



## **Intensive Care Unit Staff and Resource Utilization: Is It an Effective Factor?**

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### **Abstract**

**Background:** The aim of present study was to determine the impact of two different ICU management model, open and semi closed, on resources utilization in intensive care unit.

**Method:** Retrospective cohort analysis using data from hospital database was applied to compare the effect of ICU management model on ICU length of stay and bed disposition of 1064 patients admitted to the general ICU of Imam Khomeini Hospital of Tehran, Iran during the two consecutive 12-month periods from Mar, 2009 to Feb, 2010.

**Results:** In open and semi closed interval 380 and 684 patients were admitted to ICU respectively. There was no significant difference in age, gender and severity of illness (based on APACHE-II score) and nurse to bed ratio between two groups. Average ICU length of stay, net mortality rate and bed turnover rate were lower in semi closed model than open model management significantly ( $P<0.05$ ).

**Conclusion:** Semi closed model improves patient care and lead to lower mortality rate and resources utilization too.

**Keywords:** Intensive care units, Economics, Length of stay, Health resources

### **Introduction**

Medical advances in managing some life threatening diseases, growing population of elderly patients and increased incidence of traffic accidents with severe injuries in young population caused growing need to expensive intensive care unit (ICU) services. An ICU bed costs about three times more than a regular hospital bed (1). As a result, high-quality and affordable care management of critically ill patients is essential. Currently, there are two major ICU staffing models; (1) an “open” or “low-intensity” model in which intensivist (ICU specialist) is unavailable or is involved in the care of the patients only when the

attending physician request a consultation and (2) “closed ICU” or “high-intensity” in which intensivist is the patient’s primary attending physician or if not every patients admitted to the ICU receives a critical care consultation (2).

Several studies have attempted to investigate the impact of different ICU staffing pattern on patients’ outcome and resources utilization (3-8).

A number of studies have shown association between high-intensity ICU staffing and lower mortality rates (4, 5) but the impact of ICU staffing on use of resources is not clear. Hanson et al. (3) showed lower ICU length of stay, lower total

hospital charges, used fewer resources and better outcomes in patients supervised by intensivist vs. general surgeon (9). The benefits of high-intensity ICU staffing are clear and it is cost-effective way to improvement of patients care. They mentioned to the amount of time spent by an intensivist providing care exclusively to ICU patients, rapid access to critical care and consistent implementation of protocols to deliver evidence-based care as reasons of the effectiveness of this model. Moreover, High-intensity staffing was associated with lower ICU mortality rates in 93% of studies and reduced length of stay when compared with low-intensity staffing (no intensivist or elective intensivist consultation) (2).

Using a database of more than 100,000 patients, showed no survival benefit of closed ICU staffing and found higher mortality rate, more administration of intravenous drugs, and mechanical ventilation and continues sedation in patients who were managed by intensivist compared to patients who were not managed by a critical care team (10).

Because of the changing in our hospital policy in ICU management model from open to semi closed model and issues concerning cost and human resources, in this study the impact of two different ICU management model, with and without intensivist, on resources utilization in ICU was investigated.

## Material & Methods

In this historical cohort study the associations of ICU staffing model with patients clinical outcomes (mortality rate), ICU length of stay and bed disposition of 1064 patients admitted to the general ICU of Imam Khomeini Hospital of Tehran, Iran, were examined.

This study was approved by the Ethics Committee of Anesthesiology and Intensive Care Department of Tehran University of Medical Sciences. The data were obtained from hospital data base during the two consecutive 12-month periods from Mar, 2009 to Feb, 2010.

Two ICU management models were compared: open and semi closed ICU. During the first interval, patients treated by any attending physician

with admitting privileges; during the second interval patients supervised by full time anesthesiology-based intensivists and received critical care consultation.

The distribution of gathering data was normal and analysis was carried out using independent *t*-test (significance,  $P < 0.05$ ).

The average ICU length of stay (LOS= total length of stay of discharged patients in studied period / total No. of discharged and deaths in studied period), bed-day (active bed  $\times$  365), bed occupancy rate [(total No. of patients days  $\times$  100) / (number of beds  $\times$  365)], total death rate (total No. of ICU death  $\times$  100 / total No. of discharges and death), net death rate (No. of death 24 hours after ICU admission / total No. of discharges and deaths, minus deaths within 24 hours of admissions), turnover rate (No. of discharges / No. of beds) and turnover interval (available beds  $\times$  365-patient days / No. of discharges, including death) were calculated and compared between two groups(11). These indices were calculated routinely in ICU of Imam Khomeini hospital so we used these to compare two management models.

The average LOS shows the average number of days that patients remained in the ICU. Bed occupancy rate shows the percentage of ICU beds occupied over the studied period. Net death rate, also known as the institutional death rate, does not include deaths, which occur within 24 hours of ICU admission. Bed turnover rate indicates the use made of available beds and bed turnover interval is the average period in days that an available bed remains empty between the discharge of one patients and next admission. This index indicates a shortage of beds when it is negative and under-use or an inefficient admission system, if positive (11).

## Results

In the first and second interval 380 and 684 patients were admitted to our academic ICU respectively. There was no significant difference in age, gender and severity of illness (based on APACHE-II score) between two groups (Table 1). The number of ICU beds was increased of 16 to 26 beds in second interval so total bed-day was

increased significantly but nurse to bed ratio was similar in two studied period. Calculated variables are summarized in Table 2. Average ICU length of stay in semi closed model significantly was lower than open model ( $P = 0.04$ , 95% CI: 0.946 – 3.237). Bed occupancy rate in semi closed period was higher than open period insignificantly ( $P=0.504$ , 95% CI: -11.772 – 5.046) (Table 2). In the first and second interval 17 (4.47%) and 38 (5.55%) patients died before and 96 (25.26%) and 144 (21.05%) patients died after 24 hours of ICU admission respectively. There were no significant

difference between two groups in total mortality rate but net mortality rate was significantly lower in semi closed model ( $P=0.042$ , 95% CI: 5.666 – 10.451). Standardized mortality ratio (SMR) (observed mortality/ predictive mortality) in semi closed was lower than open model ( $P= 0.038$ , 95% CI: 0.834 – 2.017) (Table 2). Turnover rate in semi closed interval was significantly lower than open interval ( $P=0.04$ , 95% CI: 0.149 – 1.026). There was no significant difference in turnover interval between groups ( $P=0.59$ , 95% CI: -0.636 – 2.120).

**Table1:** Demographic variables compared between open and semi closed ICU management

Variables/Groups	Open management	Semi closed management	P value	95% CI	
				Lower	Upper
Age (mean± SE)	43.6 ± 17.4	45.2 ± 18.2	0.43	-7.23	3.42
Male (%)	58.7	60.7	0.76	-2.32	4.68
APACHE-II, ICU first day (mean ± SE)	19.7 ± 7.1	22 ± 7.8	0.44	-6.57	2.21

APACHE, Acute Physiology and Chronic Health Evaluation

**Table 2:** Comparison of calculated variables between open and semi closed ICU staffing

Variables/Groups	Open management	Semi closed management	P value	95% CI	
Total bed- day	4256	6354	0.000*	-230.501	-119.166
Occupied bed-day	3878	6160	0.067	-223.669	-156.664
Bed occupancy rate (%)	91.118	96.947	0.504	-11.772	5.046
Average ICU LOS (day)	6.939	4.435	0.039*	0.946	3.237
Total death rate (%)	29.737	26.608	0.154	-43.299	95.801
Net death rate (%)	25.263	21.053	0.042*	5.666	10.451
ICU mortality:					
Patient No.	380	684			
Death No.	108	187			
Prediction (%)	29.8	34.6			
Observed (%)	28.4	27.3			
SMR	0.96	0.79	0.038*	0.834	2.017
Turnover rate (%)	31.667	25.889	0.043*	0.149	1.026
Turnover interval (hour)	1.003	0.338	0.590	-0.636	2.120

LOS: length of stay, \*statistically significant, SMR: Standardized Mortality Ratio

## Discussion

This study was conducted in 1300-bed Imam Khomeini referral hospital of Tehran, Iran and showed presence of intensivist in semi closed ICU staffing lead to lower ICU length of stay, lower

net mortality rate and higher turnover rate than open ICU (no supervision of intensivist) significantly and increase resources utilization as well.

In this study retrospective analysis was applied to collected data from hospital database which makes some limitation in data analysis.

Lower average length of ICU stay in the semi closed group was seen in present study which confirms many other literatures as well as total and net mortality rates. The improved outcomes and decreased ICU length of stay in high- intensity management model have reported in medical, surgical and neurological patients needed intensive care services (12-14).

In a study which analyzed more than 100,000 ICU admissions and found lowest odds of death within 30 days in high- intensity ICU management model, suggesting that the presence of intensivist confers a survival benefit (7). In our hospital some management problems such as uncoordinated relationship between ICU and post ICU wards or shortage of regular hospital bed may cause unnecessary stay of dischargeable patients in ICU for one day more which may affect the average LOS and it can be the reason of lower bed turnover rate in semi closed group as well as increasing total ICU beds in second interval which can affect the ratio (No. of discharges/ No. of beds). Lower bed turnover interval in semi closed management model indicated more efficient admission system using by intensivists.

Dimick et al. analyzed a database of patients underwent esophageal resection in 35 nonfederal hospital with and without daily rounds by an intensivists and showed lack of daily rounds by intensivist was independently associated with a 73% increase in hospital length of stay and 61% increase in total hospital cost and some postoperative complications such as pulmonary insufficiency, renal failure, aspiration and re-intubation but there was no association with in-hospital mortality rate (12). In the study which conducted in Turkey open, early closed and late closed ICU policy were compared and showed an association between presence of critical care specialist with the admission of sicker patients and more frequent use of invasive procedure. Authors concluded that dual strategy of closed policy and simultaneously appointing an intensivist fostered admission of sicker patients and improved the survival of patients in developing countries (15). But in our study there was no spastically significant difference in severity of illnesses in

ICU admitted patients based on APACHE-II scoring. It seems it is because of ICU admission in our hospital based on first attending physician in emergency ward. Although, SMR in both of open and semi closed model was lower than one but this reduction in semi closed model was significantly more than open model ( $P= 0.038$ ) (Table 2). Lower SMR (observed mortality / predictive mortality) shows quality of care in semi closed was better than open model.

Strategic use of resources without reduction of quality of care given to patients is necessary to deliver care to growing demand for ICU services. It seems intensivist model is cost effective way to resources utilization. There are some barriers for ICU closed model management implementation. In a recent study authors have mentioned to some of those such as resistance of hospital and physicians, increasing cost association with recruiting fellowship- trained intensivists, inadequate trained physicians and administrative barriers (9) which affects our academic ICU too. More organized studies have been suggested to determine cost effectiveness and identify important barriers of semi closed ICU management model to overcome these barriers. During the time from early closed policy to late close policy, mortality rate in ICU was decreased but hospital cost did not mention in his study (15).

## Conclusion

The presence of intensivist and high-intensity ICU lead to decreased of net mortality rate, more resources utilization and higher quality of care and turnover rate than low-intensity ICU. The clinical benefits of high-intensity ICU staffing are clear but it is needed to prove cost-effectiveness of this policy. It seems more studies with regard to total hospital cost are necessary to prove cost-effectiveness of presence of an intensivist in developing country.

## Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or

falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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