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Original Research Article

Clinical prognostication of out-of-hospital cardiac arrest: insight from a prospective observational study using the shockable, witnessed, age and pH score

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ABSTRACT

Background: Cardiac arrest remains a leading cause of mortality and morbidity worldwide. Though there are many prognostic tools, the importance of predicting prognosis of out of hospital cardiac arrest in the emergency department (ED) using SWAP (Shockable, witnessed, age and pH) score has not been studied extensively.
Methods: We conducted a hospital-based prospective observational study in Kerala, India, focusing on patients who arrived at the ED after experiencing out-of-hospital cardiac arrest (OHCA). For patients who met the inclusion criteria, (all patients who came to ED with OHCA with age more than 18 years) we calculated the SWAP score using historical information and venous blood gas sample analysis. Patients who achieved return of spontaneous circulation (ROSC) were closely monitored, and post-cardiac arrest care was initiated. Patients who achieved sustained ROSC were admitted, and at time of discharge, follow-up was conducted using cerebral performance category (CPC) score.
Results: The SWAP score was computed for patients who experienced OHCA. The analysis revealed that patients with favorable outcomes (CPC 1 and 2) had an average SWAP score of 1, while patients with unfavorable outcomes (CPC 3, 4, 5) had an average SWAP score of 1.55. Among the total of 116 patients, 7 individuals (6.03%) survived with positive neurological outcomes (CPC 1 and 2), while 109 patients (93.96%) experienced poor neurological outcomes (CPC 3, 4, 5, and mortality).
Conclusions: Patients who had a high SWAP score had a reduced likelihood of survival and sustained ROSC. Conversely, patients with a SWAP score below 2 had a higher probability of experiencing a ROSC and surviving.

Keywords: OHCA, Emergency medicine, SWAP score, CPC score

INTRODUCTION

Cardiac arrest is a devastating event that significantly burdens the healthcare system. Despite advanced resuscitation efforts, the survival rate for cardiac arrest remains low.[1] An OHCA is defined as cessation of cardiac mechanical activity that occurs outside of the hospital setting and is confirmed by absence of signs of circulation.[2] Every year, millions of individuals receive training in basic and advanced life support with the goal of enhancing the quality of care provided to cardiac arrest patients.[3] In spite of relentless efforts and remarkable advancements in resuscitation techniques, the survival rates for cardiac arrest have seen minimal progress over the past three decades. The odds of surviving an OHCA until hospital discharge still hover dismally between 6.7% and 10.8%.[4]

To predict the prognosis of these patients at an early stage, the SWAP (Shockable, Witnessed, Age, pH) score was derived and retrospectively validated. This score evaluates factors such as the presence of a shock able rhythm, whether the arrest was witnessed, age and the blood pH at presentation.[5] The SWAP score can be

utilized by emergency medicine physicians to evaluate the neurological outcome of cardiac arrest patients and effectively communicate the prognosis to bystanders. Additionally, it serves as a valuable tool in making well-informed decisions regarding advanced management options. Aim of the study is to predict the prognosis of out of hospital cardiac arrest patients presenting to ED using SWAP score. The objectives are to study sensitivity, specificity of SWAP score in predicting sustained ROSC after OHCA, to correlate SWAP score with survival to discharge after OHCA, to study neurological status at time of discharge using CPC score.

The SWAP score was initially developed through a prospective cohort study and validated retrospectively through the analysis of historical data from previously hospitalized patients.[5] Despite its recent inception, there has been a significant lack of research dedicated to its prospective utilization. In our present investigation, we sought to proactively assess the SWAP score's effectiveness in predicting favorable neurological outcomes.

METHODS

Study design and setting

This was a single center prospective observational study, conducted in the emergency medicine department of Jubilee mission medical college and research institute, Thrissur, a tertiary care center in Kerala, India from August 2019 to November 2021.

The trial protocol was approved by the hospital ethical committee (Ref No:66/19/IEC/JMMC&RI).

Participants

We consecutively included 116 patients who presented to ED with OHCA. Exclusions from the study were made for cases exhibiting hard signs of death, those where blood gas analysis couldn't be obtained within the first 5 minutes, individuals with a 'do not resuscitate' status, cases resulting from circumstantial causes like trauma, hanging, drowning, or asphyxia, as well as those who declined to participate or those who were under 18 years of age.

Study method

During the study, trained healthcare providers, initiated resuscitation measures following the basic life support (BLS) and advanced cardiac life support (ACLS) guidelines recommended by the AHA. Bystanders were approached for consent, and relevant medical history was obtained. To assess the patient's condition, a venous cannula was placed for venous blood gas analysis. Patients who did not achieve ROSC and those with poorly sustained ROSC were declared deceased. On the other hand, patients who achieved sustained ROSC (where chest compressions were not required for 20 consecutive minutes and signs of circulation persisted) were closely monitored, and post-cardiac arrest care was initiated. For patients meeting the inclusion criteria, the SWAP score was calculated using parameters obtained from their medical history and venous blood gas sample analysis. Follow-up assessments were conducted at the time of discharge, and the CPC score was analyzed for each patient to evaluate their neurological status.

Sample size and statistical analysis

The minimum required sample size, determined based on the sensitivity of the SWAP score observed in a prior publication, was calculated to be 95.[5] However, we included a total of 116 patients in our study during the predetermined study duration

For assessing the association between categorical variables, the Chi^2 test was applied.

The data analysis was performed using the statistical software SPSS 20.0. Data entry and the creation of graphs, tables, and charts were carried out using Microsoft excel and word (version 2019).

RESULTS

A total of 116 patients who experienced OHCA were included in this study. Upon analyzing the data, the average age of the participants was 62.85 years, with a standard deviation of 12.25. The age range varied from 24 to 95 years. Among the 116 patients, 75 (64.4%) were male. Regarding comorbidities within the study population, diabetes mellitus was found to be the most common, affecting 65 individuals (56%). The study revealed that 53 patients (45.7%) had prior coronary artery disease, 48 patients (41.4%) had systemic hypertension, and 10 patients (8.6%) were diagnosed with chronic kidney disease.

The study assessed the initial cardiac rhythms in OHCA patients, where the majority presented with non-shockable rhythms, notably asystole, which was the most common (60.3%). This was followed by ventricular tachycardia in 26 patients (22.9%), ventricular fibrillation in 16 patients (13.8%), and pulseless electrical activity in 4 patients (3.4%). Among the 116 patients, 75 (64.7%) experienced unwitnessed cardiac arrest. Of the total patient cohort, 48 (41.4%) achieved ROSC, with 39 of them sustaining it, while 68 (58.6%) did not achieve ROSC. Bystander CPR was initiated in 18 cases (15.5%) out of 116, while 98 patients (84.5%) did not receive bystander CPR. Regarding defibrillation, 71 patients (61.2%) did not receive any shocks, 30 patients (25.9%) received 1 to 5 shocks, 13 patients (11.2%) received 6 to 10 shocks, and 2 patients (1.7%) received 11 to 15 shocks. Notably, all shocks were administered exclusively after the patients had reached the hospital, and none of the cases involved the use of automated

external defibrillators (AEDs). Figure 1 shows the patient enrollment and Utstein-style cohort template for OHCA and ROSC analysis.

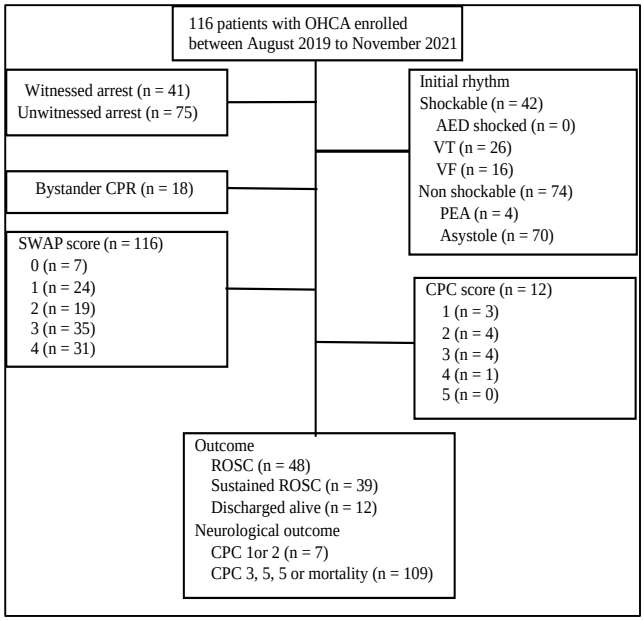

Figure 1: Patient enrollment and Utstein-style cohort template for OHCA and ROSC analysis

OHCA-Out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; AED-automated external defibrillator; VT-ventricular tachycardia; VF-ventricular fibrillation; PEA-pulseless electrical activity; SWAP-shockable witnessed age and pH; CPC-Cerebral performance category.

The SWAP score was calculated for OHCA patients, yielding scores ranging from zero to four. Among the 116 patients, 7 (6%) had a SWAP score of zero, 24 (20.7%) scored 1, 19 (16.4%) scored 2, 35 (30.2%) scored 3, and 31 (26.7%) had the SWAP score of 4 (Figure 1). While evaluating SWAP scores, we observed that the mean score for patients with a favorable neurological outcome (CPC 1 and 2) was 1, compared to 1.55 for those with a poor outcome (CPC 3, 4, 5), although this difference was not statistically significant (p=0.242).

The area under the ROC (receiver operating characteristic) curve analysis for predicting ROSC yielded a SWAP score cutoff value of 2, with an area under the curve of 0.829, with sensitivity and specificity values of 79.2% and 82.4%, respectively, while the positive predictive value was 0.76, and the negative predictive value was 0.84 (Figure 2). Furthermore, in the ROC curve analysis for predicting sustained ROSC, a SWAP score cutoff of 2 had with an area under the ROC of 0.854, coupled with a sensitivity of 84.6%, specificity of 77.9%, a positive predictive value of 0.66, and a negative predictive value of 0.90 (Figure 3).

The analysis also revealed differences in laboratory parameters between patients with and without ROSC, where PCO_2 (p=0.002), sodium (p=0.022), and hematocrit (p=0.003) showed statistical significance, while potassium (p=0.217), chloride (p=0.941), total carbon dioxide content (p=0.078), anion gap (p=0.545), anion gap corrected for potassium (p=0.279), hemoglobin (p=0.091), glucose (p=0.633), and lactate (p=0.178) showed no significant difference. And in patient who achieved sustained ROSC, hematocrit (p=0.006), and PCO_2 (p=0.010) showed some significance.

Out of 116 patients, only 12 patients (10.3%) survived at time of hospital discharge, 104 (89.6%) patients did not survive till hospital discharge (Table 1). The mean SWAP score in patients who survived to hospital discharge was 1.58.

Neurological status was assessed at time of hospital discharge using CPC score (Table 1). Good neurological outcome was patients with CPC score 1 and 2, poor neurologic outcome was CPC score 3, 4, 5 and mortality. In our study, out of the total 116 patients, 7 (6.03%) achieved a good neurological outcome (CPC 1 and 2), while 109 (93.96%) had a poor neurological outcome (CPC 3, 4, 5, or mortality) (Table 1).

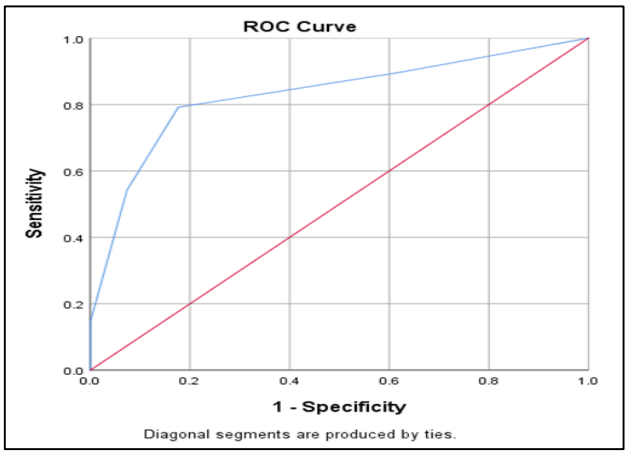

Figure 2: ROC of sensitivity and specificity of SWAP score to predict ROSC.

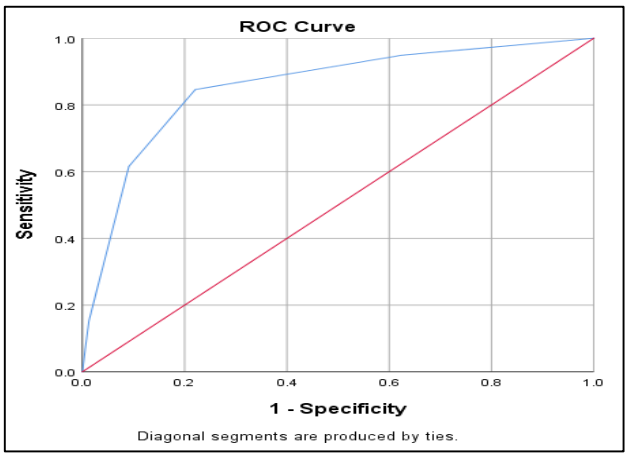

Figure 3: ROC of sensitivity and specificity of SWAP score to predict survival.

Table 1: Summary of patient survival and neurologic outcomes of OHCA at time of hospital discharge.

Variables	N	Percentage (%)
Survival status		
No survival	104	89.6
Survival	12	10.3
Total	116	100
Neurological status		
CPC 1	3	25
CPC 2	4	33.3
CPC 3	4	33.3
CPC 4	1	8.3
CPC 5	0	0
Total	12	100
Neurologic outcome		
Favorable (CPC 1 and 2)	7	6.03
Unfavorable (CPC 3, 4, 5 or mortality)	109	93.96
Total	116	100

DISCUSSION

The study population had an average age of 62.85 years, with a standard deviation of 12.25. In line with findings from the CARES study, 61.1% of cases occurred in males, and the average age at the time of cardiac arrest was 64.0 years, with a standard deviation of 18.2.[6] Another investigation by Devia et al reported a mean age of 71 years, with 65.8% of the subjects being males.[7] These demographic characteristics, specifically the distribution of sex and age, closely mirror those observed in other studies, thus establishing this study group's comparability with cohorts reported in the existing literature.

In our study, the majority of patients had multiple comorbidities, with diabetes mellitus being the most common, followed by coronary artery disease and hypertension. In a study by Hirlekar et al they observed that the most frequent comorbidity among OHCA was congestive cardiac failure, followed by myocardial infarction and uncomplicated diabetes. Additionally, in their study, 68% of patients were male, and average age was 72 years.[8]

Evaluation the initial cardiac rhythms of OHCA patients in our study, revealing that the most prevailing rhythm was a non-shockable one with asystole in 70 patients (60.3%), followed by ventricular tachycardia (22.9%), ventricular fibrillation (13.8%), and pulseless electrical activity (3.4%). In a study conducted by Devia et al they identified the most frequent initial rhythm as asystole (33%), while the least common was ventricular fibrillation/ventricular tachycardia.[7] The observation that asystole was the most prevalent initial cardiac rhythm among OHCA patients is highly relevant as it provides critical insights for clinical practice and research. It informs healthcare providers and emergency responders about the predominant rhythm they are likely to encounter, guiding their immediate treatment decisions and emphasizing the importance of effective CPR and appropriate medication interventions for non-shockable rhythms.

During our study, we noticed that patients who did not receive bystander CPR had a significantly lower rate of attaining ROSC, with only 67.3% achieving it. On the other hand, patients who received bystander CPR, 88.9% attaining ROSC and among them 33.6% of them had achieved sustained ROSC. The life-saving potential of bystander CPR in improving the rate of ROSC and, by extension, the chances of survival for OHCA patients is re-affirmed in our study. It echoes the need for widespread CPR education and training to empower bystanders to take immediate action during cardiac emergencies.

For patients who survived until hospital discharge, the mean SWAP score was 1.58. In a study conducted by Shih et al they observed that a SWAP score of 4 was 97.14% specific for an unfavorable outcome. Conversely, a SWAP score of zero had a 25-50% chance of survival with a good neurologic outcome.[5] Consistent with the findings of the study conducted by Shih et al., where 11% of patients exhibited a favorable neurological outcome (CPC 1 and 2), and 95.89% experienced an unfavorable neurological outcome (CPC 3, 4, 5, or mortality), our results similarly indicated a 6% favorable outcome, with 93.96% of patients displaying an unfavorable outcome.[5]

The venous blood gas analyses yielded a set of diverse parameters, which were subsequently examined for their relationship with both ROSC and sustained ROSC. In a study conducted by Spindelboeck et al they found that the admission paO_2 value was statistically significant to predict ROSC as well.[9] In a study conducted by Shin et al pH and potassium levels were significantly associated with survival to hospital discharge, and pH has significantly associated with neurologic recovery. In patients with a poor outcome, the average values of pH, pO_2, and base excess were lower compared to those in the good outcome group.[5] Among the other variables analyzed in blood gas analyses, only pCO_2 level demonstrated an association with sustained return of spontaneous circulation.[10]

In our study, among these lab parameters, the pCO_2 level, serum sodium level, and hematocrit value exhibited statistical significance concerning ROSC and hematocrit value and pCO_2 level had statistical significance with patients achieving sustained ROSC.

The significance of the observation lies in the identification of specific laboratory parameters that have a statistical association with different aspects of patient outcomes following cardiac arrest, such as sustained ROSC, survival to hospital discharge and neurologic recovery. These findings suggest that monitoring and

managing these particular lab parameters may be crucial in the post-cardiac arrest care of patients.

Limitations

The study was conducted in a single tertiary care center, which might limit the generalizability of the findings to other healthcare settings with different patient populations, resources, and protocols. The study included a relatively small sample size, which could affect the statistical power and precision of the results. Consecutive inclusion of cases might introduce selection bias, as cases that met the inclusion criteria might still not be fully representative of the entire population of OHCAs. The predefined exclusion criteria could have omitted certain relevant cases, potentially affecting the comprehensive understanding of OHCA situations. The accuracy of data depends on the quality of medical records and documentation, which can vary and impact the reliability of the results.

CONCLUSION

The study's findings indicated that despite prompt resuscitation efforts following established guidelines, the survival rate to hospital discharge for OHCA patients remained low, with only 10.3% of patients surviving. Neurological status, assessed using the CPC score, demonstrated poor outcomes for the majority of patients who survived until discharge. A SWAP score of less than 2 seems to be a good indicator for predicting ROSC and sustained ROSC, with higher sensitivity for sustained ROSC. Lack of adequate prehospital care as evidenced by delayed CPR and shocking as well as poor awareness among the public about the importance of bystander CPR may be the reasons for poor outcome in OHCA victims.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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