

Pre-operative pH is a predictor of 30-day mortality in patients undergoing open repair of ruptured abdominal aortic aneurysm

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Abstract

There are multiple patient characteristics that are associated with mortality following ruptured and abdominal aortic aneurysm (AAA) repair. The use of available objective tests, such as pH, within validated assessment tools to predict mortality in patients with ruptured AAA pre-operatively remains unutilised. This study aims to examine whether pH is an appropriate pre-operative marker of mortality in patients presenting with ruptured AAA and undergoing open repair. 77 patients with ruptured AAA were included over a 9 year period and their lowest pre-operative serum pH reading recorded. There was a significant relationship between lowest measured pH and 30-day mortality. For each 0.01 decrease in lowest pH, the odds of a 30-day mortality increase by 5%. Consideration should be given to including pre-operative serum pH in future studies attempting to more accurately design scoring systems for mortality and morbidity risk in patients with ruptured abdominal aortic aneurysm.

Keywords: abdominal; aneurysm; aorta; rupture; mortality

Introduction

Mortality from a ruptured abdominal aortic aneurysm (AAA) has been slowly decreasing over the last 4 decades. However, it still remains close to 80% [1]. Up to 50% of ruptured AAA die before hospital and of those who make it to hospital, a difficult decision of who to offer surgical intervention to remains. Judicious treatment relies on a rapid assessment of a critically unwell patient with varied levels of background medical history.

Initial management strategies prior to surgery are well-described, as are intraoperative approaches and considerations [2]. A ruptured AAA commonly presents with hypotension and this can quickly progress to hypovolemic shock. Total body hypoperfusion seen in shock associated with ruptured AAA causes an anaerobic state and a change in the acid-base status of the body. With the increasing prevalence of point of care testing of blood in peripheral centres in Australia [3], most critically ill patients, including those with ruptured AAA, undergo an assessment of acid-base status.

Previous studies have shown both positive and negative associations of pH in critically ill patients with mortality. This has included trauma [4], vascular injury [5], and out-of-hospital cardiac arrests [6]. A retrospective study in AAA repair has shown that lactate and base deficit tested post-operatively are good predictors of survival following ruptured AAA repair [7]. One study [8] from the USA in 2018 recorded pre-operative pH measurements of less than 7.2 in patients with ruptured AAA but this

included patients treated with Endovascular Aneurysm Repair (EVAR) and did not analyse the range of pH scores and how they may stratify mortality risk. Pre-operative pH measurement has not been thoroughly analysed in patients who undergo open repair of ruptured AAA (regardless of survival perioperatively).

There are multiple patient characteristics that are associated with mortality following ruptured and elective AAA repair. These have been collated into validated assessment tools used pre-operatively worldwide such as the Glasgow Aneurysm Score [9]. However, the use of available objective tests, such as pH, within these tools pre-operatively remains unutilised. This study aims to examine whether pH is an appropriate pre-operative marker of mortality in patients presenting with ruptured AAA and undergoing open repair. Often the pH reading is included in the assessment to determine suitability for surgery by clinicians, but its association with mortality has not been objectively tested in this cohort of patients.

Methods

This study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and prior approval by the institutions human research committee has been obtained.

Using the Operating Room Management Information System (ORMIS) database at this institution, a search for patients who underwent emergency surgical repair between January 1st 2011 and December 31st

2019 (9 years) for ruptured abdominal aortic aneurysms captured all potential patients for inclusion in this retrospective cohort study. Further scrutiny of these individual cases identified those who underwent open repair of a ruptured native, non-infected, abdominal aortic aneurysm. Patients with symptomatic AAAs, infected/mycotic AAAs, and those who had previously undergone abdominal aortic surgery were excluded. Patients who underwent Endovascular Abdominal Aortic Aneurysm Repair (EVAR) were also excluded. A simple review of the Auslab Pathology software system was undertaken, with the lowest serum pH reading (arterial or venous blood) recorded.

Cohort characteristics (age at rupture and gender) were reported overall (n%) and mean (SD)) and compared between the 30-Day mortality groups using a χ^2 tests of independence and a two-sample t-test respectively. The lowest pH was reported overall and between the two groups using median (IQR) as the data was skewed, and was compared between the 30-day

mortality groups using a Mann-Whitney U test. To further investigate the effect of lowest pH value on the 30-day outcome, logistic regression was performed with an odds ratio (OR) calculated for 30-day mortality for each 0.01 increase in lowest pH. Statistical significance was set at $p < 0.05$. All analyses were performed in Stata version 15 (StataCorp, College Station, TX, U.S.A.).

Results

Following the exclusion process, a total of 77 patients were included in the study, with the vast majority (89.6%) being male. The average age of patients undergoing surgery was 72.0 and the average pre-operative serum pH level was 7.24. Table 1 presents the descriptive statistics and comparisons for the cohort characteristics (gender and age) and the lowest pre-operative serum pH. There was no significant difference in age or gender between the 30-day mortality groups. Patients with a 30-day mortality had a significantly lower "lowest pH" ($p=0.011$).

	Overall (n=77)	30 Day Mortality		P-value
		Yes: 19 (24.7%)	No: 58 (75.32%)	
Cohort characteristics				
Gender (Male), n(%)	69 (89.6%)	53 (91.2%)	16 (84.2%)	0.37
Age, Mean (SD)	72.0 (6.7)	73.1 (6.1)	71.6 (6.9)	0.42
Lowest pH				
Lowest pH, Median (IQR)	7.24 (7.15-7.33)	7.15 (6.98-7.32)	7.26 (7.16-7.33)	0.011

Table 1. Comparison of cohort characteristics and lowest pH level between patients with and without 30 day mortality

The outcome of the logistic regression is given in Table 2. For each 0.01 increase in "lowest pH", the odds of having a 30-day mortality reduces

0.95 (95% CI: 0.92-0.99). This can also be interpreted as; for each 0.01 decrease in lowest pH, the odds of 30-day mortality increases by 5%.

Model (n=77)	Odds Ratio	P-value	Log-likelihood
	(95% CI)		
Lowest pH (0.01 interval)	0.95 (0.92 – 0.99)	0.005	-38.55

Table 2. Logistic regression model for GAS as a risk factor for post-operative mortality.

Discussion

There is a significant relationship between lowest measured pH and 30-day mortality. For each 0.01 decrease in lowest pH, the odds of a 30-day mortality increase by 5%. The utility of measuring pre-operative pH in critically unwell patients with ruptured abdominal aortic aneurysm has merit. Whilst it may be primarily used by intensivists, anaesthetists and emergency physicians in the pre-operative and intraoperative care phase for these patients, it certainly provides objective information about mortality risk for the decision-making surgeon. Consideration should be given to including pre-operative serum pH in future studies attempting to more accurately design scoring systems for mortality and morbidity risk in patients with ruptured abdominal aortic aneurysm.

Conclusion

This study demonstrates the utility of pre-operative serum pH measurement as a part of the decision-making assessment process in this critically unwell patient cohort. Scoring systems to predict mortality and morbidity are becoming increasingly detailed and accurate, and so the utilisation of this parameter in future assessment tools should be paramount.

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