International Journal of Emergency Medicine

RESEARCH

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Validating the GO-FAR score: predicting in-hospital cardiac arrest outcomes in the Middle East

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Abstract

Introduction and aim External validations of the Good Outcome Following Attempted Resuscitation (GO-FAR) score have been in populations where Do Not Attempt Resuscitation (DNAR) is practised. We aim to externally validate the GO-FAR score in a population without a DNAR order.

Methods We studied patients ≥ 18 years old who had an In-hospital cardiac arrest (IHCA) with known outcomes at Al Ain Hospital from January 2017 to December 2019, excluding those who died in the emergency department. Studied variables included demography, location, response time, code duration, initial rhythm, primary diagnosis, admission vital signs, GO FAR score variables, discharge status, and functional outcomes as determined by the cerebral performance category score ranging from 1 (good cerebral performance) to 5 (brain death).

Results 366 patients were studied; 66.7% were males. The median (IQR) age was 70 (55–81) years. Cardiac and respiratory causes were the primary diagnoses in 89 (24.6%) and 67 (18.5%), respectively. IHCA occurred in critical areas such as the intensive care unit, high dependency unit and coronary care unit in 206 (80.8%) patients. The majority, 308 (91.8%), had a non-shockable rhythm, and a return of spontaneous circulation was achieved in 159 (43.4%) of the patients. Thirty-one (8.5%) patients survived to hospital discharge, and 20 (5.5%) patients had cerebral performance category scores of 1 and 2. The area under the curve of the ROC for survival to discharge with good functional outcome was 0.74 (95% CI 0.59–0.88). The best cut-off point for predicting survival with a good neurological outcome was a GO-FAR score of < 4, having a sensitivity of 0.81, a specificity of 0.7, a positive likelihood ratio of 2.7 and a negative likelihood ratio of 0.27.

Conclusions A GO-FAR score of less than 4 predicts survival with a good neurological outcome in a healthcare system with an all-inclusive patient population with no DNAR practice.

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Introduction

In-hospital cardiac arrest (IHCA) places a significant burden on healthcare systems globally [1]. The care for patients who survived IHCA with poor neurological outcomes continues long after discharge from the hospital. Up to 50% of them may require long-term care [2]. Therefore, physicians need to discuss these possibilities with patients and their families to help them make decisions appropriate to their values and preferences. Many studies have reported that physicians' prediction of outcomes following cardiac arrest is not accurate as a result of poor knowledge of patients' and families' personal preferences, and individual physician bias. Accordingly, patients or their relatives may have unrealistic expectations of good outcomes in cardiac arrest [3–5]. Many prediction tools have been developed to help physicians and patients in shared decisions about end-of-life care. However, these tools failed to gain general acceptance due to small sample sizes and inconsistent external validations [6–9]. To address these inadequacies, Ebell and colleagues developed and internally validated the Good Outcome Following Attempted Resuscitation (GO-FAR) score using variables that are obtainable at hospital admission [10]. The authors used data from the United States cardiac arrest registry; Get With The Guideline-Resuscitation (GWTG-R) and came up with 13 variables to derive the scoring tool.

The importance of using variables obtainable at hospital admission is underscored by the recent International Liaison Committee on Resuscitation (ILCOR) 10-step recommendations of improving IHCA quality of care and outcome [11]. In particular, the 4th of the 10 steps recommends preventive strategies for IHCA, including early establishment of the patient's and family's treatment goals regarding the performance of cardiopulmonary resuscitation, considering the patient's comorbidity, frailty and values.

The GO-FAR score has been externally validated in the USA, Europe and East Asia [12–14]. However, like the derivative study, external validations excluded patients with advance directives and those on the Do-Not-Attempt-Resuscitate (DNAR) code. How the GO FAR score's ability to predict neurological outcomes following IHCA in populations with no DNAR policy remains unknown.

We aim to validate the GO-FAR score externally in an all-inclusive population where no patients were excluded due to an existing DNAR order. The study will evaluate the generalizability of the GO-FAR score, especially in low-middle-income economies with less well-developed social and healthcare systems that may not have advanced directives or DNAR practice.

Patients and methods

Setting

Al-Ain Hospital serves a population of 669,000 inhabitants in the Abu Dhabi Emirate, the UAE. The hospital has 450 in-patient beds and is one of two tertiary referral centres in the Al Ain region. All staff are trained in Basic Life Support (BLS), and all staff working in critical areas such as the coronary care unit, intensive care unit and high dependency unit are certified in Advance Cardiovascular Life Support (ACLS).

Study population

We studied all patients 18 years and older who had a cardiac arrest during their hospital admission at Al Ain Hospital from January 2017 to December 2019. We excluded patients who had a cardiac arrest in the emergency department (ED) and all trauma patients. We included outcomes for the first arrest episode in patients with multiple arrests.

The cardiac arrest team and data recording

The code team, comprising a board-certified physician, an intensive care nurse, a respiratory therapist, and a senior nurse, attended all cardiac arrest codes except the cardiac arrest in the emergency department. Cardiopulmonary resuscitation and post-resuscitation care in those who achieved a return of spontaneous circulation (ROSC) followed the standard ACLS protocol. The cardiac arrest event data were collected in real-time by a member of the code team on a standard cardiac arrest template similar to the Utstein template (Supplementary file 1). The cardiac arrest variables and outcomes are entered into a data bank by trained resuscitation officers.

Studied variables

The studied variables were the patient's demography, day and time of arrest, location, response time, code duration, initial rhythm, outcome, primary diagnosis, and admission vital signs. The GO FAR variables, admission vital signs, discharge status, and functional outcomes were retrospectively obtained from the electronic patient record by the study team. The GO-FAR score is based on 13 variables obtainable at admission. [Table 1]. Each variable is given a weighted score ranging from −15 to +11. The total score is divided into four survival categories. The lower the sum score for a patient, the higher their probability of survival. A web application is available for physicians to calculate the GO-FAR sum score. [Supplementary file 2].

Functional outcome was determined using the cerebral performance category (CPC) score- a five-point scale ranging from 1 (able to work and live independently with minor physical or psychological disability) to 5 (brain death). The CPC score is not recorded routinely

Table 1 The GO-FAR scores and the probabilities of survival

Variable		GO-FAR Score
Neurologically intact or with minimal deficits at admission		-15
Major trauma		10
Acute stroke		8
Metastatic or hematologic cancer		7
Septicemia		7
Medical noncardiac diagnosis		7
Hepatic insufficiency		6
Admit from a skilled nursing facility		6
Hypotension or hypoperfusion		5
Renal insufficiency or dialysis		4
Respiratory insufficiency		4
Pneumonia		1
Age (years)		
	70–74	2
	75–79	5
	80–84	6
	≥ 85	11
Probability of survival		Sum score
	Very low (< 1%)	≥ 24
	Low (1–3%)	14 to 23
	Average (> 3–15%)	-5 to 13
	Above average (> 15%)	≤ -6

Good Outcome Following Attempted Resuscitation (GO-FAR) scores and the probability of survival [Ebell 2013]

in discharged IHCA patients. A research team member reviewed the patient's electronic medical records and assigned the patient to a CPC score based on their documented GCS, discharge functionality such as 'full recovery', 'independent living', and 'discharge to long-term care'.

Ethical consideration

The study was approved by the Al-Ain Hospital Research Ethics Governance Committee, Al Ain, the United Arab Emirates (Ref: AAHEC-12-20-031).

Statistical analysis

Continuous data were presented as mean (SD), ordinal data were presented as median (25–75 percentiles), and categorical data as number (%). The receiver operating characteristic (ROC) curve and area Under the Curve (AUC) were analyzed by classifying the outcomes as binomial data for hospital survival and good functional outcomes. The best cut-off point for predicting the outcome was defined as the coordinates of the point nearest to the upper left corner of the ROC curve. The positive likelihood ratio of the cut-off point was calculated as sensitivity/(1-specificity), while the negative likelihood ratio was calculated as (1-sensitivity)/specificity. Statistical Package for the Social Sciences (IBM-SPSS version 29, Chicago, IL) was used for the analyses.

Table 2 Demography and severity markers of studied patients ($n = 366$)

Variable	Value
Sex (Male)	244 (66.7)
Age	70 (55, 81)
GCS	14 (6–15)
Admission vitals	
Systolic blood pressure mmHg	125 (35)
Diastolic blood pressure mmHg	70 (22)
Pulse rate (bpm)	94 (25)
Respiratory rate	21 (6)
Temperature ^{0}C	36.7 (0.8)
Primary diagnosis	
Cardiac	89 (24.6)
Respiratory	67 (18.5)
Others	206 (56.9)
Resuscitation in critical areas	295(80.8)
Initial rhythm	
Asystole	178 (48.6)
Pulseless electrical activity	158 (43.2)
Ventricular fibrillation	23 (6.3)
Pulseless ventricular tachycardia	7 (1.9)
Survival to hospital discharge	31 (8.5)
Cerebral performance category score 1 or 2	20 (5.5)

Data are presented as number (%), median (25–75 percentile), and mean (standard deviation) as appropriate

Results

There was a total of 366 patients in the study group, of which 244 (66.7) were males. Table 2. Shows the demographics and the admission physiological parameters of the patients. The median (IQR) age was 70 (55–81) years. The median (IQR) systolic blood pressure, pulse rate, and respiratory rates were 120 (102–142) mmHg, 90 (79–109) beats per minute and 19 (17–24) breaths per minute, respectively.

Cardiac and respiratory causes were the primary diagnoses in 89 (24.6%) and 67 (18.5%). Other primary diagnoses were present in 206 (56.9%) of the patients. In-hospital cardiac arrest occurred in critical areas such as the intensive care unit, high dependency unit and coronary care unit in 206 (80.8%) of the patients. Most of the patients, 308 (91.8%), had non-shockable rhythms. Return of spontaneous circulation (ROSC) was achieved in 159 (43.4%) patients. There were 31 (8.5%) patients who survived to hospital discharge, of which 20 (5.5%) patients had a good neurological outcome with cerebral performance category scores of 1 and 2.

Table 3. shows the distribution of the patients by survival probability category and CPC scores 1 or 2. Two-hundred and twenty-one patients had a poor probability of survival by GO FAR score, while 144 (39.5%) had a

Table 3 Distribution of patients by survival probability and CPC score 1 or 2

Variable	GO-FAR Score	Patients *N* (%)	CPC 1–2 *N* (%)
All groups combined			
Very low (< 1%)	≥ 24	108 (29.6)	4 (20)
Low (1–3%)	14 to 23	113 (30.9)	0 (0)
Average (> 3–15%)	-5 to 13	116 (31.8)	10 (50)
Above average (> 15%)	-15 to -6	28 (7.7)	6 (30)

good probability of survival. The GO FAR score classified 16 (80%) of the patients with a CPC score of 1 or 2 into the average or above average probability of survival categories.

Figure 1 Shows the GO-FAR prediction of outcomes. The prediction model shows a fair performance with the area under the receiver operating characteristic (ROC) curve of 0.72 (95% CI 0.6–0.84) for predicting survival outcomes to hospital discharge. The best cut-off point for predicting survival to hospital discharge was a GO-FAR score of 3.5 (less than 4), having a sensitivity of 0.82 (95% CI: 0.77–0.87), a specificity of 0.61 (95% CI: 0.38–0.85), a positive likelihood ratio of 2.10 and a negative likelihood ratio of 0.295. Figure 2 shows the prediction model for the CPC score of 1 and 2 with the area under the ROC curve of 0.74 (95% CI 0.59–0.88). The best cut-off point for predicting good clinical outcome was 3.5 (less than 4), which had a sensitivity of 0.81 (95% CI 0.75–0.86), a specificity of 0.7 (95% CI 0.42–0.95), a positive likelihood ratio of 2.7, and a negative likelihood ratio of 0.271.

Discussion

In this study a GO-FAR score of 4 predicts survival with a good neurological outcome with an AUC of 0.74 (95% CI 0.59–0.88), and for survival to hospital discharge, an AUC of 0.72 (95% CI 0.6–0.84) in a population without advance directives and DNAR practice. The AUC of 0.74 in our results is comparable with the published results of 0.78 in the original derivative study and the 0.69 to 0.8 reported in revalidation studies from populations with advanced directives and DNAR policies [10, 12, 15], and the results in populations where DNAR is uncommon [14]. To our knowledge, this is the first study to validate

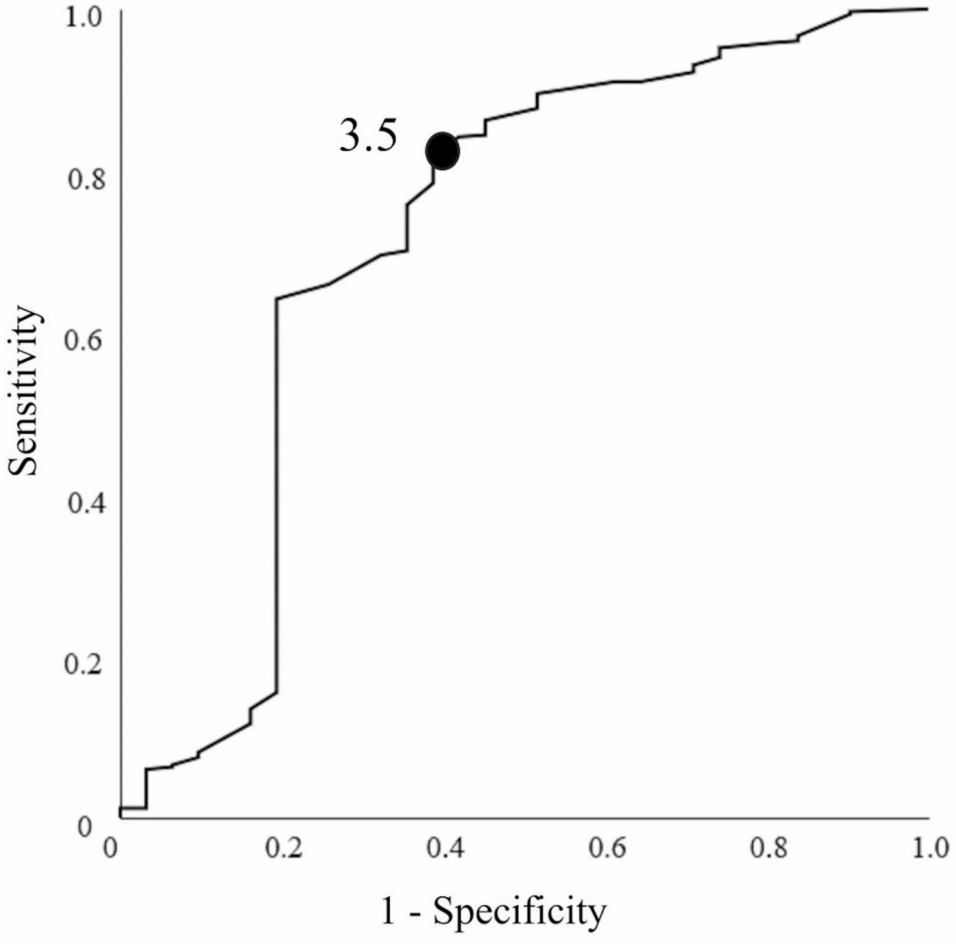

Fig. 1 Receiver Operating Characteristics (ROC) curve for survival outcome to hospital discharge. Best cut off point is 3.5, AUC = 0.72

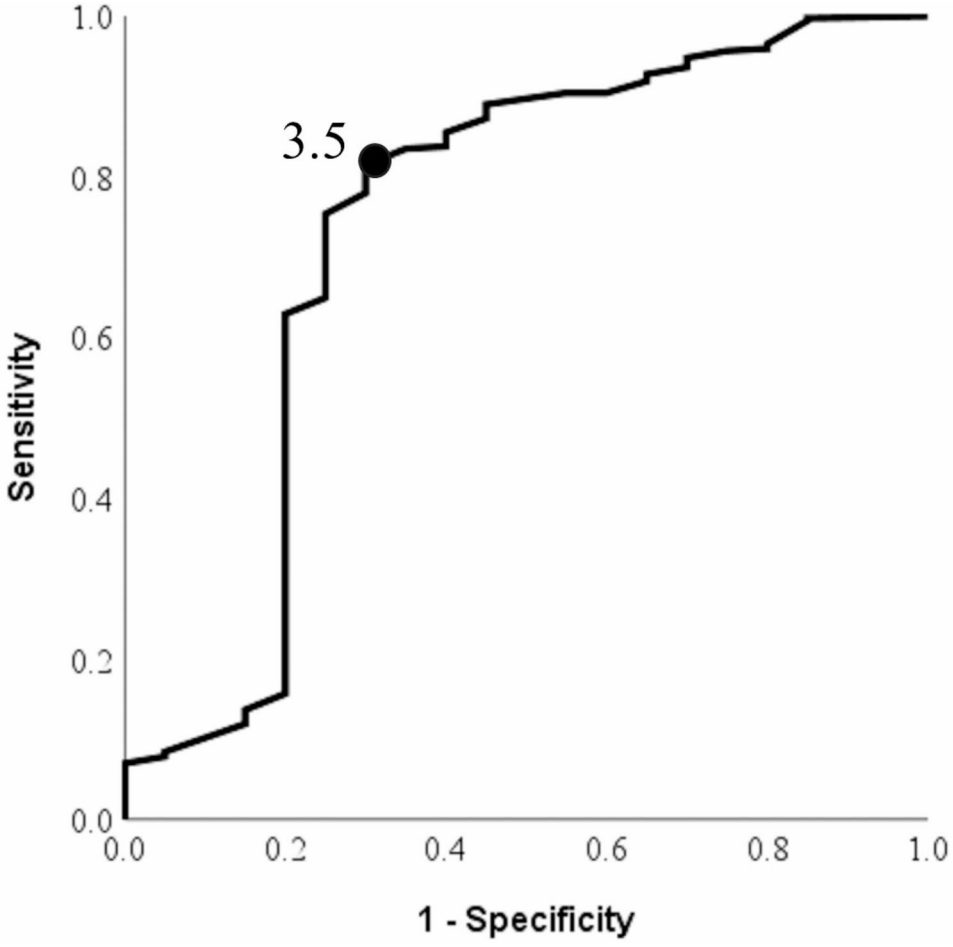

Fig. 2 Receiver Operating Characteristics (ROC) curve for survival outcome with Cerebral performance category scores of 1 and 2. Best cut off point is 3.5, AUC = 0.74

the GO-FAR score in an all-inclusive patient population where no patient is excluded due to an extant DNAR order. The results of our study will have broader applications in countries with no DNAR policies and limited resources where physicians still have to discuss the likely outcomes of attempted resuscitation with patients and families, as well as prioritize treatment options and resource utilization.

Our results differ in many ways from previously published works. First, all patients with an IHCA in our study were given CPR, while only 5–31% of IHCA patients undergo CPR in high-income countries [16–18]. Most patients who died in hospitals in these studies have been excluded due to advance directives and DNAR policies. Furthermore, our survival to hospital discharge and the proportion of patients with good neurological outcomes of 10.8% and 5.5%, are low compared with the 18% and 9%, respectively, from the original GO-FAR study and the 25.4% and 16.0% in a revalidation study [10, 14]. The observed differences may reflect the study population and their arrest characteristics.

Cardiac (24.6%) and Respiratory (18.5%) causes of arrest were fewer in our study compared with reports of cardiac (50–60%) and respiratory (15–40%) from the USA, Italy and South Korea [19–21]. Furthermore, only 8.2% of our patients had a shockable initial rhythm compared with 15.4% reported in the Get with the Guideline-Resuscitation GWTG-R [22]. Cardiorespiratory causes of cardiac arrest and shockable initial rhythm have all been associated with favourable outcomes following cardiac arrest [23, 24].

The AUC of 0.74 for hospital survival and good neurological outcomes in this study is comparable to the 0.78 in the derivative study but lower than the 0.80 reported in a Swedish revalidation study [12]. Nonetheless, our study's AUC value of > 0.7 is better at determining patient outcomes than subjective physician assessment.

Our results have added to the body of knowledge on the utility of the GO-FAR score in end-of-life discussions between physicians and patients or their surrogates. A previous study from South Korea validated the GO-FAR score in a population where the DNAR is not

commonly practised [14]. However, the study included a mixed population, with some patients excluded due to an extant DNAR order, while some patients with DNAR orders were resuscitated and included in the study. The results of our study have the potential to bring to the forefront the discussions on the futility of CPR and the need for DNAR policy in populations where such policies do not currently exist. In populations with no advance directives, our findings provide additional assurance for clinicians of the applicability of the GO-FAR score in end-of-life discussions and shared decision-making.

In 2020, the International Liaison Committee on Resuscitation (ILCOR) identified a dearth of studies on resuscitation science from low and middle-income countries, stressing the negative impact this may have on the applicability of resuscitation guidelines derived from studies from high-income countries [25]. The results of our research will add to the inchoate efforts to address this gap.

Limitations

Our study has some limitations, and our results must be interpreted accordingly. First, the Cerebral Performance Category (CPC) score is not recorded routinely in the patient's electronic medical records (EMR). A research team member assigned the patient to a CPC score based on the documented discharge functionality of the patient, such as 'full recovery', 'independent living', and 'discharge to long-term care'. We used the patient's GCS at discharge as a part of the functionality assessment. Using GCS as a surrogate for CPC score can introduce information bias as GCS assesses mental status instead of functional status.

Nevertheless, low GCS is a predictor of failure to survive after IHCA [26]. Second, we have defined renal and hepatic insufficiency as new or unresolved chronic kidney disease requiring dialysis and new or unresolved hepatic failure. We classified patients as septic based on clinical diagnosis by the treating clinicians, as this is authentic to real-life situations. Finally, we excluded a few patients for whom we were unable to abstract the GO-FAR variables from the electronic medical records and all major trauma patients. In our institution the outcome measure for trauma and IHCA are kept separately because the epidemiology and temporal distribution of trauma deaths are unique and the patients mostly die from bleeding and severe head injury. We are reassured that this did not adversely affect the validity of our results as trauma has now been excluded in the updated version of the GO-FAR 2 score [27].

Conclusions

A GO-FAR score of less than 4 fairly predicts survival with a good neurological outcome in a healthcare system with an all-inclusive patient population with no DNAR practice. The generalisability of the GO-FAR score enables physicians to objectively discuss the likely outcomes of attempted resuscitation with patients and families in different settings thus helping to manage any unrealistic expectations.

Abbreviations

ACLS	Advance cardiac life support
AUC	Area under the curve
CPC	score Cerebral performance category score
CPR	Cardiopulmonary resuscitation
DNAR	Do-not-attempt-resuscitation
ED	Emergency department
GO-FAR	Good outcome following attempted resuscitation
IHCA	In-hospital cardiac arrest
ILCOR	International liaison committee on resuscitation
ROC	Receiver's operating characteristics
ROSC	Return of spontaneous circulation
UAE	United Arab Emirates

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12245-024-00749-4.

Supplementary Material 1: Local cardiac arrest documentation form

Supplementary Material 2: Web based GO-FAR calculator

Author contributions

DOA, AAC, NM, and KM contributed to the study conception and design. NM, YH, RKS, and KM contributed to the acquisition and coding of data. FAZ analyzed the data. DOA, NM, and KM drafted the manuscript. DOA, AAC, and FAZ critically read and edited the manuscript. All authors read and approved the final manuscript.

Funding

No funding was obtained for this study.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethical approval

I certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The study was approved by the Al-Ain Hospital Research Ethics Governance Committee, Al Ain, the United Arab Emirates (Ref: AAHEC-12-20-031).

Consent to participate

A written informed consent for all participants was waivered by the Research Ethics Governance Committee, Al Ain, the United Arab Emirates as this was a registry data.

Consent for publication

Written informed consent from the patient for publication of this study and accompanying images: Not applicable.

Competing interests

The authors declare no competing interests.

Received: 12 July 2024 / Accepted: 9 October 2024
Published online: 22 October 2024

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