pISSN 2349-3305 | eISSN 2349-2902

# **Research Article**

DOI: http://dx.doi.org/10.18203/2349-2902.isj20150682

# Analysis of incidence and the value of SOFA and MOD scoring in predicting the outcome in acute mesenteric ischemia

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**Received:** 01 September 2015 **Revised:** 13 September 2015 **Accepted:** 14 September 2015

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## **ABSTRACT**

**Background:** Acute mesenteric ischemia (AMI) is defined as a sudden loss of blood supply to visceral tissue, and it potentially results in intestinal infarction. AMI is an uncommon (1-2 per 1000 hospital admissions) but highly complex clinical problem. Mortality from AMI remains high despite an aggressive approach consisting of early diagnosis, restoration of arterial perfusion, resection of nonviable intestine, second-look laparotomy, and supportive intensive care with an average from published reports ranging from 30% to 65%. Moreover, most series have not shown any improvement in mortality over the last 2 decades, regardless of the therapeutic approach applied. While major advances in the technology and availability of imaging modalities have made earlier diagnosis and treatment more feasible, this has been counterbalanced by the contemporary AMI patient presenting at an advanced age and with more severe underlying comorbidities. Likewise, mesenteric ischemia remains a highly morbid condition. According to the literatures, early diagnosis, resection of the unviable bowel, recovery of adequate blood flow, second-look laparotomy, and supportive intensive management are the basis of appropriate management.

**Methods:** The aim of the study was to analyse the incidence of AMI in our institution during April 2011– September 2013 and to study the demographics of that population and to compare the efficacy of SOFA vs MOD scoring in predicting the outcome of the patient with AMI. Treatment, consisting of surgical embolectomy or bypass grafting, has also yielded only modest improvements; some have championed an endovascular-first treatment paradigm. Moreover, accurate perioperative assessment of the risk of in-hospital mortality in patients with AMI is poorly defined.

**Results:** In our study 60.7% of the patients presented to the casualty within 24hrs of symptoms. Patients who presented later than 24hrs (39.3%) had a higher mortality rate of 60.7%. When SOFA score increased to greater than 13 all patients succumbed to the disease with a mortality of 100% in the groups with SOFA score 13-16 and 17-20. When MOD score increased to greater than 12 all patients succumbed to the disease with a mortality of 100% in the groups with MOD score 13-16 and 17-20. On comparing the predictive outcome of SOFA vs MOD scoring system, both had similar results in predicting mortality (p value < 0.0001).

**Conclusions:** To conclude, both SOFA and MOD scoring systems have similar values in predicting mortality for acute mesenteric ischemia. Other considerations such as age, comorbid illness DM /HTN/ /CAD /CVA do influence the outcome.

Keywords: Acute mesenteric ischemia, SOFA, MOD

#### INTRODUCTION

Mesenteric ischemia in chronic and acute forms carries a high morbidity and mortality rate, each increased by frequent delays in diagnosis. Based on the underlying causes, Acute mesenteric ischemia (AMI) can be categorized into 4 types: major arterial embolism (MAE), arterial thrombosis (MAT), non-occlusive major mesenteric ischemia (NOMI), and mesenteric venous thrombosis (MVT). Although laboratory studies have low specificity for diagnosing mesenteric ischemia, CT angiography and traditional angiography remain sensitive diagnostic imaging techniques. 2-4 Once diagnosed. prompt surgical therapy and anticoagulation remain cornerstones of therapy.<sup>5</sup> Although prosthetic grafts in an antegrade or retrograde fashion provide the most durable means of repair, endovascular stenting and angioplasty have high early success rates and may be preferable for patients who have prohibitive risk factors for open surgery and who do not have evidence of infarcted bowel.6 In cases in which bowel viability is questionable, multiple options including second-look operations are available and should be used, despite the relative lack of data showing improved outcomes.<sup>7,8</sup> Emerging diagnostic technologies may permit earlier diagnosis, allowing urgent treatment for mesenteric ischemia and potentially reducing the high mortality rates currently seen with this condition.

# Assessment of severity and outcome of critical illness

The advent of evidence based medicine in the past decade has made the Cartesian premise that 'if something can't be quantified, its existence should be questioned', even more pertinent in the practice of modern medicine. Intensive care has developed over the past 30 years with little rigorous scientific evidence about what is, or is not, clinically effective. The intricacies involved in conducting randomized clinical trials in ICU set up have left the care provider with no choice but to resort to observational methods as an alternative. Evolution of majority of scoring systems is from multivariate regression analysis applied to large clinical data-bases to identify the most relevant factors for prediction of mortality.

Scoring systems have been developed in response to an increasing emphasis on the evaluation and monitoring of health services. These systems enable comparative audit and evaluative research of intensive care. The ideal components of a scoring system are data collected during the course of routine patient management that are easily measured, objective, and reproducible. Scoring systems, developed in the 1980s are applicable to heterogeneous groups of critically ill patients. <sup>10</sup>

The evaluation of severity of illness in the critically ill patient is made through the use of severity scores and prognostic models. Severity scores are instruments that aim at stratifying patients based on the severity of illness,

assigning to each patient an increasing score as their severity of illness increases. Prognostic models, apart from their ability to stratify patients according to their severity, predict a certain outcome (usually the vital status at hospital discharge) based on a given set of prognostic variables and a certain modelling equation.

## Requirements of a good scoring system

- 1. Simple, reliable, easily obtainable
- 2. Wide patient applicability-different diagnoses all age groups all levels / types of ICU's
- High sensitivity/specificity- i.e. should be a good discriminator
- 4. Stimulates improvement in outcomes.
- 5. Independent of treatment.
- 6. Physiological parameters, optimal time is unclear
- 7. Number of criteria is unclear.

#### Limitations

- 1. Limit treatment of individuals
- 2. Result in nihilistic therapy
- 3. Outweigh clinical judgement
- 4. Depersonalize therapy

# Sequential organ failure assessment score

The Sequential Organ Failure Assessment score, or just SOFA score, is used to track a patient's status during the stay in an intensive care unit (ICU). It is one of several ICU scoring systems.

The SOFA score is a scoring system to determine the extent of a person's organ function or rate of failure. The score is based on six different scores, one each for the respiratory, cardiovascular, hepatic, coagulation, renal and neurological systems.

Both the mean and highest SOFA scores being predictors of outcome. An increase in SOFA score during the first 24 to 48 hours in the ICU predicts a mortality rate of at least 50% up to 95%. Scores less than 9 give predictive mortality at 33% while above 11 can be close to or above 95%.

The score tables below only describe points-giving conditions. In cases where the physiological parameters do not match any row, zero points are given. In cases where the physiological parameters match more than one row, the row with most points is picked.

# Multi organ dysfunction score

The multi-organ dysfunction score (MODS) is used in critically ill patients admitted to intensive care units to assess disease severity independently of diagnosis. Single organ failure can be separated from multiorgan failure by the MODS. Moreover, a moderate clinical presentation reflected by mild dysfunction in several organ systems

without fulfilling any criteria for severity as defined by the World Health Organization can also be expressed more precisely by the MODS.

This score can be useful in various conditions:

- Clinical field workers can evaluate the patients' severity and identify children at risk to refer them for hospitalization;
- 2. Physicians can allocate more resources to patients with a high score on admission before their condition deteriorates;
- 3. The MODS may also be useful for researchers, who often struggle to select appropriate patients for their research.

- 4. Now from table 2: The PO<sub>2</sub>/FIO<sub>2</sub> ratio is calculated without reference to the use or mode of mechanical ventilation and without reference to the use or level of PEEP.
- 5. The serum Creatinine level is measured in mmol/liter, without reference to the use of dialysis.
- 6. The serum bilirubin level is measured in mmol/liter
- 7. The PAR is calculated as the product of the heart rate and arterial (central venous) pressure, divided by the mean arterial pressure.
- 8. The platelet count is measured in platelets/mL 10-3
- 9. The Glasgow Coma Score is preferably calculated by the patient's nurse and is scored conservatively (for the patient receiving sedation or muscle relaxants, normal function is assumed unless there is evidence of intrinsically altered mentation).

Table 1: SOFA score.

SOFA Score	0	1	2	3	4
Respiration PaO/FIO <sub>2</sub> (mm Hg) SaO <sub>2</sub> /FIO <sub>2</sub>	>400	<400 221-301	<300 142-220	<200 67-141	<100 <67
Coagulation Platelets 10 <sup>3</sup> /mm <sup>3</sup>	>150	<150	<100	<50	<20
Liver Bilirubin (mg/dL)	<1.2	1.2-1.9	2.0-5.9	6.0-11.9	>12.0
Cardiovascular Hypotension	No hypotension	MAP < 70	Dopamine < 1 = 5 or dobutamine (any)	Dopamine > 5 or norepinephrine < = .1	Dopamine > 15 or norepinephrine < .1
CNS Glasgow Coma Scale	15	13-14	10-12	6-9	<6
Renal Creatinine (mg.dL) Or urine output (ml/d)	<1.2	1.2-1.9	2.0-3.4	3.5-4.9 or <500	>5.0 or <200

Table 2: MOD score.

Multiple Organ Dysfunction Score						
Organ System Values	MOD Score					Normal value Range
	0	1	2	3	4	
Hematologic: Platelet Count (x10 <sup>3</sup> /mm <sup>3</sup> or 10 <sup>9</sup> /L)	>120	81-120	51-80	21-50	<u>&lt;</u> 20	>120
Hepatic: Serum Bilirunin (mol/L)	<u>&lt;</u> 20	21-60	61-120	121-240	>240	<u>&lt;</u> 20
Renal: Serum Creatinine (mol/L)	<u>&lt;</u> 100	101-200	201-350	351-500	>500	<u>≤</u> 100
Cardiovascular : PAR	<u>&lt;</u> 10	10.1.1-	15.1-20	21-30	>30	<u>≤</u> 10
Glasgow Coma Score	<u>15</u>	13-14	10-12	7-9	<u>&lt;</u> 6	<u>15</u>
Respiratory: PO <sub>2</sub> /FiO <sub>2</sub>	>300	226-300	151-225	76-150	<u>&lt;</u> 75	>300

#### **METHODS**

The study was approved by the institutional ethics committee.

- This is a prospective study with a study population of 56 patients diagnosed to have Acute Mesenteric Ischemia admitted in the Department of General Surgery from April 2011

  September 2013. A detailed history and clinical examination details were obtained.
- 2. All patients underwent (Contrast Enhanced CT whole abdomen / X-ray abdomen / CT angiography) as pre-operative imaging.
- Parameters compared in the study include demographic information, clinical presentation, concomitant illness, surgical procedure, postoperative mortality.
- 4. Two prognostic outcome scores, Sequential organ failure assessment (SOFA) and multiple organ dysfunctions scoring (MOD) were compared to predict the outcome of acute mesenteric ischemia.
- 5. Postoperatively patient was started on injection Heparin 5000 units IV as loading dose, followed by injection heparin 5000 units IV 6th hourly as maintenance dose. Once the patient is started on oral feeds tablet acitrom 4mg was given once daily. Injection heparin is slowly tapered and stopped after 48 hours. Tablet acitrom dose is adjusted to maintain the INR between 2-3. 11

## Inclusion criteria

- All patients diagnosed to have acute mesenteric ischemia were included.
- 2. Patients between 18 80 years of age were included in the study.
- 3. Patients who underwent nonsurgical management were also included in the study.

#### Exclusion criteria

- 1. Patients operated previously for the same complaint were excluded.
- Patients with AMI secondary to mechanical obstruction or adhesion and history of disease longer than 4 weeks were excluded from the study.
- 3. Patients with Non-occlusive mesenteric ischemia were excluded from the study. The radiologic findings are diffuse change of intestine including bowel distension, intestinal wall thickening and mesenteric oedema, diffuse vasoconstriction of mesenteric vessels with evidence of luminal occlusion in angiography.

#### **RESULTS**

Our study population constituted of 56 patients who were diagnosed to have Acute Mesenteric Ischemia. Of this 33 were male and 23 were female.

Table 3: SOFA scoring calculated within 24 hrs of admission.

SOFA Score	No. of Patients	ALIVE	Dead
0-4	0	0	0
5-8	10	8	2
9-12	32	20	12
13-16	11	0	11
17-20	3	0	3
21-24	0	0	0

Patients were stratified as shown with class intervals of 4. Patients were thus stratified into 6 groups as per the class interval. The highest SOFA score was 19 and the lowest sofa score of 7 was observed in our study population. We had a maximum of 32 patients with a SOFA score of 9-12 and 12 patients died with 9-12 SOFA score. However, when SOFA score increased to greater than 13 all patients succumbed to the disease with a mortality of 100% in the groups with SOFA score >13 (Table 3).

Table 4: SOFA scoring calculated within 24 hrs of admission.

MOD Score	Total	Alive	Dead
0-4	0	0	0
5-8	13	11	2
9-12	32	17	15
13-16	9	0	9
17-20	2	0	2
21-24	0	0	0

Patients were stratified as shown with class intervals of 4. Patients were thus stratified into 6 groups as per the class interval. The highest MOD score was 17 and the lowest MOD score of 6 was observed in our study population. We had a maximum of 32 patients with a MOD score of 9-12 and a maximum death of 15 patients (46.8%) with the 9-12 MOD score. However when MOD score increased to greater than 12 all patients succumbed to the disease with a mortality of 100% in the groups with MOD score 13-16 and 17-20 (Table 4).

Table 5: SOFA vs MOD.

Scoring	Mortality	Total	Mean	P value
SOFA	Alive (28)	56	8.82	.0001
SUFA	Dead (28)	56 -	12.86	.0001
MOD	Alive (28)	56	8.64	.0001
	Dead(28)		12.11	.0001

On comparing the predictive outcome of SOFA vs MOD scoring system, both had similar results in predicting mortality (p value <0.0001) (Table 5).

The patients with a mean SOFA score of 8.82 survived their disease. But patients with a mean SOFA score of 12.86 succumbed to the disease and this was statistically significant.

The patients with a mean MOD score of 8.64 survived their disease. But patients with a mean MOD score of 12.11 succumbed to the disease and this was statistically significant.

## **DISCUSSION**

At the end of analysis of data, we reviewed literature and found two comparable manuscripts. One was study done by Ji Ho Park et al to determine the prognostic factors and risk scorings that have impact on the in hospital mortality of AMI between (January 2001 - June 2009) by the Department of Surgery, Gyeongsang National University, Post Graduate School of Medicine, Jingu, Korea and the other study was conducted by Evan J. Ryer et al a 20 year period of (January 1990 to January 2010) in division of vascular and endovascular surgery and Department of Bio-statistics and Epidemiology, Mayo Clinic. 12,13 SOFA score was compared with study to determine the usefulness of measurement of SOFA score for prediction of mortality conducted by Erasme University hospital, free university of Brusels, Belgium.<sup>14</sup> Our study conducted in Sri Ramachandra University is compared with study done by Ryer et al and Ji Ho Park et

## Demographic data

Our study population constituted of 56 patients who were diagnosed to have Acute Mesenteric Ischemia. Of this 33 were male and 23 were female. The male preponderance (59%) over females (41%) noted in our study was also observed by Ji Ho Park et al. But Ryer et al found a female preponderance. A review of literature says that male preponderance is more often observed.

In our study on acute mesenteric ischemia, was found to be more common in 5th decade which was comparable to the study done by Ji Ho Park et al. In 7th decade, there were 11 patients, 7 male and 4 females. However the study done by Ryer et al showed the incidence was common in the 6<sup>th</sup> decade. The mortality in this elderly population, however was 63.6% (Table 6). 15

# Comorbids

The incidence of Diabetes was very high in our study group. It is very well known that the prevalence of Diabetes is already on the increase in India and this is reflected in our study population as well. We had a similar increase in the incidence of hypertension 83.9%

compared to 32.5% seen by Ji Ho Park et al. 28.6% were hypertensive, 12.5% were diabetic, 19.6% had coronary artery disease, 7.1% had cerebro vascular accident. Very often these co-morbidities coexisted. DM + HTN were seen in 28.6%. CVA + HTN were found to coexist in 5.4%. On the other hand, we had a lower incidence of CAD+DM (3.6%), CAD+HTN (16.1%) & DM (3.6%).<sup>20</sup>

Table 6: Age and mortality.

			Mortality		Total
			Alive	Death	
Age	<40	Count	9	7	16
Group	Years	%	32.1%	25.0%	28.6%
	41-60	Count	15	14	29
	Years	%	53.6%	50.0%	51.8%
	>60	Count	4	7	11
	years	%	14.3%	25.0%	19.6%
Total		Count %	28 100.0%	28 100.0%	56 100.0 %

Table 7: Presentation of symptoms and mortality.

			Mortali	ity	Total
			Alive	Death	
Duration	<24	Count	23	11	34
in days	Hours	%	82.1	39.3%	60.7%
			%		
	>24	Count	5	17	22
	Hours	%	17.9	60.7%	39.3%
			%		
Total		Count	28	28	56
		%	100.0	100.0%	100.0
			%		%

We had a maximum of 32 patients with a SOFA score of 9-12 and a maximum death of 12 patients with the same SOFA score. However when SOFA score increased to greater than 13 all patients succumbed to the disease with a mortality of 100% in the groups with SOFA score 13-16 and 17-20. This stratification was designed by us to see if there was a correlation between SOFA score and mortality.

In our study, patients with SOFA scores >13 had a 100% mortality. However Erasme et al had reported mortality rates of >80% when SOFA score was >11. We had a maximum of 32 patients with a MOD score of 9-12 and a maximum death of 15 patients (46.8%) with the 9-12 MOD score. However when MOD score increased to greater than 12 all patients succumbed to the disease with a mortality of 100% in the groups with MOD score 13-16 and 17-20. This stratification was designed by us to see if there was a correlation between MOD score and mortality.

Table 8: Comorbids.

		Frequency	Percent	Valid Percent	<b>Cumulative Percent</b>
Valid	DM	7	12.5	12.5	12.5
	HTN	16	28.6	28.6	41.1
	DM+HTN	16	28.6	28.6	69.6
	DM+CAD	2	3.6	3.6	73.2
	DM+CVA	1	1.8	1.8	75.0
	HTN+CAD	9	16.1	16.1	91.1
	HTN+CVA	3	5.4	5.4	96.4
	DM+HTN+CAD	2	3.6	3.6	100.0
	TOTAL	56	100.0	100.0	

On comparing the predictive outcome of SOFA vs MOD scoring system, both had similar results in predicting mortality (p value <0.0001).

In our study population of 56 patients, 51 patients underwent surgical treatment (resection anastomosis 53.6%, Ostomy 30.4%, vascular bypass 7.1%, 5 patients were managed conservatively out of which 2 patients succumbed to admission. 20,21 the disease immediately after

In our study population of 56 patients, we found an equal incidence of survival and death. Out of the 28 patients survived 13 patients had no complications, 12 had wound infection, 3 had wound dehiscence requiring secondary suturing and wound care management.

Since the number of patients was low, it was statistically difficult to draw out precise results and the accuracy was lacking as well.

Table 9: Erasme vs our study.

STUDY	SCORE	MORTALITY
Erasme	>11	80%
Our study	>13	100%

### **CONCLUSION**

The relative infrequency of acute mesenteric ischemia and the varied clinical presentation make it difficult to undertake randomized or case control trials. It is often difficult to differentiate arterial and venous occlusion and the findings at laparotomy are only of gangrenous bowel.

There were more males then females presenting with Acute Mesenteric Ischemia. The maximum clustering was seen in 5th decade. Superior Mesenteric Artery was the vessel most often occluded in Acute Mesenteric Ischemia in our population.

Patients with SOFA score greater than 13 had a mortality of 100% and MOD score greater than 12 also had 100% mortality. Since the number of patients was low, it was statistically difficult to draw out precise results and the accuracy was lacking as well. To conclude, both SOFA and MOD scoring systems have similar values in predicting mortality for acute mesenteric ischemia. Other considerations such as age, comorbid illness DM /HTN/ /CAD /CVA do influence the outcome.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

institutional ethics committee

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**Cite this article as:** Viswanathan R, Vivekanandan S, Ravi A. Analysis of incidence and the value of SOFA and MOD scoring in predicting the outcome in acute mesenteric ischemia. Int Surg J 2015;2:480-6.