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Dr. Sandhya Chauhan
Professor, Department of Pediatrics, Shri Ram Murti Smarak Institute of Medical Sciences & R.C. Bareilly, Uttar Pradesh, India

Dr. Atul Kumar
Associate Professor, Department of Pediatrics, Shri Ram Murti Smarak Institute of Medical Sciences & R.C., Bareilly, Uttar Pradesh, India

Dr. Rahul Jaiswal
Senior Resident, Department of Pediatrics, Shri Ram Murti Smarak Institute of Medical Sciences & R.C. Bareilly, Uttar Pradesh, India

Corresponding Author:
Dr. Rahul Jaiswal
Senior Resident, Department of Pediatrics, Shri Ram Murti Smarak Institute of Medical Sciences & R.C. Bareilly, Uttar Pradesh, India

Use of PRISM III scoring for mortality prediction in a tertiary care centre of Rohilkhand region

Dr. Sandhya Chauhan, Dr. Atul Kumar and Dr. Rahul Jaiswal

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Abstract
Objective: Paediatric Risk of Mortality (PRISM III) score is a frequently used, physiologically based severity of illness measure, commonly used to control for severity of illness. It is significantly associated with morbidity and mortality and could be used to simultaneously estimate morbidity and mortality risk within the first 24 hours of admission in PICU. Predicting the outcome of any serious illness is of utmost importance for the planning and assessment of interventions in the health-care system, as well as for providing a prognosis for individual cases to the caregivers. Therefore, this study intends to evaluate the efficacy of PRISM III score in prediction of disease specific mortality rate in PICU.
Methods: In this prospective, hospital based observational study, 107 children fulfilled the required criteria and were enrolled. PRISM III score was calculated using variables in the first 24 hours after admission. Outcome was noted as survivors and non-survivors.
Results: A total of 107 patients were enrolled in the study. Out of 107 patients, 27 were non-survivors, with the mortality rate of 25%. The median PRISM III score was not found to be significantly different between survivors and non-survivors but the use of PRISM III score along with the need of mechanical ventilation and ionotropic support in the first 24 hrs of admission significantly predicted mortality. Overall, PRISM III score did help in severity assessment at the time of admission and the need of mechanical ventilation and ionotropic support.
Conclusion: In patients with hepatobiliary and CNS dysfunction PRISM III – 24 score could not predict mortality but it can be applied for severity assessment at the time of admission to PICU. PRISM III- 24 score proved to be a good predictor of mortality for children admitted with septicaemia, nephrology, respiratory dysfunction.

Keywords: PRISM score, PICU, mortality, paediatric intensive care unit

Introduction
A Pediatric intensive care unit (PICU) in a developing country has to provide the best possible care to the sick children taking into account the large patient load, shortage of resources, lack of manpower etc. while ensuring a proper functioning [1].
In recent times, new medical and social pressures related to intensive care have simultaneously emerged [2]. Prognostication is a method relevant to these pressures that highlights the natural course of disease rather than other traditional avenues of injury such as mechanisms of disease. When clinicians can characterize disease states in a way that accurately define prognosis, challenging medical and social issues can be addressed [2].
Severity of illness is replicated by magnitude of co-morbidities and physiologic disturbances in critically ill children in intensive care unit [3]. These disturbances are assessed by measuring how much apart the physiologic variables are from the normal range and objective weighing of these variables directly reflects their contribution to the mortality risk [3].
Scoring systems evaluate the patient's mortality risk in the ICU by assigning a score to patient and predicting the outcome [4]. However, patient's mortality is not only affected by PICU performance but also depends on many other factors such as demographic and clinical characteristic of population, infrastructure and non-medical factors (management and organization), case mix and admission practice [4].
The Pediatric Risk of Mortality (PRISM) is a second-generation, physiology based predictor of mortality risk for pediatric ICU patients [5]. PRISM was initially derived from the Physiologic Stability Index [5].
PRISM was developed from Physiologic Stability Index (PSI) to reduce the number of variables from 34 to 14 and number of ranges from 75 to 23 without losing the predictive

power [6]. In 1996 physiological variables and their ranges as well as diagnostic and other risk variables reflective of mortality risk were re evaluated by Pollack MM *et al*. to update and improve the performance of second generation PRISM score. Thus, PRISM III was developed. PRISM III has 17 physiologic variables subdivided into 26 ranges and is population independent. PRISM III scoring starts at the time of admission to PICU and it takes 24 hours to complete. They have been used to assess relation between severity of illness and outcome along with length of stay or cost [6].

Material & methods

The study was conducted in the PICU of Shri Ram Murti Smarak Institute of Medical Sciences (SRMS-IMS), Bareilly, a tertiary care hospital of Rohilkhand region during the study period.

Inclusion criteria

All the children admitted to Pediatric Intensive Care Unit in the age group 1 month – 18 years during the period (Dec'2018 to Jan'2020).

Exclusion criteria

1) Patients who died/ discharged/ LAMA within 1st 12 hours of admission.
2) Trauma patients and patients admitted for surgical intervention.

Study design

Prospective, Observational study.

Methodology

All the children fulfilling the study criteria were enrolled in the study.

A predesigned proforma was used for each enrolled patient to collect the demographic details of the patient (age at admission, gender, underlying disease, socioeconomic status, etc.).

The proforma also had a PRISM III chart to record the CVS /CNS, vital signs, values of Acid – base & blood gases, values of biochemistry test & hematological tests, in the 1st 24 hours of admission [6].

The following were also recorded [6]

1. Need of Ventilatory Support.
2. Need of Ionotropic Support.

At the end of 24 hours of PICU stay, PRISM III score was calculated for each patient. It was calculated with the help of 17 parameters (physiological & lab data) and for each one, the highest severity value recorded in the first 24 hours and the patients age [6]. The patient's outcome at the end of the stay was recorded as survivors and non-survivors [6].

Statistics

Median PRISM III score was calculated for survivors and non- survivors on Microsoft Excel. Z-test was used to evaluate Single sample proportion test, and categorical variables were analyzed using the Fisher's exact test and Chi square test on SPSS version 23.0, www.graphpad.com and www.socscistatistics.com. $P < 0.05$ was considered to be significant.

Results

The present study was conducted in Pediatric Intensive Care Unit (PICU) of Shri Ram Murti Smarak Institute of Medical Sciences (SRMS-IMS) of Rohilkhand region. It is a hospital based prospective observational study. During the study period, total 241 cases were admitted in PICU.

In the present study, in order to assess the risk of mortality in the patients requiring intensive care at the time of admission, PRISM scoring was done using the worst parameters in the 1st 24 hrs. of admission.

The overall mortality rate was found to be 26.4%.

For the purpose of this article, we have tried to analyse the disease specific usefulness of PRISM III scoring for mortality prediction in patients getting admitted to PICU with Renal dysfunction, CNS dysfunction, Hepatic dysfunction, Respiratory dysfunction, and Septicaemia.

So out of 241 patients, 107 patients fulfilled the required criteria and were thus finally analysed for the purpose of this article.

Table 1: Demographic distribution

	Number of patients (N=107) (%)	Survivors (N=80) (%)	Mortality (N=27) (%)	P-Value
Age				
Infant 1 month - ≤ 12 month	14	12	2	0.4354
Children >12 month - ≤ 12 year	73	52	21 (28.7%)	
ADOLSCENT > 12 years	20	16	4 (20%)	
Gender				
Male	73	58	15 (20.5%)	0.1504
Female	34	22	12 (35.2%)	
Prism Score				
< 20	87	72	15	0.000072
≥ 20	20	8	12	
Total	107	80	27	

The Patients were grouped according to the primary system involved at the time of admission to PICU. Outcome was analysed based on primary diagnosis and revealed that highest mortality was associated with nephrology (56%) followed by sepsis (44%) and Hepatic (35%) system. Details regarding admission and mortality data based on primary system involvement is described in the table 2:

Table 2: Admissions and mortality data based on primary system involvement:

Primary System	Total Admission (N=107) (% of Total Admission)	Total Survivors (N=80) (%)	Total Mortality (N=27) (%)	Mortality (%Among Admission In That Group)
CNS	33(30.8%)	29 (88%)	4 (15%)	12%
Respiratory	25 (23.3%)	24 (96%)	1 (4%)	4%
Hepatic	17(15.8%)	11 (35%)	6 (22%)	35%
Sepsis	16(14.9%)	9 (15%)	7 (26%)	44%
Nephrology	16(14.9%)	7 (14%)	9 (33%)	56%
Total	107	80	27	
Others	134			

Table 3.1: Primary system of involvement (Nephrology): Characteristics of study population

	Number of patients (N=16) (%)	Mortality (N=9) (%)	Survivors (N=7)(%)
Gender			
Male	11 (69%)	6 (55%)	5 (45%)
Female	5 (31%)	3 (60%)	2 (40%)
Age			
Infant			
1 month - ≤ 12 month	0	0	0
Children			
>12 month - ≤ 12 year	10 (62%)	6 (60%)	4 (40%)
Adolscent			
> 12 Year	6 (38%)	3 (50%)	3 (50%)
Duration of PICU Stay			
≤ 8 Days	11 (69%)	8 (73%)	3 (27%)
> 8 Days	5 (31%)	1 (20%)	4 (80%)
Mechanical Ventilation			
Yes	12 (75%)	9 (75%)	3 (25%)
No	4 (25%)	0	4 (100%)
Ionotropic Support			
Yes	12 (75%)	9 (75%)	3 (25%)
No	4 (25%)	0	4 (100%)
Prism Score			
<20	11 (69%)	5 (45%)	6 (55%)
≥ 20	5 (31%)	4 (80%)	1 (20%)
Mortality			
Yes	9 (56%)		
No	7 (44%)		

Table 3.2: Primary system of involvement (Sepsis): Characteristics of study population

	Number of patients (N=16) (%)	Mortality (N=7) (%)	Survivors (N=9)(%)
Gender			
Male	8 (50%)	2 (25%)	6 (75%)
Female	8 (50%)	5 (63%)	3 (37%)
Age			
Infant			
1 month - ≤ 12 month	6 (38%)	2 (33%)	4 (67%)
Children			
>12 month - ≤ 12 year	9 (56%)	5 (55%)	4 (45%)
Adolscent			
> 12 Year	1 (6%)	0	1 (100%)
Duration of PICU Stay			
≤ 8 Days	15 (94%)	7 (47%)	8 (53%)
> 8 Days	1 (6%)	0	1 (100%)
Mechanical Ventilation			
Yes	11 (69%)	6 (55%)	5 (45%)
No	5 (31%)	1 (20%)	4 (80%)
Ionotropic support			
Yes	13 (81%)	7 (54%)	6 (46%)
No	3(19%)	0	3 (100%)
Prism Score			
<20	12 (75%)	4 (34%)	8
≥ 20	4 (25%)	3 (75%)	1
Mortality			
Yes	7 (44%)		
No	9 (56%)		

Table 3.3: Primary system of involvement (Hepatic): Characteristics of study population

	Number of patients (N=17) (%)	**Mortality (N=6) (%)**	**Survivors (N=11)** (%)
Gender			
Male	11 (65%)	3 (28%)	8 (72%)
Female	6 (35%)	3 (50%)	3 (50%)
Age			
Infant			
1 month - ≤ 12 month	0	0	0
Children			
>12 month - ≤ 12 year	13 (75%)	6 (46%)	7 (54%)
Adolscent			
> 12 Year	4 (24%)	0	4 (100%)
Duration Of Picu Stay			
≤ 8 Days	16 (94%)	6 38%)	10 (62%)
> 8 Days	1 (6%)	0	1 (100%)
Mechanical Ventilation			
Yes	6 (35%)	4 (67%)	2 (33%)
No	11 (65%)	2 (18%)	9 (82%)
Ionotropic Support			
Yes	7 (41%)	6 (86%)	1 (14%)
No	10 (59%)	0	10 (100%)
Prismscore			
<20	14 (82%)	4(29%)	10
≥20	3 (18%)	2(67%)	1
Mortality			
Yes	6 (35%)		
No	11 (65%)		

Table 3.4: Primary system of involvement (CNS): Characteristics of study populations

	Number of patients (N=33) (%)	**Mortality (N=4) (%)**	**Survivors (N=29)** (%)
Gender			
Male	24	3 (13%)	21 (87%)
Female	9	1 (1%)	8 (89%)
Age			
Infant			
1 month - ≤ 12 month	2	0	2 (100%)
Children			
>12 MO - ≤ 12 year	28	4 (15%)	24 (85%)
Adolscent			
> 12 Year	3	0	3 (100%)
Duration Of PICU Stay			
≤ 8 Days	25	4 (16%)	21 (84%)
> 8 Days	8	0	8 (100%)
Mechanical Ventilation			
Yes	14 (42%)	4 (29%)	10 (71%)
No	19 (58%)	0	19 (100%)
IONOTROPIC SUPPORT			
Yes	17 (52%)	4 (24%)	13 (76%)
No	16 (48%)	0	16 (100%)
Prism Score			
< 20	**26**(79%)	**1** (4%)	25 (96%)
≥ 20	**7**(21%)	**3** (43%)	4 (57%)
Mortality			
Yes	4 (12%)		
No	29 (88%)		

Table 3.5: Primary system of involvement (Respiratory): Characteristics of study populations

	Number of patients (N=25) (%)	**Mortality (N=1) (%)**	**Survivors (N=24)** (%)
Gender			
Male	19 (76%)	1 (5%)	18 (95%)
Female	6 (24%)	0	6 (100%)
Age			
Infant			
1 MO - ≤ 12 MO	6 (24%)	0	6 (100%)
Children			
>12 MO - ≤ 12 YR	13 (52%)	0	13 (100%)

Adolscent			
> 12 YRS	6 (24%)	1 (17%)	5 (83%)
Duration of PICU Stay			
≤ 8 Days	19 (76%)	1 (5%)	18 (95%)
> 8 Days	6 (24%)	0	6 (100%)
Mechanical Ventilation			
YES	3 (12%)	1 (33%)	2 (66%)
NO	22 (88%)	0	22 (100%)
Ionotropic Support			
Yes	11 (44%)	1 (9%)	10 (91%)
No	14 (56%)	0	14 (100%)
Prism Score			
< 20	**24 (96%)**	**1 (4%)**	23 (96%)
≥ 20	**1 (4%)**	**0**	1 (100%)
Mortality			
Yes	1 (4%)		
No	24 (96%)		

Table 4: Prism III scoring vs ionotropic support & mechanical ventilation

Neurology						
	Prism Score < 20 (n)			**Prism Score ≥ 20 (n)**		
Ionotropic Support	**S (n)**	**N.S. (n)**	**P value**	**S (n)**	**N.S. (n)**	**P value**
Yes	9	1	0.0001	4	3	0.8774
No	16	0	0.0000	0	0	1
Total	25	1		4	3	
M.V.	S (n)	N.S. (n)	P value	S (n)	N.S. (n)	P value
Yes	6	1	0.0001	4	3	0.8774
No	19	0	0.0000	0	0	1
Total	25	1				
Respiratory						
Ionotropic Support	**S (n)**	**N.S.(n)**	**P value**	**S (n)**	**N.S. (n)**	**P value**
Yes	10	0	0.0001	0	1	0.0001
No	14	0	0.0001	0	0	0.0001
Total	24	0		0	1	
M.V.						
Yes	2	0	0.0001	0	1	0.0001
No	22	0	0.0001	0	0	0.0001
Total	24	0		0	1	
Hepatic						
Ionotropic Support	**S (n)**	**N.S. (n)**	**P value**	**S (n)**	**N.S. (n)**	**P value**
Yes	0	4	0.0001	1	2	0.0053
No	10	0	0.0001	0	0	1
Total	10	4		1	2	
M.V.						
Yes	1	2	0.0053	1	2	0.0053
No	9	2	0.0039	0	0	1
Total	10	4		1	2	
Sepsis						
Ionotropic Support	**S (n)**	**N.S. (n)**	**P value**	**S (n)**	**N.S. (n)**	**P value**
Yes	6	4	0.0487	0	3	0.0001
No	2	0	0.0001	1	0	0.0001
Total	8	4		1	3	
M.V.						
Yes	5	4	0.0551	0	2	0.0001
No	3	0	0.0001	1	1	1
Total	8	4		1	1	
Nephrology						
Ionotropic Support	**S (n)**	**N.S. (n)**	**P value**	**S (n)**	**N.S. (n)**	**P value**
Yes	2	5	0.0036	0	4	0.0001
No	4	0	0.0001	1	0	0.0001
M.V.						
Total	6	5		1	4	
Yes	2	5	0.0036	0	4	0.0001
No	4	0	0.0001	1	0	0.0001
Total	6	5		1	4	
Note: Use the following legend : S- Survivors, N.S.-Non-Survivors, M.V. Mechanical Ventilation						

Discussion

In the present study, (Table2, Table 3.1) total number of patients admitted to PICU (Pediatric Intensive Care Unit) during the study period with Renal dysfunction were 16 with mortality rate of 56% (9 of 16). In the present study, median PRISM score for survivors was 14 (range 5-35) and 15 (range 9-37) for non-survivors. At the time of admission, PRISM III score could not differentiate between survivors and non-survivors. Out of 16 patients, 11 patients had PRISM score < 20 with mortality rate of 45% (5 of 11) and all of them were on MV (Mechanical Ventilation) and ionotropic support. 5 patients had PRISM score ≥20 with the mortality rate of 80% (4 of 5) and all of them were on MV and ionotropic support. It was found in the present study,(Table 4) that PRISM-24 scoring significantly predicted mortality among the patients who needed ventilation and ionotropic support in first 24hrs ($p< 0.0001$). Popli *et al.* [7] in their prospective analytical study done on 145 patients have reported that 19 patients were admitted with renal dysfunction during the study period with the mortality rate of 47.36% (9 of 19). He has stated that the cause of renal dysfunction were HUS, AGN, AKI, and CRF. Also that mortality increases with the increase of PRISM III score, reaching almost 100% by score of 19 and above. Khajeh *et al.* [8] in their cohort study have reported mortality rate of 28.6% in Renal dysfunction patients. They have also reported that mortality significantly increased as PRISM score increased and a 7.2 fold mortality risk was present in patients with score 21-30 compared with score 0-10. On one hand where the above 2 studies indicated the reliability of PRISM III score in predicting mortality in children with renal dysfunction study by Fargason *et al.* [9] suggested otherwise. In their retrospective study [9] done on 31 children with ARF (including primary and secondary causes) requiring dialysis have reported that the mortality predicted by PRISM score in children who primarily presented with AKI and required PICU admission was significantly lower than the actual mortality rates.

In the present study, (Table2, Table 3.2) total number of patients admitted to PICU during the study period with the diagnosis of septicaemia were 16 with mortality rate of 44% (7 of 16). In the present study median PRISM score for survivors was 13 (range 0-21) and 16 (range 0-29) for non-survivors. Out of 16 patients, 12 patients had PRISM score < 20 with mortality rate of 33% (4of 12) and all of them were on MV and ionotropic support and 4 patients had PRISM score ≥ 20 with the mortality rate of 75% (3 of 4) and all 3 of them were on ionotropic support and 2 were on MV. In septicaemia patients the difference between survivors & non-survivors (Table 5) who were on MV and ionotropic support was found to be statistically insignificant in cases with PRISM < 20 (p=0.0487 & p=0.0551 respectively). In patients with PRISM ≥ 20, the difference between survivors & non-survivors (Table 5) who were on MV and ionotropic support was found to be statistically significant (p=0.0001, p= 0.0001 respectively). This suggests that in Septicemic patients, a higher PRISM score at the time of admission significantly predicts mortality specially if the patient needs MV and ionotropic support. Available literature presents variable usage of PRISM score in predicting mortality in septicemic patients as well.

The prospective study done in Egypt by A. EL Nawawy [10] on 406 children, where 15.5% (63) children presented with sepsis syndrome, out of whom 41 died i.e. with mortality rate of 65% (41 of 63). They have noted that sepsis syndrome was associated with a higher PRISM score at admission and significantly increased mortality compared with admissions associated with other systemic involvement.

The prospective observational study done by Patki *et al.* [11] has reported 35.7 % mortality in sepsis patients. They have reported that the expected mortality (5.68%) using PRISM scoring was lower than observed (21.7%) mortality. Thus suggesting that PRISM is not a good predictor of mortality in PICU.

In the present study, (Table 2, Table 3.3) total number of patients admitted to PICU during the study period with the involvement of HepatobIliary systemat the time of admission were 17 with the mortality rate of 35% (6 of 17). In the present study median PRISM score for survivors was 5 (range 3-21) and 15 (range 3-27) for non-survivors. Out of 17 patients, 14 patients had PRISM score < 20 with mortality rate of 28.6% (4 of 14). Among the non survivors in this group, all of them were on ionotropic support, and 2 were on MV. 3 patients had PRISM score ≥ 20 with the mortality rate of 66.6% (2 of 3) and all of them were on MV and ionotropic support. The difference between the survivors and non survivors in groups with PRISM score <20 and ≥ 20 was not found to statistically significant (p>0.05). This suggests that PRISM score cannot predict severity and mortality in patients with Hepatobiliary system dysfunction.

In the retrospective study done by Tissieres *et al.* [12] on 109 patients in infants and children with fulminant liver failure have reported mortality of 45.8% (50 of 109). In their study also, the observed mortality was significantly higher to PRISM score based expected mortality.

The prospective study done on 30 patients with ESLD (End Stage Liver Disease) and FHF (Fulminant Hepatic Failure) by El-Karaksy *et al.* [13] in Egypt have reported mortality of 56.7%. In their study PRISM score was calculated within 24 hrs of admission to PICU and outcome was recorded as deceased or survivors. On logistic regression analysis, PRISM score was not predicting mortality but on ROC curve analysis it was significantly associated with mortality. They have reported that median PRISM score for survivors was 9 (range 2-17) and 15 for deceased patients (range 6-44) (p=0.04).

In the present study, (Table 2, Table 3.4) total number of patients admitted to PICU during the study period with CNS dysfunction were 33 with mortality rate of 12% (4 of 33). In the present study median PRISM score for survivors was 8 (range 2-34) and 12 (range 4-41) for non-survivors. The difference between the number of survivors and non-survivors (Table5) who were on MV and ionotropic support in the group with PRISM ≥ 20, was found to be statistically insignificant, whereas in the group with PRISM < 20 it was statistically significant**.** This suggests that higher PRISM-24 scoring underestimates severity and mortality in patients with CNS dysfunction.

In the prospective study done by Thorburn *et al.* [14] in children with severe meningococcal disease with or without CNS dysfunction havereported that observed mortality (11) was lower thanpredicted (24.88) by PRISM. This suggests that PRISM based scoring overpredicted mortality in patients with CNS dysfunction.

Van Brakel *et al.* [15] in their retrospective study done on 53 children have reported mortality of 19% in patients with

meningococcal disease. They have also reported that PRISM score based expected mortality (29%) was higher than observed mortality (19%). The highest expected and observed mortality was found in septicaemic patients without documented meningitis whereas meningitis patients without septicaemia had the lowest mortality. This shows that PRISM score cannot predict mortality but it can be used as a measure of severity of illness in patients with CNS dysfunction.

In the present study, (Table 2, Table 3.5) total number of patients admitted to PICU with Respiratory dysfunction were 25 with the mortality rate of 4% (1 of 25). In the present study median PRISM score for survivors was 7 (range 0-22) and 3 (range 0-3) for non-survivors. Out of 25 patients, 24 patients had PRISM score < 20 with no mortality, and 1 patient had PRISM score ≥ 20 with the mortality rate of 100% (1 of 1) and it was both on MV and ionotropic support. The difference between survivors and non-survivors who were on MV and inotropes was statistically significant in both groups i.e. PRISM <20, PRISM ≥20. This suggests that PRISM III score can predict both severity and mortality in patients with respiratory dysfunction, if the patientsrequire mechanical ventilation and ionotropic support within 24 hrs of admission.

Kesici *et al*. [16] in their retrospective study done on 150 patients have reported that PRISM 24 score failed to predict mortality. They have also found that PRISM 24 score was higher in non-survivors than in survivors ($p< 0.05$), but the performance of score was considered poor for severity assessment and prediction of risk of mortality in mechanically ventilated patients.

Zhang *et al*. [17] in their retrospective observational study on patients with respiratory dysfunction found that total PRISM III score in the non-survivors were significantly higher than those in the survival group.

Conclusion

In patients with hepatobiliary and CNS dysfunction PRISM III- 24 scoring cannot predict mortality but it can be applied for severity assessment at the time of admission to PICU. In patients with septicaemia, nephrology, respiratory dysfunction, PRISM III -24 score proved to be a good predictor of mortality for children admitted in our PICU.

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