Exploratory study on Nursing Manpower required for caring critically ill patients in Intensive Care Unit

Rajni Bala, Sukhpal Kaur, LN Yaddanapudi

Abstract: Intensive Care Unit (ICU) is a specially designed and equipped facility staffed by skilled personnel to provide comprehensive and continuous care to critically ill patients. Nursing Manpower is one of the most important factors to meet the needs of the critically ill patients. The present study is aimed at exploring the Nursing Manpower required for caring critically ill patients in ICU in a tertiary care hospital. Thirty patients over the period of 34 days were studied. The study tools included Nursing Assessment Worksheet, Guidelines for Carrying out Nursing Activities in ICU, Nursing Activity Time Record Sheet and Nursing Activity Frequency Sheet. The parameters studied comprised of the total number of nursing activities (including their frequency) done for caring critically ill patients. The average time and frequency of each nursing activity was calculated to find total nursing time required per patient per day. The total time required per patient per day was found to be 20 hours. It was concluded that nurses spend 47% of the total time (approx. 10 hours per day) for performing activities related to airway management, mobility promotion and maintaining hygiene of the patient. Considering 38% leave reserve, the number of nurses required to care for critically ill patients in 12 bedded ICU was calculated to be 63 by Arndt and Huckabay equation. The calculated nursing manpower of the ICU is significantly more than the existing manpower of 36 bedside nurses. The nursing manpower explored in this study can be beneficial for nurse managers to determine nurse-to-patient ratio in the ICU.

Key words: Nursing manpower, Nurse-patient ratio, Intensive Care Unit.

Introduction

Nursing manpower calculation or nurse staffing has become important at all levels from national and regional structures to ward levels. Forecasting the demand of nurses is a complex and difficult problem\(^1,2\). The scheduling of appropriate number of nurses is critical to the provision of high quality care, especially in the intensive care unit where patients are fully dependent upon nurses for care\(^3\).
The ideal nurse-to-patient ratio is considered to be one nurse per patient. However, it is recognized that manpower limitations prevent this from being realized in most of the settings. Most guidelines set a ratio 4.25 nurse per bed plus one senior nurse in-charge in each shift. Increase in registered nurse proportions was associated with decrease in the odds of pressure ulcers and pneumonia. Amaravadi et al and Dimick et al found that a nurse caring for more than two patients was associated with increased risk of postoperative pulmonary and infectious complications and was associated with increased resource use amongst patients undergoing high-risk surgery.

A higher proportion of nurses is associated with better clinical outcomes and more satisfaction. A higher proportion of nursing manpower is associated with lower mortality rate, decreased prevalence of urinary tract infection, pneumonia, venous thrombosis, pulmonary compromise, decreased frequency of medication errors, lower prevalence of pressure ulcers and fewer complaints from patients.

The various methods used for calculating nurse-to-patient ratio include top down basis, bottom up methods, patient dependency/classification systems and patient dependency scoring systems. The best people to decide on nursing staffing levels are senior critical care nurses themselves, who have the skills and experience in assessing patient need as well as measuring individual patient dependency. Several author emphasized on aspects of needs of the patients, the different activities carried out to meet the needs of the patients and the time consumed in carrying out various procedures etc. There is a lack of an objective and rational formula for staffing, which could guarantee the delivery of safe and high quality nursing care. Moreover, setting universal staffing norms can be problematic as there has to be a general acceptance of the methods used to arrive at the norms. Locally, all methods may not be sufficiently sensitive to rapid changes in workload or individual patient needs.

Nurses are the ones who provide 24-hour-cover in the hospitals. Providing optimal level of health care and ensuring patient safety has been a prime area of concern for nurses. The existing pattern of nurse-patient ratio worldwide evidences a very critical picture and it needs attention. Thus the present study was planned with an objective to explore nursing manpower required for caring critically ill patients in the Intensive Care Unit.

Materials and methods

The study was conducted in the Intensive Care Unit of Nehru Hospital, Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh. It is a tertiary level teaching hospital with bed strength of over 1600. There are different critical care units in the hospital like main ICU (12-bedded), Respiratory ICU, Neurosurgical ICU, Pediatric ICU, Neonatal ICU and Neonatal surgical ICU etc. The study was conducted in 12-bedded
main ICU. It is a highly specialized unit equipped with recent monitors, ventilators, transport ventilators, defibrillators, infusion pumps etc. Each bed has individual access to monitor, ventilator and resuscitation equipment etc. The ICU provides services of continuous monitoring, close observation, artificial ventilation and other invasive treatment modalities to the critically ill patients. Patients with trauma, poisoning, hemorrhage, multi-system organ failure, disseminated intravascular coagulopathy or those with postoperative complications etc., are admitted in this unit. Most of these patients have respiratory failure or impending threat of the same. These patients require close observation, intensive care and continuous monitoring.

The study population comprised of the total number of nursing activities and their frequency carried out for caring critically ill patients admitted in Intensive Care during the study period of 34 days. Investigator prepared the list of all the nursing care activities which were carried out in ICU. There were total 96 nursing care activities. Further all the Nursing Activities were categorized in 14 categories. These categories were Airway management, Monitoring vital signs, Drug Administration, Nutritional Management, Mobility Promotion, Hygiene Maintenance, Elimination Care, Other procedures, Activities for assisting physician, Activities for assisting other staff, Reporting / Rounds, Communication, Errands, and Associated work.

The tools used for data collection were: Nursing Assessment Worksheet, Guidelines for carrying out Nursing Activities in the Intensive Care Unit, Nursing Activity Time Record Sheet and Nursing Activity Frequency Sheet. The validity of each tool was established. The Nursing Assessment Worksheet was prepared to assess the health care needs of the critically ill patients in the ICU. It included demographical data and various aspects for the assessment/observation of the patients i.e., Glasgow Coma Scale, pain perception, mode of breathing and mode of nutrition etc. Nursing diagnosis was framed on the basis of assessment/observation of the patient. This worksheet helped in planning nursing care to the patients as per their health care needs in order to record frequency of activities and the time taken for performing the nursing activities.

Common guidelines were developed for nursing personnel to carry out Nursing Activities in order to ensure consistency in time taken for performing these activities. The Nursing Activity Time Record Sheet was used for recording the time taken by the nursing personnel for performing each activity in three observations and average time of the three observations was considered as time needed to perform that activity. Nursing Activity Frequency Sheet was similar to Nursing Activity Time Record Sheet in terms of list of Nursing Activities. In addition it included the frequency of Nursing Activities per patient per day. Apart from this a stop watch was used for acquiring time taken for doing nursing activities.
Data was collected from 29th July, 2008 to 31st August, 2008. Nursing activities were planned and carried out on the basis of nursing care needs assessed through Nursing assessment worksheet and treatment plan of the patient. Guidelines for carrying out nursing activities were made available at the bedside of the patient. Nurses were asked to go through these guidelines to ensure consistency. Nursing activities of 30 patients were observed by participatory observation. Every day nursing activities of one patient was observed for 12 hours. So 15 patients were observed during the day time i.e. from 8am to 8pm and nursing activities on another 15 patients were observed during night hours i.e. 8pm to 8am.

Time required for each activity and the frequency of each nursing activity was recorded on Nursing Activity Time Record Sheet and Nursing Activity Frequency Sheet. The average frequency of each activity per patient per day was calculated by dividing the nursing activities into two major types. First type includes the activities which are performed frequently on individual patients, e.g. suctioning, nebulization, chest physiotherapy etc., (airway management). From this, the mean frequency of each activity was calculated by observing 30 patients. The second category includes activities which were less frequently performed on an individual patient, e.g. assisting in CPR, endotracheal intubation and care of dead patient etc. The frequency of these events was measured for the whole Unit and converted into frequency of nursing activity per patient per day.

Data was entered and processed using Microsoft Excel 2003. Descriptive statistical methods were used for deriving the results. The process of calculating the required nursing manpower has been divided into four categories:

I. Calculation of mean nursing time per nursing care activity
II. Calculation of average frequency of nursing care activities per patient per day
III. Determination of average nursing time per patient per day
IV. Calculation of nursing manpower

Results

I. Mean time required per nursing care activity:

Figure 1 depicts the average time required per category of nursing activity per episode. It shows that the maximum time is consumed in performing activities under the category of other procedures i.e. receiving and shifting patient, care of dead patient, shifting patient for investigations etc. This category of activities consumed 176 minutes of nursing time per patient per day. This was followed by activities related to assisting the physician i.e. Cardio-pulmonary resuscitation, endotracheal intubation, changing tracheostomy tube etc. for which 165 minutes of nursing time was required. Hygiene maintenance and elimination needs were met in 63 and 41 minutes of nursing time respectively. Airway management was another important nursing activity which
consumed 37 minutes of nursing time. This was followed by drug administration which consumed 30 minutes. Minimum time per episode was spent on monitoring vital signs. A single episode of vital sign monitoring (Blood pressure, Heart rate, Temperature, Respiratory rate, Oxygen saturation) was done only in one minute as all the beds have vital sign monitors.

Figure 1: Average nursing time required per category of Nursing Activity per episode

II. Average frequency of Nursing Activities per patient per day

Most frequently performed nursing activity was monitoring vital signs which were on the average performed 38 times on one patient per day. This was followed by activities related to airway management as this was a very important requirement of critically ill patients. Other procedures i.e. receiving and shifting patient, care of dead patient, shifting patient for investigations etc. was another frequently performed activity which ranked third. This was followed by nursing activities related to elimination care, drug administration and hygiene maintenance which were ranked 4th, 5th and 6th position as per frequency of nursing care activities. Least frequently performed nursing activity was assisting other staff which was performed on the average just once per day per patient.

III. Determination of average nursing time per patient per day:

The average nursing time per nursing activity per day is derived by multiplying average time per patient per episode and average frequency of nursing activity per patient per day. Figure 2 display the average time required for performing nursing activities
per patient per day (category-wise). It shows that maximum time is consumed in performing nursing activities related to airway management. This was followed by the nursing activities for promoting mobility of the patients as critically ill patients have poor motor response. Nursing activities categorized under other procedures i.e. receiving and shifting patient, care of dead patient, shifting patient for investigations etc. required 148 minutes of nursing time per patient per day. This was followed by time required for nursing activities for hygiene maintenance and elimination care. The least time i.e. only 8 minutes were spent for assisting other staff for obtaining an X-ray or ECG etc.

Out of the total time consumed in rendering care to the critically ill patients one fifth of total time (21%) was spent on airway management. As these patients were bedridden so 14% of the time was spent in promoting mobility. Hygiene maintenance required 12% of the total time and same portion of the time spent in doing Other Procedures. On the other hand, only 3% of the total time was spent in activities in assisting physician or other paramedical staff (Table 1).

Hence the total time required for caring for a critically ill patient per day turned out to be 1202 minutes or approximately 20 hours. It was further observed that 82% of nursing time was spent in rendering direct nursing care whereas 18% was spent in providing indirect nursing care.
Table 1. Percentage of time required per patient per day

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Activities (Category-wise)</th>
<th>Percentage time required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Airway management</td>
<td>21</td>
</tr>
<tr>
<td>2.</td>
<td>Mobility promotion</td>
<td>14</td>
</tr>
<tr>
<td>3.</td>
<td>Other procedures</td>
<td>12</td>
</tr>
<tr>
<td>4.</td>
<td>Hygiene maintenance</td>
<td>12</td>
</tr>
<tr>
<td>5.</td>
<td>Elimination care</td>
<td>9</td>
</tr>
<tr>
<td>6.</td>
<td>Drug administration</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>Reporting / Rounds</td>
<td>6</td>
</tr>
<tr>
<td>8.</td>
<td>Associated work</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>Nutritional management</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>Monitoring vital signs</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>Communication</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>Assisting physicians</td>
<td>2</td>
</tr>
<tr>
<td>13.</td>
<td>Errands</td>
<td>2</td>
</tr>
<tr>
<td>14.</td>
<td>Assisting other staff</td>
<td>1</td>
</tr>
</tbody>
</table>

IV. Calculation of Nursing Manpower

Arndt and Huckabay (1975)\textsuperscript{13} derived a formula for calculating nursing manpower from the daily hours of nursing care per patient per day as follows:

\[
n = \frac{h \times c \times 365}{(365-o) \times d}
\]

Where:
- \( n \) = number of full time nurses needed,
- \( h \) = daily hour of nursing care per patient per day,
- \( c \) = Average daily patient census,
- \( o \) = Expected off days per employee per year, and
- \( d \) = daily duty hours per employee,

In ICU, the values of these various parameters were:
- Daily hours of nursing care per patient per day = 20
- Average daily patient census = 12
- Days per year = 365
- Number of off days per year = 120
Number of working days per year = 245 days
Expected night duties per year = 72 days of 12.25 hrs = 882 hrs
Expected morning/evening shifts per year = 173 days of 6.25 hrs = 1081 hrs
No. of working hours per employee per day = 8.00 hrs

On the other hand when the attendance record of nurses (from July 2007-June 2008) working in the ICU was reviewed, it was found that on an average 62% of the staff was present on duty on a particular day and 33% were on expected offs. Only 5% were on leave other than mandatory offs.

Substituting these values in the Arndt and Huckabay equation, the number of full time nurses required for caring for the 12 critically ill patients in our ICU turns out be 45. Adding the 38% nurses on the basis of attendance records, the total number nurses is calculated to be 63 i.e., 5.25 nurses per bed.

**Discussion**

Critical Care Nursing is a labor intensive, high cost system for looking after the sickest hospital patients. The critically ill patients are fully dependent on the nurses for all the care, which necessitates the need for an adequate number of competent hands.

The calculation of nurse to patient ratio is very challenging and is usually done on the basis of scoring systems, viz. Therapeutic Intervention Scoring System (TISS), Therapeutic Outcome Scoring System (TOSS) etc. In contrast, the present study focused on the health care needs of the critically ill patients, considering the prescribed treatment in order to calculate nursing manpower.

Miranda et al developed Nine Equivalents of Nursing Manpower (NEMS) in order to calculate nursing manpower. They focused on the severity of illness score for calculating the nurse-to-patient ratio. However they didn't include basic nursing care activities such as administering bed baths, changing the position of the patients, and evacuation care. The present study not only focused on the medical interventions but also included activities related to hygiene and mobility with a due focus on elimination needs.

Yamase focused on 73 nursing job items which were grouped under only eight categories i.e., monitoring, transfusion of blood/fluids, injections, respiratory management, assisted circulation, drainage tube management, special therapy and basic nursing care. In the present study nursing activities were divided into 2 groups and then these groups were categorized under 14 separate headings covering 96 nursing activities. The categories of nursing activities were airway management, monitoring vital signs, drug administration, nutritional management, mobility promotion, hygiene maintenance, other procedures, reporting/rounds, communication, errands, associated work and the activities related to assisting physician and other paramedical staff.
The average time required for performing nursing activities was acquired by observing each activity three times. The frequency of each activity was noted by recording the frequency of nursing activities on individual patients. The frequency of certain activities such as CPR, intubation etc., was recorded per unit which was finally converted into frequency per patient. The present study concluded that one-fifth of the total time (i.e., 4 hours per day) was spent in the airway management of ICU patients, as most of these patients were either tracheostomised or had endotracheal tube in situ connected to a mechanical ventilator. The results were similar to those of another Indian study by Raj et al.\textsuperscript{17} They also concluded that patients who were ventilated required significantly more time than other patients admitted in the ICU. In the present study, the time spent by nurses on personal comfort activities such as tea/meal breaks was not connected to patient care, hence was not included in the time taken for patient care.

Nurse staffing for\textsuperscript{17} nursing care hours allowed at a ratio of about 1:1\textsuperscript{17}. On the other hand, the present study showed that the critically ill, fully dependent patient needed about 20 hours of direct and indirect nursing care. Out of these about 16.4 hours (82\%) were spent in providing direct nursing care. Indirect nursing care consumed only 18\% of the total time i.e. 3.6 hours. It was found that about half of the total time required for patient care was consumed in the activities related to airway management, hygiene maintenance and mobility promotion. Thus the nurse to patient ratio for providing 20 hours of direct and indirect nursing care was 1:1.25 in the present study, higher than the traditional ratio of 1:1. These findings are similar to the findings of another study in which it was concluded that patients who received mechanical ventilation required 21 hours of nursing care and thus, a nurse-to-patient ratio of 1:1 with extra help may be required to ensure adequate care\textsuperscript{17}.

The ideal ratio in ICU is traditionally considered to be one nurse per patient. This requires approximately 6.5 nurses to be employed for each ICU bed. However it has been recognized that manpower limitations prevent this from being realized in most settings. The 12 bedded ICU of PGIMER, Chandigarh has only 36 bedside nurses i.e. 3 nurses per bed. It makes it impossible to have nurse-to-patient ratio of 1:1. The present study determined the need of 5.25 nurses per bed considering 33\% off-days and 5\% leave reserve other than off-days i.e. 63 nurses are required for 12-bedded ICU. The decrease in nurse to bed ratio might have occurred as the activities which were not a part of our routine such as in-service education; health teaching and counseling sessions were not included in the present study.

It was concluded that a fully dependent critically ill patient requires about 20 hours of direct and indirect nursing care. The number of nurses required for meeting health care needs of patients in a 12-bedded ICU is 63 i.e., 5.25 nurses are required per bed. The findings of the study could be useful for Nurse Educationalists, Nursing Practitioners and
Nursing Administrators in their respective fields. Also, a similar study can be replicated in the same setting to give more authenticity to the findings.

References