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EFFICACY OF SHOCK INDEX AND MODIFIED SHOCK INDEX AS PREDICTOR OF POST-INTUBATION HYPOTENSION IN CRITICALLY ILL PATIENTS PRESENTING IN ED

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ABSTRACT

Objective: To assess the predictive capability of pre-intubation shock index (SI) and modified shock index (MSI) in predicting post-intubation hypotension in critically ill patients who were seen in the emergency department.
Study Design: Cross-sectional study.
Place and Duration: Adult Emergency Department, Indus Hospital and Health Network, Karachi from January 2026 to June 2026.
Methodology: A total of 96 critically ill adult patients who need emergency endotracheal intubation. Pre-intubation SI (Heart Rate/Systolic Blood pressure) & MSI (heart rate/mean arterial blood pressure) were calculated. Post-intubation hypotension (PIH) was defined as a decrease in the SBP to 90 mmHg or less (≥20% decrease from baseline measured within 30 min after intubation). Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) and diagnostic accuracy of SI (greater than 1) and MSI (greater than 1.3) were derived with a reference outcome of PIH. The collected data were analysed in SPSS (26).
Results: The overall mean age category was adult (14 years and above) and the likelihood was higher for males (60.4%). 32 patients (33.3%) developed post intubation hypotension. Shock index at a cut-off > 1, had a sensitivity of 56.2%, a specificity of 79.7%, PPV of 58.1%, NPV of 78.5 % and a diagnostic accuracy of 71.9 % when compared to endpoints. Modified shock index had a sensitivity of 53.1%, specificity of 67.2%, PPV of 44.7%, NPV of 74.1% and diagnostic accuracy of 62.5% at a cut-off >1.3.
Conclusions: Pre-intubation shock index was more overall diagnostic accurate and more specific than modified shock index for prediction of post-intubation hypotension. Both are simple bedside measures that can be quickly calculated and can aid in risk stratifying critically ill patients before intubation, but have only limited sensitivity, which makes them poor, stand-alone predictors.

KEYWORDS: Shock index, Modified shock index, Post-intubation hypotension, Emergency department, Endotracheal intubation, Critically.

INTRODUCTION

The traditional vital signs, including the heart rate, blood pressure and respiratory rate, is not a reliable indicator of the effects of critical illness and trauma [1]. The shock index (SI) as the ratio of heart rate to systolic blood pressure and the modified shock index (MSI), the ratio of heart rate to mean arterial blood pressure have been shown to more effectively predict outcome in both traumatic and non-traumatic patients who present to the emergency department (ED). [2,3] Shock index is a parameter that has been clinically utilised to assess the severity of hypovolaemic and non-hypovolaemic shock – with a normal range of between 0.5 and 0.9, and with an MSI < 1.3 described as a powerful predictor of mortality [4,5].

Rapid sequence intubation is often used to avoid emergency scenarios and considered the standard approach to emergency airway management. Post-intubation hypotension (PIH) is a common, life-threatening post-intubation complication and has been defined as a drop in systolic blood pressure (SBP) < 90 mmHg or a 20% fall from baseline or both within 30 minutes of intubation [6]. Around 25% of patients intubated in the ED develop PIH and this is linked to poor outcomes such as raised mortality [7]. The mechanisms are complex, involving the loss of adrenergic tone caused by sedative/paralyzing agents, increased intrathoracic pressure from positive pressure ventilation and the direct effect on the cardiovascular system by induction drugs [8].

If patients who are at risk of PIH can be identified early on, pre-emptive haemodynamic optimization may occur and could lead to a reduction in peri-intubation morbidity [9]. SI and MSI have the potential to be good candidate

predictors as both can be easily calculated at the bedside with vital signs alone and are very easy to calculate typically, without the need for laboratory investigations or specialized equipment/measurements [10]. International studies have shown validity of these indices for prediction of PIH; however local evidence for its validity is limited in the emergency setting of Pakistan [11,12]. Therefore to evaluate the predictive value of pre-intubation SI and MSI for prediction of post-intubations hypotension in critical illness in the ED of a tertiary care hospital, Karachi this study was undertaken.

MATERIALS AND METHODS

Study Setting and Design

A cross-sectional study was carried out in the Adult Emergency Department of The Indus Hospital and Health Network (IHHN), Karachi, from January 2026 to June 2026. The study selected the critically ill adult patients who met the inclusion criteria for the emergency insertion of the endotracheal intubation consecutively after receiving written informed consent from the attendants under the principal investigator's guidance.

Ethical Approval

The study was conducted after approval from the Institutional Review Board of Indus Hospital and Health Network (IRB approval number: IHHN_IRB_2024_08_006) and the Research Evaluation Unit (REU), College of Physicians and Surgeons Pakistan (Reference No: CPSP/REU/EMD-2022-218-298, dated 5th July 2024). All participants or their attendants signed a written informed consent form prior to enrolment in the study, and patient data were kept strictly confidential throughout.

Sample Size and Sampling Technique

Sample size was determined with Open Epi software based on the prevalence of post-intubation hypotension in the ED (47%), precision (7.5%) and 95% confidence. In the current study, consecutive sampling with non-probability method was used to enroll 96 patients.

Inclusion Criteria

- All adult patients of age group 18-65 years.
- Patients who are Full code, and have a signed Full code consent form for Emergency Department care.
- Intubated patients in the Emergency Department with blood pressure measure and pulse.

Exclusion Criteria

- Patients with unmeasurable blood pressure and pulse.
- Patients intubated following cardiopulmonary resuscitation (post-CPR).
- Patients who have a do not resuscitate (DNR) or do not intubate (DNI) order.

Operational Definitions

The shock index (SI) was calculated by the SI = Heart Rate ÷ Systolic Blood Pressure and a value > 1 was used as a cut off for predicting the occurrence of PIH. Modified shock index (MSI) was calculated as the ratio of the heart rate and the mean arterial pressure (MAP) (MAP = diastolic BP + ⅓ Pulse BP), and an MSI > 1.3 was used as the cut-off. Post-intubation hypotension was defined as a reduction in systolic blood pressure 90 mmHg or less (≥20% decrease from baseline measured within 30 min after intubation).

Data Collection Procedure

All patients who met the inclusion criteria were included, and signed informed consent forms obtained. Pre-intervention blood pressure, pulse and mean arterial pressure were taken and pre-intubation SI and MSI calculated. After intubation blood pressure, pulse, intubation support, requirement for CPR and post-intubation indices were documented and the post-intubation hypotension was measured within 30 minutes. The principal investigator collected data on a predesigned proforma which contained information on age, gender, attending physician category, blood pressure, pulse, MAP and occurrence of PIH and maintained the patients' confidential information at all times.

Statistical Analysis

Data were analysed by the SPSS version 26. Continuous data like age, blood pressure, heart rate, Si, MSI were expressed as mean ± SD or median with IQR for skewed data which was tested by Shapiro-Wilk test. Frequencies and percentages were used to present categorical variables: gender, intubating physician category, use of inotropic agents and post-intubation hypotension. Using a 2×2 contingency table, sensitivity, specificity, PPV and NPV as well as diagnostic accuracy of SI and MSI were calculated compared to PIH as a reference outcome. Post-stratification chi-square / Fisher's exact test was used for controlling the effect modifiers after stratification and p value <=0.05 was considered significant.

RESULTS

Ninety-six critically ill, adult patients who received emergency endotracheal intubation were included. There were 58 (60.4%) male patients compared with 38 (39.6%) women. Out of 49 patients (51.0%) were intubated by senior residents, 39 (40.6%) by senior medical officer and 8 (8.3%) by junior residents. Thirty one patients (32.3%) needed inotropic support. 32 patients (33.3%) had hypotension after intubation. Demographic and clinical baseline values are shown in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n=96).

Variable	Frequency	Percentage
Male gender	58	60.4%
Female gender	38	39.6%
Intubation by senior resident	49	51.0%
Intubation by senior medical officer	39	40.6%
Intubation by junior resident	8	8.3%
Inotropic support used	31	32.3%
Post-intubation hypotension (PIH)	32	33.3%

Taking post-intubation hypotension as the reference outcome, the diagnostic performance of pre-intubation SI (cut-off greater than 1) and MSI (cut-off greater than 1.3) was determined. Shock index demonstrated a sensitivity of 56.2%, specificity of 79.7%, PPV of 58.1%, NPV of 78.5% and overall diagnostic accuracy of 71.9%. The sensitivity of modified shock index was 53.1%, specificity 67.2%, PPV 44.7%, NPV 74.1% and diagnostic accuracy of 62.5%. This information is reported in Table 2 and graphically displayed in Figure 1.

Table 2: Diagnostic Accuracy of Shock Index and Modified Shock Index for Predicting Post-Intubation Hypotension (n=96).

Parameter	Shock Index (SI >1)	Modified Shock Index (MSI >1.3)
True Positive	18	17
False Positive	13	21
False Negative	14	15
True Negative	51	43
Sensitivity	56.2%	53.1%
Specificity	79.7%	67.2%
Positive Predictive Value	58.1%	44.7%
Negative Predictive Value	78.5%	74.1%
Diagnostic Accuracy	71.9%	62.5%

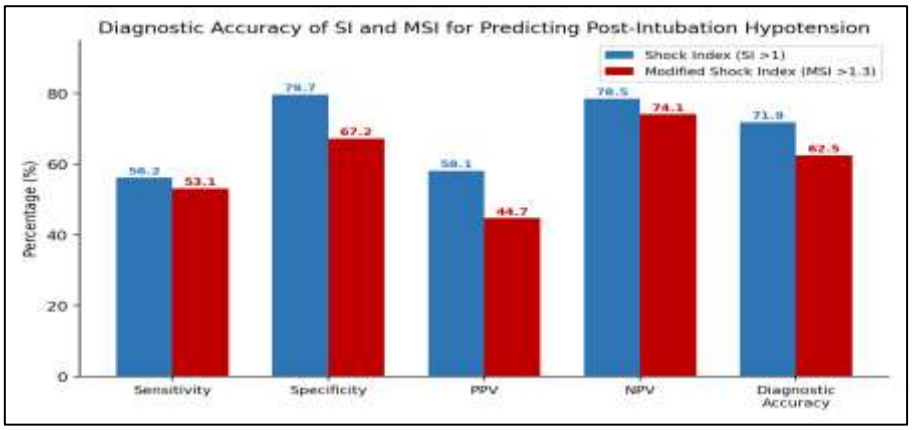

Figure 1. Diagnostic Accuracy Parameters of Shock Index and Modified Shock Index for Predicting Post-Intubation Hypotension.

DISCUSSION

In this cross sectional study of 96 critically ill patients undergoing emergency intubation, post intubation hypotension was present in 33.3% of patients and pre intubation shock index had better overall diagnostic accuracy (71.9%) as well as specificity (79.7%) compared to modified shock index (62.5% and 67.2% respectively) in predicting this complication. The observed incidence of PIH (33.3%) is in agreement with the pooled incidence of PIH in the international setting and with the range reported in emergency department studies (0.5%–44%) [7,10]. Heffner et al. reported 22% PIH in 300 intubated patients, which was generally similar to the present study after making adjustments for differences in case-mix and severity of illness [7].

The higher specificity and diagnostic accuracy of SI than MSI found on this study suggest that a pre-intubation SI > 1 is a better rule-in for predicting PIH in this patient population. However, this is in contrast to the results of Trivedi et al. who assessed pre-intubation SI and MSI in 417 patients and found both indices to be similar in identifying post-intubation hypotension [2]. This discrepancy might be explained by differences in patient population, the high proportion of non-traumatic critical ill patients in this present emergency group, and differences in the choice of drug and resuscitation in both the settings [3]. A recent review by Althunayyan reiterated the current evidence and concluded that shock index is useful to predict post intubation hypotension or cardiac arrest and should be used as part of pre intubation risk assessment [3].

The not insignificant values of the sensitivity of both indices (56.2% for SI and 53.1% for MSI) is a key point: there was a large proportion of patients who developed PIH who would not be identified, were they to be identified individually by either index. However, this limitation has been emphasized by Koch et al. who had noted that the shock index, used in emergency department, can be used in conjunction with clinical judgment and other haemodynamic indicators but should be not used by itself [12]. Low negative predictive values (78.5% for SI and 74.1% for MSI) still indicate that a normal pre-intubation predictive index offers fairly good reassurance that the post-intubation hypotension will not be severe [13].

From a clinical and health-systems perspective, adding SI and MSI to the pre-intubation checklist in busy EDs like IHHN is an easily deployable and cost-free strategy of identifying high-risk patients for whom pre-emptive fluid resuscitation, careful induction agent choice, and availability of vasopressor may help reduce risk of PIH [9,11]. In a nested case control study, Smischney et al. found that pre-intubation haemodynamic elevated heart rate and a high shock index were the most significant haemodynamic parameter associated with pre-intubation instability, recommended structured haemodynamic optimization-including fluid resuscitation and vasopressor readiness-prior to emergency airway control [15].The incidence of peri-intubation haemodynamic instability requiring inotropic support in 32.3% of this population highlights the burden of this problem in clinical practice and continually reminds the value of any easy bedside tool that can lead to earlier intervention for preventing such instability [8].

Limitations of Study

This was carried out at one tertiary ED and may not apply to other settings. Power is limited because of the cross sectional design and small sample size, and cannot be adjusted for factors such as induction agent, comorbidity load and baseline volume status. Post intubation hypotension was only measured in the first 30 minutes and longer-term outcomes of haemodynamics and survival were not evaluated. Both indices have a relatively low sensitivity and cannot be used as screening tools alone. We suggest it is worthwhile to further explore the role of SI and MSI in this area with multi-centre studies and better adjustment for induction and resuscitation variables in future.

CONCLUSION

The overall diagnostic accuracy and specificity of pre-intubation shock index was superior to the modified shock index in predicting hypotension post-intubation in emergency department critically ill patients. Both are simple bedside tests, are quickly calculated, and are free of cost which could be used by emergency physicians to risk stratify patients before an emergency intubation. The sensitivity is however not high and should be complemented with, and not taken as a substitute for, clinical judgement and a raised index should trigger pre-emptive haemodynamic optimization prior to intubation.

CONFLICT OF INTEREST

None.

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