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Original Article



# The Vicious and Virtuous Facets of ICU Structure

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## Abstract

**Background:** In the provision of medical facilities, intensive care units are very critical and it seems almost difficult to use the new therapeutic strategies without Intensive Care Unit (ICU). There are two types of ICU structure, known as the open or closed model. The aim of this study was to assess the variables driving the selection of the appropriate ICU management structure and modeling of the appropriate ICU management structure.

**Methods:** This descriptive-exploratory study was performed among all resident doctors, consultants, therapists and neurosurgeons, ICU specialists, internal medicine specialists, respiratory diseases specialists, heads of associated units and head nurses, neurosurgery ICU workers and staff, and doctors of the Loghman Hakim Hospital in Tehran, Iran in 2018. The influence of independent variables on dependent variables and the effect of observed variables on latent variables were tested using the Structural Equation Technique (SEM technique) and the data collected in the LISREL program was analyzed.

**Results:** This research included one hundred persons, including 91 men and 9 women. The factors affecting the performance and structure of the ICU were structural context (including open, semi-closed, and closed structure), organizational context, strategic context, treatment economics context, processes, and quality improvement.

**Conclusion:** There is a good association between quality management and the application of the closed system of the ICU and each of the organizational, strategic, care economics, and processes factors.

**Keywords:** Hospital units, Intensive care unit, Physicians, Quality Improvement, Specialization

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## Introduction

Today, intensive care units are very important in providing medical services and it seems almost impossible to use the latest treatment methods without ICU. That is why hospitals have increased the number of ICU beds over time. At the same time, due to the complex and unique equipment and special capabilities required in the intensive care units, the cost of developing and maintaining these units is of particular importance. One of the effective factors in increasing the efficiency and effectiveness of intensive care units is the management of these departments (1-5).

There are several methods for managing intensive care units, often chosen based on local experience and local factors, and less dependent on the cost-effectiveness system. There are three structures of the ICU, referred to as the open, closed, or hybrid ICU model (3,5).

In the open model, ICU patients are managed and treated by a non-intensivist. This person can seek advice from an intensivist at his/her own discretion. This often leads to conflicting treatment strategies. Besides, responsibility and accountability are shared, and no physician assumes ultimate responsibility for patient care. Such a system is not cost-effective and is not conducive to achieving optimal patient care. The intensivists' role in open ICU management is to try to strike a balance between all the services involved in patient care and also to prevent the patient from missing or "falling through the cracks" due to shared care (2).

Closed units are units in which the intensivist controls all admissions and discharges and is fully responsible for all aspects of patients' treatment and quality of health care (6). Key elements of Leapfrog's recommendations for intensivist physicians are that all ICU patients are managed by the intensivist or co-managed with the intensivist (7). As a result, frequent delivery of shifts leads to disconnection and incompatibility in the care of ICU patients. The daily changes in intensivists lead to inconsistent care. Also, the lack of continuity of care by a physician is very confusing for patients' families as well as other members of the ICU team. On the other hand, burnout syndrome is a real problem among intensivists because of long working hours and ICU organizational structure (7-11). Such a model can be cost-ineffective and impractical however, due to the work force of the intensivists (12).

In hybrid/transitional/semi-closed ICU, the primary treating physicians are not a part of the ICU team, but remain actively involved in their patients' care. In this model, critical care specialist provides direct patient care in collaboration with other physicians, who are also allowed to write orders (13).

To design or modify intensive care units, it is necessary to review ICU demand based on resource evaluation, patient admission and discharge statistics, and the number of patients in this unit in other hospitals in the same field. Using standards in the ICU will increase patient survival and reduce costs by preventing mismanagement of ICU affairs and reducing preventable deaths (14-16).

Jadidi believes that improving the quality and quantity of educational, physical, and human resources can pave the way for better services, although it may not have a direct impact on reducing casualties after 24 hours (17,18). Identifying risk factors related to mortality in the ICU is the first step that can lead to better identification of at-risk patients, vital medical interventions, and better and more efficient medical care in the ICU (19,20).

There have been many studies on the coding of ICU standards in most countries of the world, especially in developed countries. Designing an ICU and improving its current condition requires the experience and skills of both standard programming organizations and ICU medical staff who are fully aware of the needs of patients at the same time. It seems that in Iran, not enough attention has been paid to these standards and different management models and the importance of their use in medical centers (21-23). Due to this issue, in this study, the factors affecting the selection of the appropriate management structure of the ICU were examined and a model for the appropriate management structure of the ICU was presented in order to improve medical services in the ICU of Loghman Hakim Hospital.

## Materials and Methods

The study method is given in figure 1. This applied study is based on the descriptive-exploratory method. Important factors of ICU performance as well as

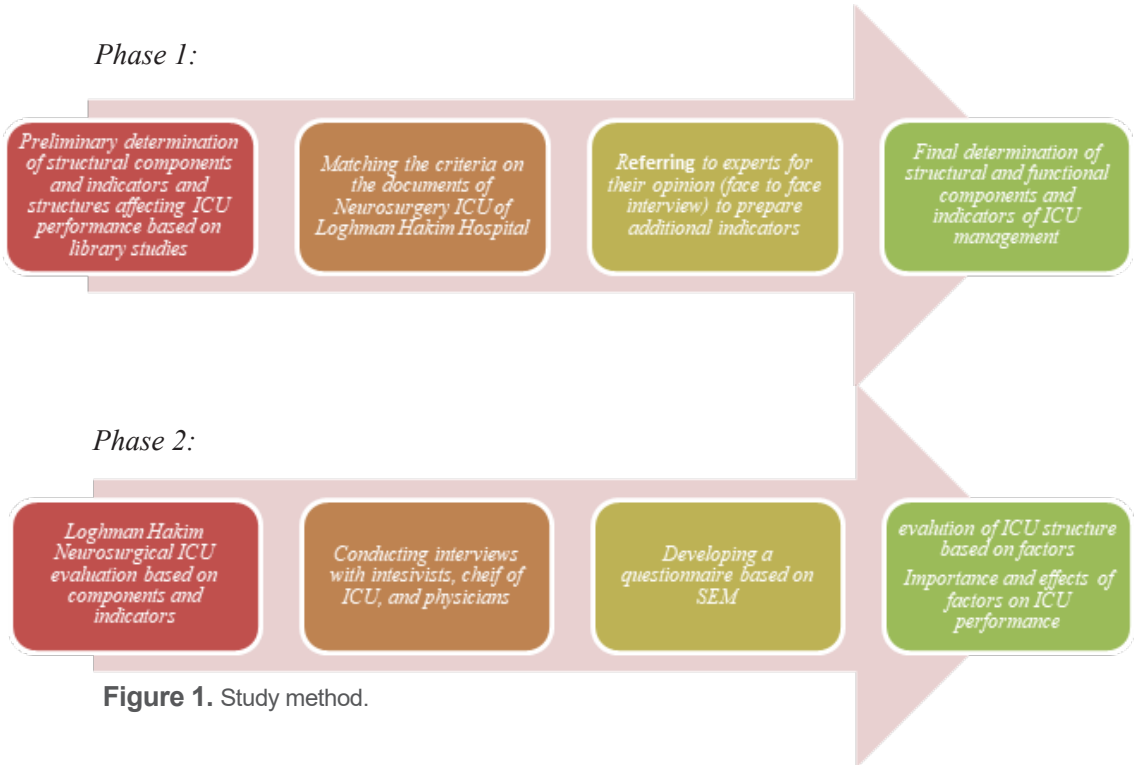


**Figure 1.** Study method.

factors affecting the structure were identified and categorized. Facto affecting the ICU performance were classified into 5 groups as management structure, the existence of required departments, human resources, equipment and technology status, and available records and documentations. Totally 137 factors have been recognized. After expert interviews, 56 factors in 6 categories were selected.

Based on the criteria and indicators obtained from reviewing the literature of articles and expert opinions, a questionnaire was prepared to assess the situation and determine the importance of each individual and structural factor (the questionnaire is given in appendix 1).

Structural Equation Modeling (SEM) has been chosen for analysis of data. The recommended sample number in SEM was based on N:q ratio that shows observations (participants) for each estimated parameter in the model. Kline recommended that the N:q ratio should be 20 to 1, since if there are 6 parameters to evaluate, the sample size should be at least 120 (24).

The questionnaire was conducted in Clinical Research Development Unit of Loghman Hakim Hospital in Tehran, Iran in 2018. A total of 156 completed questionnaires were obtained. Participants included resident physicians, consultants, therapists, and neurosurgeon ICU specialists, internal medicine and infectious diseases specialists, heads of related departments, head nurses and nurses, and neurosurgery ICU physicians.

For validity of the questionnaire, a pilot study was conducted between 5 ICU specialists and based on feedbacks, the final questionnaire was prepared. For reliability, the Cronbach's alpha was calculated. Since all values were more than 0.75, the questionnaire was considered reliable. The results are shown in table 1.

Then, using the structural equation technique or SEM technique, the effect of independent variables on dependent variables and the effect of observed variables on latent variables were investigated and the data obtained in LISREL software were analyzed. $\lambda$ denotes the hidden variables to visible variables. $\Lambda$ is called factor weights or factor loads. According to, factor loads greater than 0.3 indicate the importance of the relationship. A factor load of between 0.3 and 0.6 is acceptable, and if greater than 0.6, it is highly desirable (25).

The coefficient of causal relationship between two latent variables related to $\beta$ is shown. To check the significance of the relationship between the variables, t-test was used. Because significance level is checked at the error level of 0.05, if the amount of factor loads observed is less than 1.96 calculated by test-test, the

**Table 1:** Cronbach's alpha.

| Key ctors | Number of factors | Cronbach's alpha |
|---|---|---|
| Organizational | 15 | 0.7821 |
| Strategic | 18 | 0.8309 |
| Health economics | 9 | 0.8436 |
| Processes | 6 | 0.8790 |
| Quality improvement | 8 | 0.7957 |

**Table 2:** Strategic field scores

| | Coefficients | Rank |
|---|---|---|
| The effect of closed structure on the training of surgical assistants | 0.93 | 4 |
| The effect of closed structure on the training of anesthesia assistants | 0.88 | 6 |
| The effect of closed structure on the training of pharmacology assistants | 0.98 | 2 |
| The effect of closed structure on the training of other assistants | 0.96 | 3 |
| The effect of closed structure on the training of fellowships | 0.90 | 5 |
| The effect of closed structure on regulations | 0.77 | 7 |
| The effect of closed structure on management opinion | 0.99 | 1 |
| The effect of closed structure on issuance of death certificate | 0.78 | 8 |

*In this table, the relative chi-square value is 1.478, which indicates an acceptable status for the model.

relationship is not significant and it will be displayed in red in LISREL software (26).

## Results

One hundred people, including 91 men and 9 women, participated in this study. Also, 40% of the selected individuals had 5 to 10 years of work experience and 35% had 2 to 5 years of work experience. About university education of the participants in the study, 46% of the selected sample had a doctoral degree, 44% had specialized education, and 10% had a nursing degree.

After reviewing and evaluating the data, the factors affecting the performance and structure of the ICU were determined in six fields of structural (including open, semi-closed, and closed structure), organizational, strategic, healthcare economics, processes, and quality improvement.

After calculating the regression weights or factor loads, strategic factors with coefficient of 0.94, quality improvement factors with coefficient of 0.91, and process factor with coefficient of 0.88 were significantly correlated with ICU performance and ICU structure and therefore, they have more weight in calculations related to this hidden variable. In contrast, the organizational factor with a coefficient of 0.53 had less correlation with ICU performance. As a result, it weighs less in the relevant calculations. In table 2, the Tucker-Lewis index (TLI) was equal to 0.937 and the Comparative Fit Index (CFI) was equal to 0.954, and since their values are more than 0.90, based on these indicators, the developed model is considered acceptable. Based on the mentioned indicators, it seems necessary to study the indicators to consider the model acceptable. Values of 0.50 and above are considered acceptable for the Parsimony Normed Fit Index (PNFI) and the Parsimony Comparative Fit Index (PCFI), and some sources indicated 0.60 or higher for the suitability of the developed model. In table 2, the value of the normed fit index was equal to 0.796, which shows acceptable values. The values of the general fit indices in the table show that the measurement model of this research is in an acceptable condition. The data correlations are

**Table 3:** Data correlations

| | | Correlations | | |
|---|---|---|---|---|
| | | The field of healthcare economics | The field of processes | The field of quality improvement |
| The field of treatment economics | The correlation coefficient | 1 | 0.741** | 0.568** |
| | Significance level | | 0.0001 | 0.0001 |
| | Number | 156 | 156 | 156 |
| The field of processes | The correlation coefficient | 0.741** | 1 | 0.501** |
| | Significance level | 0.0001 | | 0.0001 |
| | Number | 156 | 156 | 156 |
| The field of quality improvement | The correlation coefficient | 0.568** | 0.501** | 1 |
| | Significance level | 0.0001 | 0.0001 | |
| | Number | 156 | 156 | 156 |

The significance level is the same as the P-value stated at the bottom of the table, which is the values given by *.
*The significance level of 0.05 and ** the significance level of 0.01. In fact, a hypothetical test has been performed here, the zero assumption of which is the absence of a relationship between variables. Therefore, if the values related to the significance level are smaller than the value of 0.01 or 0.05 (according to the sign * and **), it indicates the existence of a relationship between the variables. The phrase (tailed -2) means that the test is two-sided.

presented in table 3. tables of the correlation matrix and commonalities are given in appendix 2.

## Discussion

This research shows that the complexity of implementing a suitable ICU structure can be broadly classified under the organizational, strategic, healthcare economics, processes, and quality improvement contexts that surround the system.

In order to investigate the relation between ICU structural model with organizational, strategic, healthcare economics, processes and quality improvement factors and on ICU performance, SEM method was used. The results showed that there is a significant relation between ICU structure and every other factors and ICU performance. The closed ICU between three different models has positive effects on performance and other factors.

The research shows the value and effective role of closed structure in ICU in improving ICU performance by ward management and hospital management and supporting the institutions can be the first step in preparing for the implementation of closed structure in neurosurgery ICU. In the study of Checkley *et al*, it was found that closed ICU was not associated with a reduction in mortality in the ICU and an improvement in quality, which was different from the current study. The study also found that factors that improve quality include a lower bed-to-nurse ratio and review of day care, which were not seen in the present study (27). In the study of Treggiari *et al*, it was found that closed ICUs perform better than open ICUs and closed models improve the quality of intensive care units, which is similar to the current study. Of course, one of the differences between the mentioned study and the current study is that the first was performed on patients with acute lung injury, but the present study was related to neurosurgical patients (28).

The findings of this study indicate that among the effective dimensions, the strategic factor with 0.94 has a higher impact than other dimensions both in ICU structure and also in ICU performance.

In this study, outcomes show that the most important variables affecting the strategic, healthcare economics,

processes, organizational, and quality improvement factors respectively are administrative factor, length of stay, timely diagnosis processes, treatment services, and control of the use of therapeutic antibiotics. The study by Weled *et al*, also found that institutional support for comprehensive quality improvement programs as well as ICU programs improves the quality of this effective hospital ward. It was also found that to improve the organizational performance of the ICU, high-performance treatment services are needed, which in this respect is similar to the current study (29). In the study by Donovan *et al*, it was found that the cooperation of different care and treatment services improves the performance of the ICU staff and the various needs of patients and even their families should be met by care and treatment teams. The above study was similar to the current study in terms of the effect of coordinated performance of experienced care and treatment personnel (30).

In the present study, the scope of research was limited. Larger sample size can result in more accurate results. Also, about 91% of participants were male that may cause a bias in the outcomes.

## Conclusion

The findings of this study, using data collected from the neurosurgery ICU of Loghman Hakim Hospital in Tehran, show that there is a positive relation between the implementation of the closed structure of the ICU and each of the organizational, strategic, treatment economics, processes, and quality improvement factors. It also shows the relation between these factors with ICU performance.

Closed ICU structure has a positive effect on ICU performance. However, obedience to hospital leaders, supporting managers and heads of departments, fostering creative people, and facilitating hospital changes and facing the issues can be considered as solutions to reduce the challenge of implementing closed structure in the hospital.

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