this accuracy, typically achieving a 200% rise in the number of patients accurately identified as suffering from cardiac arrest, compared with free script.⁸ Recently the National Health Service (NHS) has developed its own telephone triage system called 'NHS Pathways' which sets out to deliver a clinical assessment tool that provides effective triage over the telephone for taking calls from the public. It is now used by six of the 12 UK ambulance services (South East Coast Ambulance Service, South Western Ambulance Service, South Central Ambulance Service, West Midlands Ambulance Service, North East Ambulance Service, Isle of Wight NHS Trust). The performance of this triage system has recently been evaluated for adults and has been shown to have a sensitivity of 75.9% and a positive predictive value of 26.8%.⁹ In practical terms, this means that approximately one quarter of adult cardiac arrests are not identified at the time of the initial emergency call, which is likely to adversely affect outcome for these patients. Paediatric cardiac arrests are identified by NHS Pathways using a different script, the performance of which has not been evaluated. Although paediatric cardiac arrests are fewer in number compared to adults, their impact on life-years and the family unit is significant and it is vital that any telephone triage system is optimised to strengthen the initial link in the chain of survival and optimise the chances of survival for these children. This study therefore aims to evaluate the diagnostic accuracy of the NHS Pathways as a telephone triage tool to identify patients less than 16 years age in cardiac arrest.

Methods

Setting

South Central Ambulance Service (SCAS) is one of 10 NHS Ambulance Trusts providing emergency medical care for England, covering four counties in southern England (Hampshire, Berkshire, Buckinghamshire and Oxfordshire) and encompassing a population of more than 4,000,000 over an area of 3554 square miles.

Ethics approval

The National Research Ethics Service (NRES) decision tool classifies this study as service evaluation (<http://www.hra-decisiontools.org.uk/research>). Therefore NHS Research Ethics Committee approval was not required.

Call handling

All emergency calls are received by one of two Emergency Operations Centres (EOC), both of which use NHS Pathways as a primary triage system to manage emergency calls. Data is logged to a central database from which records can be electronically searched. Over a

12-month retrospective period from March 2015 to February 2016, during which time NHS Pathways (v9.04) was in use, all emergency (999) calls received by SCAS were examined to identify those where the call categorisation was consistent with paediatric cardiac arrest (Red 1).

Patient age was determined either from data that was autofilled from the NHS database at the time of the call, entered manually by the call taker or obtained from the PRF. 'Paediatric' was classified as those aged 15 years or less, which corresponded with the division between adult and paediatric cardiac arrest protocols used by NHS Pathways.

Identification of cardiac arrest calls with NHS Pathways

NHS Pathways triages patients by gradually decreasing the response priority through a series of questions designed to rule out the most urgent conditions first. Based on the responses to these initial questions, the system assigns a code to the event, which is then allocated to a pre-determined response time. When identifying patients in cardiac arrest, there are two relevant codes (DX010, DX0101), both named "emergency ambulance response for potential cardiac arrest". These codes result if the answer to the first two immediate questions "Is the patient conscious" and "Is the patient breathing normally" (or "Is the breathing noisy") are affirmative.

Identification of cardiac arrest calls using the ambulance crew's Patient Report Form

Following patient contact, ambulance crews complete a Patient Report Form (PRF) to record the patient event. The PRF has a code specifically for the presenting condition, including one for cardiac arrest. All corresponding ambulance PRFs over the same time period were examined to identify patients identified as cardiac arrest by the ambulance crew at the time of their arrival on scene. Patient age was taken from the PRF or EOC call data.

Cross-referencing of patient data

The NHS Pathways categorisation for each call was cross-referenced with each of the corresponding ePRF forms to identify patients where both NHS Pathways categorisation matched the ePRF categorisation with regards to cardiac arrest and those where it did not.

Calls were categorised in to one of four groups:

- True positive:
 - Cardiac arrest diagnosed by NHS Pathways.
 - Cardiac arrest on arrival of the ambulance crew.
- True negative:
 - Diagnosis other than cardiac arrest diagnosed by NHS Pathways.
 - Patient not in cardiac arrest on arrival of the ambulance crew.
- False positive:
 - Cardiac arrest diagnosed by NHS Pathways.
 - Patient not in cardiac arrest on arrival of the ambulance crew.
- False negative:
 - Diagnosis other than cardiac arrest diagnosed by NHS Pathways.
 - Cardiac arrest on arrival of the ambulance crew.

Sub-categorising the resulting false negative and false positive groups was done using a combination of further information on the PRF, symptom discriminators in NHS Pathways (used to assign

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