

Evaluation of critically ill patients in intensive care unit in tertiary care hospital in south India with respect to SOFA scoring system – for predicting the prognosis – A prospective cohort study.

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Abstract: In critically ill intensive unit patients, due to any/all cause multiple organ involvement and deterioration of their function is a hallmark. Sequential assessment of vital organ function is a useful predictor of outcome of the disease irrespective of the cause. This study undertakes 100 continuously admitted patient in intensive care unit of South Indian tertiary care hospital and analysis SOFA scoring system [sequential organ failure assessment] in a prospective manner. Out of the hundred analysed patients, 47 patients died. The evaluation of SOFA scoring has a very high predictor value at 96 hours after admission – High the scores greater the mortality. This study takes into consideration two comorbid conditions Systemic hypertension and Diabetes Mellitus which had no association with the mortality. This study also shows patients placed on mechanical ventilator support had a higher mortality. To conclude regular periodical assessment of SOFA score in any ICU setting will help in prognosticating the outcome which directs the treating physician to decide on the utility of resources and necessity for interventional procedure. Though there are many scoring systems available, SOFA scoring system involves analysis of everyday routinely carried out parameters in any tertiary care ICU.

I. Introduction

Intensive care unit is a place in which critically ill patients are managed. These patients suffer morbidity and mortality to a large extent due to their complicated nature of illness. In most of the ICU patients more than one organ system is involved. This makes the management even more challenging. So prediction of prognosis becomes important in these patients. The idea behind this strategy is, to give a reliable outcome of the disease process, to the relatives of the patient. This helps in resolving unnecessary conflicts between the health care personnel and the patient relatives. Next important thing is, as to decide to which patient, the available resources need to be utilised.

This lead to the idea of devising scoring systems. These systems guide the efficient utilisation of ICU resources, especially in a resource starved setting. This helps in preventing dumping of valuable drugs and treatment modalities in a patient, who may not survive in spite of all efforts. On the contrary they can be utilised for a person, who may improve well with such costly intervention.

Sequential organ failure assessment called the SOFA scoring system is a simple scoring system calculated using easily available basic investigations, to predict outcome, especially mortality in ICU patients.

This study was undertaken to evaluate the score among ICU patients in Coimbatore medical college hospital admitted with various systemic illness and features of multi organ dysfunction.

II. Aims Of The Study

- To study the usefulness of sequential organ failure assessment score in predicting mortality among ICU patients.
- To study the impact of comorbid illness like diabetes and hypertension on outcome, in ICU patients in relation to SOFA score.
- To study the mortality among mechanically ventilated patients and its correlation with SOFA score.

III. Materials And Methods

This is a prospective cohort study, involving 100 continuously admitted patient in intensive care unit of age group 15 to 85 years during the period January 2015 to December 2015. Patient with less than 48 hours of

ICU stay who either Recovered or died were excluded from the study. Informed consent with appropriate ethical clearance were obtained for the study.

SOFA score parameters were obtained from these 100 patients on admission, 48 and 96 hours after admission. The scores were obtained and the end point is mortality or recovery.

Blood Investigations were taken under aseptic conditions with adequate care and sent to the hospital 24 hours laboratory immediately. All the investigations were done in our hospital. Any experimental or so far unused materials or methods were not used on the patients.

Serum bilirubin were calculated using an auto analyser using the method of malloy and evelyn.

ABG was done using ion selective electrode in an ABG analyser

Platelet count was done using sysmex KX21.3 which is an automated cell count analyser, in clinical pathology lab.

Statistical Analysis

Data were analysed using SPSS software version 17.

IV. Procedure And Results

Sequential Organ Failure Assessment Sofa Score

Organ system	Score 0	Score 1	Score 2	Score 3	Score 4
Respiratory Pa O ₂ /FiO ₂	> 400	≤ 400	≤ 300	≤ 200	≤ 100
Serum creatinine mg/dl	< 1.2	1.2 to 1.9	2.0 to 3.4	3.5 to 4.9	>5
Serum bilirubin mg/dl	< 1.2	1.2 to 1.9	2.0 to 5.9	6.0 to 11.9	>12
Cardiovascular hypotension	No hypotension	MAP <70mmHg	Dopamine ≤5 µg/kg per min Dobutamine [any dose]	Dopamine >5 µg/kg per min or Epinephrine ≤ 0.1 µg/kg per min Nor-epinephrine ≤ 0.1 µg/kg per min	Dopamine >15 µg/kg per min or Epinephrine > 0.1 µg/kg per min Nor-epinephrine > 0.1 µg/kg per min
Platelet/ml	>150	≤ 150	≤ 100	≤ 50	≤ 20
GCS	15	13 – 14	10 – 12	6 – 9	< 6

As per the SOFA scoring system, the following parameters were obtained 48, 96 hours and on day 6 as the case may be.

1. Serum bilirubin - Marker of liver function
2. Serum Creatinine – Assessment of Renal function
3. ABG analysis to calculate PaO₂/FiO₂
4. Platelet count to assess coagulation function
5. Glasgow coma scale though initially designed for head injury patients, application of GCS has become routinely used for any patient with worsening level of consciousness
6. Blood Pressure monitoring and necessity of inotropes

V. Results Are Discussed Below

Results

Survivors and non survivors:

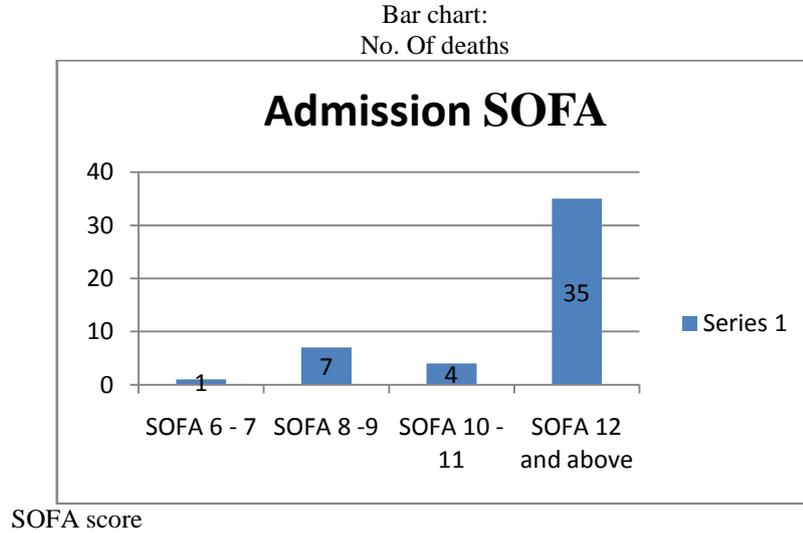
Among the 100 patients involved in the study 53% survived and 47% succumbed to their illness. The minimum age of the person enrolled in the study was 17 and the maximum age was 85.

SOFA score on admission:

SOFA score	Survivors	Non survivors	Total
6 – 7	5	1	6
8 – 9	19	7	26
10 – 11	13	4	17

12 and above	16	35	51
Total	53	47	100

The minimum SOFA score of the patients admitted was 6. Hence the data column starts with values of 6 and above. This table shows that there is a sharp rise in non survivors at a SOFA score above 12.



The minimum admission SOFA score of patients in this study is 6. Among the 6 patients who had this score 1 patient expired. That is, the mortality rate is 16.7 %. Among the 61 patients who had an admission SOFA score of 12 and above 35 patients expired escalating the mortality rate to 57.4 %.

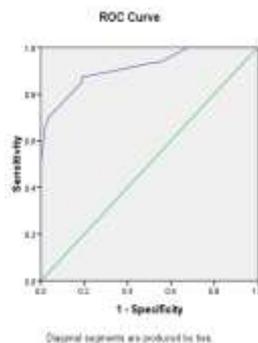
SOFA at 48 hours for non survivors:

SOFA score	No. of Non survivors
8 – 9	3
10 - 11	4
12 and above	40

At 48 hours the minimum SOFA score observed among the study population is 8. Hence the data column starts with 8 and above.

Area Under the Curve				
Test Result Variable(s):SOFA48Hr				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.914	.028	.000	.859	.970
The test result variable(s): SOFA48Hr has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.				
a. Under the nonparametric assumption				
b. Null hypothesis: true area = 0.5				

ROC curve for SOFA at 48 hours:



No. Of deaths

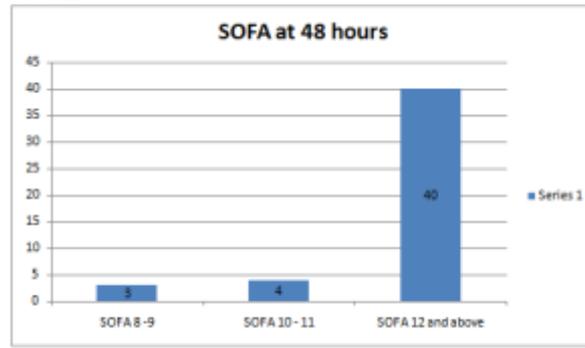


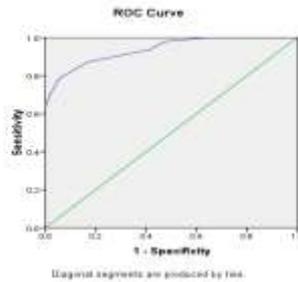
Figure 2

SOFA score

This picture shows that a SOFA score of 12 and above at 48 hours of admission shows an increase in the number of non survivors. The minimum SOFA score of the study population at 48 hours is 8. Among the 47 non survivors, 3 patients had these minimum score. Patients who had a score of 12 and above were 40.

SOFA score at 96 hours for non survivors :

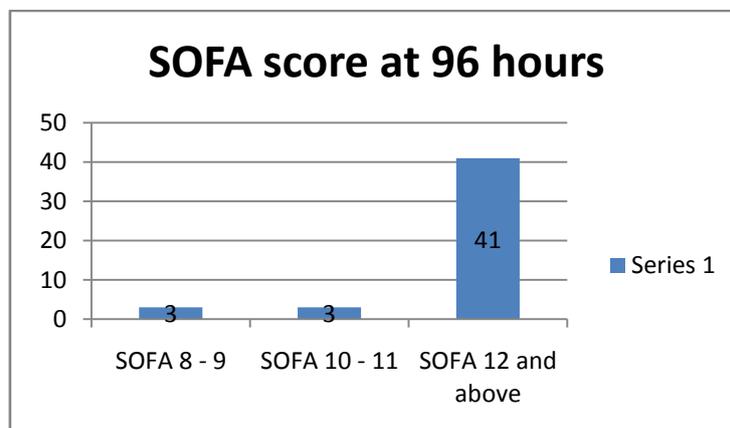
SOFA score	No. Of non survivors
8 – 9	3
10 – 11	3
12 and above	41



ROC curve at 96 hours

Area Under the Curve				
Test Result Variable(s):SOFA96HR				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.937	.023	.000	.892	.982

Bar diagram:



This chart depicts that survival rate is reduced when the SOFA score increases above 12, at 96 hours of admission. At 96 hours 41 out of the 47 patients expired, had a score of 12 and above.

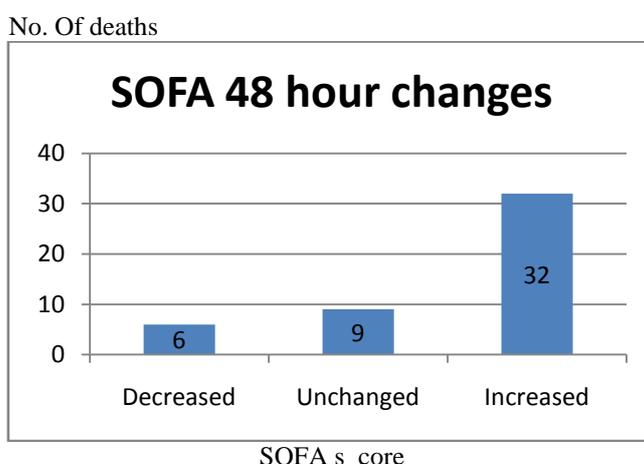
Delta SOFA:

It is the difference between the subsequent SOFA scores. Δ SOFA 48 is the difference between admission score and the score at 48 hours. Δ SOFA 96 is the difference between the score at 48 hours and 96 hours.

SOFA score 48 hour changes:

The patient data is analysed as those who decreased, unchanged and increased from the initial score respectively, and the outcome is analysed.

Δ SOFA 48	Survivors	Non survivors
Decreased	35	6
Unchanged	8	9
Increased	10	32



These data depicts that when the SOFA score is increased from admission to 48 hours, there is an increase in mortality. On contrary the mortality rate has decreased when the score falls. Among the 47 non survivors 32 (68.08%) had an increase in their Δ 48 scores.

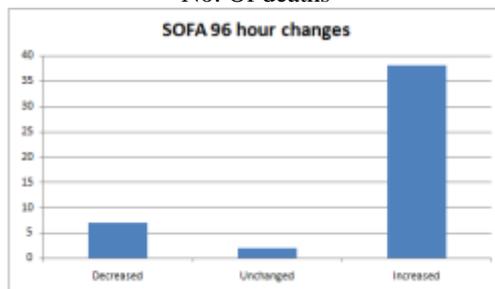
SOFA score 96 hour changes:

The patient data is analysed as those who decreased, unchanged and increased from the initial score respectively, and the outcome is analysed.

Δ SOFA 96	Survivors	Non survivors
Decreased	39	7
Unchanged	7	2
Increased	7	38

Bar chart:

No. Of deaths

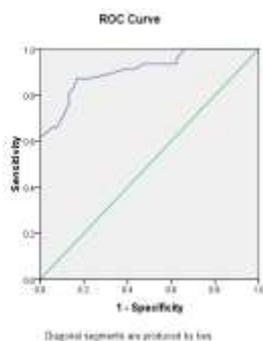


SOFA score

This chart depicts mortality rate is increased when the SOFA score is increased from admission to 96 hours. On contrary, the mortality rate has decreased when the score falls. Among the 47 non survivors 38 (80.85%) had an increase in their Δ 96 scores.

Mean SOFA:

Mean SOFA calculates the average value of the prognostic score during the entire ICU stay of the patient.



Test Result Variable(s):MEANSOFA				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.908	.029	.000	.851	.966

Coordinates of the Curve		
Test Result Variable(s):MEANSOFA		
Positive if Greater Than or Equal To ^a	Sensitivity	1 – Specificity
4.3333	1.000	1.000
5.6667	1.000	.962
6.3333	1.000	.925
7.0000	1.000	.755
7.5000	1.000	.660
7.8333	.979	.642
8.1667	.957	.623
8.5000	.936	.623
8.8333	.936	.491
9.1667	.936	.472
9.5000	.915	.434
10.0000	.915	.396
10.5000	.894	.321
10.8333	.872	.226
11.167	0.87	0.17
11.5000	.830	.151
11.8333	.809	.132
12.1667	.766	.132
12.5000	.723	.113
12.8333	.660	.075
13.1667	.660	.057
13.5000	.617	.000
13.8333	.574	.000
14.1667	.532	.000
14.5000	.489	.000
14.8333	.404	.000
15.1667	.383	.000
15.5000	.319	.000
16.1667	.277	.000
16.8333	.213	.000
17.1667	.191	.000
17.5000	.149	.000
18.0000	.106	.000
18.5000	.064	.000
20.0000	.021	.000
22.3333	.000	.000

The test result variable(s): MEANSOFA has at least one tie between the positive actual state group and the negative actual state group.

a. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff

value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

These data shows that, a mean SOFA score of 11 and above is an excellent predictor of mortality, above which the number of non survivors increase.

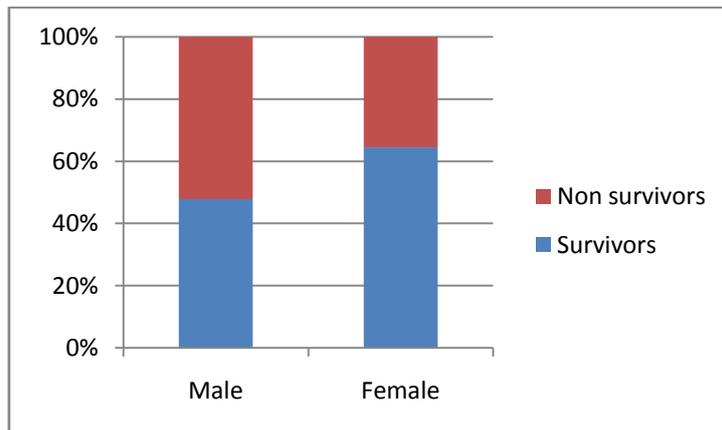
Total SOFA:

It is the sum total of all the scores obtained from an individual patient during his hospital stay. It gives information about the severity of the illness since gives the total worst score of all organs.

Area under the curve: Test Result Variable(s):TOTALSOFA Table 11:				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.908	.029	.000	.851	.966
Coordinates of the Curve				

Outcome based on sex:

Sex	Survivors	Non survivors	Total
Male	33	36	69
Female	20	11	31
Total	53	47	100

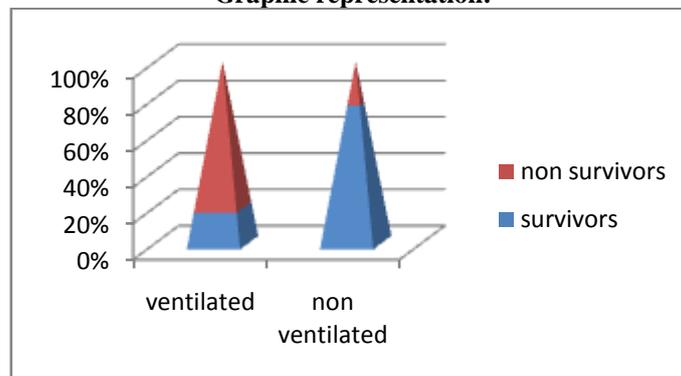


Out of 69 male patients, 36 (52.2%) patients expired and out of 31 female patients, 11(35.5%) patients expired.

Outcome for ventilator support:

Mechanical Ventilation status	Survivors	Non survivors
Ventilated	8	33
Non ventilated	45	14

Graphic representation:



Statistical significance of outcomes related to need for mechanical ventilation: Chi-Square Tests						
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	
Pearson Chi-Square	31.285 ^a	1	.000			
Continuity Correction ^b	29.048	1	.000			
Likelihood Ratio	33.141	1	.000			
Fisher's Exact Test				.000		.000
Linear-by-Linear Association	30.972	1	.000			
N of Valid Cases ^b	100					

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 19.27.

Among the 41 patients ventilated 33 (80.5%) expired and among the 59 patients who did not require ventilator support 14 (23.7%) expired.

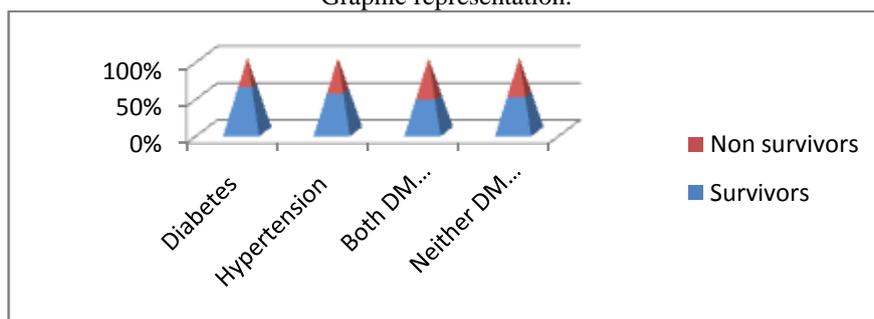
Outcome related to comorbidities:

Two comorbid illness are taken in this study. The patients were categorised as having

- 1) Diabetes
- 2) Hypertension
- 3) Both diabetes and hypertension
- 4) Neither diabetes nor hypertension

Comorbid illness	survivors	Non survivors
Diabetes	15	9
Hypertension	6	5
Both DM and SHT	7	8
Neither DM nor SHT	25	25

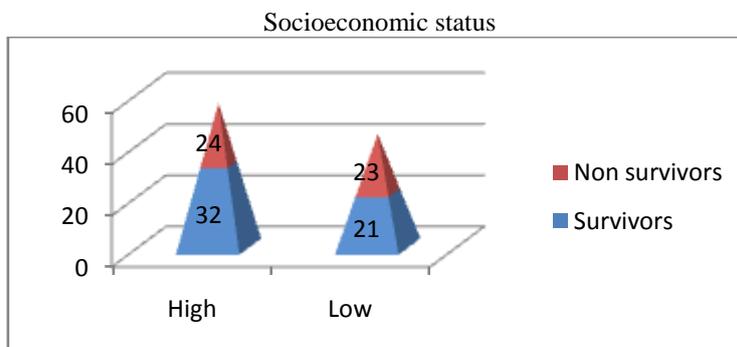
Graphic representation:



Among the 47 non survivors, 9 are diabetics, 5 are hypertensives, 8 are both diabetic and hypertensives, 25 are neither diabetic nor hypertensive. These comorbidities are not found to have any relationship with outcome in our study.

Outcomes in relation to socioeconomic status:

Socioeconomic status	Survivors	Non survivors
High	32	24
Low	21	23
Total	53	47



Chi-Square Tests:						
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	
Pearson Chi-Square	.877 ^a	1	.349			
Continuity Correction ^b	.540	1	.463			
Likelihood Ratio	.878	1	.349			
Fisher's Exact Test				.421	.231	
Linear-by-Linear Association	.868	1	.351			
N of Valid Cases ^b	100					

Patients were segregated into low and high socioeconomic groups based on modified kuppusamy scale. Out of the 56 patients belonging to high socioeconomic group 24 (42.9%) expired. Out of the 44 patients in the low socioeconomic group 23(52.3%) expired.

MODIFIED KUPPUSAMY SCALE

(A) Education Score			
1	Professional or Honors		4
2	Graduate or Post Graduate		3
3	High school or Intermediate or Diploma		2
4	Illiterate or Primary school		1
(B) Occupation Score			
1	Legislators, Senior Officials, and Managers		13
2	Professionals		11
3	Technicians and Associate Professionals		9
4	Clerks		7
5	Service Workers and Shop and Market Sales Workers		6
6	Skilled Agricultural and Fishery Workers		5
7	Craft and Related Trades Workers		4
8	Plant and Machine Operators and Assemblers		3
9	Unskilled worker		2
10	Unemployed		1
(C) Monthly family income in ₹			
	Score	Modified for 1998 ⁽¹⁾ in ₹	Modified for 2012 in ₹
1	≥2,000	≥13,500	≥32,050
2	1,000-1,999	6,750-13,499	16,020-32,049
3	750-999	5,050-6,749	12,020-16,019
4	500-749	3,375-5,049	8,010-12,019
5	300-499	2,025-3,374	4,810-8,009
6	101-299	676-2,024	1,601-4,809
7	≤100	≤675	≤1,600
Total Score			
26-29		Socioeconomic class	
16-25		Upper (I)	
11-15		Upper Middle (II)	
5-10		Middle/Lower middle (III)	
<5		Lower/Upper lower (IV)	
		Lower (V)	

VI. Discussion

Most of the ICU patients have more than one disease process which is manifested by the vital organ involvement. This gave rise to the concept of multiorgan dysfunction syndrome(MODS), which means the abnormal function or failure of more than one organ system.

So the standard of care for these set of population lies in proper diagnosis, monitoring of treatment response and progress every day and even every hour to ensure proper outcome, which means survival from that illness or atleast not to succumb to the illness. To ensure this we need to understand the nature of illness a critical care unit patient is going through, the pathogenesis of the disease process and its prognosis.

In addition to their inherent disease process, a critical care unit patient is also more prone for nosocomial infections due to improper nutrition, immunodeficient states, systemic illness like diabetes, hypertension etc. Geriatric patients falls under an even more riskier group. So all these factors add fuel to the entity called multi organ dysfunction syndrome(MODS).

Multi organ dysfunction syndrome:

The abnormal function or failure of more than one organ or organ system requiring medical support to maintain homeostasis is called MODS. In a susceptible individual, under the influence of associated comorbidities, the organ systems fail one by one ultimately leading to a complicated disease process and death. The general principles governing the syndrome of multiorgan dysfunction are,

- 1) Organ failure, no matter how defined, must persist beyond 24 hours
- 2) Mortality risk increases as the patients accrue additional failing
- 3) Prognosis is worsened by increased duration of organ failure.

These observations remain true across various critical care settings all over the world. Systemic inflammatory response syndrome(SIRS) is the common basis for multi organ system failure. Infection is by far the commonest cause of SIRS. Though other triggers like pancreatitis, trauma and burns etc can also elicit a similar response.

Systemic inflammatory response syndrome¹

It includes more than two of the following:

- 1) Rise in temperature >38 degree celcius or hypothermia (<36 degree celcius)
- 2) Tachypnoea (respiratory rate>24 /min)
- 3) Heart rate> 90/min
- 4) Leukocytosis(>12 ×10³/microlitre), leukopenia(<4 × 10³/microlitre).

Since the cost of health care is increasing day to day, assessment of a patient's prognosis is vital during the course of treatment. Outcome prediction gains importance in this regard. So scoring systems have been used to predict this. Various scoring systems are,

Scoring systems:

A few of the most commonly used such systems are

- 1)APACHE^{12,13,14,15}
- 2)SOFA^{12,13,14,15}
- 3)Simplified acute physiology score(SAPS⁸)
- 4) Mortality probability model(MPM)
- 5) Therapeutic intervention scoring system(TISS¹⁰)
- 6)Logistic organ dysfunction score(LODS¹¹)
- 7) Multiorgan dysfunction score(MODS)

Among these SOFA, MODS and LODS are organ dysfunction scoring system. APACHE, SAPS II and MPM II are general severity scoring systems.

APACHE SCORING SYSTEM

Simplified acute physiology score(SAPS):

Mortality probability model:

(Mortality Probability Models)

Variables (Ppt)	Values (1 if yes, 0 otherwise)	Beta
Medical or unscheduled surgery admission	<input type="checkbox"/>	1
Metastatic neoplasm	<input type="checkbox"/>	1
Cirrhosis	<input type="checkbox"/>	1
Chronic renal insufficiency	<input type="checkbox"/>	1
C.P.R. prior to admission	<input type="checkbox"/>	1
Coma (Glasgow 3-5) (Help)	<input type="checkbox"/>	1
Heart Rate >= 150	<input type="checkbox"/>	1
Systolic Blood Pressure <= 90 mmHg	<input type="checkbox"/>	1
Acute renal insufficiency	<input type="checkbox"/>	1
Cardiac dysrhythmia	<input type="checkbox"/>	1
Cerebrovascular incident	<input type="checkbox"/>	1
Gastrointestinal bleeding	<input type="checkbox"/>	1
Intracranial mass effect	<input type="checkbox"/>	1
Mechanical ventilation	<input type="checkbox"/>	1
Age	<input type="text" value="0.0057"/>	0.0057
Predicted Death rate :		Legit = 0
		Legit = Sum (values * beta) + age * 0.03057 - 5.86216
		Predicted death rate = $e^{Legit} / (1 + e^{Legit})$

THERAPEUTIC INTERVENTION SCORING SYSTEM:

(Therapeutic Intervention Scoring System - Update 1983)

4 points	3 points
a. Cardiac arrest and/or counter shock within past 48 h	a. Central n/ hypernatremation (includes renal, cardiac, hepatic failure fluid)
b. Controlled ventilation with or without PEEP	b. Pacemaker on standby
c. Controlled ventilation with intermittent or continuous muscle relaxants	c. Chest tubes
d. Balloon tamponade of varices	d. IMV or assisted ventilation
e. Continuous arterial infusion	e. CPAP
f. Pulmonary artery catheter	f. Concentrated K ⁺ infusion via central catheter
g. Atrial and/or ventricular pacing	g. Nasotracheal or orotracheal intubation
h. Hemodialysis in unstable patient	h. Blood retransfusion (autologous)
i. Peritoneal dialysis	i. Complex metabolic balance (frequent intake and output)
j. Induced hypothermia	j. Multiple ABG, bleeding, and/or STAT studies (> 4 total)
k. Pressure-activated blood infusion	k. Frequent infusion of blood products (> 6 units/24 h)
l. Graft	l. Beta n medication (noncardiac)
m. Intracranial pressure monitoring	m. Vasopressor drug infusion (> 1 drug)
n. Platelet transfusion	n. Continuous antiarrhythmia infusions
o. IABP (Intra Aortic Balloon Pressure)	o. Cardioversion for arrhythmia (not defibrillation)
p. Emergency operative procedures (within past 24 h)	p. Hypothermia blanket
q. Lapar of acute GI bleeding	q. Arterial line
r. Emergency endoscopy or bronchoscopy	r. Acute digitalization - within 48 h
s. Vasopressor drug infusion (> 1 drug)	s. Measurement of cardiac output by any method
	t. Active diuresis for fluid overload or cerebral edema

LOGISTIC ORGAN DYSFUNCTION SCORE:

Logistic organ dysfunction score was developed in 1996, using data collected from various ICU(77). A score was made with the evaluation of 6 organ systems and 12 variables were analysed. The grading is between 0 and 5 for each organ. The worst value of score obtained in the first 24 hours of icu stay is documented. Though it is not much useful in serial assessment of patients it can assess improvement or worsening of organ dysfunction.

All these existing severity scoring systems utilise a large number of variables and involves a large number of blood investigations which may not be available in all centres except for a sophisticated icu set up. In an emergency it is difficult to do all such investigations and do a detailed assessment. Also it is so costly to follow up patients with all such investigations. This warranted the need for a simplified scoring system for easy evaluation of patients

VII. Sofa Scoring System

The SOFA score was developed in 1994, by the European Society of Intensive Care and Emergency Medicine, to provide a means to describe the degree of organ failure in individuals and groups of ICU patients. Vincent et al published the SOFA score and proved that infected patients had more risk of organ dysfunction than the non infected (78)

Sequential Organ Failure Assessment Sofa Score

Organ system	Score 0	Score 1	Score 2	Score 3	Score 4
Respiratory Pa O ₂ /FiO ₂	> 400	≤ 400	≤ 300	≤ 200	≤ 100
Serum creatinine mg/dl	< 1.2	1.2 to 1.9	2.0 to 3.4	3.5 to 4.9	>5
Serum bilirubin mg/dl	< 1.2	1.2 to 1.9	2.0 to 5.9	6.0 to 11.9	>12
Cardiovascular hypotension	No hypotension	MAP <70mmHg	Dopamine ≤ 5 µg/kg per min Epinephrine ≤ 0.1 µg/kg per min Dobutamine [any dose]	Dopamine >5 µg/kg per min or Epinephrine > 0.1 µg/kg per min Nor-epinephrine ≤ 0.1 µg/kg per min	Dopamine >15 µg/kg per min or Epinephrine > 0.1 µg/kg per min Nor-epinephrine > 0.1 µg/kg per min
Platelet/ml	>150	≤ 150	≤ 100	≤ 50	≤ 20
GCS	15	13 – 14	10 – 12	6 – 9	< 6

SOFA scoring system analyses 6 variables namely

- 1) Pao₂/Fio₂ ratio(for respiration)
- 2) Platelets(for coagulation)
- 3) Bilirubin(for liver function)
- 4) Creatinine(for renal function)
- 5) Glasgow coma scale(to assess level of consciousness)
- 6) Blood pressure and the need for inotropic support.

A score of 0 to 4 is given for each of these six variables and a score is obtained using sum total value of each of these parameters. The worst values oneach day are recorded and organ function total score canthus be monitored over time(79)

The increasing SOFA score and the mean SOFA score are highly useful in assessing prognosis and risk stratification of patients(80 - 82).

Parameters:

Pao₂/Fio₂ ratio:

It is simply defined as the amount of inspired oxygen that reaches the blood. It is impaired in case of lung injury due to any cause. It is also called carrico index. A Pao₂/Fio₂ ratio of less than or equal to 200 is required for the diagnosis of acute respiratory distress syndrome according to the AECC criteria(83).

Pao₂ is the partial pressure of oxygen in the arterial blood. It is measured in millimetres of mercury(mmHg) or torr units. It is measured by an arterial blood gas analyser(ABG). Normal Pao₂ is 75 – 100mmHg.

Fio₂ is the percentage of oxygen in the inspired mixture of air. Normal Fio₂ in inspired atmospheric air is 0.21(21%). In a mechanical ventilator it is usually set as 30 – 40%. In a mechanically ventilated patient 100% oxygen is not administered due to high risk of oxygen toxicity.

Kerbing and his co workers assessed the clinical relevance of variation in Pao₂/Fio₂ ratio(84). They demonstrated the clinical utility of this parameter.

The Pao₂/Fio₂ scores are

- Score 0 – more than 400
- Score 1 – less than or equal to 400
- Score 2 – less than or equal to 300
- Score 3 – less than or equal to 200
- Score 4 – less than or equal to 100.

VIII. Creatinine

In SOFA scoring serum creatinine values are estimated periodically to assess the renal function over a period of time till the patient is in icu. Creatinine is a breakdown product of creatine phosphate, which is found in muscle. Each day 1-2 % of muscle creatine is converted to creatinine. It is excreted both by glomerular filtration and tubular secretion. Rise in serum creatinine is a marker of damage to nephrons. Normal serum

values are 0.7 – 1.2(males) and 0.5 – 1.0(females). Impaired renal function can be due to pre renal, renal or post renal causes. Some of the commonest causes of renal failure are

- 1) Severe dehydration
- 2) Acute pyelonephritis
- 3) Diabetes
- 4) Hypertension
- 5) Renal calculi
- 6) Hemorrhagic fevers
- 7) Disseminated intravascular coagulation
- 8) Autoimmune and other connective tissue disorders.

The scores used for creatinine in SOFA score are,

Score 0 – less than 1.2 mg/dl

Score 1 – 1.2 to 1.9mg/dl

Score 3 – 2.0 to 3.4mg/dl

Score 4 – 3.5 to 4.9mg/dl

Score 5 – more than 5mg/dl

Platelet count

Platelet count is used as a parameter in SOFA score to assess coagulation function and its impairment during disease states. The coagulation mechanism involves activation, adhesion and aggregation of platelets in response to a stimuli, say an injury or infection. Both platelet number and function should be adequate for this function to be intact. Coagulation cascade is one of the best understood system in humans(85). Primary hemostasis is mainly due to platelets, which is characterised by formation of platelet plugs(86). Activated platelets release stored granules into the blood. These granules contain

- 1) Serotonin
- 2) ADP
- 3) Platelet activating factor
- 4) Platelet factor 4
- 5) Vonwillebrand factor
- 6) Thromboxane A₂

All these substances when released into the blood stream activate additional platelets. These steps lead on to the activation of various enzymes of coagulation cascade resulting in activation of clotting factors, which is called secondary hemostasis.

Various systemic illness can be associated with a decreased platelet count.

It can be either due to decreased production, increased destruction or impairment of platelet function.

Causes of thrombocytopenia:

- 1) Vitamin B12 and folate deficiencies
- 2) Infections like HIV disease
- 3) Leukemias
- 4) Disseminated intravascular coagulation
- 5) Thrombotic thrombocytopenic purpura
- 6) Viral infections
- 7) Gram negative septicaemia
- 8) Heparin induced thrombocytopenia
- 9) Radiation induced bone marrow suppression
- 10) Drug toxicity

The scores used for platelet count in SOFA are

Score 0 - $>150 \times 10^3/\text{mm}^3$

Score 1 - $<150 \times 10^3/\text{mm}^3$

Score 2 - $<100 \times 10^3/\text{mm}^3$

Score 3 - $<50 \times 10^3/\text{mm}^3$

Score 4 - $<20 \times 10^3/\text{mm}^3$

Bilirubin:

Bilirubin levels are measured as a marker of liver function. Liver plays a pivotal role in regulating a large number of metabolic pathways in the body. Bile is secreted in the hepatic lobules and it drains ultimately into the bile duct after traversing through canaliculi, small bile ducts and larger bile ducts(87).

It consists of bile acids, phospholipids and unesterified cholesterol. Daily bile output from the liver is 500 – 600ml. It consists of two fractions. Direct or hydrophilic type and indirect or hydrophobic type. Conjugation of indirect to direct fraction takes place in the liver, which is an enzyme mediated process. This whole array of steps in the formation to elimination of bile can be disturbed in disease states. Elevations in bilirubin levels can be used to assess liver function over time, which helps in predicting worsening or improvement of liver function in an ICU patient.

Some of the conditions in which bilirubin levels are raised are,

- 1) Acute hepatitis
- 2) Alcoholic liver disease
- 3) DIC and septicaemia
- 4) Hepatocellular carcinoma
- 5) Autoimmune and connective tissue disorders
- 6) Storage disorders
- 7) Haemolytic jaundice
- 8) Obstructive jaundice
- 9) Congenital liver enzyme abnormalities
- 10) Massive blood transfusion

Most biologic system in the body gets affected by excess bilirubin in blood. Normal bilirubin levels in blood are 1.0 to 1.5mg/dl(88). Upto 30% of that is direct or conjugated bilirubin, which equals 0.3 mg/dl. It is water soluble. The rest of the

Fraction is insoluble in water and it is called unconjugated bilirubin. This is the toxic form of bilirubin, which when accumulates in excess gets deposited in the brain especially in the basal ganglia which may lead to seizures or neurological deficits.

The scores used for bilirubin are

Score 0 - < 1.2mg/dl

Score 1 – 1.2 to 1.9mg/dl

Score 2 – 2.0 to 5.9mg/dl

Score 3 – 6.0 to 11.9mg/dl

Score 4 - >12 mg/dl

Glasgow coma scale:

It gives a reliable and objective way of recording the conscious state of a person. It is easy to use both for the medical and paramedical personnel for initial as well as continuing medical assessment in an ICU. It has value in predicting ultimate outcome. Three types of responses are assessed.

GCS scale was used initially only for head injury patients. Now it is being used both for acute medical and trauma patients. It is also being used to monitor patients in ICU in a seriously ill state(89). The scale was published in 1974 by Graham Teasdale and Bryan J. Jennett, at the University of Glasgow Institute of Neurological Sciences. Both of them were neurosurgeons.

Glasgow Coma Scale		
Eye Response	Open Spontaneously	4
	Open to Verbal command	3
	Open in response to pain	2
	No response	1
Verbal Response	Talking / Orientated	5
	Confused speech / Disorientated	4
	Inappropriate Words	3
	Incomprehensible sounds	2
	No response	1
Motor Response	Obeys commands	6
	Localizes pain	5
	Withdraws from pain	4
	Abnormal flexion	3
	Extension	2
	No response	1

The highest possible score is 15, that is in a fully awake person. The lowest possible score is 3, which means deep coma or death.

The scores used for GCS in SOFA are

- Score 0 – 15
- Score 1 – 13 to 14
- Score 2 – 10 to 12
- Score 3 – 6 to 9
- Score 4 - <6

Blood pressure:

Hypotension and shock may occur as a final consequence of any organ dysfunction. Maintaining an adequate blood pressure is essential for perfusion and oxygenation of vital organs. In short, shock is a clinical syndrome resulting from inadequate tissue perfusion of any cause, resulting in an imbalance between the requirement and supply of oxygen, causing cellular dysfunction. This goes on and on like a vicious cycle resulting in cellular death and multi organ dysfunction.

In an ICU setting cardio respiratory complications are the most common cause of circulatory collapse and shock

Classification of shock:

Hypovolemic	Septic
Traumatic	Hyperdynamic(early)
Cardiogenic	Hypodynamic(late)
Intrinsic	Neurogenic
Compressive	Hypoadrenal

The scores used for blood pressure in SOFA are

- Score 0 – No hypotension
- Score 1- Mean arterial pressure <70
- Score 2 – dopamine infusion ≤ 5 or requiring dobutamine
- Score 3 – dopamine infusion ≥ 5 or requiring nor epinephrine ≤ 0.1
- Score 4 – dopamine infusion > 15 or or requiring nor epinephrine 0.1

SOFA scoring system, because of its simplicity and easy applicability, has been widely used in ICU setting. This system has also been evaluated in many ICUs and found to be useful as a simple bedside tool. The scoring system was applied irrespective of underlying disease, with an aim of showing the importance of this scoring system.

Also comorbidities like diabetes and hypertension did not influence the outcome much, since there is no much statistical significance.

But, the need for mechanical ventilation clearly predicted mortality outcome since, the patients who were ventilated showed a higher mortality rate compared to those who did not require ventilator support, as evidenced by the statistically significant p value < 0.001.

Patients belonging to low socioeconomic status showed higher mortality rate(52.3%) compared to their counterparts belonging to high socioeconomic state(42.9%). Though the values are not statistically significant in our study, to prove the association.

There is a significant increase in mortality rate when the SOFA score is above 12. There is a steep rise in the mortality curve at this value. Admission SOFA, 48 hours SOFA and 96 hours SOFA are all statistically significant with a p value < 0.001.

Delta SOFA which is the difference in values over a period of time is also statistically significant in our study. There is a strong evidence that, patients whose delta SOFA values when increased from the previous value, there is a greater chance that the patient may succumb to his illness.

Mean SOFA value also proved to be an independent predictor of mortality. A value of more than 11 showed a sharp rise in mortality.

Total SOFA score is also statistically significant in predicting mortality, irrespective of the disease state. A total SOFA score of more than 33.5 is associated with increased mortality.

Limitations of study are limited number of subjects involved in the study. A larger study population will give more precise results. SOFA scoring system for every individual disease group may give a prognostic guidance for that individual disease.

In summary SOFA score is very useful in predicting mortality in critically ill patients, since there is a strong correlation between a rise in the score and mortality in all stages of admission.

IX. Conclusion

- There is a strong association between rise in SOFA score and mortality.
- Mechanically ventilated patients have a high risk of mortality compared to non ventilated patients.

- There is no significant association between comorbidities like diabetes and hypertension with mortality outcome.

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