Research Article

Intensive Care in India: The Indian Intensive Care Case Mix and Practice Patterns Study

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Abstract

Aims: To obtain information on organizational aspects, case mix and practices in Indian Intensive Care Units (ICUs). **Patients and Methods:** An observational, 4-day point prevalence study was performed between 2010 and 2011 in 4209 patients from 124 ICUs. ICU and patient characteristics, and interventions were recorded for 24 h of the study day, and outcomes till 30 days after the study day. Data were analyzed for 4038 adult patients from 120 ICUs. **Results:** On the study day, mean age, Acute Physiology and Chronic Health Evaluation (APACHE II) and sequential organ failure assessment (SOFA) scores were 54.1 ± 17.1 years, 17.4 ± 9.2 and 3.8 ± 3.6, respectively. About 46.4% patients had ≥1 organ failure. Nearly, 37% and 22.2% patients received mechanical ventilation (MV) and vasopressors or inotropes, respectively. Nearly, 12.2% patients developed an infection in the ICU. About 28.3% patients had severe sepsis or septic shock (SvSpSS) during their ICU stay. About 60.7% patients without infection received antibiotics. There were 546 deaths and 183 terminal discharges (TDs) from ICU (including left against medical advice or discharged on request), with ICU mortality 729/4038 (18.1%). In 1627 patients admitted within 24 h of the study day, the standardized mortality ratio was 0.67. The APACHE II and SOFA scores, public hospital ICUs, medical ICUs, inadequately equipped ICUs, medical admission, self-paying patient, presence of SvSpSS, acute respiratory failure or cancer, need for a fluid bolus, and MV were independent predictors of mortality. **Conclusions:** The high proportion of TDs and the association of public hospitals, self-paying patients, and inadequately equipped hospitals with mortality has important implications for critical care in India.

Keywords: Adult, case-mix, India, intensive care, practice

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Introduction

In the past two decades, there has been tremendous growth of intensive care medicine in India. However, there are scant data on the organizational aspects, case mix and practice patterns in Indian Intensive Care Units

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(ICUs). Most of the available information comes from either single-center studies or studies in specific groups of patients or conditions.[1-7] It is essential to have data from several Indian ICUs to reflect the vast and diverse spectrum of critical care illness, services, and practices. Such information may be useful to identify deficiencies in the organization of care and to identify targets for education, clinical improvement, and research. The data would provide baseline estimates of disease prevalence, severity of illness and mortality, essential for designing research studies.

This multicenter study was planned to gather such information about ICUs all over India. In order to enable participation from a large number of ICUs throughout the country, we used a point prevalence design, obtaining data on four different days over a 1-year period.

Patients and Methods

A steering committee was set up in 2009. The study was publicized, and all ICUs in India were invited to participate. All investigators obtained approval from their respective hospital ethics committees and hospital administrations. The study is registered at clinicaltrials.gov (NCT01384929).

The study protocol, forms, and instructions were uploaded on the study website. Individual sites could contribute on any or all days of the study.

This was a multicenter, observational, point prevalence study, performed on four separate days. All patients present in the ICU on July 14, 2010, October 13, 2010, January 12, 2011 and April 13, 2011 were included in the study. These days were the second Wednesdays in the 1st month of each quarter and were representative of the major seasons. Data were recorded for all patients present in the ICU during the 24 h starting 08.00 am on the study day to 08.00 am next day. Neonatal ICUs were not included. There were no other exclusion criteria. All data were submitted to a dedicated website.

The first time an ICU joined the study, data about the ICU was recorded. This included parameters listed in Tables 1 and 2. A closed ICU was defined as one in which final orders for the patient were written by the ICU team; an open ICU was defined as one in which care of the patient was directed by non-ICU doctor teams, and orders could be written by non-ICU team doctors. A center was considered adequately equipped if all the following facilities were available either in the ICU or in the hospital: Renal replacement therapy (RRT), computerized tomography scan, microbiology, biochemistry and hematology laboratories, echocardiography and cardiac catheterization laboratory.

Table 1: Facilities available in the Intensive Care Unit and hospital in 120 centres

Facility	Available in ICU	Available in hospital	Not available
Chest X-ray	108 (90)	11 (9.2)	1 (0.8)
Blood gas analysis	63 (52.5)	54 (45)	3 (2.5)
Ultrasonography (excluding echocardiography)	82 (68.3)	36 (30)	2 (1.7)
Echocardiography	85 (70.8)	33 (27.5)	2 (1.7)
Hemodialysis	59 (49.2)	48 (40.0)	13 (10.8)
Continuous renal replacement therapy	54 (45.0)	14 (11.7)	52 (43.3)
Fibreoptic bronchoscope	67 (55.8)	40 (33.3)	13 (10.8)
Biochemistry/hematology laboratory	Not applicable	119 (99.2)	1 (0.8)
Microbiology laboratory	Not applicable	109 (90.8)	11 (9.2)
Computerised tomography	Not applicable	102 (85.0)	18 (15.0)
Magnetic resonance imaging	Not applicable	76 (63.3)	44 (36.7)
Cardiac catheterization laboratory	Not applicable	81 (67.5)	39 (32.5)

ICU: Intensive Care Unit; Data are presented as Number of ICUs (%)

Data collected for each patient included the following:

- Primary reasons for ICU admission, source of admission, demographics, patient characteristics and comorbidities as listed in Tables 3 and 4. Admission was defined as surgical if the patient was admitted to the ICU from the operation theatre or recovery room. Elective surgery was defined as a surgical procedure which was planned more than 24 h prior to ICU admission. Emergency surgery was defined as a surgical procedure before ICU admission which was planned <24 h in advance. The primary reason for ICU admission was the single most applicable diagnostic category based on the Acute Physiology and Chronic Health Evaluation (APACHE) III classification[8]
- Age, physiological parameters, and comorbidities used to calculate the APACHE II score[9] and sequential organ failure assessment (SOFA) score.[10] Physiological variables were the worst recorded values during the 24-h study period. When data for any parameter required calculation of the APACHE II and SOFA score was missing, that parameter was assumed to be normal. A SOFA score of 3 or 4 for any individual organ was used to identify organ failure
- Interventions are listed in Table 5
- Presence of infection (suspected or proven infection at ICU admission or during the 24-h study period); severe sepsis or septic shock (SvSpSS) at any time during the patient's ICU stay; suspected or proven tropical infections (malaria, dengue, leptospirosis, scrub typhus); microrganisms, and antibiotic

Table 2: Intensive Care Unit characteristics

Characteristic	Number of ICUs (%)	Number of patients (%)	APACHE II score (mean±SD)	ICU mortality (%)	Hospital mortality (%)
All ICUs	120 (100)	4038 (100)	17.4±9.2	729 (18.1)	877 (21.7)
Type of ICU					
Open	89 (74.2)	3148 (78)	17.3±9.2	561 (17.8)	686 (21.8)
Closed	31 (25.8)	890 (22)	17.8±9.2	168 (18.9)	191 (21.5)
ICU specialty					
Mixed medical-surgical	97 (80.8)	3355 (83.1)	17.4±9.2*	549 (16.4)#	671 (20.0)#
Medical	14 (11.7)	425 (10.5)	18.6±9.5	147 (34.6)	161 (37.9)
Surgical	2 (1.7)	16 (0.4)	16.1±6.7	2 (12.5)	3 (18.8)
Cardiac	4 (3.3)	138 (3,4)	15.5±9.1	11 (8.0)	13 (9.4)
Other	3 (2.5)	104 (2.6)	16.8±9.2	20 (19.2)	29 (27.9)
Number of beds in ICU					
1-6	16 (13.3)	287 (7.1)	17.3±9.3#	42 (14.6)	59 (20.6)
7-10	27 (22.5)	677 (16.8)	17.6±9.4	130 (19.2)	145 (21.4)
11-20	47 (39.2)	1578 (39.1)	17.2±9.3	269 (17.0)	341 (21.6)
>20	30 (25)	1496 (37)	17.6±9.1	288 (19.3)	332 (22.2)
Number of hospital beds					
1-49	11 (9.2)	95 (2.4)	17.3±8.3	11 (11.6)#	18 (18.9)**
50-99	7 (5.8)	59 (1.5)	15.5±9.2	14 (23.7)	17 (28.8)
100-199	27 (22.5)	670 (16.6)	18.1±9.6	119 (17.8)	157 (23.4)
200-499	33 (27.5)	1334 (33.0)	17.6±9.4	199 (14.9)	240 (18.0)
≥500	42 (35)	1880 (46.6)	17.2±9.0	386 (20.5)	445 (23.7)
Patient to nurse ratio					
≤2:1	60 (50)	1816 (54.4)	16.6±9.1#	335 (18.4)	395 (21.8)
>2:1	37 (30.8)	1522 (45.6)	17.9±9.2	272 (17.9)	331 (21.7)
Missing	23 (19.2)	700 (17.3)			
Hospital					
Public hospital ICUs	13 (10.8)	391 (9.7)	17.8±9.7	118 (30.2)#	128 (32.7)#
Private hospital ICUs	107 (89.2)	3647 (90.3)	17.4±9.2	611 (16.8)	749 (20.5)
Postgraduate teaching/training programme in intensive care					
None	73 (60.8)	1417 (35.1)	16.8±9.0**	292 (20.6)^	339 (23.9)$
Present	47 (39.2)	2621 (64.9)	17.8±9.3	437 (16.7)	538 (20.5)
Equipment and facilities					
Adequate	81 (67.5)	3528 (87.4)	17.5±9.3	618 (17.5)^^	735 (20.8)#
Not adequate	39 (32.5)	510 (12.6)	17.4±8.8	111 (21.8)	142 (27.8)

#$P<0.001$; *$P=0.007$; **$P=0.001$; ^$P=0.002$; ^^$P=0.02$; $$P=0.01$. APACHE: Acute Physiology and Chronic Health Evaluation; ICUs: Intensive Care Units; SD: Standard deviation

therapy. Investigators were asked to follow the European-American Consensus Definitions for SvSpSS.[11]

Survival status at ICU discharge was recorded within 30 days from the day of the study. Patients discharged alive from ICU were followed up till hospital discharge, or 30 days from the day of the study, whichever was earlier. For patients dying in the ICU, investigators were asked to record whether any form of limitation of treatment occurred. Terminal discharges (TDs) from ICU to a location outside the hospital, either on family or patient request, as well as those documented as left against medical advice,[12] were also recorded.

Nonsurvivors were patients who died in the ICU as well as those who were TDs within 30 days from the day of the study. The number of nonsurvivors was used to calculate ICU mortality, the primary outcome.

Secondary outcomes were as follows: Hospital mortality, defined as a composite of those who died in the hospital and TDs from the ICU within 30 days from the day of the study, and ICU and hospital lengths of stay, till 30 days from the study day.

The standardized mortality ratio (SMR) using the hospital mortality and that predicted by APACHE II was calculated for those patients who were admitted to the ICU within 24 h of the study day.

For calculation of ICU and hospital length of stay, missing data were not included in the analysis.

Investigators were contacted by E-mail to complete missing data. Prior training of investigators and verification of source data was not performed.

Analysis

Analysis was confined to data from adult patients (>16 years of age).

Table 3: Primary reason for Intensive Care Unit admission

Primary reason for ICU admission	Number of patients	APACHE II score	ICU nonsurvivors *n* (%)	Hospital nonsurvivors *n* (%)
Medical	3115	18.3±9.4*	644 (20.7)*	760 (24.4)*
Cardiovascular	585	15.1±9.1	72 (12.3)	87 (14.9)
Respiratory	613	20.0±9.6	150 (24.5)	167 (27.2)
Gastrointestinal	263	18.8±8.9	71 (27.0)	77 (29.3)
Neurological	624	16.8±7.9	118 (18.9)	153 (24.5)
Sepsis	404	21.9±9.5	120 (29.7)	130 (32.2)
Trauma	122	13.8±7.3	11 (9.0)	10 (8.2)
Metabolic	106	19.6±9.3	20 (18.9)	26 (24.5)
Hematological	77	15.4±9.1	21 (27.3)	24 (31.2)
Renal	145	25.6±8.9	40 (27.6)	45 (31.0)
Unclassified	176	17.6±9.3	21 (11.9)	41 (23.3)
Surgical	923	14.4±7.9	85 (9.2)	117 (12.7)
Cardiovascular	173	15.2±8.7	3 (1.7)	11 (6.4)
Respiratory	39	13.5±9.3	1 (2.6)	2 (5.1)
Gastrointestinal	198	13.7±8.4	26 (13.1)	30 (15.2)
Neurological	193	15.1±7.2	23 (11.9)	36 (18.7)
Trauma	185	14.1±7.3	26 (14.1)	28 (15.1)
Renal	42	14.2±8.3	2 (4.8)	3 (7.1)
Obstetric	35	13.7±8.5	1 (2.9)	1 (2.9)
Hip or extremity fracture	47	14.3±6.8	3 (6.4)	4 (8.5)
Unclassified	11	13.4±6.2	0 (0)	2 (18.2)
Type of surgery				
Elective surgery	571	13.5±7.9	29 (5.1)*	54 (9.5)*
Emergency surgery	352	15.8±7.7	56 (15.9)	63 (17.9)

*$P < 0.001$ comparing medical versus surgical admissions; and elective versus emergency surgery. APACHE: Acute Physiology and Chronic Health Evaluation; ICU: Intensive Care Unit

Continuous variables were compared with the use of the Student's *t*-test, analysis of variance, Mann–Whitney test or the Kruskal–Wallis test. Categorical variables were compared using the Chi-square test. A two-tailed $P < 0.05$ was considered as statistically significant. Multivariate binary logistic regression analysis was performed to determine the independent predictors of ICU mortality. A stepwise forward conditional multivariate analysis was performed with ICU characteristics, patient factors, and interventions found to be statistically significant in the univariate analyses.

Results

Totally, 4209 patients from 124 ICUs were enrolled. Data analysis was done for adult patients (n = 4038) from 120 ICUs. Details of participation are provided in the Supplementary Tables 1-4.

Table 1 summarizes the facilities available in the ICU or in the hospital. About 81 centers (67.5%) were considered adequately equipped, whereas 29 (32.5%) were categorized as "not adequately equipped."

Table 2 summarizes the characteristics of the 120 ICUs. Patients in medical ICUs had significantly higher severity of illness and mortality compared to patients in other types of ICUs. More than half the number of participating ICUs had a patient-nurse ratio of two or less patients per nurse.

The Primary APACHE III diagnostic categories are summarized in Table 3, and patient demographics, severity of illness, and outcomes are detailed in Table 4.

3250 (80.5%) patients were self-paying. Almost 546 patients died in the ICU, and 183 patients were TDs from the ICU. The number of ICU nonsurvivors was thus 729, with ICU mortality 18.1%. The hospital mortality was 21.7% and included 694 patients who died in hospital and 183 TDs. Median length of ICU stay was 6 (interquartile range [IQR] 3–13) days, with significantly longer stays in nonsurvivors than in ICU survivors [Table 2].

Figures 1 and 2 show the distribution of APACHE II scores and number of organ failures with the associated mortality. Almost 53.6% patients did not have any organ failure on the study day; mortality was 8.3% in these patients.

A subset of 1718 patients were admitted within 24 h of a study day, of which 1627 patients could have an APACHE II diagnostic category assigned to enable calculation of the predicted mortality. Of these, 428 patients were predicted to die in hospital, whereas the observed hospital mortality was 286. The SMR was thus 0.67. APACHE II over predicted mortality at scores above 19, as seen in Figure 3.

Mortality was higher in inadequately equipped ICUs compared to well-equipped ICUs (27.8% vs. 20.8%, $P < 0.001$), despite similar APACHE II scores.

Medical admissions accounted for 77.1% of admissions; they had a higher severity of illness than surgical admissions and a significantly higher mortality. Similarly, mortality was significantly higher for admissions after emergency surgery than elective surgery [Table 3]. Almost 124 patients were admitted after poisoning or drug overdose, including 72 organophosphorus or organochlorine poisoning, 5 snake bites and 21 unknown toxins. ICU mortality in this group was 15.3%.

A sub-group of 1144 patients (28.3%) had SvSpSS during the ICU stay, with mortality of 34.0%. About 12.2% patients developed an infection during their ICU stay and 1455 patients had a suspected or confirmed infection during the 24-h study period. Microbiological cultures and other tests for microbial identification were obtained in 2039 patients, and positive results

Table 4: Patient demographics, Intensive Care Units admission characteristics and severity of illness*

	All (*n*=4038)	ICU survivors (*n*=3309)	ICU nonsurvivors (*n*=729)	*P*
Patient demographics				
Age (years) (mean±SD)	54.1±17.1	53.7±17.7	55.6±17.7	0.01
Male	2671 (66.1)	2179 (65.9)	492 (67.5)	0.40
Female	1367 (33.9)	1130 (34.1)	237 (32.5)	
Financial resources				
Self-paying	3250 (80.5)	2639 (79.8)	611 (83.8)	0.046
Not self-paying (payment by employer, insurance, etc.)	675 (16.7)	570 (17.2)	105 (14.4)	
Missing	113 (2.8)	100 (3.0)	13 (1.8)	
Type of ICU admission				
Medical/nonoperative	3115 (77.1)	2471 (74.7)	644 (88.3)	<0.001
Surgical	923 (22.8)	838 (25.3)	85 (11.7)	
Elective postoperative	571 (14.1)	542 (16.4)	29 (4.0)	
Unscheduled/emergent postoperative	352 (8.7)	296 (8.9)	56 (7.7)	
Source of admission				
Home	707 (17.5)	590 (17.8)	117 (16.0)	<0.001
Emergency department	975 (24.5)	806 (24.4)	169 (23.2)	
Ward of same hospital	755 (18.7)	544 (16.4)	211 (28.9)	
Other hospital	458 (11.3)	359 (10.9)	99 (13.6)	
From operation theatre	923 (22.9)	838 (25.3)	85 (11.7)	
Not known/missing	220 (5.4)	172 (5.2)	48 (6.6)	
Co-morbidities				
Chronic obstructive pulmonary disease	317 (7.9)	230 (7.0)	87 (11.9)	<0.001
Diabetes mellitus	554 (13.7)	463 (14.0)	91 (12.5)	0.28
Heart failure	237 (5.9)	197 (6.0)	40 (5.5)	0.63
Cancer	239 (5.9)	165 (5.0)	74 (10.2)	<0.001
Hematological malignancy	32 (0.8)	18 (0.5)	14 (1.9)	0.001
Metastatic cancer	86 (2.1)	57 (1.7)	29 (4.0)	<0.001
Chronic renal failure	241 (6.0)	179 (5.4)	62 (8.5)	0.001
Cirrhosis of the liver	112 (2.8)	74 (2.2)	38 (5.2)	<0.001
Immunosuppressive treatment	179 (4.4)	130 (3.9)	49 (6.7)	0.001
Number of co-morbidities				
0	2536 (62.8)	2147 (64.9)	389 (53.4)	<0.001
1	1182 (29.3)	923 (27.9)	259 (35.5)	
2	268 (6.6)	206 (6.2)	62 (8.5)	
3	47 (1.2)	29 (0.9)	18 (2.5)	
4	5 (0.1)	4 (0.1)	1 (0.1)	
Patients with suspected or confirmed infection on the study day	1455 (36.0)	1060 (32.0)	389 (53.4)	<0.001
Patients in whom infection developed during the ICU stay	493 (12.2)	353 (10.7)	140 (19.2)	<0.001
Severe sepsis or septic shock during ICU stay	1144 (28.3)	755 (22.8)	389 (53.4)	<0.001
Suspected or confirmed tropical infection	231 (5.7)	181 (5.5)	50 (6.9)	0.14
Acute respiratory failure with PaO_2/FiO_2 ratio <300	754 (18.7)	552 (16.7)	202 (27.7)	<0.001
Severity of illness				
APACHE II score (mean±SD)	17.4±9.2	16.1±8.7	23.6±9.0	<0.001
SOFA score (mean±SD)	3.8±3.6	3.2±3.2	6.4±4.2	<0.001
Number of organ failures, median, (IQR)	0 (0-1)	0 (0-1)	1 (0-2)	<0.001
ICU stay (data available)	3172 (78.6)	2485 (75.1)	687 (94.2)	
ICU stay, days, median, (IQR)	6 (3-13)	5 (3-11)	10 (4-17)	<0.001
Hospital STAY (data available)	2988 (74)	2328 (70.4)	660 (90.5)	
Hospital stay, days, median, (IQR)	12 (7-22)	12 (7-22)	13 (6-22)	0.11
Interval between hospital admission and ICU admission, days, median, (IQR)	0 (0-1)	0 (0-1)	0 (0-2)	<0.001
ICU admission to study day interval, days, median, (IQR)	2.0 (1-6)	2.0 (1-6)	4.0 (1-9)	<0.001

Figures represent number of patients (percentage) unless otherwise indicated. *P* values compare survivors versus nonsurvivors. APACHE: Acute Physiology and Chronic Health Evaluation; ICU: Intensive Care Unit; SD: Standard deviation; SOFA: Sequential organ failure assessment; IQR: Interquartile range

were obtained in 35.9%. Overall, 1077 organisms were identified: 68.9% Gram-negative organisms, 15.9% Gram-positive organisms, 7.5% fungi, 2.4% mycobacteria, 1.7% viruses, and 1.1% malarial parasites.

Various interventions in the ICU are detailed in Table 5.

On the study day, 5342 antibiotics were given to 72.4% patients, while 4.7% patients received antimalarials. About 60.7% of 2583 patients who did not have a suspected or confirmed infection on the study day received antibiotics, whereas 6.7% of the 1455 patients with a suspected or confirmed infection on the study

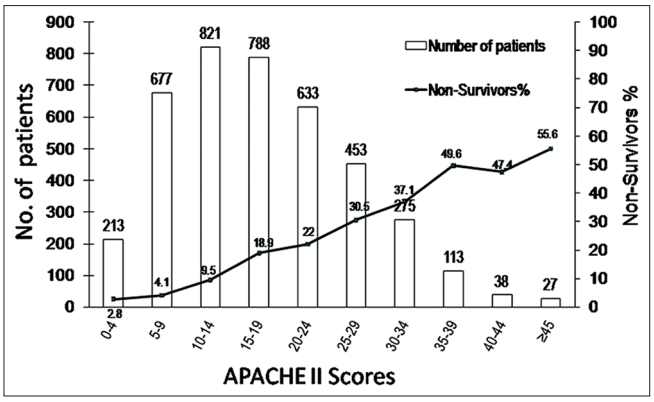

Figure 1: Distribution of Acute Physiology and Chronic Health Evaluation II scores (number of patients in vertical bars on the Y1 axis) and mortality rate (solid line on the Y2 axis)

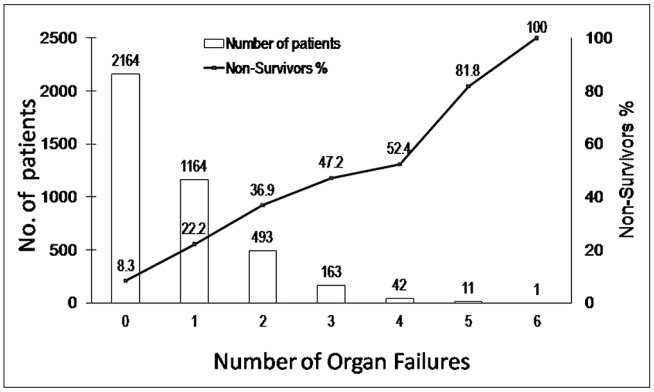

Figure 2: Distribution of organ failures (number of patients in vertical bars on the Y1 axis) and mortality rate (solid line on the Y2 axis)

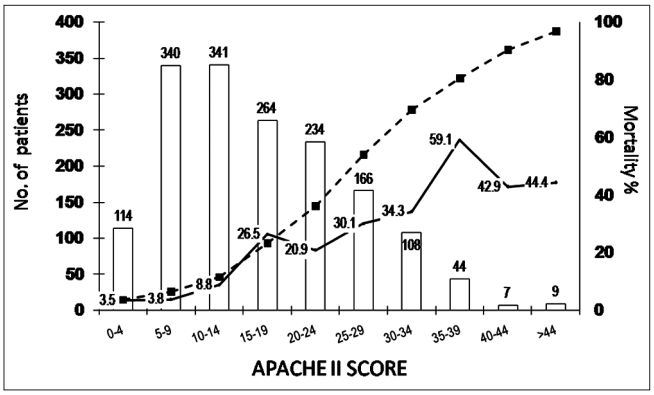

Figure 3: Observed mortality (solid line) versus Acute Physiology and Chronic Health Evaluation II Predicted mortality (dashed line) on the Y2 axis in 1627 patients. Horizontal bars denote number of patients (Y1 axis)

day did not receive antibiotics. About 56.0% of medical patients and 72.3% of surgical patients received antibiotics without having a suspected or confirmed infection on that day. In patients receiving antimicrobials, a median of 2.0 (IQR 1, 2) antimicrobials were given. About 14.9% patients received 3 or more antibiotics.

Patients receiving invasive mechanical ventilation (MV), vasopressors or inotropes (VIs), and RRT had significantly higher mortality than those who did not (35.6% vs. 11.1%, $P < 0.001$; 36.1% vs. 12.9%, $P < 0.001$; and 31.5% vs. 16.2%, $P < 0.001$, respectively).

In 898 patients receiving VIs, arterial and central venous catheters were inserted in 46.7% and 71.4% patients, respectively, and cardiac output and lactate levels were measured in 10.9% and 18.8% patients, respectively. Norepinephrine was the most common vasopressor used (71.2%). Normal saline was the preferred fluid in more than 86% of the 1085 patients that received a fluid bolus.

The results of the multivariate analysis of organizational and patient characteristics, severity of illness, and need for interventions are summarized in Table 6. The APACHE II and SOFA scores, public hospital ICUs, medical ICUs, inadequately equipped ICUs, medical admission, self-paying patient, the presence of SvSpSS shock, acute respiratory failure (PaO_2/FiO_2 ratio <300) or cancer, and the need for a fluid bolus and MV were independent predictors of mortality.

Discussion

The study provides insights into several aspects of adult critical care in India. Patients had moderate severity of illness, as evidenced by an APACHE II and SOFA scores of 17.4 ± 9.2 and 3.8 ± 3.6, respectively. About 53.6% patients had no organ failures, 62.8% patients were without comorbidities.

The 183 TDs represent an additional 33% of the number of 546 ICU deaths. This widespread practice of TDs is contrary to that reported in one single center study[13] and one study of end-of-life care practices in four hospitals in Mumbai.[14] It suggests that end-of-life care in Indian ICUs may be suboptimal and is probably related to the unresolved legal status of withholding and withdrawal of life-sustaining treatments in critically ill patients in India.[12,15] It may also perhaps reflect a small proportion of cases in which the patients' or families' wishes to have a peaceful death at home were respected. We assumed that all TDs from the ICU eventually died and included these in the ICU mortality. Admittedly, while a small proportion of TDs may have survived, merely counting the number of patients who died in ICU would underestimate the number of nonsurvivors.

The low SMR observed in a subset of patients in this study must be interpreted with caution. It may reflect the quality of care, but could also be due the visibly poor calibration of APACHE II. Further, the quality of data input and consistency of definitions were not verified. Variables such as the Glasgow Coma Scale may have

Table 5: Interventions

	All (*n*=4038)	Survivors (*n*=3309)	Nonsurvivors (*n*=729)	*P*
	n (%)	*n* (%)	*n* (%)	
Patients not receiving antibiotics	1113 (27.6)	1021 (30.9)	92 (12.6)	
Patients receiving antibiotics	2925 (72.4)	2288 (69.1)	637 (87.4)	<0.001
One antibiotic	1253 (31.0)	1052 (31.8)	201 (27.6)	
Two antibiotics	1071 (26.5)	825 (24.9)	246 (33.7)	
Three antibiotics	457 (11.3)	313 (9.5)	144 (19.8)	
Four or more antibiotics	144 (3.6)	98 (3.0)	46 (6.3)	
Mechanical ventilation	1495 (37.0)	990 (29.9)	505 (69.3)	<0.001
Noninvasive ventilation	310 (7.7)	236 (7.1)	74 (10.2)	0.01
Invasive ventilation	1256 (31.1)	809 (24.4)	447 (61.3)	<0.001
Tracheal intubation	1042 (25.8)	671 (20.3)	371 (50.9)	<0.001
Tracheostomy	464 (11.5)	263 (11.0)	101 (13.8)	0.06
Surgical tracheostomy	326 (8.1)	258 (7.8)	68 (9.3)	
Percutaneous tracheostomy	138 (3.4)	105 (3.2)	33 (4.5)	
Vasopressors/inotropes	898 (22.2)	574 (17.3)	324 (44.4)	<0.001
Renal replacement therapy	486 (12.0)	333 (10.1)	153 (21.0)	<0.001
Arterial catheter	789 (19.5)	558 (16.9)	231 (31.7)	<0.001
Central venous catheter	1599 (34.6)	1178 (35.6)	421 (57.8)	<0.001
Hourly urine output monitoring	2873 (71.1)	2301 (69.5)	572 (78.5)	<0.001
Cardiac output monitoring	120 (3.0)	98 (3.0)	22 (3.0)	0.94
Stroke volume variation	113 (2.8)	87 (2.6)	26 (3.6)	0.17
Blood lactate measured	456 (11.3)	336 (10.2)	120 (16.5)	<0.001
$ScvO_2$ measured	340 (8.4)	254 (7.7)	86 (11.8)	<0.001
Fluid boluses	1085 (26.9)	848 (25.6)	237 (32.5)	<0.001
Normal saline	936 (23.2)	746 (22.5)	190 (26.1)	0.04
Gelatins	143 (3.5)	93 (2.9)	50 (6.8)	<0.001
Starches	158 (3.9)	111 (3.4)	47 (6.4)	<0.001
Albumin	95 (2.4)	63 (1.9)	32 (4.4)	<0.001
Whole blood/packed red blood cells	249 (6.2)	189 (5.7)	60 (8.2)	0.01
Fresh frozen plasma	120 (3.0)	76 (2.3)	44 (6.0)	<0.001
Platelets	64 (1.6)	40 (1.2)	24 (3.3)	<0.001
Intra-aortic balloon pump	47 (1.2)	38 (1.1)	9 (1.2)	0.84
Intracranial pressure monitoring	107 (2.6)	82 (2.5)	25 (3.4)	0.15
Stress ulcer prophylaxis	3635 (90.0)	2953 (89.2)	682 (93.6)	<0.001
Deep venous thrombosis prophylaxis	2166 (53.6)	1734 (52.4)	432 (59.3)	0.001
Parenteral nutrition	302 (7.5)	235 (7.1)	67 (9.2)	0.05

Table 6: Multivariate regression analysis

	OR	95% CI		*P*
Mechanical ventilation	2.786	2.267	3.424	<0.001
Acute respiratory failure (PaO_2/FiO_2 <300)	2.224	1.703	2.903	<0.001
Presence of cancer	1.982	1.404	2.79	<0.001
Medical ICU	1.923	1.469	2.518	<0.001
Severe sepsis or septic shock during the ICU stay	1.699	1.391	2.075	<0.001
Medical admission	1.588	1.199	2.104	0.001
Public hospital	1.586	1.185	2.125	0.002
Not adequately equipped ICU	1.554	1.193	2.024	0.001
Self-paying patient	1.329	1.033	1.711	0.027
Fluid bolus	1.329	1.067	1.654	0.011
SOFA score	1.147	1.108	1.187	<0.001
APACHE II score	1.044	1.031	1.057	<0.001

Factors not significantly associated with mortality: number of hospital beds, presence of an accredited intensive care training programme, age, presence of comorbidities, presence of COPD, cirrhosis, or chronic renal failure, immunosuppressed patient, infection that developed in the ICU, need for vasopressors or inotropes, renal replacement therapies, receipt of any blood products, stress ulcer prophylaxis, deep venous thrombosis prophylaxis and parenteral nutrition. APACHE: Acute Physiology and Chronic Health Evaluation; ICU: Intensive Care Unit; SD: Standard deviation; SOFA: Sequential organ failure assessment; CI: Confidence interval; OR: Odds ratio

been inaccurately recorded in sedated patients, with resultant erroneously high APACHE II scores. Our mortality in patients with APACHE II scores above 19 and in patients with 3 or more organ failures was lower than that predicted by APACHE II or that observed by Vincent *et al*. in their study of the SOFA score.[16] A formal evaluation of APACHE II as well as other scoring systems is necessary to determine the scoring system that works best in our circumstances.

Our overall ICU mortality rate of 18.1% was higher than the 16.2% rate observed in the intensive care over nations (ICON) audit.[17] Our ICU mortality of 34.0% from SvSpSS was similar to the 36.7% mortality in a multicenter study of 150 ICUs from 16 Asian countries.[18] However, it was higher than that reported in the IMPRESS study (28.4% globally and 30.8% for Asia)[19] and in the ICON Study (25·8%).[17] In mechanically ventilated patients, mortality of 33.8% in our study was more than the 28% mortality reported in the third International Survey on MV.[20] Thus, improvements are required in the organization and delivery of critical care in Indian ICUs.

About 80.5% patients were self-paying. It is essential to increase health insurance plans and government schemes to reduce the economic burden on individuals and families. Absence of adequate facilities in the hospital may lead to inadequate or delayed care or may necessitate transport that may increase the risk of complications, with consequent increase in mortality. A study by Parikh and Karnad in a large public hospital ICU in Mumbai had an observed mortality of 36%, SMR of 1.67 and lower intensity of interventions.[3] This could represent either variations in case mix and clinical practice or could reflect inadequate facilities as well as patients' inability to afford expensive interventions. Perhaps, greater spending to attain higher levels of care in terms of equipment, drugs, interventions, staffing, and organization may lead to better outcomes with greater cost-effectiveness. A more detailed analysis that includes costs and the participation of more public hospital ICUs is essential to answer these questions.

The presence of a training program in critical care medicine was not associated with improved outcome on multivariate analysis. A majority of the programs were of 1-year duration,[21] and there have been variations in the intensity and quality of training between the accredited ICUs. The content and structure of the program, as well as the accreditation process, may need to be reviewed.

We defined a closed ICU as one where the final orders were written by the intensive care team. This includes the completely closed model, the semi-closed, transitional, or mandatory consult model or the high-intensity multidisciplinary care models.[22-24] Studies of the impact of high-intensity models on outcome have shown mixed results, with several studies showing improved mortality and better resource utilization,[25-29] some showing no effect[30] and one showing higher mortality.[31] However, we were unable to demonstrate that closed units were associated with lower mortality, and this study was not designed to detect other benefits of a closed ICU model.

This study confirms that Gram-negative infections are predominant in India (69%), as opposed to Gram-positive infections in Western countries.[32] About 12.2% of patients developed an infection in the ICU. While antibiotics were given in 60.7% of noninfected patients, some patients may have been completing their course of antibiotics, and a proportion of noninfected surgical patients may have received antibiotics as perioperative prophylaxis. Nevertheless, these data suggest that infection control practices and antibiotic stewardship need to be strengthened in Indian ICUs.

In patients receiving VIs, insertion of arterial catheters, cardiac output monitoring and estimation of lactate levels were infrequently performed, perhaps because monitoring was not either available or was not utilized. Monitoring practices in seriously ill patients can be improved.

There are limitations to our study. Participation was purely voluntary. Arguably better-performing ICUs that were motivated and willing to share data contributed to the study, while ICUs with poor performance did not. Only 11% of ICUs and 10% patients were from the public sector, but this may represent the general distribution of ICUs between the private and public sectors in India.[33] Source data verification was not performed. We assumed that the investigators correctly applied the definitions and diagnostic criteria for sepsis and other conditions such as malaria, dengue fever, etc., Some data were incomplete, especially for the length of ICU stay and hospital stay. However, there was no systematic exclusion of data, and the information obtained would still remain valuable. We were unable to obtain data on physician staffing patterns, protocols and night-time coverage by intensivists.[25,34-36]

The strengths of this study include a large number of ICUs and patients from all regions of the country and from different types of ICUs. Data from this study can be used to determine the prevalence of different conditions in Indian ICUs, as well as to determine the baseline mortality rates in important subgroups of patients, e.g., 34.0% in patients with SvSpSS, 33.8% and 36.1% in patients requiring MV and VIs, respectively. This information can be useful in planning future studies. We did not estimate the SMR from the APACHE II score for all patients as we calculated the score on the study day, and not in the first 24 h of ICU admission. However, we did estimate the SMR for those patients whose APACHE scores were calculated within 24 h of ICU admission. We only analyzed data from adult patients as there were only 171 children in the database.

Conclusion

This multicenter, point-prevalence study of 4038 adult patients from 120 ICUs is a snapshot of intensive care in India. Highlights include a moderate severity of illness with relatively high mortality in patients with severe sepsis and septic shock, patients on vasopressors or inotropes or receiving mechanical ventilation. Antibiotics are often given in noninfected patients, monitoring practices in seriously ill patients can be improved. Self-paying patients, public hospitals ICUs, and inadequately equipped ICUs are independently

associated with a worse outcome. Terminal discharge from the ICU is widely practiced and legal, social, and other issues related to end-of-life care need to be resolved.

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Conflicts of interest

There are no conflicts of interest.

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Annexure

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