THE PREVALENCE OF MORTALITY OF PATIENTS ADMITTED TO THE INTENSIVE CARE UNITS AND ITS RELATED FACTORS: A META-ANALYSIS AND SYSTEMATIC REVIEW

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Abstract

Background and Aims: The most important indicator in evaluating the therapeutic abilities of intensive care units (ICU) of hospitals is studying the patients’ mortality rate. A lot of electronic research has been shown related to the prevalence of mortality in ICU. The aim of the present research was to estimate the prevalence of mortality of patients hospitalized in ICUs using meta-analysis.

Materials and Methods: Searching PubMed, Science direct, Scopus and Google scholar databases, the related articles published between 2000 and 2015 were studied. Keywords were searched based on inclusion and exclusion criteria. Then, the final papers were selected for entering in the meta-analysis. To analysis data, Stata software was used. To estimate the prevalence of mortality in ICUs, the random effect model was used.

Findings: In this meta-analysis and systematic review, 33 related articles were selected, and the prevalence of mortality was examined among 842,523 patients admitted to the ICU. The mortality rate among primary studies included to the present meta-analysis varied from 8.2% in American with a sample size of 29084 people to 48.8% in France with a sample size of 203 patients. Pooled estimate of mortality in ICU was determined 24.02% (CI 95%: 19.6-28.4).

Conclusions: Despite the fact that there are significant differences in the prevalence of mortality in ICUs in different countries, the estimated rate is relatively high. Thus, it is necessary to conduct more studies on the risk factors and their roles in prognosis and to examine treatment and care status more carefully.
Keywords: prevalence, Mortality, Inpatient, Intensive Care Unite

1. Introduction

Nowadays, hospital mortality accounts for a big part of mortality in the society. Easy access to the hospital and increased facilities have caused people to be taken to hospital before death. However, the hospital mortality is closely associated with hospital facilities and medical equipment, hospital services and the quality of medical and nursing care, the number of medical personnel and nurses, the quality of medical and nursing care, hospital type, different wards, characteristics of hospitalized patients and types and severity of diseases (1, 2).

According to global estimates, mortality in ICUs is between 6 and 40% when special medical care is applied (3). Results of some studies conducted in Iran showed that the mortality rate in the ICUs was between 27.9 and 33.7% (4, 5). The mortality rate always refers to the biological death recorded in the ICUs (2).

One of the most important challenges of the health care system is to improve the quality of life, reduce the length of stay and reduce mortality (6).

There are different reports about the mortality rate and complications of hospitalization in the ICUs. There has been a huge controversy over the causes of mortality and the relationship between the length of stay and increased or decreased complications. Numerous studies have been conducted to identify the factors increasing the risk of mortality in ICUs; patients who are in ICUs and who require ventilator for more than 14 days, patients older than 65, septic shock, patients with kidney and heart problems and nosocomial infections are factors that increase mortality in the ICUs (7). A study showed that aging was a very important factor in increasing the mortality rate. For every five years of age, mortality increases (8). Owing to different reasons, trauma can cause people to be hospitalization in the ICUs, with car accidents being the most common causes. In a 3-year study conducted by Nouri et al, duration of hospitalization in the ICU was 12.3 ±8.4 days, and the most frequent causes of death were severity of lesions and brain damages (58%) and septicemia (21%) (9).

Given the importance of information on the mortality in patients hospitalized in the ICUs and according to the search results that show that numerous studies have been conducted on the mortality rate in the ICUs, the aim of the present study was to estimate the prevalence of mortality in the ICUs using meta-analysis.

2. Materials and Methods

Search strategy:

In this study, to find studies published electronically from 2000 to 2015, we searched available databanks such as PubMed, Science direct, Scopus and Google scholar using the keywords of prevalence, mortality, inpatient and...
Intensive Care Units with operators “or and” in the title and abstract. The articles were evaluation search randomly by two researchers so as to avoid exclusion of studies.

**Study Selection**: full text or abstracts of all papers, documents and reports resulted from the advanced search were extracted. After the repeated studies were excluded, the title, abstract and full-text of all articles were examined and the unrelated articles were excluded and the related ones were selected. To avoid bias resulted from re-publishing, the findings were examined to recognize and exclude the repeated studies. Two researchers selected the articles; in the case of inconsistency, the third researcher examined the cases and then they decided to exclude or keep them.

**Inclusion criteria**: data was extracted based on the title, the corresponding author, publication year, sample size, the country in which the study was conducted, type of the study and the average mortality. After assessing and examining the studies, all Persian and English studies which had reported the mortality rate of patients hospitalized in ICUs were selected.

**Exclusion criteria**: studies which hadn’t reported the mortality rate and sample size, abstracts related to congresses and conferences, abstracts without full texts and case studies were excluded.

**Quality assessment**: Studies quality assessed using STROBE checklist(10). This checklist was including 22 item addressing various aspects of methodology such as type and design of the study, appropriate sample size estimation and selection, data collection methods and tools, study population, variable definition and assessment, study objectives, statistical tests, illustration and presentation of the results. Studies achieved at least 15.5 quality scores, were considered eligible for meta-analysis.

**Data extraction**: data was extracted in Excel based on the name of the corresponding author, type of the study, place of study, year of publication, sample size, overall prevalence of mortality, cause of death and cause of hospitalization.

**Analysis**: to analyze data, Stata was used. The standard error of the prevalence of every study was calculated based on the binomial distribution. The random effect model was used to estimate the prevalence of mortality in the ICUs. The prevalence point of mortality in the ICUs was evaluated for each study; its overall estimation (95% confidence interval) was calculated in the forest plots.

**3. Results**

During the search of databases, 22302 articles was extracted. Then, using the operator “and”, limiting the search strategy, increasing its features and eliminating unrelated articles, 1907 articles were obtained. 855 articles were excluded due to overlap of the databases; 896 articles were also excluded after examining the titles and abstracts. Finally, 156 related articles were obtained. The full texts of 156 articles were examined to assess the inclusion and
exclusion criteria. 118 articles were excluded because they were unrelated or didn’t have the inclusion criteria. Moreover, 2 articles were examined completely by examining the references of previous articles. Finally, 33 articles entered the meta-analysis and the systematic review (Figure. 1). Most studies were of descriptive types. In this meta-analysis, the prevalence of mortality was examined among 842,523 patients hospitalized in the ICUs. The prevalence of mortality in the initial studies varied from 8.2% in an America study conducted by Ensminger (11) with the sample size of 29084 people to 48.8% in a French study carried out by Rigon with a sample size of 203 people(12). In the present study, causes of death and hospitalization were mentioned in a systematic review. Causes of hospitalization were related to the nervous system in 4 studies, to the cardiovascular system in 7 studies, to the respiratory system in 9 studies, to the infectious diseases in 1 study, to the immune system in 2 studies and to diabetes, surgery and cancer in 3 studies. Moreover, the hospitalization causes weren’t mentioned in 7 studies. Respiratory problems were the most common causes of death in most studies (Table 1).

Results of the meta-analysis showed that there was a huge divergence between the results of the initial studies (Q = 64520.2, I-squared = 100%, p-value <0.001). Thus, the random effect model was used to estimate the incidence of mortality in the ICUs. Combining the results of the initial studies entered into the meta-analysis, the incidence of mortality in the ICUs was 24.02%. (19.6-28.4) (Figure. 2).

Table 1. Baseline characteristics of included studies in meta-analysis of prevalence of Death in ICU.

<table>
<thead>
<tr>
<th>First author</th>
<th>Publication year</th>
<th>Sample size</th>
<th>The overall prevalence of death (%)</th>
<th>Cause of Death</th>
<th>Cause hospitalization</th>
</tr>
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<tbody>
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<td>270</td>
<td>27</td>
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<td>Diseases of the nervous system</td>
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<td>296</td>
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<td>Trauma</td>
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<tr>
<td>parnia</td>
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<td>157</td>
<td>37.6</td>
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<tr>
<td>norozi</td>
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<td>150</td>
<td>33.3</td>
<td></td>
<td>Emergency Surgery</td>
</tr>
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<td>200</td>
<td>22</td>
<td></td>
<td>-</td>
</tr>
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<td>27.9</td>
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<tr>
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<td>Lizana</td>
<td>2003</td>
<td>202</td>
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<td>-</td>
</tr>
<tr>
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<td>Year</td>
<td>Age</td>
<td>Disease</td>
<td></td>
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<td>19</td>
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<td>3778</td>
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<td>110558</td>
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<td>342</td>
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<tr>
<td>AHSAN</td>
<td>2005</td>
<td>238</td>
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<td>23134</td>
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<tr>
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<td>2013</td>
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<tr>
<td>Laura C. McPhee</td>
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<td>65</td>
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Figure 1. Literature search and review flowchart for selection of primary studies.

Figure 2. The prevalence of mortality in the ICUs in each study and its overall estimation with the confidence interval of 95%.
4. Discussion and Conclusions

This study estimated the prevalence of mortality in the ICUs. Results revealed that about a quarter of patients hospitalized in the ICUs died. However, mortality had different causes in different studies entered into the meta-analysis. Mortality rate was different in different studies. It seems many causes such as severe shortage of the ICUs, patients aged more than 70, increased prevalence of chronic diseases, hospitalization of different and heterogeneous groups of patients and policies governing hospitals affected the way patients were admitted to the hospitals. Severe shortages of the ICUs in terms of space and standard equipment like ventilators, monitoring devices, etc. and qualified and trained personnel could be another factor which increased morbidity and mortality, especially in the field of transmission of infections and respiratory problems resulted from the devices disorder. The occurrence of in-hospital mortality is related to the quality of staff and equipment.

Kabirzadeh et al conducted a study entitled “examining the effects of an anesthesiologist’s stay on the patients’ mortality rate in the ICUs” in Sari in Iran. In this study, records of the treatment group (patients who died in the presence of anesthesiologist) and the control group (patients who died in the absence of anesthesiologist) were examined, demographic and medical characteristics were collected and recorded, and homogeneous intervening variables such as equipment weren’t checked in both groups. Findings showed that the mortality rate in the ICUs was high in men (61.9%) and in women (38.1%). In the presence of an anesthesiologist, total hospitalization period of patients decreased from 14 days to 11 days, and the mortality rate decreased from 24 to 14%. Moreover, the results revealed a significant relationship between age and death, age and cause of death, and cause of admission and death and the referral service. The results showed that the presence of an anesthesiologist was effective in reducing mortality.

Concerning the limited number of beds in the ICUs and admission of various patients, patients must be selected based on classical indications. On equal conditions, patients who need the ICUs more, patients who are less likely to die and those who have better prognosis must be hospitalized first. It must be noted that other factors like admitting patients at nights, admitting patients who are dying, management systems (open or closed) and fast and timely visits by doctors affect the mortality rate in the ICUs.

Abrishamkar (2004) showed that admission of patients increased each year; he concluded that it could be due to increased population growth, increased frequency of trauma in the society and activation of the ICU section. Of 296 patients admitted to the ICUs in Shahre Kord, 34.7% died (relatively high). The major contribution of the mortality
rate was observed in infants and patients with internal problems, especially respiratory problems. However, different traumas accounted for 29.6% of the mortality (9).

In a study entitled “the mortality rate of patients admitted with intracranial hemorrhage and the factors affecting it”, of 157 patients, women (57.9%) had the highest frequency. The mortality rate was 37.6% in this study. It was found that there was a relationship between the extent of hemorrhage and intra-ventricular hemorrhage and the mortality rate of patients with stroke (14).

Norouzi et al conducted a study entitled “comparing two SAPS II (Simplified acute physiology score II) and APACHE IV (Acute Physiology and Chronic Health Evaluation II) instruments in predicting the mortality of patients admitted to the ICUs. This study aimed to compare the prediction of the mortality rate in patients admitted to the ICUs using SAPS II and APACHE IV. The information related to 150 patients was collected by a demographic questionnaire using SAPS II and APACHE IV; it was then analyzed by standard methods. The mortality rate was 33.3% in this study. Results showed that SAPS II and APACHE IV were able to predict the mortality rate in the ICUs (15).

In a study carried out on the mortality rate of 200 patients admitted to the ICUS, 66.5% were men and 33.5% were women. Of them, 22% (n= 44) died (16). Soleimani et al (2010), the mortality rate observed by the APACHE II was 27.9%. Results of this study conducted using patients’ treatment trend showed that this index could precisely predict the mortality rate (5).

In 2004, a study was conducted by Vandewoude in Belgium. To investigate the mortality rate in this study, APACHE was used. The mortality rate was 18.9% in this study (17).

One study examined the causes and duration of hospitalization and the mortality rate in the ICUs in Markazi Province in Iran. Respiratory status, hemodynamics, vital signs and physical injuries were examined in this study. The mortality rate in hospitals which had the ICUs was 28.32%; as age increased, the mortality rate increased in the ICUs (18).

Bahrami et al (2012) conducted a study entitled “predicting the length of stay and the percentage of mortality in the ICUs” using APACHE IV. In this study, the demographic specification tool and APACHE IV were used. The average score of APACHE IV was 50.62± 19.07. The mortality rate predicted using APACHE IV was 11.81% and the observed mortality was 33.7%. Results showed that the APACHE IV could precisely predict the mortality rate in the ICUs (4).
Garcia Lizana (2003) conducted a study entitled “the consequences of long-term hospitalization of patients in the ICUs”. The aim of this study was to determine the mortality rate of patients admitted to the ICUs and the life quality of these patients after discharge from the hospital. Of 202 patients admitted to the ICU, 16.8% died (19). Rodriguez et al (2008) conducted a cohort study entitled “the mortality rate of pneumonic patients admitted to the ICUs”. This study examined the relationship between the mortality rate and age, sex and comorbidity diseases (alcoholism, COPD (chronic obstructive pulmonary disease), cardiovascular disease, diabetes and diseases of the nervous system). To estimate the severity of the disease and the mortality rate, APACHE was used. In this study, 529 patients were studied. The mortality rate of patients admitted to the ICU was 25.3% (20).

Owing to isolation, decreased enough sensory stimulations, decreased contact with others or the noisy environment and devices and limited movement resulted from ventilator and other devices, patients admitted to ICUs are naturally prone to problems of inadequate or extra sensory stimulations that cause the incidence of psychosis in them.

Vandijck et al conducted a study entitled “the effect of reducing the function of organs on the mortality rate of the ICU patients with hematologic malignancy” in Belgium. During this study, 344 patients with hematologic malignancy were admitted to the ICU. To examine the mortality and the severity of the disease, SOFA (Sequential Organ Failure Assessment) and APACHE II were used. Results showed that the mortality rate of patients admitted to the ICU was 40.7% (21).

Krinsley et al examined 1826 patients admitted to the ICUs in America. Results revealed that there was a significant relationship between the increased amount of glucose and the mortality. The lowest mortality rate was found in patients with glucose between 80 and 99 mg/dL. The highest mortality rate was observed in patients with glucose above 300 mg/dL. The mortality rate was 19% in this study. To avoid complications, effective measures must be taken to reduce mortality as a general rule (22).

Training personnel and providing health care services based on new practical information is an effective step towards reducing the mortality and morbidity in patients admitted to the ICUs. Moreover, making use of advanced equipment and monitoring the vital signs have a significant impact on the consequences of ICU admission.

Ensminger et al conducted a study entitled “the mortality rate of patients admitted to the ICUs on the weekend”. The statistical population consisted of 29084 patients. The mortality rate was 8.2% in this study. Results showed that there was no difference between the mortality rate of patients admitted on weekends and patients admitted on weekdays. However, the mortality rates of patients admitted to surgery ICUs on weekends were more (11).
In a study conducted in France, the effect of increased weight was examined on the mortality rate of ICU patients. Since overweight patients seemed to be more susceptible to complications during their stay in the ICUs, this study aimed to investigate the relationship between BMI (Body Mass Index) and the mortality rate in ICU patients. The mortality rate was 15.6% in this study. There was a statistically significant difference between the obese patients and age, length of stay in ICU, SAPS II and the mortality rate. Results showed that high levels of BMI were an independent prognostic factor for mortality in ICU patients (23).

Quach et al conducted a study entitled “comparing the APACHE II and Charlson Index Score to predict the mortality rate of critically ill patients in Canada”. In this study, the mortality rate was 18.9%. Results showed that APACHE II was more effective than the Charlson index in predicting the mortality rate in ICUs (24).

Zimmerman et al studied 110558 patients; the mortality rate was 13.6%. Results revealed that the (APACHE) IV was useful for predicting the mortality rate in ICU. (APACHE) IV also precisely predicted the length of stay in the ICU. Examining the mortality status in the ICUs in American medical centers, it was found that improving the quality of health care services could significantly decrease the mortality rate (25).

In another study conducted by Zimmerman et al, 482601 patients admitted to the ICUs from 1988 to 2012 were studied. Results showed that the mortality rate was 35% and that the most common cause of admission was COPD (26).

In a study by Rigon et al, the mortality rate was 47.8%. The most common cause of hospitalization was acute respiratory failure (12).

The mortality rate was 10.7% in a study carried out by Lilly et al in America. Results revealed that there was a relationship between the use of tele-ICU and the mortality rate and reduced length of stay in ICUs (27).

Kiekkas et al conducted a study entitled “the relationship between nursing workload and the mortality rate in the ICUs in Greece”. In this study, (TISS)-28 (Therapeutic Intervention Scoring System) was used to measure the required care. Of 396 patients in this study, 32.6% died. The most common cause of hospitalization was cardiovascular disease. Results showed that examining the shortage of nursing staff was important to reduce the mortality rate in the ICUs. High working hours in split shifts could be an intervening factor in mortality in working shifts (28).

893 patients were examined for 18 months in a study by Timsit et al in France. The mortality rate was 22.7% in this study. The most common cause of hospitalization was respiratory failure (29).
In a study conducted by Chen et al, the mortality rate of 342 trauma patients admitted to the ICU was 22.5%. In this study, the main factor leading to increased mortality was systemic inflammatory response syndrome (30).

Another study in France showed that the mortality rate was 26.3% in ICU patients. Results showed that the delay in the treatment of patients with active pulmonary tuberculosis and respiratory failure resulted in increased mortality of patients admitted to the ICUs (31).

In a study conducted in Taiwan on 87479 patients admitted to the ICUs due to acute respiratory failure, 12.1% patients with pneumonia died (32).

In their study, Uusaro et al showed that the most common cause of hospitalization in the ICUs was acute renal failure in the circulatory system. In this study, the mortality rate was 10.9%. Results showed that there was a relationship between admission of patients on weekends and the increased mortality (33).

In a study conducted in Holland by Brinkman et al, the mortality rate was 15.7% in the ICUs(34).

McPhee tried to show that the first amount of Etomidate was not associated with the increased mortality rate in ICU patients with Sepsis. He studied 741036 patients from 2008 to 2010; of them, 2014 patients participated in his study. Results showed that the mortality rate was 30.1% (35).

In a study conducted in America by Muller et al, PSI score (Pneumonia Severity Index) was used to predict and reduce the mortality rate of patients admitted to the ICUs due to influenza. The mortality rate was 12% in this study. Results revealed that this tool could be useful for reducing the incidence of influenza (36).

In a study conducted by Holguin et al, the mortality rate of patients admitted to the ICU was 16.9% (37).

Pisani et al reported that the mortality rate of elderly patients admitted to the ICU was 16%. Results revealed that there was a relationship between the number of days of delirium in elderly patients and their mortality rate (38).

Ahsan et al conducted a study entitled “prognosis and mortality of patients in the ICUs”. The mortality rate was 45.5% in this study. Results showed that the mortality rate of patients was high in the ICUs. This could be due to the admission criteria and low standard procedures of taking care of the ICU patients (39).

Concerning the above-mentioned studies and results, it is obvious that finding the causes of hospitalization in the ICUs and factors that increase mortality help make suitable plans to treat critically sick patients. Various factors may cause differences in the mortality rate in different populations including the average age of patients, type and severity of disease, lack of access to medical support and lack of access to medicines and new techniques used in the ICUs. To understand which factor plays a more important role in increasing the mortality, more controlled studies designed to evaluate such factors must be conducted.
Since the mortality rate is various in different studies and also in some studies is high, preventive and health measures such as controlling blood pressure and appropriate healthy diet, evaluating therapeutic interventions and improving nursing and care services for patients in the ICUs must be taken into huge consideration. Concerning the prevalence of mortality in the ICUs, further studies must be conducted on risk factors and their role in the prognosis of diseases, and more accurate evaluation must be conducted in terms of care and therapeutic status.

References


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