Research Article

Age influences the predictive value of Acute Physiology and Chronic Health Evaluation II and Intensive Care National Audit and Research Centre scoring models in patients admitted to Intensive Care Units after in-hospital cardiac arrest

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Abstract

Introduction: Outcomes following in-hospital cardiac arrest (IHCA) are generally poor though different patient populations may benefit to different degrees from admission to Intensive Care Units (ICUs). Risk stratification algorithms may be useful in identifying patients who are most likely to benefit from ICU admission and so may aid allocation of this scarce resource. We aimed to compare the performance of the Acute Physiology and Chronic Health Evaluation II (APACHE II) and Intensive Care National Audit and Research Centre (ICNARC) scoring systems in predicting outcome following ICU admission after IHCA in younger (≤69 years) and older (≥70 years) patients. **Materials and Methods:** We performed a retrospective observational study in two adult ICUs from January 2006 to February 2010 inclusive. Patients were divided into younger (≤69 years) and older (≥70 years) patients. The primary outcome measures were acute hospital mortality and area under the curve (AUC) calculation for receiver operating characteristic (ROC) analysis. **Results:** Two hundred and sixty-one adult consecutive adult patients admitted following IHCA. Hospital mortality was 58.6%. ROC analysis demonstrated that ICNARC was more accurate than APACHE II in predicting acute hospital outcomes in the adult population (AUC 0.734 vs. 0.706). Both scoring systems performed weaker when predicting outcomes in younger patients compared to older patients (ICNARC AUC 0.655 vs. 0.810; APACHE II AUC 0.660 vs. 0.759). **Discussion**: Both APACHE II and ICNARC predict outcome well in older patients. In younger patients, their value is less clear, and so they must be used with caution.

Keywords: Acute Physiology and Chronic Health Evaluation II, in-hospital cardiac arrest, Intensive Care National Audit and Research Centre

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Introduction

Outcomes following in-hospital cardiac arrest (IHCA) are generally poor, with survival to hospital discharge having been reported at <20% in the UK.[1] Older patients might be expected to perform worse after IHCA and Intensive Care Unit (ICU) admission due to decreased functional reserve, yet previous studies have suggested that age itself is not a valid predictor of overall survival.[2,3] Life expectancy in the UK has risen sharply from 71.1 to 79.0 for males and from 77.0 to 82.8 for females over the last 30 years, and is projected to continue to rise over the next 30 years to 84.7 and 89.9 for males and females, respectively.[4] As our population ages we can expect more older patients to be put forward for consideration for ICU admission following IHCA and

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we will have to develop reliable mechanisms for triage to ensure the optimal use of limited ICU capacity.

Predictive models assessing the severity of disease may be useful tools in objectively estimating the prognosis of ICU candidates. Some algorithms, such as the Acute Physiology and Chronic Health Evaluation II (APACHE II) model and the Intensive Care National Audit and Research Centre (ICNARC) model, are already in use in ICUs across the UK and have been applied to patients suffering IHCA, though with conflicting results.[5-13] While these scores incorporate age into their calculations, they also include a selection of physiological and biochemical variables, and thus may be useful information to aid clinical decision-making. However, the performance of these algorithms in different age groups has not been determined. Thus, with this study, we aimed to compare the performance of two major scoring systems (APACHE II and ICNARC) in predicting outcomes of patients admitted to ICUs after IHCA.

Materials and Methods

A retrospective cohort study was performed using audit data routinely collected from two adult ICUs at a large teaching hospital. The Local Research Ethics Committee issued a waiver of consent in accordance with national guidance. All ICU admissions between January 2006 and February 2010 inclusive were considered and all patients admitted following IHCA were selected for analysis. Where APACHE II and ICNARC scores were initially unavailable, they were retrospectively calculated using the raw variables collected during the first 24 h of ICU admission. Patients ≤69 years at admission were classed as "younger patients," while those ≥70 years at admission were classed as "older patients."

Descriptive statistics is reported as counts and percentages for categorical data and medians and interquartile ranges for continuous data. Comparisons between patient groups were performed using the Mann–Whitney U-test or Pearson's Chi-squared test as appropriate. Receiver operating characteristic (ROC) analysis was used to determine the success of the APACHE II and ICNARC models in predicting patient outcome at the end of ICU admission. Area under the curve (AUC) for ROC curves was approximated using the trapezium rule.

Results

Baseline patient characteristics

Between January 2006 and February 2010, there were 261 patients admitted to ICU following IHCA. 131 (50.2%) were younger patients and 130 (49.8%) were older patients [Table 1]. Older patients had a significantly worse predicted outcome at ICU admission than younger patients, as determined by higher mean APACHE II ($P < 0.001$) and ICNARC ($P < 0.001$) scores.

Patient outcomes in Intensive Care Unit and hospital

Despite poorer APACHE II and ICNARC scores on admission to ICU, by the end of the ICU admission, there was no significant difference in outcome between the two age groups (odds ratio [OR] = 1.52; 95% confidence interval [CI] = 0.92–2.50; P =0.101). However, at the end of the hospital admission, the outcome for older patients was significantly worse than for younger patients (OR = 2.46; 95% CI = 1.45–4.17; P = 0.001) [Figure 1].

Performance of scoring models

The APACHE II and ICNARC models performed similarly in predicting the ICU outcomes of all patients [Figure 2]. Calculation of AUC showed that the ICNARC model (0.734) was more accurate than the APACHE II model (0.706). However, both models were less accurate in younger patients compared to older patients [Figure 3]. AUC calculation showed a larger discrepancy for the ICNARC model (0.655 vs. 0.810; difference = 0.155) than for the APACHE II model (0.660 vs. 0.759; difference = 0.099).

Discussion

In this study, acute hospital mortality in patients admitted to ICU following IHCA was 58.6%, which is in line with previous studies which have reported figures in the range of 58–78%.[1,14-19]

Overall, the ICNARC scoring system performed better than the APACHE II system in predicting outcomes

Table 1: Patient characteristics

	All patients	Younger patients	Older patients	Crude *P* value
Number, *n* (%)	261 (100)	131 (50.2)	130 (49.8)	-
Age (years), median (IQR)	69 (54-77)	54 (42-60)	78 (74-82)	<0.001
Male, *n* (%)	152 (60.8)	76 (61.3)	76 (60.3)	=0.875
Cause of cardiac arrest				
Cardiac, *n* (%)	186 (71.2)	87 (66.4)	99 (76.2)	=0.126
Noncardiac, *n* (%)	75 (28.7)	44 (33.6)	31 (23.8)	
Score on admission				
APACHE II, median [IQR]	21 [16-28]	19 [14-26]	24 [19-30]	<0.001
ICNARC, median [IQR]	70 [36-85]	57 [33-78]	80 [54-93]	<0.001
ICU mortality, *n* (%)	131 (50.2)	58 (46.8)	73 (56.2)	=0.101
Hospital mortality, *n* (%)	153 (58.6)	62 (47.3)	91 (70.0)	=0.001

IQR: Interquartile range; APACHE II: Acute Physiology and Chronic Health Evaluation II; ICNARC: Intensive Care National Audit and Research Centre; ICU: Intensive Care Unit

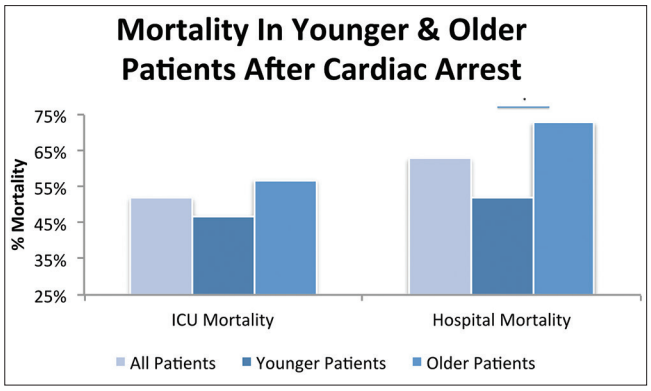

Figure 1: Mortality in younger and older patients after cardiac arrest *$P<0.05$

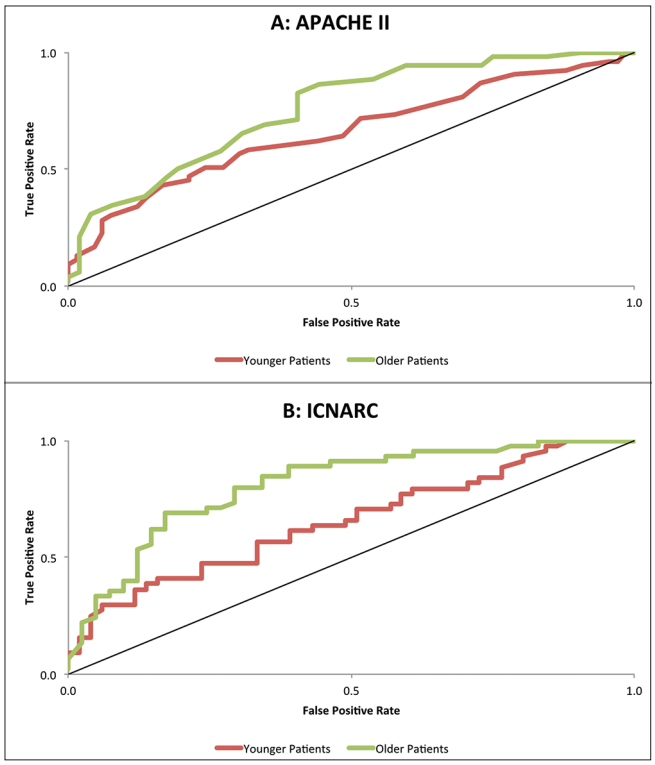

Figure 3: Receiver operating characteristic curves for younger and older patients; Acute Physiology and Chronic Health Evaluation II versus Intensive Care National Audit and Research Centre

following return of spontaneous circulation in all adult patients. This is consistent with previous studies comparing the two models in patients admitted to ICU following cardiac arrest, head injury, hematological malignancy, and esophagectomy for esophageal cancer.[9,11,13] This difference may be attributed to the periodic recalibration of the ICNARC score.

When considering the value of scoring systems in older versus younger patients both systems performed much better in older patients, with the ICNARC model outperforming the APACHE II model. These findings support the hypothesis that predictive models may be of

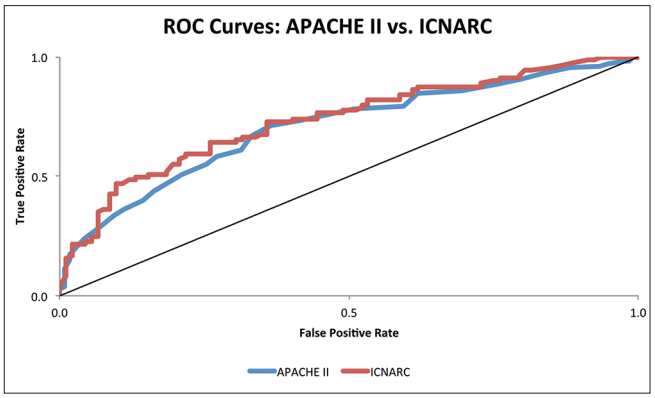

Figure 2: Receiver operating characteristic curves for all patients; Acute Physiology and Chronic Health Evaluation II versus Intensive Care National Audit and Research Centre

benefit in helping triage older patients being considered for ICU admission. Conversely such systems may not be of benefit when considering younger ICU candidates, and so may be of reduced value in centers with a more youthful patient cohort (e.g., trauma centers). The reasons for this age-related discrepancy are unclear. It is possible that the APACHE II and ICNARC scoring systems were developed from databases containing disproportionate numbers of older patients, in whom cardiac arrest may be more common. Alternatively, it is possible that the younger population in this analysis are atypical when compared to the general population.

Study limitations

This study is limited by the underlying data; it is a single center study with a relatively small sample size. These results must, therefore, be validated by further multicenter studies utilizing much larger population samples to determine its wider significance. A larger sample size would also allow for a greater number of age categories, as currently a heterogeneous population of individuals under 70 are grouped together. Finally, this study is at risk of diagnostic review bias as criteria incorporated within the scoring systems will influence the decision to admit to ICU.[20]

Conclusions

The APACHE II and ICNARC models both provide a good prediction of outcome for older patients admitted to ICU following IHCA. However, their prognostic value in younger patients is less clear, and so they must be used with caution in these individuals.

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