RESEARCH ARTICLE

Epidemiology and Descriptive Analysis of Neuro-Critical Care Unit; Shiraz, South of Iran

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Background: Neurocritical Intensive Care Units (NICUs) have been provided as new sub-special intensive care wards to give more special services for patients with acute neurology problems. As we know, there is no organized database about epidemiology of NICU patients in our country. Population-based assessment (even in a small population) could be a starting point to achieve an insight about neuro-critical ill patients in our area.

Methods: This study is a retrospective cross-sectional study. We included all patients admitted in our NICU, a subspecialty neurology center in the south of Iran. The patients' hospital charts were used for gathering data. SPSS version 18.0 (SPSS Inc, Chicago, Illinois) was used for statistical analysis.

Results: From a total of 130 patients, 68 (52.3%) were male and 62 (47.7%) female. Their mean age was 53.7±18.9 years. CVA was the most common cause of ICU admission (50% of total patients) and status epilepticus was the least (8.5%). The discharge- death ratio was 2.6. 84 patients (64.6%) were admitted for less than 14 days and 46 (35.4%) for more than 14 days. 85 (65.4%) patients took ventilator support with the mean duration of 8.29±10 days.

Conclusion: Our findings provide an introduction into NICU field in our area. It could help us asses the effectiveness of our health care system and may additionally serve new planning for future needs to improve our general and neuro-ICUs. However, much research with larger patients' population is required for better definition of details.

Keywords: neurointensive care unit; epidemiology; descriptive analysis

Intensive care for critical patients is a young field in medicine as it was not common before the 1970s; however, organized data of intensive care units (ICU) has recently continued to be improved. For example, some ICUs have been divided into those that provide full organ support, intermediate units with medium level of support and levels for monitoring of patients who are at risk of further deterioration [1].

Recently, Neurocritical Intensive Care Units (NICUs) have been provided as new sub-special intensive care wards to give more special services for patients with acute neurology problems [2]. Actually, it has evolved from a limited field into a distinct teaching medical area that includes persons with primary neurology and neurosurgery diseases or patients admitted in other medical wards with secondary life threatening neurological problems [3]. However, patients with primary neurological problems like stroke, Guillain Barre Syndrome(GBS), status epilepticus and myasthenia gravis benefit more from NICU than those who have other medical or surgical diseases and suffer from secondary neurological problems [4].

Recent studies are supporting the role of the ICU in management of these patients. However, a group of patients will not benefit from such multidisciplinary care. Sometime these patients are difficult to identify because there is no adequate information with sufficiently sensitive and specific predictive values for survival [5].

Data about the characteristics of patients admitted in general ICUs is not large, i.e. their age, sex, diagnosis, management and outcome [6], and it is more obvious in neurologically ill patients in NICUs. So, epidemiologic studies of ICUs (and NICUs) could contain a variety of goals. At first, they serve important data about patients' characteristics, disease type, complications, frequency and outcomes of the disease [7].

As we know, there is no organized database about epidemiology of NICU patients in our country. Population-based assessment (even in a small population) could be a starting point to achieve insight about neuro-critical ill patients in our area. It could help us asses the effectiveness of our health care system and may additionally serve new planning for future needs to improve our general and neuro-ICUs.

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Methods

This study is a retrospective cross-sectional study over a period of one and half year. We included all patients admitted in our NICU, a subspecialty neurology center of Nemazee hospital, Shiraz, the south of Iran which is an academic center affiliated to Shiraz University of Medical Sciences.

In Nemazee hospital, many of critically ill-patients in the neurology field receive primary intensive care in a multidisciplinary ICU in the emergency room and after they are stable, they are transferred to the neurology wards. This ICU has 15 beds and takes care of critical patients in all medical fields in the emergency department. However, some of the other patients are transferred to our NICU which is a subunit of a 10-bed ICU and has 4 subspecialty neurology beds. Inclusion criteria for admission to NICU are cardiovascular instability, need to mechanical ventilation, diminished level of consciousness, and malignant ischemic infarction with surgical intervention.

According to the hospital's regulations, patients with subarachnoid hemorrhage (SAH), brain tumor and intracranial hemorrhage (ICH) that need neurosurgical interventions and also patients with traumatic brain injury are admitted in the neurosurgery ICU. Because of the limitation in the number of beds, there is no indication of admission for patients with irreversible Glasgow Coma Scale (GCS) 3 or potentially terminal illnesses such as end stage cancers.

The patients' hospital charts were used for gathering data. For all patients, an information form was provided to record demographic and medical data including sex, age, disease diagnosis, duration of NICU admission, need to ventilator, outcome (discharge or death), and complications such as bed sore, aspiration pneumonia and deep venous thrombosis (DVT). This study was approved by medical university ethics committee with the code of 7871.

SPSS version 18.0 (SPSS Inc, Chicago, Illinois) was used for statistical analysis. Continuous variables were described by mean and their standard deviation (SD) and categorical variables by numbers and percentage appropriately. Comparison between groups was performed through T-test, Chi-Square and Pearson correlation test as appropriate. The significance level was set at 0.05 or less ($P \leq 0.05$).

Results

From a total of 130 patients, 68 (52.3%) were male and 62 (47.7%) female. Statistically, no significant difference was seen in sex (p=0.661). The youngest patient was 16 and the oldest was 92 years old. Their mean age was 53.7±18.9 years. The mean age for men was 59.22± 17.54 and that for women was 47.64±18.38 years. There was a significant difference between the mean age of the males and females (P<0.001).

We divided the patients into 3 groups according to their ages: less or equal to 45, between 45 to 65 and equal or more than 65 years old. 44 (33.8%) patients were in the first group, 50 (38.5%) in the second and 36 (27.7%) in the third one. In the male population, the maximum admission was 45 to 65 years and in females, the patients who were younger than 45 years old had the most rate of NICU admission (Figure 1).

The patients were divided into 4 groups regarding their disease diagnosis, including ischemic and hemorrhagic cerebrovascular accident (CVA), cerebral sinus venous thrombosis (CSVT), GBS, and status epilepticus. There were few other patients out of the above diagnosis such as encephalitis, transvers myelitis, brain abscess and myasthenia gravis categorized as "others" in our classification (Table 1). CVA was the most common cause of ICU admission (50% of total patients) and status epilepticus was the least (8.5%). Among the mentioned disease groups, CVA was the main reason for prolonging the NICU admission (56.5%).

Among all patients, 36 patients (27.7%) died during the hospital course and 94 (72.3%) were discharged. Our discharge rate was 2.6 which was significant (P=0.002). Although the greatest rate of death was among 45 to 65 year-old patients (41.7%), there was no significant difference in mortality rate among the 3 groups (p=0.183) as well as among the males and females (p=0.472). Between the disease groups, GBS has the least number of deaths (2.8%) and CVA had the most (77.8%). The longest period of hospital course was 55 days in CSVT and the shortest period was 1 day in CVA. The mean days of admission were 13.68±11.

We considered prolonged NICU course if the patient was admitted longer than 14 days. Accordingly, 84 patients (64.6%) were admitted for less than 14 days and 46 (35.4%) for more than 14 days. Prolonged admission was more likely in patients with CVA than other diseases (20%). Patients with seizure were the last group with prolonged admission (2.3%).

85 (65.4%) patients took ventilator support with the mean duration of 8.29±10 days. The shortest time of supportive ventilation was 1 day for hemorrhagic CVA (3 patients) and the longest time was 52 days for ischemic CVA (1 patient). There was no significant linear correlation between the age groups and duration of ventilator support (R=0.11, p = 0.2) (Figure 2). Mortality rate was significantly higher in ventilator supported groups (26.9% vs. 0.8%, P<0.001).

Some notable NICU complications such as fever, DVT, bed sore and aspiration pneumonia were evaluated:

- Fever: 77 patients (52.2%) developed new onset fever at least 48 hours after hospital admission. Most of them belonged to the CVA group.
- DVT: We detected DVT in 11 (8.5%) patients. 45.5% of them had CSVT and 54.5% had CVA. There were no DVT in patients with GBS, status epilepticus or the group labeled with “others”. As a rule, all patients admitted in our ICU with noticeable movement disabilities or decreased level of consciousness received prophylactic dose of anticoagulant (low molecular weight or unfractionated heparin). 7 (5.4%) patients developed pulmonary emboli while 3 of them had previous DVT. In our study, DVT had correlation with pulmonary emboli (P=0.001).
- Bed sore: It was seen in 57 (43.8%) patients. Among them, patients with CVA were the most frequent group (61.4%).
- Aspiration pneumonia: 27 (20.8%) patients complicated with aspiration pneumonia and like previous complications, it was seen more in patients with CVA.

Figure 1- Frequency of patients according to their sex and age

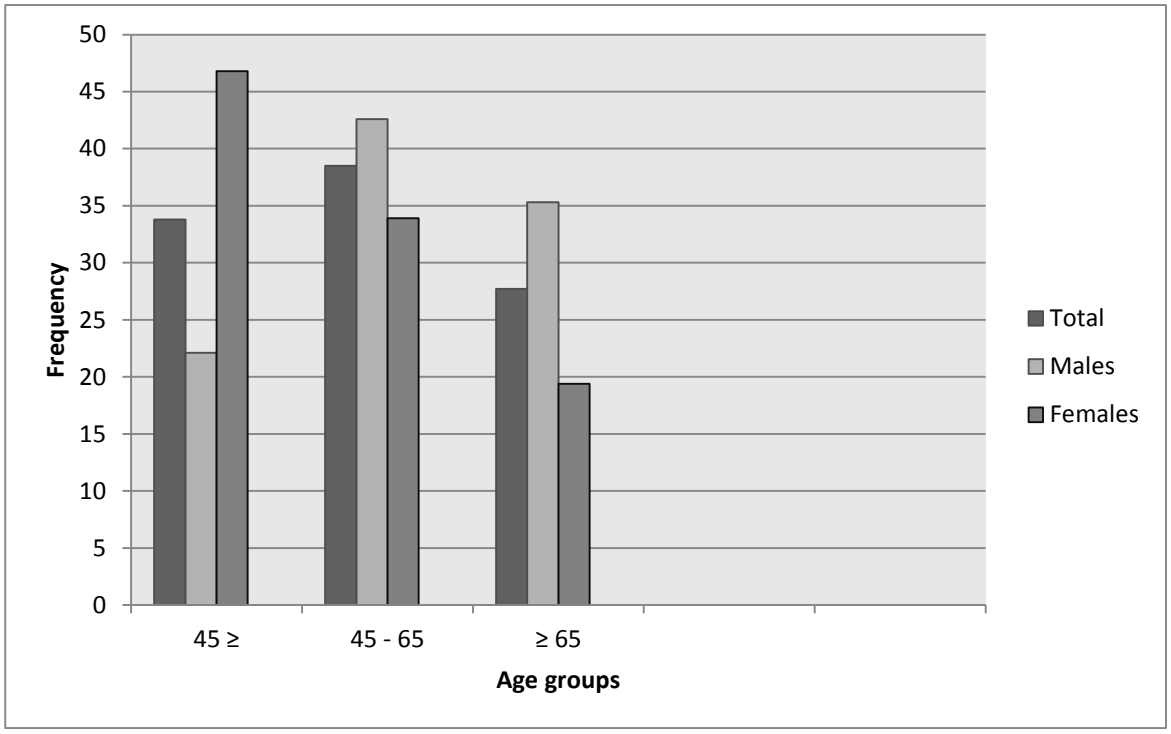
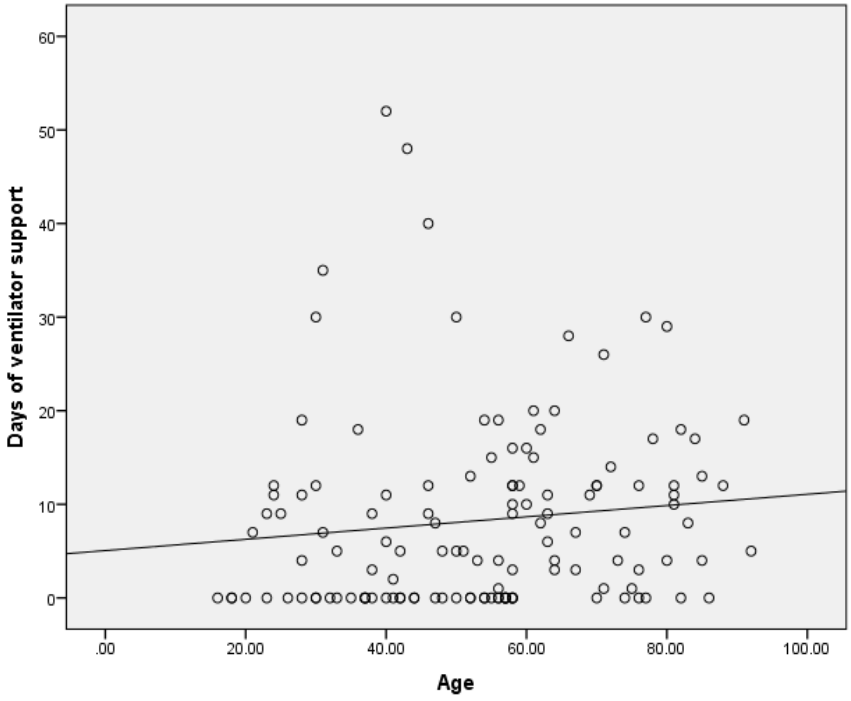


Table 1- Patients' characteristics, diagnosis, complications and outcome in NICU

Variables	Total (patients) N (%)	CVA N (%)	CSVT N (%)	GBS N (%)	Status epilepticus N (%)	Others* N (%)
Sex:						
Male	68 (52.3%)	37 (28.5)	3 (2.3%)	9 (6.9%)	8 (6.2%)	11 (8.5%)
Female	62 (47.7%)	28 (21.5%)	13 (10%)	6 (4.6%)	3 (2.3%)	12 (9.2%)
Age:						
≤ 45 years	44 (33.8%)	6 (4.6%)	11 (8.5%)	4 (3.1%)	10 (7.7%)	13 (10%)
45- 65 years	50 (38.5%)	31 (23.8%)	4 (3.1%)	8 (6.2%)	0	7 (5.4%)
≥ 65 years	36 (27.7%)	28 (21.5%)	1 (0.8%)	3 (2.3%)	1 (0.8%)	3 (2.3%)
DVT	11 (8.5%)	6 (4.7%)	5 (3.8)	0.00	0.00	0.00
Pulmonary emboli	7 (5.4%)	6 (4.6%)	0.00	0.00	1 (0.8%)	0.00
Aspiration pneumonia	27 (20.8%)	17 (13.1)	4 (3.1%)	1 (0.8%)	1 (0.8%)	4 (3.1%)
Fever	77 (59.2%)	42 (32.3%)	10 (7.7%)	3 (2.3%)	6 (4.6%)	16 (12.3%)
Length of stay:						
<14 days						
>14 days	84 (64.6%)	39 (30%)	10 (7.7%)	11 (8.5%)	8 (6.2%)	16 (12.3%)
	46 (35.4%)	26 (20%)	6 (4.6%)	4 (3.1%)	3 (2.3%)	7 (5.4%)
Bed sore	57 (43.8%)	35 (26.9%)	7 (5.4%)	4 (3.1%)	3 (2.3%)	8 (6.2%)
Use of ventilator	85 (65.4%)	52 (40%)	7 (5.4%)	6 (4.6%)	6 (4.6%)	14 (10.8%)
Outcome:						
Discharge	94 (72.3%)	37 (28.5%)	14 (10.8%)	14 (10.8%)	8 (6.2%)	21 (16.2%)
Death	36 (27.7%)	28 (21.5%)	2 (1.5%)	1 (0.8%)	3 (2.3%)	2 (1.5%)
Total	130 (100%)	65 (50%)	16 (12.3%)	15 (11.5%)	11 (8.5%)	23 (17.7%)

*"Others" refers to the small number of patients with encephalitis, transvers myelitis, brain abscess and myasthenia gravis which are not separately mentioned in the table. CVA: cerebrovascular accident. CSVT: cerebral sinus venous thrombosis. GBS: Guillaine Barre syndrome. DVT: deep venous thrombosis.

Figure 2- Linear correlation between age and days of ventilator support



Discussion

These days intensive care is known as an effective way to cure most critically ill medical and surgical patients. The primary purpose of this study is to describe the critical care pattern, complications and outcome in our area which could be of great concern when considering effectiveness, cost strategy and future planning.

Our results showed no significant difference in admission between men and women; this is in contrast to the results of some other studies. In a large cohort study on 466,792 patients in 2007, among patients older than 50 years old, women were admitted less than men in the ICU and received lower supportive treatment. They were also more susceptible to die after critical illness. The authors supposed that differences in presentation of the disease, decision-making or unknown confounding factors might cause these results [8]. In another study conducted on ICU patients in 2013, women had higher mortality and it was more obvious in medical patients. That study could not explain the reason for delay in recognition or admission [9]. In our study, the mean age for males was significantly higher than females. The majority of female patients were younger than 45 years compared with men who were between 45 and 65 years; however, mortality rate was not different between the 2 sexes. We think limitation of beds, small number of our patients' population and sub-specialty of the ward may influence the results and explain the difference between literature and what we achieved.

In the current study, there was no significant difference in mortality rate among the 3 age groups. There are some agreement and disagreement reports about the effect of the age on death rate during and after critical care. For example, in 2008 one study compared the patients younger and older than 65 years old and admitted in ICU during a 9-year period. That study showed that ICU mortality was consistently higher in the patients older than 65 years compared with the younger ones [10]. But another study in 2010 evaluated the characteristics and intensity of treatment for the elderly people admitted in the ICU over a decade and suggested that patients aged 80 could benefit from advanced ICU facilities that were usually used for younger persons [11]. These conflicting results may be explained by more heterogeneity of the patients in the studies, variations in comorbidities and severity of disease between the patients' population and different policies for ICU admission based on advanced age. As mentioned before, our ICU is a sub-specialty ward which is just for a group of homogeny patients with neurologically ill state (compared with general ICUs). Due to bed limitation, in our study advanced age may have influenced preferences in decision-making to transfer to the ICU. Moreover, in our hospital some of the neurology patients are transferred to emergency ICU which is located in the emergency part. So, more critical patients sometimes are directly transferred to that ward. All of the above mentioned points could make our results different from others.

In this study, venous infarction mostly occurred in women (10% vs. 2.3% in men). This type of brain infarction usually presents earlier than arterial type and usually occurs in the presence of underlining risk factors such as OCP consumption rather than atherosclerosis [12]. It may explain the lower age of women compared with men. Of 130 patients, 85% received mechanical ventilator support for a mean duration of 8.29 days. This percentage of mechanical ventilation (MV) seems considerable compared with the others' reports in general ICUs. A study by Esteban and coworkers represented at least 40% MV in half of the ICUs in North America [13].

In NICUs, MV support is usually needed due to impaired

consciousness as a result of central injuries such as CVA and status epilepticus or respiratory muscle weakness like GBS and MG. Moreover, the major pulmonary complications may occur after brain injuries especially severe ones that lead to the need to ventilator support. Systemic inflammatory response seems to play a major role in starting pulmonary failure after acute brain damage. After that, change in the blood brain barrier (BBB) permeability leads to release of the discharge toward the systemic circulation with a transcranial gradient and it could be responsible for pulmonary dysfunctions and necessary Mechanical ventilator support [14].

Our patients, who underwent mechanical ventilation, had a higher rate of in-hospital death. It shows that need to mechanical ventilation might be an independent risk factor for the outcome regardless of disease etiology. In 2010, one study was conducted about the epidemiology of mechanical ventilation use in acute hospital care in the United States. In this study, mortality for these patients is reported high [15]. In another study, Esteban and colleagues reported 52% death in patients who received ventilation because of acute respiratory distress syndrome. Their survey was a prospective cohort study on consecutive adult patients admitted in 361 intensive care units; they received mechanical ventilation for more than 12 hours [16].

The majority of our patients (72.3%) were discharged from NICU (discharge/death ratio 2.6). We have the same reports from Iran (Tehran and Sari) in 2012. During the first cross-sectional survey done on 70 patients admitted in ICU with congestive heart failure and COPD (Tehran), 71.4% of the subjects survived and 28.6% died [17]. In the second study in Sari, out of 391 subjects 71.6% were discharged and 28.6% died [18].

There are many reports that indicate 6.4% to 40% death among critically ill patients in deferent ICUs. It seems ICU mortality highly depends on the cause of the admission, severity of the disease and field of medicine [19]. Recently, some reports have shown better outcome when patients are admitted in a specialized NICU [20-21]. These specialized ICUs provide intensive care for patients who suffer from ischemic stroke, traumatic brain and spinal cord injury, intracerebral and subarachnoid hemorrhage, status epilepticus, intracranial neoplasms, and neuromuscular respiratory failure [22]. It has caused newer neuro-monitoring and therapeutic strategies that enable the physician to improve outcome of these patients. Kurtz and coworkers compared 231 patients with primary neurological diagnosis that were divided into 2 groups and admitted in NICU or medical/surgical ICUs. They found some differences in care among the 2 groups and supposed these differences might explain such disparities in outcome between neurocritical and general critical care [23].

The length of stay (LOS) in ICUs has been shown to be from 24 hours to 132 days in the literature. The mean days of NICU stay of our patients was 13.63±11 days. Chan and colleague evaluated 1599 patients with intracranial hemorrhage from 2005 to 2009. They reported the mean LOS to be 16.7±12 days [24]. Ingeman and co-workers studied 13721 stroke patients in 2003 to 2009 who had median LOS of 13 days [25]. Different factors could affect the ICUs' LOS. Weaning from MV and delirium have shown to correlate with increased ICUs' LOS [26]. The definition of prolonged ICU stay varies by ICU type and different diseases. We supposed prolonged ICU stay when it lasted at least for 14 days. In our study, 35.4% of the patients had the LOS more than 14 days. Besides, 56.4% of them received MV which may correlate with this high proportion of prolonged admission. It seems that good ventilator care has a positive effect on shortening of LOS. Malkoc and his colleagues did an extensive chest physiotherapy program on 277 ventilator-dependent patients and compared them with a control group (233 persons) that received only standard nursing care. They found that the length of ICU stay was significantly shorter in the interventional group than in the controls [27]. Other factors like severity and morbidity of the disease and degree of disability could influence the length of stay of the patients in ICUs. Also, medical complications (DVT and pulmonary emboli, respiratory problems, infections and fever) may also associate with longer LOS. In one study, fever has caused longer LOS in a general sample of NICU patients [28]. 59.2% of our patients developed fever, 43.8% bed sore, 20.8% aspiration pneumonia, and 8.5% DVT. So, there is an urgent need for preventive measures and careful treatment of medical complications such as infection (in particular pneumonia) and DVT, especially among patients with stroke.

This study has some strengths and limitations. As mentioned, it is the first study which describes and analyzes a newly developed and sub-specialty neurology ICU in Iran; this could be a good starting point for further studies about critically ill patients, especially in neurology. However, its retrospective nature, small number of beds, and patients may affect our judgment about the results. Some of our patients were not able to be categorized. Indeed, we did not have follow up of the patients and their outcome after discharge. Although our reported mortality rate was like the others, we did not have any information about the patients' disability on discharge.

Conclusion

In this retrospective cross-sectional study, we found that men and women equally gained from NICU care, although the mean age of the women was significantly lower than the men. The main cause of NICU admission was stroke (ischemic or hemorrhagic) with the highest rate of prolonged (>14 days) stay, MV support and mortality among other diagnoses. Fever and bed sore were the frequent complications in the patients, although 72.3% of the patients were successfully discharged from NICU. Our findings provide an introduction into NICU field in our area. However, much research with larger patients' population is required for better definition of details. So, we recommend new population-based studies carried out in a much larger scale and including more hospitals and ICUs.

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