Modelling of patient outcomes after emergency treatment for out-of-hospital cardiac arrest by paramedics and community first responders

East Midlands Ambulance Service NHS Trust

Emergency Care | Urgent Care | We Care

LIVES. SAVING LIVES IN LINCOLNSHIRE

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Introduction

Patient outcomes for out-of-hospital-cardiac-arrest (OHCA) should include shorter term response resulting from the care delivered by first aiders and emergency services as well as any longer term response achieved following handover of the patient into hospital care. We develop statistical models of Return of Spontaneous Circulation while under emergency care (ROSC) and Discharge Alive from hospital (DA).

Aims

1. To develop statistical models of OHCA patient outcomes linked to both shorter term prehospital care and longer term hospital care
2. Patient characteristics such as age and sex, incident features such as day of week and incident location alongside service factors such as waiting time and treatment time to be incorporated as confounders

Methods

Data

- Obtained from anonymised records of 15,103 OHCA patients aged 4 weeks or older attended by the East Midlands Ambulance Service NHS Trust
- The sampling frame was the 3-year period April 2014 to March 2017
- Patient outcomes collected and recorded included a suite of those occurring during the period of pre-hospital care, from which we selected the binary indicator (yes=1, no=0) of the occurrence of ROSC, and as second outcome longer term survival represented by the binary indicator DA (yes=1, no=0)
- Time duration variables included:
  - waiting time (WT; time from 999 to emergency service arrival at the patient's side)
  - total treatment time (TOT; time from emergency service arrival to patient handover at hospital)
  - time to ROSC (TtoR; time from emergency service arrival to first ROSC achieved)
- Included in each episode were indicators to show Community First Responder (CFR) attendance as well as any bystander attempt at cardiopulmonary resuscitation. If a CFR was first-on-scene the emergency service arrival time corresponded to their arrival time

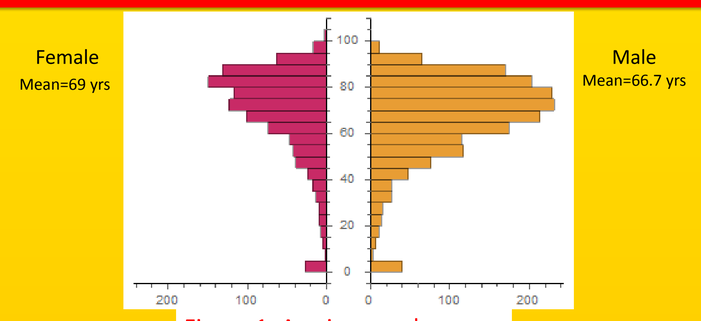

Figure 1: Age in years by sex

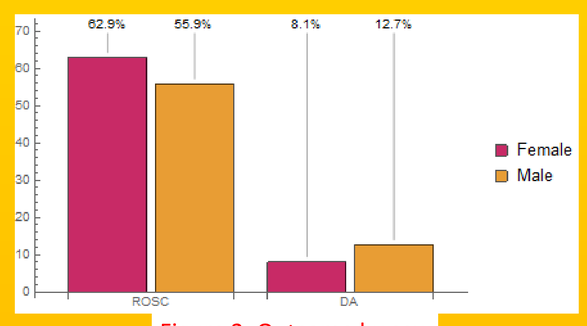

Figure 2: Outcome by sex

Statistical Methods

Statistical analyses were conducted on the complete records of 2,825 OHCA patients who were treated and transported to hospital. A bivariate probit model was fitted to the joint outcome indicators (ROSC, DA) controlling for patient characteristics (sex, age), incident location (at home / not at home), day of week, CFR attendance (yes / no) and bystander CPR (yes / no), WT and TOT. A probit model was fitted to the conditional outcome (DA|ROSC=1) with added control TtoR, modelling the outcome DA contingent on successful attainment of ROSC during the period of pre-hospital treatment.

Results

Descriptive Results

Males represented the majority of OHCA patients (63.7%), where Figure 1 depicts paired histograms of age by sex. Of the patient outcomes we considered: short term ROSC (occurrence 58.4%) and longer term survival DA (occurrence 11%). Figure 2 depicts paired bar charts of proportionate outcomes by sex. Shorter term ROSC appears more likely in females however this tendency is not sustained. Service time durations: waiting time WT (median=8.8 mins, mean=11.3 mins, SD=14.1 mins), total treatment time TOT (mean=63.4 mins, SD=25.8 mins), for the subgroup in which ROSC occurs the time taken to achieve that ROSC TtoR (mean=23 mins, SD=14.8 mins).

Table 1: Selected parameter estimates

Variable	Bivariate Probit		Probit
	ROSC	DA	DA|ROSC=1
Sex (F=0, M=1)	-0.182***	+0.150**	+0.442***
CFR on scene	-0.009	+0.040	+0.001
Bystander CPR	-0.072	-0.054	-0.177*
Wait time	-0.002	-0.006	-0.006
Total time	+0.002**	-0.006***	+0.001
Time to ROSC			-0.039***

* p<0.1, ** p<0.05, *** p<0.01

Modelled Results (Table 1 lists selected estimation results for both models)

- The effect of patient sex on outcomes was statistically significant in both models and reflective of the pattern seen in Figure 2. Females were significantly more likely to have ROSC (estimate<0, p<0.001), but males chances of longer term survival DA were improved (estimate>0, p=0.035) and reinforced in the event that a ROSC occurs (estimate>0, p<0.001)
- Age entered both models via a quadratic specification ($\alpha\ age + \beta\ age^2$), the coefficient estimates (not given) provide the curves depicted in Figure 3. These fitted curves show diminishing effects on both patient outcomes as age increases (all $\hat{\beta} < 0$, all p<0.001). Chances of successful longer term DA outcome worsen in older patients, being approximately 80+ years in unconditional DA and 60+ years in the subgroup of patients in which ROSC occurs
- CFR attendance had no statistically significant influence on either patient outcome
- Waiting time WT estimates were such that patient outcomes worsened as wait time increased (i.e. estimate<0); however, while expected in sign all estimates were statistically insignificant when compared to no effect
- TOT, the total time of pre-hospital care, was statistically significant when modelling both outcomes; with positive influence on occurrence of ROSC the longer that time period (estimate>0, p=0.036), but worsening the chance of longer term survival DA (estimate<0, p<0.001)
- A key driver in the conditional DA|ROSC=1 model was the time to ROSC (estimate<0, p<0.001), providing significant evidence of the anticipated result that the sooner ROSC was achieved the better the chances of longer term survival DA. This was to the exclusion of the service characteristics WT and TOT, both of which were insignificant

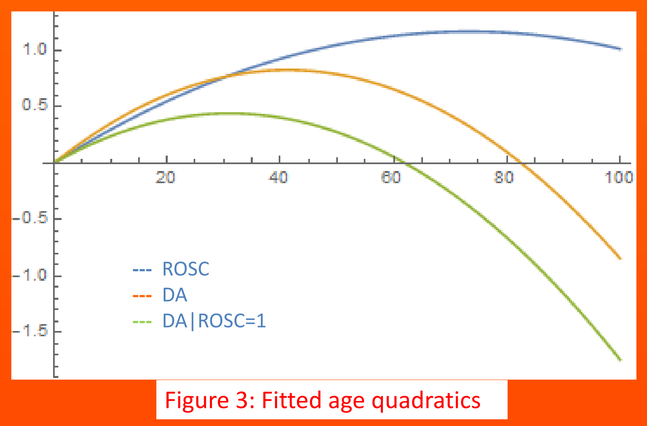

Figure 3: Fitted age quadratics

Conclusion

Our results show that OHCA patient outcomes depend crucially on the quality of clinical care delivered to them by the emergency services. Next steps include the need to gather granular data evidencing the pre-hospital care that is administered to patients by paramedics and community first responders.

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