Original Research Article

Impact of Optimizing Critical Care Resources in Pediatric Surgery Patients

Abstract

Background: Prediction scores could help to timely identify patients at risk. More intense care monitoring outside the pediatric intensive care unit (PICU) could improve outcomes. These concepts of critical care without borders could be implemented shortly with local resources and improve patient safety. Predict more, do less in PICUs, and more in the ward.

Aim: The aim of this work was to evaluate the impact of prediction scores for identification of postoperative high risk surgical patients and their need for pediatric intensive care unit admission.

Methods: This prospective study was carried out on 40 pediatric patients. The studied patients were divided into three groups. LR Group: 14 cases with ASA = 1, 2 PEWS ≤ 2, pSOFA ≤ 7, LqSOFA < 2. IR Group: 10 cases with PEWS = 3, 4 pSOFA = 8 -11 HiR Group: 16 cases with ASA = 3 -5, PEWS ≥ 5, pSOFA ≥ 12, LqSOFA ≥ 2. American Society of Anaesthesiologists (ASA) scoring was obtained from each patient preop.

Results: Regarding prognostic performance of different scores to predict mortality. For ASA score: it was statistically significant with AUC = .882, cut off values > 3, sensitivity = 75%, specificity = 88.89%, PPV = 42.9% and NPV = 97%. -For PEW score: it was statistically significant with AUC = .892, cut off values > 5, sensitivity = 79%, specificity = 80.56%, PPV =30% and NPV = 96.7%. -For pSOFA score: it was statistically significant with AUC = .931, cut off values > 14, sensitivity = 85%, specificity = 86.11%, PPV =37.5%, and NPV = 96.9%. All ASA, PEW, and pSOFA were statistically significant as univariate but none was significant as multivariate.

Conclusions: Decreased platelets and increased WBCs, urea, creatinine, AST, and RBG were significant with HiR. LqSOFA is a simple variable bedside tool for identifying septic patients at high risk for poor outcomes.

Keywords: Pediatric Surgery, Critical Care, Optimizing Resources, American Society of Anaesthesiologists (ASA) score, Pediatric Early Warning (PEWS) Score, Pediatric

Sequential Organ Failure Assessment (pSOFA) Score, Liverpool quick Sequential Organ Failure Assessment (LqSOFA) score

Introduction:

Post-surgery complications continue to be the leading cause of mortality globally, and in many healthcare systems, admission to an intensive care unit (ICU) following major surgery is considered standard of care. However, the resources of a paediatric intensive care unit (PICU) are limited and expensive. However, advancements in surgical and perioperative treatment have shifted the emphasis of postoperative (postop) care to minimise problems and shorten hospital stays. [2] Health services research has been unable to establish a correlation between PICU admission and improved result in several elective major noncardiac surgical procedures. Moreover, post-anaesthesia care units (PACUs), high dependency units (HDUs), or specialist wards with improved nursing care may provide an acceptable alternative to the traditional model of PICU admission for many cases undergoing major surgery. Admission to a paediatric intensive care unit (PICU) has been a standard of treatment for decades following many types of surgery; nevertheless, PICU admission is sometimes arbitrary, driven by local practise or bed availability, and not always practicable in low-income or middle-income nations. As ICU resources are scarce and costly, identifying which patients are most likely to benefit from PICU admission is a critical concern for perioperative care providers. Identifying high-risk patients (HiR), developing strategies for appropriate postoperative placement, either in a paediatric intensive care unit (PICU) or a suitable alternative, and allowing early detection of deteriorating patients are essential for improving outcomes in this group and optimising the use of limited resources. Due to the limited availability and high expense of paediatric intensive care unit (PICU) beds, intermediate-level care has become an attractive option for kids who do not require full PICU support but who might benefit from a higher level of care than is often offered. Mandatory PICU hospitalisation may result in excessive PICU utilisation for postsurgical patients. Three organisational models may be explored as alternatives to the PICU: the intermediate care unit, the PACUS, and intensive care outreach teams. [7]

Management of resources is a major responsibility of PICU leadership. Budgeting is essential for optimising resource usage, preparing for future demands, and monitoring current resource use continuously. Budgeting on a short-term basis involves operational planning, but budgeting on a mid- and long-term basis should emphasise strategy. [8] Managing resources is a vital and ongoing component of the PICU management process. Consequently, regional and local availability of health care services is rarely determined only by logical or objective reasons. The demand for intensive care for the population of the hospital's primary referral region, the existing structure of the local health care system, and the likelihood of change throughout the strategic planning period should be addressed for budgetary considerations. [9]

To maximise critical care resources for surgical kids at high risk of postoperative complications, the treatment approach should involve intensive care and surveillance in paediatric intensive care units (PICUs) and tight monitoring on the ward. [10] Prediction scores might expedite the identification of at-risk patients. Outside of the PICU, more intensive care monitoring might enhance patient outcomes. This notion of critical care without borders might be quickly implemented with local resources, hence enhancing patient safety. Predict more; perform less in intensive care units, and more in the ward. [11]

The objective of this study was to examine the influence of prediction scores on the identification of postoperative high-risk surgical patients and their requirement for admission to a paediatric critical care unit.

Patients and Methods:

This prospective study was carried out on 40 pediatric patients from 2 to 216 months (19 males, 21 females) undergoing surgery and admitted to the pediatric surgery ward and PICU, Tanta University Hospital from December 2020 to December 2021. The study was approved by the Ethics committee of the Faculty of Medicine, Tanta University, Egypt. Written informed consent was obtained from the guardians of all patients included in the study.

The exclusion criteria were brain death and multiple organ dysfunction syndrome.

Cases were divided into 3 groups.

Low-Risk Group (LR): 14 cases with (ASA = 1, 2 - PEWS ≤ 2, pSOFA ≤ 7, LqSOFA < 2.

Intermediate- Risk (IR) Group: 10 cases with (PEWS = 3, 4, pSOFA = 8 -11.

High-Risk Group (HiR): 16 cases with (ASA = 3 -5, PEWS ≥ 5, pSOFA ≥ 12, LqSOFA ≥ 2.

All the studied patients were subjected to the following:

1-Clinical: (a) Detailed history taking with special emphasis on: Demographic data: age, sex, Initial symptoms: date of onset of symptoms and its duration and cause of illness, History of other diseases such as Asthma, CHD, DM, Epilepsy……. etc. (b) -Thorough clinical examination including vital signs with special emphasis on: Vital signs: heart rate, respiratory rate, temperature, Arterial blood pressure, SpO2, GCS. [12]

2-Laboratory investigations: Complete blood count [13], C-reactive protein [14], Arterial blood gases (blood gas analyzer Stat Profile ® pHOx ® Series plus nova biomedical UK: Innovation house Aston Lane South, Runcorn, Cheshire WA7, 3FY, UK) [15]. Random blood glucose [16], Serum sodium-serum potassium [17], Alanine –aminotransferase [17], Aspartate-aminotransferase [18], Blood urea [18], Creatinine clearance [18].

3-Monitoring: (Oxygen saturation, MABP, heart rate, respiratory rate).

4- Scores:

1. American Society of Anaesthesiologists (ASA) scoring was obtained from each patient preop.

2. The Pediatric Early Warning (PEWS) Scoring was obtained from each patient immediately postop.

3. The Pediatric Sequential Organ Failure Assessment (pSOFA). Scoring was obtained from patients admitted to PICU on day 1 and day 7.

4. Liverpool quick Sequential Organ Failure Assessment (LqSOFA) scoring was obtained from all patients on admission.

Statistical analysis

Data were inputted into the computer and analysed using IBM SPSS version 20.0 software programme. (Armonk, New York: IBM Corporation) Quantitative and percentage descriptions were provided for qualitative data. The Kolmogorov-Smirnov test was performed to determine the distribution's normality. Using range (minimum and maximum), mean, standard deviation, and the interquartile test, quantitative data were reported (IQR). Chi-square test (For categorical variables, to compare different groups). Fisher's Exact or Monte Carlo correction Student t-test (For normally distributed quantitative variables, to compare two studied groups). ANOVA with repeated measurements (For normally distributed quantitative variables, to compare between more than two periods or phases, using the Bonferroni-adjusted Post Hoc test for paired comparisons) Test Mann Whitney (For abnormally distributed quantitative variables, to compare two studied groups). Wilcoxon signed rankings examination (For abnormally distributed quantitative variables, to compare two periods). Friedman test (For abnormally distributed quantitative variables, to compare more than two periods or stages; Post Hoc Test (Dunn's) for pairwise comparisons. At the 5% significance level, the acquired findings were deemed significant.

Results:

There was statistically significant decrease in age in HiR compared to LR. Otherwise, there was no significant difference between the studied groups. Table 1

Table 1: Demographic Data of the Studied Groups.

Age (months)	LR (n = 14)	IR (n = 10)	HiR (n = 16)	^{H}p
Median (IQR)	30.0 (14.0 – 60.0)	14.0 (8.0 – 72.0)	6.0 (4.0 – 16.0)	0.017*

Sig. bet. Grps.	p_1=0.446, p_2=0.005*, p_3=0.081	

HiR: high risk, **IR**: intermediate risk, **LR: low** risk **IQR**: Inter quartile range **H**: H for Kruskal Wallis test**,** pairwise comparison bet. each 2 groups were done using **Post Hoc Test** (Dunn's for multiple comparisons test); **p**: p value for comparing between the three studied groups **p_1**: p value for comparing between LR and IR **p_2**: p value for comparing between LR and HiR; **p_3**: p value for comparing between IR and HiR

*: Statistically significant at $p \le 0.05$.

Regarding ASA there was statistically highly significant increase in HiR compared to LR and IR. Otherwise, there was no significant difference between the studied groups. Regarding PEW Score: There was statistically significant increase in IR compared to LR. There was statistically highly significant increase in HiR compared to LR. There was statistically increase in HiR compared to IR. Regarding LqSOFA: There was statistically highly significant increase in HiR compared to LR. There was statistically significant increase in HiR compared to IR. Otherwise, there was no significant difference between the studied groups. There was statistically significant increase in IR compared to LR and significant increase in HiR compared to IR in postop and 7th day postop. There was statistically highly significant increase in HiR compared to LR in postop and 7th day postop. There was statistically significant increase in postop compared to 7th day postop in HiR and IR. Otherwise, there was no significant difference between the studied groups (Table 2).

Table 2: Comparison of Score between the three Studied Groups.

	LR (n = 14)	IR (n= 10)	HiR (n= 16)	^{MC}p
	No. %	**No. %**	**No. %**	
ASA				
Normal healthy patients	8 (57.1%)	2 (20%)	0 (0%)	
Mild systemic disease	5 (35.7%)	3 (30%)	0 (0%)	<0.001*
Sever systemic disease	1 (7.1%)	5 (50%)	6 (37.5%)	
Sever systemic disease that is a constant threat to live	0 (0%)	0 (0%)	10 (62.5%)	
PEW				
Median (IQR)	0.0 (0.0 – 0.0)	3.0 (3.0 – 4.0)	6.50 (5.50 – 7.50)	<0.001*
Sig.bet.Grps	p_1=0.005*, p_2<0.001*, p_3=0.023*			
LqSOFA				
Median (IQR)	0.0(–)	1.0(0.0 – 1.0)	2.0(2.0 – 2.50)	<0.001*
Sig.bet.Grps	p_1=0.051, p_2<0.001*, p_3=0.007*			
pSOFA – Postop				
Mean ± SD	0.14 ± 0.36	8.50 ± 0.71	14.75 ± 2.86	<0.001*
Sig.bet.Grps	p1 = 0.012*, p2 = <0.001*, p3 = 0.005*			
pSOFA - 7th day postop				
Mean ± SD	0.0 ± 0.0	3.20 ± 0.92	12.75 ± 4.73	<0.001*
Sig.bet.Grps	p1 = 0.011*, p2 = <0.001*, p3 = 0.005*			

HiR: high risk, **IR**: intermediate risk, **LR:** low risk, MC: **Monte Carlo**, p: p value for comparing between the studied groups. **LqSOFA:** Liverpool quick sequential organ failure assessment, **PEW:** pediatric Early Warning Score, IQR: **Inter quartile range H**: H for **Kruskal Wallis test,** pairwise comparison bet. each 2 groups were done using **Post Hoc Test (Dunn's for multiple comparisons test),** p: p value for comparing between the **three** studied groups, p_1: p value for comparing between **LR and IR,** p_2: p value for comparing between **LR and HiR,** p_3: p value for comparing between **IR and HiR**

*: Statistically significant at $p \leq 0.05$

There was statistically highly significant increase in HiR patients compared to LR and IR patients. Otherwise, there was no significant difference between the studied groups. There was statistically significant increase in recovery for LR and IR patients compared to HiR patients. Otherwise, there was no significant difference between the studied groups (Table 3).

Table 3: **Comparison of the need for ventilator and outcome between the three Studied Groups.**

		LR (n = 14)		IR (n= 10)		HiR (n= 16)		p
		No.	**%**	**No.**	**%**	**No.**	**%**	
The need for ventilator	No	14	100.0	10	100.0	0	0.0	<0.001*
	Yes	0	0.0	0	0.0	16	100.0	
	Min. – Max.	–		–		4.0 – 37.0		–
	Median (IQR)	–		–		11.0 (7.0 – 19.50)		
Outcome	Recovery	14	100.0	10	100.0	12	75.0	0.053
	Death	0	0.0	0	0.0	4	25.0	

HiR: high risk, **IR**: intermediate risk, **LR:** low risk, P: p value for comparing between the studied groups
*: Statistically significant at $p \le 0.05$

For ASA score: it was statistically significant with AUC = 0.763, cut off values > 3, sensitivity = 57.14%, specificity = 84.21%, PPV = 57.1% and NPV = 84.2%. **For PEW Post score**: it was statistically significant with AUC = 0.838, cut off values > 5, sensitivity = 71.43%, specificity = 73.68%, PPV =50% and NPV = 87.5%. **For pSOFA score**: it was statistically significant with AUC =0 .914, cut off values > 14, sensitivity = 85.71%, specificity = 89.47%, PPV =75%, and NPV = 94.4% (figure 1).

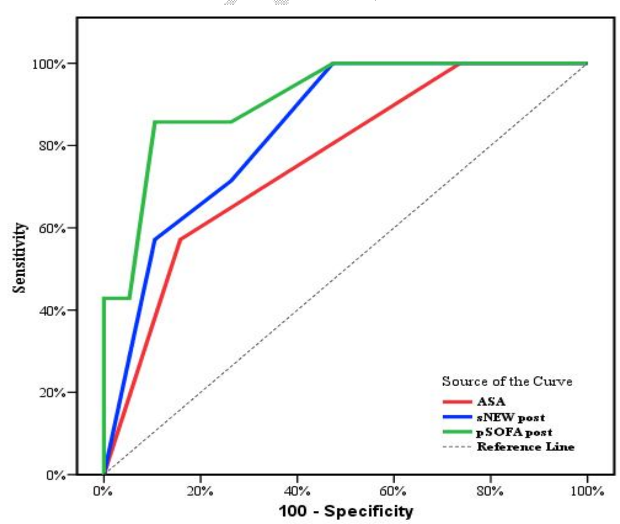

Figure (1): ROC Curve for Different Parameters to Predict Length of Stay (>21days).

ASA: American Society of Anesthesiologists, **PEWS**: Pediatric Early warning Score, **pSOFA:** Pediatric Sequential Organ Failure Assessment Score

ASA, PEW, and pSOFA were statistically significant as univariate variables (Table 4).

Table 4: Univariate and Multivariate Logistic Regression Analysis for the Scores Predicting Length of Stay (>21 days)

	Univariate		#Multivariate	
	P	**OR (LL – UL 95%C.I)**	**p**	**OR (LL – UL 95%C.I)**
ASA	**0.045***	5.995(1.042 – 34.478)	0.879	0.775(0.029 – 20.685)
PEW post	**0.019***	2.461(1.160 – 5.219)	0.193	2.396(0.643 – 8.932)
pSOFA	**0.017***	1.907(1.121 – 3.245)	0.051	1.863(0.998 – 3.479)

OR: Odd`s ratio, C.I: Confidence interval LL: Lower limit UL: Upper Limit
#: All variables with $p<0.05$ was included in the multivariate
*: Statistically significant at $p \leq 0.05$

For ASA score: it was statistically significant with AUC =0.882, cut off values > 3, sensitivity = 75%, specificity = 88.89%, PPV = 42.9% and NPV = 97%. **For PEW score**: it was statistically significant with AUC = 0.892, cut off values > 5, sensitivity = 79%, specificity = 80.56%, PPV =30% and NPV = 96.7%. **For pSOFA score**: it was statistically significant with AUC =0 .931, cut off values > 14, sensitivity = 85%, specificity = 86.11%, PPV =37.5%, and NPV = 96.9% (figure 2).

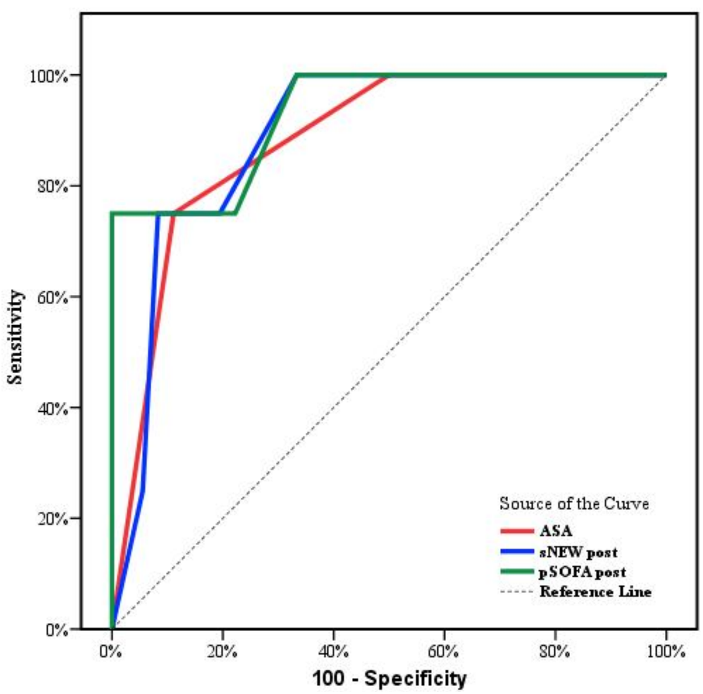

Figure (2): ROC Curve for Different Scores to Predict Mortality.

ASA: American Society of Anesthesiologists **PEWS**: Pediatric Early warning Score **pSOFA:** Pediatric Sequential Organ Failure Assessment Score

ASA, PEW, and pSOFA were statistically significant as univariate but none were significant as multivariate (Table 5)

Table (5): Univariate and Multivariate Logistic Regression Analysis for the Scores Predicting Mortality

	Univariate		#Multivariate	
	P	**OR (LL – UL 95%C. I)**	**p**	**OR (LL – UL 95%C. I)**
ASA	**0.035***	12.070(1.187 – 122.764)	0.599	2.561(0.077 – 85.590)
PEW post	**0.040***	2.339(1.039 – 5.265)	0.291	2.328(0.486 – 11.152)
pSOFA	**0.023***	1.862(1.089 – 3.184)	0.064	1.800(0.966 – 3.354)

OR: Odd`s ratio
C.I: Confidence interval LL: Lower limit UL: Upper Limit
#: All variables with p<0.05 was included in the multivariate
*: Statistically significant at $p \le 0.05$

For ASA score: it was statistically significant with AUC =0.882, cut off values > 3, sensitivity = 75%, specificity = 88.89%, PPV = 42.9% and NPV = 97%. **For PEW score**: it was statistically significant with AUC = 0.892, cut off values > 5, sensitivity = 79%, specificity = 80.56%, PPV =30% and NPV = 96.7%. **For pSOFA score**: it was statistically significant with AUC =0 .931, cut off values > 14, sensitivity = 85%, specificity = 86.11%, PPV =37.5%, and NPV = 96.9% (**Figure 3**)

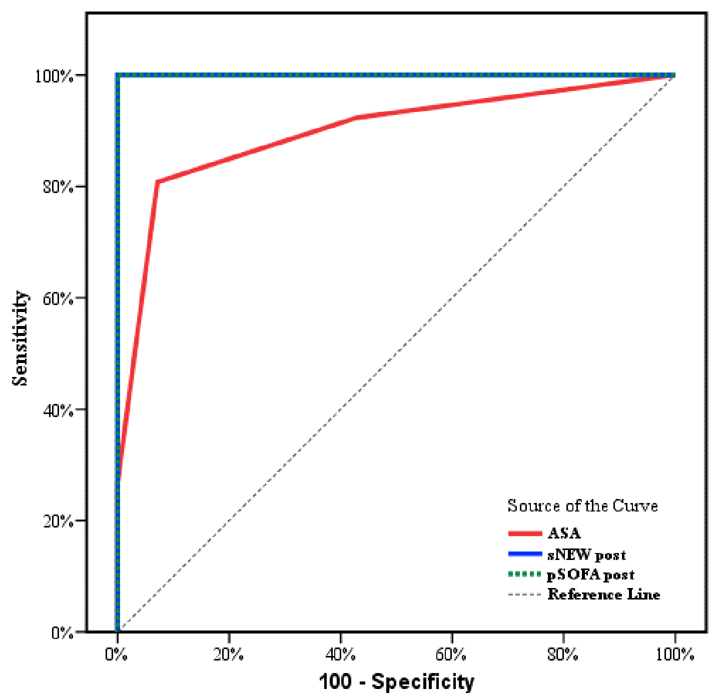

Figure (3): ROC Curve for Different Parameters to Predict PICU Admission Postop.

ASA: American Society of Anesthesiologists **PEWS**: Pediatric Early warning Score **pSOFA:** Pediatric Sequential Organ Failure Assessment Score

ASA, was statistically significant as univariate but none was significant as multivariate.

Table 6: **Univariate and Multivariate Logistic Regression Analysis for the Parameters Affecting PICU Admission Postop**

	Univariate		#Multivariate	
	P	**OR (LL – UL 95%C.I)**	**P**	**OR (LL – UL 95%C.I)**
ASA	**0.001***	7.754(2.421 – 24.832)		
PEW post	**0.995**	–		
pSOFA	**0.996**	–		

OR: Odd`s ratio
C.I: Confidence interval, LL: Lower limit, UL: Upper Limit, #: All variables with $p<0.05$ was included in the multivariate
*: Statistically significant at $p \le 0.05$

Discussion

The major cause of death following surgery is postop complications. A large proportion of admissions to PICUs concern surgical patients following surgery to monitor organ function and treat postop complications. [1] As PICU resources are finite and expensive, we need to define which patients benefit most from postop PICU admission. Preop and postop scores (ASA, PEWS, PSOFA, and LqSOFA) have been proposed to detect high-risk patients who need PICU admission postop. [19] To optimize critical care resources, we can use alternatives to PICU for low and intermediate-risk patients as intermediate care units which provide a location for patients who are potentially low risk for major complications and who require more care than the ward but less than that available in PICU. [20]

The present study showed that PEWS increased in IR compared to LR and showed a high increase in HiR compared to LR. This was in accordance with Solevåg et al., [21] who revealed that PEWS ≥ 3 (IR and HiR) indicate that careful monitoring of the patient is required. Likewise, agreed with Akre et al., [22] who stated that PEWS is sensitive as an early indicator of a patient's deterioration leading to a Rapid Response Team /code event. The present study showed that LqSOFA increased in HiR patients compared to IR patients. As well, showed a high increase in LqSOFA in HiR patients compared to LR patients. This agreed with Minejima et al., [23] who stated LqSOFA is a simple variable bedside tool for identifying septic patients at high risk for poor outcomes. The present study showed that there was an increase in pSOFA in IR patients compared to LR patients, and in HiR patients compared to IR patients in Postop and 7th day postop. Likewise, showed a high increase in pSOFA in HiR patients compared to LR patients. Moreover, showed an increase in pSOFA in postop compared to the 7th day postop in HiR patients compared to IR patients. This agreed with Jain et al., [24] who stated that maximum SOFA indicates the most critical point of time in a patient's stay in the PICU.

The present study showed that there was a high increase in the need for mechanical ventilation in HiR patients compared to LR and IR patients. This agreed with CAN et al., [25] who stated that preop high ASA score was closely related to prolonged mechanical ventilation.

The present study showed an increase in recovery for LR, and IR patients compared to HiR patients. This agreed with Jain et al., [26] who stated that SOFA score on admission has shown a strong correlation with the outcome. Too, agreed with El-Mashad et al., [27] who stated that SOFA score at admission is useful for predicting outcomes in the general PICU population and is more accurate than SIRS for the definition of pediatric sepsis. Besides, agreed with Ramteke et al., [28] who stated that there is a linear trend between the probability of death and the PEWS.

The present study stated that regarding prognostic performance for different scores to predict length of stay (>21 days). This agreed with Garcia et al., [29] who stated that ASA classification proved useful in estimating LOS. Furthermore, this was in accordance with

Song et al., [30] who found that the ASA classification was one of the factors contributing to a prolonged LOS.

Correspondingly, agreed with Shafi et al., [31] who stated that lower PEWS was observed for patients who had short stays in comparison to those requiring longer inpatient cares. Therefore, the PEWS is a useful tool to predict LOS and aid ED physicians to determine disposition.

This also agreed with Mohamed El-Mashad et al., [25]and, Milić Met al., [32] whom both stated that SOFA score was positively correlated to the length of stay in the PICU. Univariate and Multivariate regression analysis predicted that ASA, PEWS, and pSOFA were significant in predicting LOS more than 21 days as univariate predictors, but none of them was significant as multivariate.

The present study stated that ASA, PEWS, and pSOFA were significant as a Crude Odd`s ratio. However, pSOFA was the only significant Adjusted Odd`s ratio. The present study stated that regarding the prognostic performance of different scores to predict mortality. This agreed with Ramteke et al., [26]who stated that PEWS is highly sensitive and specific in predicting mortality. Also, this was in accordance with Hackett et al., [28] who stated that ASA has strong, independent associations with postop medical complications and mortality across procedures. This agreed with Baloch et al., [28] who stated that the pSOFA score is a predictor for 30-day mortality in critically ill children. Univariate and Multivariate predicted that ASA, PEWS, and pSOFA were significant in predicting mortality as univariate predictors but none of them was significant as multivariate.

The present study stated that ASA, PEWS, and pSOFA were significant as a Crude Odd`s ratio. However, none of them was significant as Adjusted Odd`s ratio.

Limitations of study were the relatively small number of studied patients. There were large numbers of variables in the pSOFA score.

Conclusions:

ASA score, pSOFA score and PEWS score were significant predictor to length of stay (>21 days). ASA score, PEW score and pSOFA score were significant as predictor to mortality. ASA score and PEWS score were highly significant as to predict PICU Admission postop. PEWS score was highly significant as to predict PICU Admission postop. ASA, PEWs, and pSOFA were predictors for LOS for more than 21 days, predictors of mortality and predictors for PICU admission Postop. Decreased platelets and increased WBCs, urea, creatinine, AST, and RBG were significant with HiR. LqSOFA is a simple variable bedside tool for identifying septic patients at high risk for poor outcomes.

References:

1. Weiser TG, Haynes AB, Molina G, Lipsitz SR, Esquivel MM, Uribe-Leitz T, et al. Estimate of the global volume of surgery in 2012: an assessment supporting improved health outcomes. Lancet. 2015;385 Suppl 2:S11.

2. Ghaffar S, Pearse RM, Gillies MA. ICU admission after surgery: who benefits? Curr Opin Crit Care. 2017;23:424-9.

3. Ozdemir BA, Sinha S, Karthikesalingam A, Poloniecki JD, Pearse RM, Grocott MP, et al. Mortality of emergency general surgical patients and associations with hospital structures and processes. Br J Anaesth. 2016;116:54-62.

4. Kristensen SD, Knuuti J, Saraste A, Anker S, Bøtker HE, Hert SD, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). Eur Heart J. 2014;35:2383-431.

5. Kan CG, Nurok M. The ethics of interventional procedures for patients too ill for surgery. Curr Opin Anaesthesiol. 2018;31:190-4.

6. Myburgh J, Abillama F, Chiumello D, Dobb G, Jacobe S, Kleinpell R, et al. End-of-life care in the intensive care unit: Report from the Task Force of World Federation of Societies of Intensive and Critical Care Medicine. J Crit Care. 2016;34:125-30.

7. Neto AS, da Costa LGV, Hemmes SNT, Canet J, Hedenstierna G, Jaber S, et al. The LAS VEGAS risk score for prediction of postoperative pulmonary complications: An observational study. Eur J Anaesthesiol. 2018;35:691-701.

8. Harrison AM, Thongprayoon C, Kashyap R, Chute CG, Gajic O, Pickering BW, et al. Developing the surveillance algorithm for detection of failure to recognize and treat severe sepsis. Mayo Clin Proc. 2015;90:166-75.

9. Ahmed AH, Thongprayoon C, Schenck LA, Malinchoc M, Konvalinová A, Keegan MT, et al. Adverse in-hospital events are associated with increased in-hospital mortality and length of stay in patients with or at risk of acute respiratory distress syndrome. Mayo Clin Proc. 2015;90:321-8.

10. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). Jama. 2016;315:801-10.

11. Maitra S, Som A, Bhattacharjee S. Accuracy of quick Sequential Organ Failure Assessment (qSOFA) score and systemic inflammatory response syndrome (SIRS) criteria for predicting mortality in hospitalized patients with suspected infection: a meta-analysis of observational studies. Clin Microbiol Infect. 2018;24:1123-9.

12. Borgialli DA, Mahajan P, Hoyle JD, Jr., Powell EC, Nadel FM, Tunik MG, et al. Performance of the Pediatric Glasgow Coma Scale Score in the Evaluation of Children With Blunt Head Trauma. Acad Emerg Med. 2016;23:878-84.

13. Fischbach FT, Dunning MB. A manual of laboratory and diagnostic tests: Lippincott Williams & Wilkins; 2009.

14. Thompson D, Pepys MB, Wood SP. The physiological structure of human C-reactive protein and its complex with phosphocholine. Structure. 1999;7:169-77.

15. Baillie J. Simple, easily memorised “rules of thumb” for the rapid assessment of physiological compensation for respiratory acid-base disorders. Thorax. 2008;63:289-90.

16. Pagana K, Pagana T, Pagana T. Mosby's Diagnostic and Laboratory Test Reference, St. Louis, Mo: Elsevier. 2019:600-50.

17. Okposio MM, Onyiriuka AN, Abhulimhen-Iyoha BI. Point-of-Admission Serum Electrolyte Profile of Children less than Five Years Old with Dehydration due to Acute Diarrhoea. Trop Med Health. 2015;43:247-52.

18. Mishra P, Pandey CM, Singh U, Gupta A, Sahu C, Keshri A. Descriptive statistics and normality tests for statistical data. Ann Card Anaesth. 2019;22:67-72.

19. Hadjianastassiou VG, Tekkis PP, Poloniecki JD, Gavalas MC, Goldhill DR. Surgical mortality score: risk management tool for auditing surgical performance. World J Surg. 2004;28:193-200.

20. Capuzzo M, Volta C, Tassinati T, Moreno R, Valentin A, Guidet B, et al. Hospital mortality of adults admitted to Intensive Care Units in hospitals with and without Intermediate Care Units: a multicentre European cohort study. Crit Care. 2014;18:551.

21. Akre M, Finkelstein M, Erickson M, Liu M, Vanderbilt L, Billman G. Sensitivity of the pediatric early warning score to identify patient deterioration. Pediatrics. 2010;125:e763-9.

22. Minejima E, Delayo V, Lou M, Ny P, Nieberg P, She RC, et al. Utility of qSOFA score in identifying patients at risk for poor outcome in Staphylococcus aureus bacteremia. BMC Infect Dis. 2019;19:149.

23. Jain A, Palta S, Saroa R, Palta A, Sama S, Gombar S. Sequential organ failure assessment scoring and prediction of patient's outcome in Intensive Care Unit of a tertiary care hospital. J Anaesthesiol Clin Pharmacol. 2016;32:364-8.

24. Guner can M, Ozer A. Prolonged Mechanical Ventilation Predictors in Patients Undergoing Liver Transplantation. Bezmialem Science. 2019;7:191-7.

25. Mohamed El-Mashad G, Said El-Mekkawy M, Helmy Zayan M. [Paediatric sequential organ failure assessment (pSOFA) score: A new mortality prediction score in the paediatric intensive care unit]. Anales de pediatria. 2020;92:277-85.

26. Ramteke S, Tikkas R, Jain A. Pediatric early warning score as a prognostic indicator in critically ill children-a prospective study.

27. Hackett NJ, De Oliveira GS, Jain UK, Kim JY. ASA class is a reliable independent predictor of medical complications and mortality following surgery. Int J Surg. 2015;18:184-90.

28. Baloch SH, Shaikh I, Gowa MA, Lohano PD, Ibrahim MN. Comparison of Pediatric Sequential Organ Failure Assessment and Pediatric Risk of Mortality III Score as Mortality Prediction in Pediatric Intensive Care Unit. Cureus. 2022;14:e21055.

29. Garcia AE, Bonnaig JV, Yoneda ZT, Richards JE, Ehrenfeld JM, Obremskey WT, et al. Patient variables which may predict length of stay and hospital costs in elderly patients with hip fracture. J Orthop Trauma. 2012;26:620-3.

30. Song X, Xia C, Li Q, Yao C, Yao Y, Chen D, et al. Perioperative predictors of prolonged length of hospital stay following total knee arthroplasty: a retrospective study from a single center in China. BMC Musculoskeletal Disorders. 2020;21:62.

31. Shafi OM, Diego Rondon JD, Gulati G. Can the Pediatric Early Warning Score (PEWS) Predict Hospital Length of Stay? Cureus. 2020;12:e11339.

32. Milić M, Goranović T, Holjevac JK. Correlation of APACHE II and SOFA scores with length of stay in various surgical intensive care units. Coll Antropol. 2009;33:831-5.