

Shock index: Easy to use, but can it predict outcomes following major abdominal emergency surgery?

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Major abdominal emergency surgery (MAES) is commonly performed for various potentially life-threatening intra-abdominal surgical conditions with high perioperative mortality of up to 45%.¹ Certain patient factors (e.g. advanced age, frailty, and presence of multiple comorbidities) and disease factors (e.g. perforated viscus and intra-abdominal sepsis) have been shown to predict higher post-operative complications and mortality following MAES.² Pre-operative risk stratification scores, such as the Portsmouth-Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (P-POSSUM) and National Emergency Laparotomy Audit (NELA) score, have also been developed to assist clinicians and/or surgeons in decision making and patient counselling. While these scoring systems have been widely studied and validated in patients of various demographics,³ they require input of multiple variables which may be cumbersome, especially in the emergency setting. Simple bedside scoring systems remain attractive for quick risk stratification and guidance of subsequent management.

The shock index (SI) is a quickly calculated score derived from easily obtained vital parameters, defined as heart rate (HR) divided by systolic blood pressure (SBP). The SI was initially created in 1967 by Allgöwer and Burri to measure severity of shock,⁴ but its use has been expanded to the prediction of the need for transfusion and mortality in trauma, risk of ectopic pregnancy rupture, haemodynamic response in sepsis, and in-hospital mortality in acute coronary syndrome.⁵ However, literature on its use in MAES remains scarce. The recent retrospective propensity-score-matched (PSM) study by Loh et al. adds value to the lacuna in current literature on the clinical utility of SI in patients undergoing MAES.⁶ Loh et al. retrospectively reviewed 212,089 patients who underwent MAES (defined as exploratory laparotomy for perforated viscus, soiled abdomen or with an infected appendix or gallbladder) across an 8-year period. PSM

was performed (matched for gender, operative risk and presence of end-stage renal failure [ESRF]) in the ratio of 1:8, resulting in 3980 patients (SI>0.9: n=439, SI≤0.9: n=3521).⁶ The authors demonstrated that SI>0.9 was independently associated with higher 1-month mortality (odds ratio [OR] 3.51; 95% confidence interval [CI] 1.38, 2.25; $P<0.021$), 3-month mortality (OR 3.05; 95% CI 1.07, 8.54; $P=0.034$), post-operative intensive care unit (ICU) admission (OR 2.72; 95% CI 1.03, 7.25; $P=0.043$) and acute kidney injury (AKI) (OR 3.39; 95% CI 2.35, 4.87; $P<0.001$). In light of new evidence, this editorial will re-explore the utility of SI in the prognostication of outcomes following MAES and will discuss about 3 main points: (1) timing of calculation of SI, (2) cut-off value of SI, and (3) confounding factors in their study which limits the interpretability of results.

First, while the definition of SI is clear and easily obtained, it is important to standardise the timing of calculation of SI. In the study by Loh et al.,⁶ SI was defined as the first HR and SBP recorded in the anaesthesia chart, i.e. pre-operatively before induction of anaesthesia. This raises an important question about when SI should be calculated. Should SI be calculated based on the vitals taken on admission, following initial resuscitation, or just prior to induction as per the authors' study? Majority of existing studies evaluating the use of SI centres around the management of acute conditions, where most do not require surgical intervention except for trauma.⁵ Hence, these studies do not face the challenge of deciding when should be the appropriate time point used to calculate SI. To our knowledge, the study by Loh et al. is the first to evaluate the use of SI to predict post-operative outcomes following MAES.⁶ Kosola et al. retrospectively evaluated the use of SI in patients who underwent emergency laparotomy in 100 blunt abdominal trauma patients; patients who required complex skills (defined as need for organ-specific subspecialty surgeon) had higher SI (mean 1.43 vs 0.95, $P=0.012$) compared to those who did not require complex skills.⁷ However, SI was measured on admission for their study.

The definition of SI was similar for studies evaluating the utility of SI for other conditions; for instance, the study by Al Aseri et al. evaluating the use of SI to predict haemodynamic collapse in patients who presented with hypotension had defined SI based on the vitals obtained on triage in the emergency department.⁸ This concept of using parameters obtained on admission also applies for other scoring systems, such as the Glasgow-Imrie

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score for acute pancreatitis, Boey score for perforated peptic ulcer and Tokyo Guidelines for acute cholecystitis and acute cholangitis. It is likely that scoring systems use initial variables obtained to better reflect the clinical status of the patient. Hence, the choice of timing for calculation of SI used by Loh et al. is interesting. In their cohort of patients who underwent MAES for perforated/soiled abdomen, patients may be haemodynamically unstable and require resuscitation prior to transfer to surgery. Normal SI just prior to induction may suggest response to initial resuscitation and imply better intra-operative and postoperative outcomes. Clinicians should always ensure that patients are adequately resuscitated before bringing them to surgery, unless the surgery is critical for haemodynamic support, such as in the instance of ruptured aortic aneurysm. Perioperative hypotension, which reflects lack of adequate resuscitation, has been associated with intra-operative hypotension and postoperative complications, such as AKI.⁹ Trend of haemodynamics and SI (i.e. delta SI) may instead reflect better on the prognosis of patients, as this reflects the physiologic response to resuscitation. Hosseinpour et al. however showed that SI measured in the emergency department (ED) outperforms delta SI (defined as change in SI from prehospital to ED) in prediction of mortality (area under curve [AUC] 0.86 vs 0.60) for trauma.¹⁰

Second, while the dichotomisation of a continuous variable (i.e. SI in this context) is a simple way to categorise patients into two groups and compare outcomes between the groups, care must be taken on the choice of cut-off value used. In the study by Loh et al., a cut-off value of 0.9 was used.⁶ While the normal range of SI is reported to be 0.5 to 0.7, an upper limit of up to 0.9 is also acceptable.⁵ The cut-off for SI used in the study by Loh et al. is reasonable. Subsequent studies evaluating the use of SI in MAES may consider calculating the AUC for the receiver operating characteristic curves for various cut-offs for SI. The cut-off value with highest AUC should then be used to dichotomise patients into two groups.

The authors also used PSM to balance covariates, which reduces bias in a retrospective study. Gender, operative risk and incidence of ESRF were matched for. However, despite PSM, patient demographics were statistically significantly different between the two groups. For instance, patients with SI>0.9 were younger (mean age 53 vs 57), had different cardiac risk profiles and higher incidence of American Society of Anesthesiologists score 3–5 (49% vs 33%). Additionally, despite matching for ESRF, patients with SI>0.9 still had higher incidence of ESRF (5.9% vs 3.3%). Higher post-operative mortality and need

for ICU admission following MAES in patients with SI>0.9 may be confounded by advanced age and worse comorbidities. The findings obtained by the authors therefore need to be validated in prospective studies, or at least in patient groups with comparable demographics to reduce the effect of confounding factors.

In conclusion, the large retrospective PSM study by Loh et al. adds valuable literature to the use of SI in MAES which has not been previously evaluated.⁶ This remains an attractive easy-to-use triage and scoring system to predict post-operative outcomes. This may be used to identify high-risk patient groups and triage for urgency of surgery, as well as post-operative clinical pathways for enhanced recovery. However, the clinical utility of SI remains to be validated with more large-scale prospective studies and/or PSM studies, with the need to standardise the cut-off value and timing of calculation of SI.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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