Cardiac Dysfunction and Serum Ferritin Level as Early Prognostic Markers in Children with Sepsis.

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Abstract

Objective: This study aimed to evaluate the association of Cardiac dysfunction assessed by Echocardiogram study, ferritin, c-reactive protein, and leukocyte count with unfavorable outcomes in pediatric sepsis within the pediatric intensive care unit.

Methods: A prospective cohort study was carried out from September 2019 to April 2020, with 40 patients admitted to a pediatric intensive care unit (PICU) at Minia University Children and Maternal hospital, aged between 28 days and 15 years. Inclusion criteria were patients diagnosed with sepsis, need for mechanical ventilation for quite 48h, and vasoactive drugs. Serum levels of C-reactive protein, ferritin, and leukocyte count were collected within 24 h of admission (D1), and 72 h (D3) after admission to PICU. Patients underwent echocardiography study to figure out the ejection fraction of the ventricle on D1 and D3. The outcomes measured through length of stay at hospital and at the pediatric intensive care unit, mechanical ventilation (MV) duration, free hours of VM, duration of use of inotropic agents, maximum inotropic score, and mortality.

Results: Patients with elevated ferritin levels on D1 had less ventilator-free time and higher maximum inotropic score. Patients with cardiac dysfunction by echocardiogram on D1 had longer hospital stay pediatric intensive care unit, stay longer duration of mechanical ventilation higher maximum inotropic score, and fewer ventilator-free hours

Conclusion: Cardiac dysfunction by echocardiography study and serum ferritin value was significantly related to unfavorable outcomes in pediatric patients requiring admission to PICU with sepsis.

Introduction

Sepsis remains a crucial explanation for morbidity and mortality within the pediatric intensive care unit (PICU) environment. Definitions for sepsis and organ dysfunction for children have been developed by the International Consensus Conference on Pediatric Sepsis

Systemic inflammatory response syndrome — The systemic inflammatory response syndrome (SIRS) is present when a child has an abnormality of temperature (fever or hypothermia) or age-specific abnormality of the white blood cell count and one among the followings: tachycardia, bradycardia, respiratory distress, or pulmonary condition requiring mechanical ventilation. SIRS within the presence of suspected or proven infection constitutes sepsis. Clinical manifestations typically progress along a continuum of severity from sepsis to severe sepsis, septic shock, and multiple organs failure [1]. [2].

Finding tools which will anticipate or monitor unfavorable evolution in sepsis can contribute to the development of care in these critically-ill patients.

Thus, several biological markers have recently been studied as tools to gauge disease progression in bacterial infections, sepsis, and septic shock.(3–8)

Among the biomarkers, the foremost often utilized in the authors' setting are leukocyte count, c-reactive protein (CRP), procalcitonin, and ferritin levels(4,6–8)

Inflammatory biomarkers, such as C-reactive protein and procalcitonin, may be useful in select cases, (9,10). For example, For example, procalcitonin and C-reactive protein(CRP) could also be useful in identifying the presence of significant bacterial infection in infants and young children who present to an emergency department with emergency department with fever and no apparent source of infection (11,12) They may also be useful in predicting bacterial infection in patients with fever and neutropenia (13,14) In addition, C-reactive protein may guide safe de-escalation of antibiotics for patients who clinically improve in the absence of an identifiable source of infection (15).However, there are limited studies in pediatrics correlating serum levels with unfavorable outcomes

In pediatric sepsis, myocardial dysfunction is one of the foremost causes of clinical deterioration. (16) Myocardial dysfunction could even be present in up to 50% of cases of severe sepsis or septic shock, causing systolic or diastolic ventricular dysfunction and contributing to shock and mortality.(17) The echocardiogram is already utilized in the management of patients with septic shock during volumetric resuscitation and to settle on the simplest vasoactive drug.(18,19) it's speculated that evaluations obtained by echocardiographic assessment are often used as markers of sepsis evolution. Additionally, few studies have associated these measures with unfavorable outcomes in pediatric sepsis.(20)

Patients And Methods

This prospective cohort study included 40 patients; they were recruited during the period from September 2019 to April 2020 at Minia University Children and Maternal hospital, department of pediatrics, pediatric intensive care unit. This study was approved by ethical committee, faculty of drugs, El- Minia University. A written consent was obtained from each parent to agree to participate within the study. Protect the participant's confidentiality, avoiding using deceptive practice. Giving participants the proper to withdraw from our research.We declared no conflict of interest with respect of the study. Demographic and clinical data of patients included within the study were collected and analyzed

All patients hospitalized during the abovementioned period who required mechanical ventilation (MV) for quite 48 h using cardiovascular support and who had clinical diagnosis or suspicion of sepsis were included. Exclusion criteria were: congenital heart disease, presence of confirmed or suspected endocrine disease, diagnosis of congenital or acquired immunosuppression, severe liver impairment. Sepsis was defined because the presence of two or more of subsequent four criteria: tachycardia, tachypnea, temperature change, leukocytosis, or leukopenia for age within the presence of confirmed or suspected infection based on 2001 SCCM/ ACCP/ ATS/ eSCiM/ SiS Consensus Conference **(24)**.

The organic dysfunctions were classified consistent with Goldstein et al. **(21)** The presence of two or more organic dysfunctions was considered as multiple-organ dysfunction syndrome. All patients within the study had their serum levels of CRP, ferritin, and leukocyte counts assessed at study entry 24 h (D1),

and 72 h (D3) after admission. The sample was stratified consistent with CRP values (greater than 6 mg/L), ferritin (≥ 250 ng/mL) **(22)**, and leukocyte count (15,000/ L) for association with outcomes.

On D1 and D3, all patients underwent transthoracic echocardiography to work out left ventricular ejection fraction (EF). The EF represents the ejected volume, in percentage, of the left ventricular end-diastolic volume, i.e., what proportion blood is ejected into the aorta at systole. **(23)**

Assessment of cardiac dysfunction: done by transthoracic echocardiography to work out left ventricular ejection fraction on day of admission D1 & D 3. The device used is logic v2 GE echo with 3 and 6 MHz transducer. All assessments were performed using an equivalent device and by an equivalent pediatric cardiologist with experience within the Pediatric Cardiology Service of the Hospital.

Technique: Bedside echo cardiogram is usually used for assessing ventricular measurements and function. The left ventricle's systolic function is tested qualitatively on "eye-balling" visual inspection and quantitatively by evaluating circumferential fraction shortening or Simpson's planimetry determining the fraction of the ejection. The assessment of left ventricular diastolic activity is predicated largely on the examination of the mitral valve and pulmonary venous Doppler tracings or Doppler tissue. Measurement of Cardiac Dimensions: The ventricular axis are often measured using M-mode, which is measured using the leading-edge technique. The left ventricular M-mode trace is collected from the parasternal long-axis (PLAX) or parasternal short-axis (PSAX) vision, the cursor in M-mode should be positioned at the level of the posterior mitral valve leaflet perpendicular to the interventricular septum and posterior wall.

Evaluation of Left Ventricular Systolic Function was done using Qualitative Assessment: An experienced non-echo cardiographer can perform visual inspection to assess left ventricular function, and Quantitative Assessment: the foremost widely used parameters for determining systolic left ventricular function are fraction shortage and ejection fraction. The FS is obtained from M- mode tracings or 2D imaging within the long parasternal axis view at the ideas of the bicuspid valve leaflets or within the short parasternal view at the papillary muscle level. The left ventricular end -diastolic dimension (LVEDD) is estimated at the top of the T-wave, the R-wave of the cardiac cycle and therefore the left ventricular end-systolic dimension (LVESD) is calculated using the subsequent equation: $FS (\%) = LVEDD - LVESD / LVEDD \times 100$. The EF may be a measurement, expressed as a percentage, of what proportion blood the ventricle pumps out with each contraction, calculated using the subsequent equation: $EF (\%) = LVEDV - LVESV / LVEDV \times 100$. **(23)**

The left ventricular shortening fraction was also measured, using an equivalent formula, altogether patients. The results obtained were overlapping; therefore, it had been decided to use only the EF within the statistical analyses.

The following outcomes were evaluated: length of hospital stay (days), length of stay within the PICU (day's time of total MV (hours), time without MV (hours), total time of inotropic use, maximum inotropic score, and mortality.

For the maximum inotropic score, the absolute best value, obtained on any day of the study, was calculated through a summation obtained from the formula: dose of dopamine + dobutamine + (epinephrine $\times$ 100) +(noradrenaline $\times$ 100) +(milrinone $\times$ 10). All of them were expressed in mcg/kg/min. **(25)** The Pediatric Index of Mortality 2 (PIM2) was calculated on the first day of the PICU, according to the routine of this service. **(26)** A PIM2 value of 6% was chosen because the cutoff point for severity, because it's that the upper limit of historical mortality during this service.

The analysis of the data was administered using the IBM SPSS 20.0 statistical package software and MedCalc version 12.2.1.0 (MedCalc Software, Ostend, Belgium). Data were expressed as median, interquartile range (IQR), mean $\pm$ standard deviation (SD) for quantitative measures additionally to both number and percentage for categorized data. The normality of data was assessed using Kolmogorov-Smirnov test. Mann Whitney test was used for comparison between independent groups and Wilcoxon test for dependent groups for non-parametric data. The Chi-square test or Fisher's exact test were used to compare categorical variables.

Receiver operating characteristic (ROC) curve was computed and therefore the area under the ROC curve was used to evaluate the ability of serum ferritin and ejection fraction to predict occurrence of mortality. The optimum cutoff was defined because the value that maximized the area under the ROC curve. Spearman correlation was used to describe the association between two variables. Multiple binary logistic regressions were used to create a predictive model. A P-value of 0.05 or less was considered significant.

Results

There were 150 hospitalizations during the above-mentioned study period and, of these, 40 patients were eligible for the study. Socio-demographic characters of the studied cases, as presented in Table 1 shows the percentage of the females was (60%), males were (40%), eighty-five percent (85%) of cases was between 1 month and 2 years and 15% was between 2-6years, 65% of cases were from rural areas, with weight had mean $\pm$ SD (9.1 ± 4.4), and length/height had mean $\pm$ SD (75.9 ± 17.7). positive consanguinity was found in 30% of cases, As shown in Table (2), Serum Ferritin level among studied cases at day of admission (D1) and day 3, most cases show increased serum ferritin level above normal range and significantly decreased between day 3 and day of admission D1 ($p < 0.001$) also as shown in the same table Ejection fraction at day of admission D1 and day 3 among studied cases, there is a statistically significant increase between day 3 and day of admission D1 as regard to Ejection fraction ($p = 0.001$). in our study, there was a statistically significant difference between patients with cardiac dysfunction ($EF < 55\%$) and those without cardiac dysfunction ($EF \geq 55\%$) as regard to serum Ferritin level (ferritin level increased in pediatric patients with cardiac dysfunction) (table 3).

In our study, the Outcome of studied cases, shows that the number of nonsurvivors was 24 and their percentage was 60%, while the number of survivors was 16 and their percentage was 40%, in our study, the Median value of serum Ferritin level is significantly higher among non-survivors than survivors

pediatric patients with sepsis ($p = 0.021$), Our results also show that the Median value of Ejection fraction is significantly lower among non-survivors than survivors septic pediatric patients ($p = < 0.001$) as presented in Table (4).

Table (5) shows the relation between cardiac dysfunction at day of admission D1 and outcome among studied cases, This table shows that the number of non-survivors was 18 and their percentage was 94.7% and the number of survivors was 1 and their percentage was 5.3% among studied cases with cardiac dysfunction, while the number of non-survivors was 6 and their percentage was 28.6% and the number of survivors was 15 and their percentage was 71.4% among studied cases without cardiac dysfunction.

Table (6) shows that serum ferritin level has a sensitivity of 62.5% and specificity of 81.2% in prediction of mortality with (p value = 0.002) with cut-off point > 550 , while ejection fraction has sensitivity of 83.3% and specificity of 87.5% in prediction of mortality with (p value = < 0.001) with cut-off point $\leq 56\%$ Also as shown in the same, serum ferritin level had a sensitivity of 68.4% and specificity of 66.7% in prediction of cardiac dysfunction with (p value = 0.016) with cut-off point > 510 .

Final Table (7) shows Univariate and multivariable binary logistic regression analysis for predictors of mortality, This table clarify that factors found to be significantly associated with mortality by univariate analysis were entered the multivariable model to detect the significant predictors of mortality. Cardiac dysfunction and serum ferritin were found to be predictors of mortality. Patients with cardiac dysfunction were more likely to die than patients without cardiac dysfunction ($p = 0.035$). The increase in serum ferritin by 10 units was associated with a 10% increase in the odds of child to die (AOR = 1.01, 95% CI = 1.0–1.02).

Discussion

Sepsis is an important cause of mortality and morbidity in the pediatric intensive care unit, early identification and therapeutic interventions is the cornerstone in the outcome of sepsis, early recognition of sepsis is not always straightforward and clinical signs at presentation can be misleading due to frequent comorbidities or variable demographic characteristics. (27)

Cardiac dysfunction is one of the main causes of clinical deterioration in pediatric patients (16), the echocardiogram is already used in the management of patients with septic shock during volumetric resuscitation and to choose the best vasoactive drug (18), evaluations obtained by echocardiographic assessment can be used as markers of sepsis, few studies have associated these measures with unfavorable outcomes in pediatric sepsis (20).

Our study aimed to verify the association between serum ferritin levels and cardiac dysfunction with unfavorable outcomes in pediatric sepsis.

This present study was conducted on 40 infants and children suffering from sepsis of different causes admitted in the pediatric intensive care unit at Minia University Children and Maternal hospital,

department of pediatrics. 85% of cases were between 1 month and 2 years, they were 24 females (60%) and 16 males (40%).

Ferritin was the most prominent inflammatory marker in our study. It is an iron-storing protein, responsible for releasing it in a controlled way. In inflammatory processes, a great production of ferritin occurs, inducing a decrease in serum iron, believed to decrease the availability of iron to microorganisms. For this reason, ferritin in critically ill pediatric patients may be increased, and it is associated with severity in some illnesses (7).

C-reactive protein is an acute-phase reactant; it rises within six hours of the onset of inflammation and may raise to 10,000 folds with a peak at 48 hours, and disappears equally rapidly after the destructive process has stopped. CRP is not only useful in detecting the presence of an inflammatory disease but is also useful in following its progress and effectiveness of treatment. In particular serial measurements of CRP are very useful, for instance when one has to decide about the duration of antibiotic therapy in infection (28).

The diagnoses of the studied cases were three main categories: pneumonia (50%), central nervous system (CNS) infection (30%), and gastroenteritis (20%). The etiology of increase the risk of pneumonia may include environmental factors, genetic susceptibility, and ethnic causes (29). In this respect (Weiss et al., 2014) carried a study on the global epidemiology of pediatric sepsis and found that the most frequent site of infection was the respiratory system with pneumonia (40%). (30)

This present study showed that there was a highly statistically significant difference between a day of admission D1 and third day as regard to C-reactive protein with median value of CRP was higher on the day of admission 48 mg/L (24–104) compared to third day that was 24 mg/L (12–48) with P-value < 0.001.

Our study showed that there was a highly statistically significant difference between a day of admission D1 and third day as regard to serum ferritin level with median value of Ferritin level was higher on the day of admission 522 ng/ml (395–652) compared to third day that was 400 ng/ml (335.5–562) with P-value < 0.001.

In the current study, we found that the median value of Ferritin level was significantly higher among nonsurvivors septic cases 565 ng/ml (453.5-769.5) than survivors septic cases 456.5 ng/ml (347.5–539) with p-value = 0.021. This result agrees with (Bennett et al., 2011) (35) who found that very high serum ferritin levels are associated with high mortality in pediatric intensive care patients.

Our current study showed that cardiac dysfunction (EF < 55%) was present among 47.5% of the studied cases. This finding of cardiac dysfunction in sepsis (low Ejection fraction) of 47.5% of cases is higher than studies published by (Raj et al., 2014) (16) 37% of cases ;(Pulido et al., 2012) (33) 27% of cases; and (Furian et al., 2012) (34) 33% of cases.

The current study showed that the median value of Ejection fraction% was significantly lower among non-survivors 44% (36.5–55.5) than survivors with sepsis 60% (58.5–65.5) with P-value < 0.001.

This comes in agreement with (Elgazzar et al., 2018) **(32)** whose study carried out on 50 pediatric patients admitted to the pediatric intensive care unit (PICU) of Menoufia University Hospital with septic shock and found decreased EF% was higher among died than improved septic cases.

The present study showed that the number of cases died with cardiac dysfunction (18 patients 94.7%) was higher than that with no cardiac dysfunction (6 patients 28.6%) with p-value < 0.001.

In our study, we found that the median value of serum Ferritin level was significantly higher among cases with cardiac dysfunction than cases without cardiac dysfunction. In this respect (Tonial et al., 2017) **(31)** found that the mean value of serum Ferritin level was significantly higher among cases with cardiac dysfunction than those without cardiac dysfunction.

In our study, we found a statistically significant difference between cases with cardiac dysfunction and those without cardiac dysfunction as regard to duration of mechanical ventilation (hr) with p-value < 0.001, duration of inotropes (hr) with p-value 0.002, and maximum inotropic score with P-value < 0.001 while there was no statistically significant difference between cases with cardiac dysfunction and those without cardiac dysfunction as regard to duration of PICU admission (days) with P-value 0.713.

(Garcia et al., 2007) **(6)** found a statistically significant difference between cases with cardiac dysfunction and those without cardiac dysfunction as regards to duration of mechanical ventilation (hr) with P-value = 0.011, duration of PICU admission (days) with P-value = 0.02, and maximum inotropic score with P-value = 0.001. while there was no statistically significant difference between cases with cardiac dysfunction and those without cardiac dysfunction as regards to duration of inotropes (hr) with P-value = 0.231.

The receiver operating characteristics area under the curve (ROC-AUC) value of ferritin level > 550 ng/ml as cut point was 0.741 has a sensitivity of 62.5% and specificity of 81.2%. in prediction of mortality among studied patients.

Factors found to be significantly associated with mortality by univariable analysis were entered the multivariable model to detect the significant predictors of mortality, cardiac dysfunction, and serum ferritin were found to be predictors of mortality. Patients with cardiac dysfunction were more likely to die than patients without cardiac dysfunction (p = 0.035), the increase in serum ferritin by 10 units was associated with a 10% increase in the odds of child to die (AOR = 1.01, 95% CI = 1.0–1.02).

(Garica et al., 2007) **(6)** found ferritin level > 500 ng/ml is associated with a higher mortality rate with P-value 0.02.

Conclusion

cardiac dysfunction by echocardiogram (EF < 55%) on D1 and serum ferritin values (≥ 300 ng/mL) on D0, obtained in pediatric patients with sepsis admitted to the PICU, were significantly associated with unfavorable outcomes.

Study Limitations

Some limitations of this study should be indicated. The first is related to EF measurement by echocardiogram, which is a professional-dependent assessment. This method was chosen, despite its limitations, because it is available in most PICU services in Minia university hospital. The second is the lack of other biomarkers already studied in pediatric sepsis. It was decided to study the ones that are easily obtained and most commonly used in our PICU. Finally, the number of patients was a limitation. The authors studied an expressive group of very severe patients, in whom the inclusion and exclusion criteria were strict. The sample, while producing significant differences in results, had a low statistical power.

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Tables

Table 1

Demographic, clinical and laboratory data for studied patients at presentation

Parameter	Total Patients (n=40)			
Demographic data	No & %			
Age (months)	Range			
	1 month – 2 years	34(85%)		
	2 – 6 years	6 (15%)		
Sex	Male	16 (40.0%)		
	Female	24 (60.0%)		
Residence	Rural	26 (65%)		
	Urban	14 (35%)		
Weight (kg)	Range	3.5-23		
	Mean± SD	9.1±4.4		
Length/Height (cm)	Range	55-120		
	Mean± SD	75.9±17.7		
Consanguinity	+ve	12 (30%)		
	-ve	28 (70%)		
Family history of similar condition	+ve	9 (22.5%)		
	-ve	31 (77.5%)		
Diagnosis prior to PICU admission	No & %			
Pneumonia	20 (50.0%)			
CNS infection	12 (30.0%)			
Viral encephalitis	11 (27.5%)			
Gastro-enteritis	8 (20.0%)			
Meningococccemia	1 (2.5%)			
Laboratory tests	Range	Median	Mean± SD	
Hemoglobin (g/dl)	8-10	9	9±1.5	
Total leucocyte count (x109/L)	9.5-23.5	15.5	16.8±9.3	

Platelets (x10 ⁹ /L)	82.5-310	194.5	222.6±174.9
C-reactive Protein (mg/dl)	24-104	48	61.6±40.4
Alanine transaminase (ALT)	10-485	46	86.8±96.8
Aspartate transaminase (AST)	11-354	44.5	60.2±64.3
Albumin (g/dl)	2.5-5.5	3.6	3.6±0.6
Prothrombin time (seconds)	11-25	16.5	16.8±3.7
Urea (mg/dl)	11-120	36	42.4±26.8
Creatinine (mg/dl)	0.3-2	0.7	0.7±0.4
sodium (mmol/L)	125-168	141	142.7±10.9
potassium (mmol/L)	2.5-6.5	3.5	4.1±0.9
Calcium (mg/dl)	2-10	8	8±1.8

Table 2

Serum Ferritin level & Ejection fraction among studied cases at day of admission D1 and day 3

	D1	D3	Wilcoxon test	p value
Ferritin (ng/ml)				
Median (IQR)	522 (395–652)	400 (335.5–562)	-3.677	< 0.001*
Mean ± SD	554.4 ± 223.3	447.8 ± 183.8		
EF%				
Median (IQR)	55 (41.5–60)	60 (55-68.5)	-3.417	0.001*
Median ± SD	52.28 ± 11.2	59.65 ± 9.64		
This table shows that most cases show increased serum ferritin level above normal range and significantly decreased between day 3 and day of admission D1 (p < 0.001). Also shows that there is statistically significant increase between day 3 and day of admission D1 as regard to Ejection fraction (p = 0.001).				

Table 3

Relation between Serum Ferritin level and cardiac dysfunction (EF %) at day of admission D1 among studied cases.

	With cardiac dysfunction EF < 55%	Without cardiac dysfunction EF ≥ 55%	ZMWU test	p value
	(n = 19)	(n = 21)		
Ferritin				
Median (IQR)	568 (457–754)	463 (365–568)	-2.181	0.029*
Mean ± SD	625.6 ± 214.3	490 ± 216.2		
Z _{MWU} → Z value of Mann Whitney U test				
The table shows that there was statistically significant difference between pediatric patients with cardiac dysfunction (EF < 55%) and those without cardiac dysfunction (EF ≥ 55%) as regard to serum Ferritin level (ferritin level decreased in pediatric patients without cardiac dysfunction).				

Table 4

Outcome regarding serum ferritin level and Ejection fraction% among studied cases.

	Outcome		ZMWU	p value
	Non survivors (n = 24) (60.0%)	survivors (n = 16) (40.0%)		
Ferritin				
Median (IQR)	565 (453.5-769.5)	456.5 (347.5–530)	-2.306	0.021*
Mean ± SD	630.7 ± 244.2	440 ± 122.4		
Range	(254–1150)	(240–650)		
EF%				
Median (IQR)	44 (36.5–55.5)	60 (58.5–65.5)	-4.106	< 0.001*
Mean ± SD	46.17 ± 10.82	61.44 ± 5.3		
Range	(33–70)	(50–72)		
This table shows that Median value of serum Ferritin level is significantly higher among non-survivors than survivors septic pediatric patients (p = 0.021).				
This table also shows that Median value of Ejection fraction is significantly lower among non-survivors than survivors septic pediatric patients (p = < 0.001).				

Table 5

relation between cardiac dysfunction at day of admission D1 and outcome among studied cases

	With cardiac dysfunction EF < 55%	Without cardiac dysfunction EF ≥ 55%	χ ²	p value	OR (95% CI)
	(n = 19)	(n = 21)			
Outcome			18.195	< 0.001*	45.5 (4.9- 416.5)
Non- survivors	18 (94.7%)	6 (28.6%)			
Survivors	1 (5.3%)	15 (71.4%)			
This table shows that the number of non-survivors was 18 and their percentage was 94.7% and the number of survivors was 1 and their percentage was 5.3% among studied cases with cardiac dysfunction, while the number of non-survivors was 6 and their percentage was 28.6% and the number of survivors was 15 and their percentage was 71.4% among studied cases without cardiac dysfunction.					

Table 6

serum ferritin level EF% and as predictive value of mortality among the studied cases.

	Cut-off	AUC	P value	Sensitivity	Specificity	PPV	NPV
Ferritin	> 550	0.741	0.002*	62.5%	81.2%	83.3%	59.1%
EF%	≤ 56	0.887	< 0.001*	83.3%	87.5%	90.9%	77.8%
This table shows that serum ferritin level has sensitivity of 62.5% and specificity of 81.2% in prediction of mortality with (p value = 0.002) with cut-off point > 550, while ejection fraction has sensitivity of 83.3% and specificity of 87.5% in prediction of mortality with (p value = < 0.001) with cut-off point ≤ 56%.							

Table 7

Univariate and multivariable binary logistic regression analysis for predictors of mortality

Predictors	Mortality			
	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
EF				
No cardiac dysfunction	1.00 (Reference)		1.00 (Reference)	
Cardiac dysfunction	45. (4.86–416.5)	0.001	63.22 (1.35–2963)	0.035*
Serum Ferritin	1.01 (1.00-1.02)	0.005	1.01 (1.00-1.02)	0.038*
Duration of MV (hr)	1.03 (1.01–1.04)	0.002	1.00 (0.96–1.04)	0.874
Duration of inotropes (hr)	1.03 (1.01–1.05)	0.008	0.99 (0.95–1.03)	0.538
Max. inotropic score	1.03 (1.01–1.06)	0.004	1.00 (0.95–1.05)	0.924
N.B. Dependent variable mortality, OR odds ratio, CI confidence interval				
R ² = 0.758				
This table shows that factors found to be significantly associated with mortality by univariate analysis were entered the multivariable model to detect the significant predictors of mortality. Cardiac dysfunction and serum ferritin were found to be predictors of mortality. Patients with cardiac dysfunction were more likely to die than patients without cardiac dysfunction (p = 0.035). The increase in serum ferritin by 10 unit was associated with 10% increase in the odds of child to die (AOR = 1.01, 95% CI = 1.0–1.02).				

Figures

Figure 1

Receiver operating characteristic (ROC) curve displaying the diagnostic accuracy of serum ferritin to predict the mortality in the studied cases This figure shows that serum ferritin level has sensitivity of 62.5% and specificity of 81.2% in prediction of mortality with (p value=0.002) with cut-off point>550.

Figure 2

Receiver operating characteristic (ROC) curve displaying the diagnostic accuracy of EF% to predict the mortality in the studied cases. This figure shows that ejection fraction has sensitivity of 83.3% and specificity of 87.5% in prediction of mortality with (p value=<0.001) with cut-off point $\leq 56\%$.

Figure 3

Receiver operating characteristic (ROC) curve displaying the diagnostic accuracy of serum ferritin to predict the occurrence of cardiac dysfunction in the studied cases. This figure shows that serum ferritin level had sensitivity of 68.4% and specificity of 66.7% in prediction of cardiac dysfunction with (p value=0.016) with cut-off point>510.