Research of Patient’s Nursing Care Demand at Emergency Room

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ABSTRACT

Background: The allocation of nurses is not only related to hospitals’ operation, but also related to quality of medical service and patient care. In previous research, work sampling and snapshot observation were commonly used in nursing hours study and nurse staffing to record the frequencies of each nursing activities that nurses implement. However, few researches observed the time that patients received direct patient care.

Objective: This research aims to investigate the demand and supply of direct patient care in the emergency department in a district teaching hospital, and to propose some recommendations in nurse staffing.

Data source: Data of patients in the emergency department from July 10 to July 16, 2005 were collected from the database of Hospital Information System. These data included patients’ basic data, medical management received, arrival time and leave time. Furthermore, the time demanded for direct patient care was estimated by consulting senior doctors and nurses about the content and treatment time of each diagnosis.

Methods: Descriptive statistics was used to examine the patient care need of each triage category, and the time demanded for direct patient care by every hour and every nursing shift were presented. Then the discrepancies of demand and supply time of direct patient care were examined. Appropriate time units of nurse shifts were obtained by calculating Move Average of demand/supply ratio in different time periods. Finally, recommendation of flexible time units of nurse shifts and nurse staffing was proposed.

Results: By analyzing patients’ length of stay in each category of triage, the result reveals that emergency department triage classification system couldn’t reflect demand of patients’ care in each triage category. On the other side, by analyzing demand and supply time of direct patient care, the result shows that the supply is usually unable to meet the demand from eight o’clock to midnight every day. The results suggest that the emergency department should arrange nurse staffing every four hours, instead of every eight hours, to decrease the discrepancy between demand and supply time of direct patient care in the emergency department.

Keywords: ER patient, nursing care, nurse’s manpower, moving average.

INTRODUCTION

It has been estimated that approximately 45%-70% of the total number of hospitalized patients are emergency room (ER) patients, so that the ER is also called as the frontline of hospitals (Chou, 2002). An ER takes charge of the quality of medical services expected by patients during an emergency. When sent
to ER, ER patients easily tend to feel anxious due to their various conations of discomfort or illness, and hope that medical staff can deal with their problems as soon as possible (Chen, et al., 2002). Most ER-related studies involve the issues of over-crowding and waiting. Asplin et al. (2003) suggested that the phenomenon of “ER crowdedness” reveals an imbalance in supply and demand of emergency care services. Many studies have indicated that over-crowding of an ER will reduce the quality of medical care, increase the risk of errors, and may even aggravate patients’ condition, leading to a possible fatality (Karpiel, 2004; Wang, 2004; Trzeciak & Rivers, 2003; Yang, 2003). Therefore, there have been a growing number of studies focusing on reducing over-crowdedness and ER waiting time, with the aim to increase the efficiency of emergency operations. The methods applied include human resource planning or process reengineering (Spaite et al., 2002; Chuang, 2005). In terms of human resource planning, researcher suggested that there is a need to integrate patients’ needs with care resources and inspect whether the daily human resources or the human resources on every shift is sufficient and adjust it as needed to efficiently allocate and make use of human resources to avoid affecting the quality of medical care (Chuang, 2005). However, there are few previous studies regarding emergency care hours and staffing issues (Maio et al., 1995; Hobhood et al., 2005), and the activities of nursing staffs are usually recorded through work sampling or moment to moment observations. These studies merely observed the activities of nursing staffs and calculated the frequency of various nursing activities. Moreover, they failed to observe patients in order to understand ER patients’ needs during emergency care, as demanded by individual patient’s circumstances from admission to discharge.

In an ER, patients’ circumstances vary in their demands of direct nursing care. However, each nursing activity should meet standard time requirements. Unfortunately, the actual condition in an ER is that when the number of ER patients increases, or patients with severer conditions are admitted to an ER, their individual demands for direct nursing care will increase; thus, their needs often cannot be met by the standard direct nursing services provided by fixed nursing staffing. Therefore, nursing staffs may be forced to reduce the nursing care available or the time provided for each patient. When the supply of direct nursing care is less than the demand at the time, it may pose a threat to the health of patients. Therefore, this study selected the patients and nursing staff in the ER of a certain regional teaching hospital in order to analyze the differences between the demand and supply of direct nursing care services, and proposed some suggestions for the adoption of flexible nursing staffing to reduce the gap between the supply and demand of direct nursing care services.

**Research Sites and Subjects**

The research site was a regional teaching hospital equipped with more than 500 beds, where emergency medical care services are provided. The ER at the research site included four divisions, the Division of Internal Medicine, Division of Surgery, Division of Gynecology, and Division of Pediatrics, as well as a First Aid Area, an Operation Area, and an Observation Area. The study was conducted from July 10 to July 16, 2005, and the subjects were the ER patients during this period of time. In 2005, there were 36,889 patients admitted to the ER, with 3,133 ER patients in July. During the investigation period, there were 714 ER patients. Nursing staffing included three shifts, namely, the night shift (0-8 am), the day shift (8 am-16 pm), and the evening shift (16 pm-24 pm), and the numbers of nursing staff for the three shifts were 3, 4, and 3, respectively.
Data Collection

In terms of care supply, the direct nursing care time (unit: person/min) provided was used to represent quantity supplied. According to a study conducted by Mu et al. (1995), the frequency of ER direct nursing care activities accounts for 29.71% of all nursing activities. Therefore, the nursing care time of every shift and in every hour was multiplied by 29.71% the result of which is the standard direct nursing care timeframe. In terms of care demands, the direct nursing care time (unit: person/unit) demand was used to represent the quantity demanded. The direct nursing care time demanded by patients was calculated according to the collection of patients’ medical records and interviews with professional medical staffs. In addition, ER patients’ medical information during the investigation period (July 10 to July 16, 2005) was obtained from the information system of the research hospital. The information included the number of patients in the ER, triage category assessment, divisions attended for care, primary diagnosis, hospital referral method, hospital admission/discharge date/time (including the “minute”). Among these, the primary diagnosis was determined based on an ICD code, and the length of the hospital stay was calculated using the discharge time minus the admission time (i.e. duration of hospital stay in ER). After the medical records of patients were collected, emergency physicians were consulted regarding the treatments for the major diagnoses of the subjects, and then, nursing staff were consulted regarding the time (in minutes) required to execute each treatment. This study focused on the time required to execute each treatment, rather than of the number of nursing staffs executing such treatment.

Data Analysis

1. Calculation of patients’ length of hospital stay:

   From the moment of admission to an ER to discharge, direct nursing care provided by nursing staffs is required. Those patients remaining under observation in the hospital must also receive an hourly 2-minute routine examination (vital signs monitoring), which is performed by nursing staffs. Therefore, the information on the patients’ length of hospital stay was collected in order to calculate the direct nursing care time demanded by each individual.

2. Analysis on the direct nursing care time demanded by patients

   The hospital referral methods for patients were classified into two categories, namely, discharge and non-immediate discharge. The total time of various care procedures demanded by each patient was calculated on an individual basis. Based on on-site observations, the activities undergone, according to these two categories, for each patient during their stay in the ER are as follows:

   (1) Patients under the category of discharge: length of hospital stay = time to undergo triage category assessment + time of medical treatment + idle time

      Taking patients with burn of hand or skin redness (first degree burns) as an example, their medical treatment procedures included; a. triage category assessment (3 minutes), b. doctor consultation, c. administration of analgesics (2 minutes), and d. conducting medical bill payment and prescription pick-up. Among these procedures, the direct nursing care received by patients was under the triage category assessment and administration of analgesics, which took approximately 5 minutes.

   (2) Patients under the category of non-immediate discharge: length of hospital stay = time to undergo triage category assessment + time to undergo the hourly routine examination performed by nursing staff + idle time
Taking a patient with epilepsy remaining in the hospital under observation for example, the patient’s hospital admission time was 12:04am, with a discharge time of 12:26pm. The medical treatment procedures for the patient included; a. triage category assessment (3 minutes), b. receiving medical treatment (15 minutes), c. remaining in hospital under observation and undergoing routine examinations, and d. discharged. Among the medical treatment procedures, in addition to the time for triage category assessment and medical treatment (18 minutes), the total time of the hourly routine examinations during the hospital observation period was 22 minutes.

Therefore, the direct nursing care time required was 40 minutes.

3. Calculation of the standard direct nursing care time provided:

The ER nursing staffing included 3 nurses on the night shift, 4 nurses on the day shift, and 3 nurses on the evening shift, while the nursing care (person/minute) provided during each shift was 8×60×3=1440, 8×60×4=1920, and 8×60×3=1440, respectively. The nursing care (person/minute) during each shift was multiplied by 29.71%, thus, the standard direct nursing care time provided was obtained.

4. Assessment of the optimized supply and demand model for direct nursing care:

(1) Comparison of the differences between supply and demand for direct nursing care:

The direct nursing care time demanded by each patients during each timeframe (each nursing shift and in every hour) was compared with the standard time supplied in order to inspect the difference between supply and demand for care during each timeframe.

(2) Flexibly plan nursing staffs according to the direct nursing care time demanded

The ratio of the hourly direct nursing care demanded to the standard direct nursing care provided during the investigation period was calculated, and the ratio of hourly demand/supply and the fluctuation trends were obtained. Afterwards, the cycle was changed to every 2 hours, 3 hours, and 4 hours, where the moving average method was used to calculate the predictive value of the demand/supply ratio (moving average).

The cycle of the least oblique movement average time was used as the time unit. In addition, according to the existing nursing manpower of the ER, one day during the investigation period was taken as an example for linear programming in order to obtain the best staffing to minimize the difference between supply and demand of nursing care time.

RESEARCH RESULTS

Distribution of ER Patients

During the investigation period, a total of 714 patients were sent to the ER, and on average, 102 patients were sent to the ER every day. Based on the triage category assessment, the majority of the patients (476 patients) were third degree patients, followed by second degree patients (210 patients). In terms of divisions, the majority of the patients (366 patients) attended the Division of Internal medicine, followed by the Division of Surgery (207 patients). Regarding hospital referral methods, the majority of the patients were discharged (291 patients; 40.9%), followed by hospitalized under observation (288 patients; 40.5%).
Patients’ Length of Hospital Stay

During the investigation period, the total daily lengths of hospital stays for all patients were 14645, 13843, 13654, 11967, 15765, 11907, and 13322 minutes. According to the planning of nursing shifts, the total length of hospital stay of patients during evening shifts on July 10, 13, 15, and 16 was the longest.

Direct Nursing Care Time Demanded and Standard Time Provided

After the daily direct nursing care time demanded by patients during each shift was calculated, it was found that, during the investigation period, the timeframes requiring the greatest amount of direct nursing care time for patients were day shift, day shift, evening shift, day shift, evening shift, and evening shift.

In terms of direct nursing care supplied, the nursing care (person/minute) provided during the night shift, day shift, and evening shift was 1440, 1920, and 1440 (person/minute), respectively. After the values were multiplied by 3, the standard direct nursing care time supplied during each timeframe was obtained, as 427.82, 570.43, and 427.82, respectively. Similarly, the daily standard direct nursing care time supplied during the three timeframes, namely, 0~8, 8~16, and 16~24, were 53.48, 71.30, and 53.48 (person/minute), respectively.

Difference Between Supply and Demand for Direct Nursing Care Time

Based on the nursing shift-based calculation, it was found that the direct nursing care time demanded by patients during day shift and evening shift was usually higher than that provided. In addition, the direct nursing care time demanded during evening shift of each day was higher than that provided (Table 1). Based on hourly-based calculations, the results indicated that, the supply of direct nursing care time from 0-2 o’clock and 7~8 o’clock during night shifts was usually unable to meet demand, and the supply of direct nursing care time from 11~13 o’clock and from 14~15 o’clock during the day shifts usually was unable to meet demand.

<table>
<thead>
<tr>
<th>Date</th>
<th>Night shifts</th>
<th>Day shifts</th>
<th>Evening Shifts</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Demand</td>
<td>Demand-Supply</td>
<td>Demand</td>
</tr>
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<td>85.18</td>
<td>803</td>
</tr>
<tr>
<td>7/11 (Mon.)</td>
<td>382</td>
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<td>698</td>
</tr>
<tr>
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<td>334</td>
<td>-93.82</td>
<td>654</td>
</tr>
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<td>462</td>
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<td>631</td>
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<tr>
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</table>

* Positive values of “Demand-Supply” represent that the supply of direct nursing care time is unable to meet the demand.

Based on the calculations of the ratio of daily/hourly direct nursing care time demanded to standard care time provided (the ratio>1: supply is unable to meet demand; the ratio<1: supply exceeds demand), it was found that, the ratio of demand to supply was larger than 1 for least 12 hours a day (Figure 1).
Moving Average of the Demand/Supply Ratio

To reflect the changes and fluctuations of the demand/supply ratio, 2-hour, 3-hour, and 4-hour-based cycles were used to calculate the moving average of the demand/supply ratio. It was found that, the longer the cycle of moving average, the fewer the standard deviations of the average moving time, namely, the less the fluctuation of the moving average, the more possible the difference between supply and demand will be reflected (Table 2).

Table 2: Mean and standard deviations of the moving average of different cycles from demand/supply ratio during the investigation period

<table>
<thead>
<tr>
<th>period (hour)</th>
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<th></th>
<th>7/11</th>
<th></th>
<th>7/12</th>
<th></th>
<th>7/13</th>
<th></th>
<th>7/14</th>
<th></th>
<th>7/15</th>
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<td>$\sigma$</td>
<td>$\bar{X}$</td>
<td>$\sigma$</td>
<td>$\bar{X}$</td>
<td>$\sigma$</td>
<td>$\bar{X}$</td>
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<td>$\sigma$</td>
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<tr>
<td>1</td>
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<td>1.09</td>
<td>0.44</td>
<td>1.13</td>
<td>0.53</td>
<td>1.07</td>
<td>0.52</td>
<td>1.21</td>
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<td>1.04</td>
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<td>1.06</td>
<td>0.27</td>
<td>1.02</td>
<td>0.34</td>
<td>1.11</td>
<td>0.21</td>
<td>0.98</td>
<td>0.47</td>
<td>1.06</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Optimized Nursing Staffs

Based on the analysis results of the moving average, the moving average of the least fluctuation was used as the time unit (4 hours) in order to re-plan the emergency nursing manpower. In addition, the differences among 4-hour, 2-hour, and the current 8-hour-based nursing staff shifts were also compared (Figure 2). Due to the restrictions of the nursing manpower of 10 nursing staff attending the ER at the research site, linear planning was used to obtain optimized nursing staffing and shifts in order to reduce the gap between the supply and demand of direct nursing care.
Taking July 14 as an example, the original staff of 3 nurses working the night shift, 4 nurses working the day shift, and 3 nurses working the evening shift, the supply of direct nursing care time failed to meet demand, with a gap of 446.48 minutes. If 4-hour shifts are adopted, it can be found that, the optimized daily staffing from 0-24 o’clock should be 3, 2, 5, 3, 4, and 3 nurses during each timeframe, which can minimize the gap between supply and demand to 409.35 minutes. If 2-hour shifts are adopted, the optimized daily staffing from 0-24 o’clock should be 5, 2, 2, 3, 6, 4, 1, 3, 4, 3, and 4 nurses, which can reduce the gap between the supply and demand to 353.66 minutes. A comparison of direct nursing care time provided and demanded of these three shifting methods is shown in Figure 2, as follows:

![Figure 2: Comparison on the direct nursing care time supplied and demanded during 2-hour, 4-hour, and 8-hour shifts](image)

Although the 2-hour shifts can minimize the gap between direct nursing care time supplied and demanded, in order to avoid the excessively complicated nursing staffing, it is advised to adopt the flexible staffing of 4-hour shifts.

**DISCUSSION**

The cause for the short supply of direct nursing care time in 5 day shifts and each evening shift over 7 days was investigated. It was found that, the major cause was the demand for direct nursing care during day shifts and evening shifts was greater, thus, short supply is easily experienced. Moreover, due to the number of nurses working the evening shifts was one nurse less than those the working day shift, the daily supply of direct nursing care failed to meet demand. In terms of direct nursing care time supplied, the direct nursing care time actually provided was not as fixed as that assumed in this study. The daily direct nursing care time provided by nursing staffs for patients varied with the factors, such as the total
number of patients, severity of ailments, nursing staff’s quality, nursing staff’s professional knowledge, etc. (Hsu, Su and Huang, 1992b). However, this study only presented the most fundamental relationship between the supply and demand of direct nursing care in the ER at the research site, as based on the most fundamental assumptions. In terms of the demand/supply ratio of direct nursing care time, it was found that, if the gap between supply and demand is merely determined by the absolute difference between the time supplied and demanded, only the gap between supply and demand can be explained, while the level of difference between them cannot be fully explained. Therefore, the demand/supply ratio was used in this study in order to analyze the level of difference between supply and demand. The ratio was used to reflect the scope and amount of direct nursing care required to be provided by the existing nursing manpower. In terms of flexible nursing staffing, 4-hour shifts were used to re-plan staffing, and the reason was that the moving average obtained from the 4-hour cycle was less discrete, as compared to those obtained from 2-hour and 3-hour cycles. Although 2-hour and 3-hour time units can be used to re-plan manpower, which can significantly reduce the gap between supply and demand, management must constantly change staffing during the 2-hour and 3-hour cycles, which is not practical. Therefore, the research site is advised to adopt 4-hour shifts, and try their best to supply nursing care that meets the demand in order to reduce the gap between supply and demand in an ER for nursing care procedures.

**SUGGESTION**

In terms of the measurement of direct nursing care demanded, only medical and nursing staffs were consulted regarding the time required to execute the treatment of each diagnosis and complete each action recorded in this study. If the time required to execute each treatment by ER nursing staff can be observed in real-time in the future, more accurate and actual time values can be obtained. In terms of the study period, this study is merely a preliminary investigation of the relationship between supply and demand for ER nursing care. Future studies that include a longer study period (e.g. 1 month or 1 year) can be conducted in order to investigate the relationship between supply and demand. Moreover, in order to achieve a supply/demand balance, corresponding nursing supply can be redesigned to meet different demands. In terms of practical suggestions, if it is difficult to plan a flexible nursing staff for an ER, thus, the phenomenon of the supply of direct nursing care failing to meet demand can be reduced by other methods. Hsu et al. (1992a) indicated that, a decrease in the frequency of indirect and relevant nursing activities may increase patients’ direct nursing activities. Yin (1998) suggested that, the inter-division staffing and mutual support among wards, ICU, and the ER can improve gaps of a nursing manpower.

**REFERENCES**


