Study on Ward Planning of Acute Hospitals from the Nurses' Standpoint

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Abstract

In order to improve the functional layout of acute wards to cope with modern changes, this paper aims at examining the current nursing activities in two acute hospitals, and clarifying the requirements of ward planning from the nurses' standpoint. As a first study, two nurses on day duty and all nurses on evening and night duties were followed and observed in every nursing unit. A second observation study was carried throughout the day duty (8:00am-5:00pm) on the same day of the following week. For this latter study, five observers were positioned in designated locations and recorded the time of entering and exiting of all the nurses to each room in the ward. A questionnaire and an interview survey were also carried out in order to obtain a better understanding of the nurses' evaluation of the ward planning. As a result of this study, the following five items were highlighted:

1. The actual situation of the nursing activities was obtained.
2. The investigated data was compared with those obtained in previous studies.
3. The influential factors affecting nursing activities were discussed.
4. Design guidelines set up in the past were reconsidered.
5. Problems concerning the rooms' layout were pointed out.

Keywords: acute wards; nursing activities; influential factors; design guidelines

1. Introduction

1.1 Background

In recent years, the situation concerning acute hospitals has changed greatly in Japan. Acute beds and chronic beds are categorized according to the 4th revision of the Medical Care Law of 2001, and it aims to offer a more suitable care and built environment for the treatment of acute and chronic care patients Note1. In an acute ward, although there is a growing move towards a shorter hospitalization period, the proportion of critically ill patients is increasing; consequently, the load of nursing activities has also increased Note2. Furthermore, with the influence of several other factors Note3, the hospital ward's environment is changing drastically. As for the architectural planning of the hospital wards, in Japan, traffic diagram researches of nurses' circulation in wards began in the 1950s and were performed actively until the 80s. As a result, a series of design indicators were acquired. Yet, it is unclear whether the application of these guidelines may also be possible for acute wards, especially after reorganization of the medical facilities.

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Table 1. Outline of Nursing Units Surveyed

| Name of Hospital | K Hospital | F Hospital |
|------------------|------------|------------|
| Type of hospital | General hospital | Special Hospital |
| Total Number of Beds | 1066 Beds | 1193 Beds |
| Composition of wards | ICU (2.6%) | ICU (2.7%) |
| (Breakdown of Beds) | General nursing units (97.4%) | General nursing units (95.4%) |
| Name of nursing units | NU-A | NU-B |
| Medical Ward (M)/Surgery Ward (S) | M | S |
| Number of patient rooms | 20/0/7 | 19/0/7 |
| 1-bed/2-beds/4-beds | 44 Beds | 44 Beds |
| 2) Questionnaire survey & interview

A questionnaire completed by nurses, as the user, was undertaken to evaluate a hospital ward's plan in 2003. An interview was undertaken in 2003 with the head nurse to get information about staffing, work responsibilities, the features of the patients, procedures of nursing activities, and the problems in each NU.

3) Comparative analysis

A comparative analysis was carried out in order to explore changes in the results of this observation investigation compared with the results of previous studies. The compared items are as follows, and were widely analyzed in past research.

- **Patient’s room**
  - A: Staff station
  - B: Treatment room
  - C: Examination room
  - D: Dirty utility room
  - E: Instrument room
  - F: Linen room
  - G: Dining room
  - H: Butler’s pantry
  - I: Bathroom
  - J: Shampoo room
  - K: Toilet for wheelchair user
  - L: Day room
  - M: Interview room
  - N: Dressing room
  - O: Equipment room
  - P: Storage site for rubbish
  - Q: Shared space for staffs of two nursing units
  - R: Elevator hall for patients
  - S: Elevator hall for staffs
  - T: Anteroom for family

Note 4:

- **TVPR**: an index for the degree of communication between the nurses and the patients.
- **TSPR**: an index to identify room relationships.
- **NOT**: an index to identify room relationships.
- **DNC**: an index for conserving nurses' energy for direct nursing services.
4) Discussion on Influential Factors

Physical, management, patient and nurse factors of acute wards that affect nursing activities were discussed based on the result of observation investigation and a questionnaire, in order to clarify the impact of these factors on nursing activities.

1.4 Outline of nursing units (NU) surveyed

The surveys were carried out in two medical wards and two surgical wards of two newly built acute hospitals in Tokyo, Japan. Table 1. shows the features of the ward plan, the nursing delivery systems adopted, the degree of introduction of IT, staffing, patients' information on the investigation day, etc.

2. Results

2.1 Times of visiting / spent in patients' rooms

The data obtained by this survey and collected from previous studies were concerning this subject are shown in Table 2., and were used as analytical data and the basis of uncorrelation tests in order to clarify the impact of the 6 factors (size of nursing units: SONU, ratio of number of single rooms: ROSR, floor area of the NU per bed: FAPB, number of nurses: NON, number of patients: NOP, ratio of PAL level A and level B patients: RABP) on the number of the TVPR on day duty, with a significance probability of a=5%, null hypothesis (the TVPR and the factors are assumed to be unrelated). The results are shown in Table 3.

Firstly, the factor of SONU is discussed. Because the significance probability is 0.494>significant level a=5%, the assumption is reasonable. That is, the amount of TVPR on day duty is not related to the SONU. It is also similar for other factors such as the FAPB, NON, NOP, and RABP which seems to be unrelated.

Next, the factor of the ROSR is discussed. Because the significance probability of 0.027<significant level a=5%, it refutes the hypothesis. That is, the ROSR is correlated to the amount of the TVPR by nurses on day duty.

2.2 Results on Influential Factors

Table 3. The Results of the Uncorrelation Test against the Impact of Six Influential Factors on the Total Times of Visiting Patients' Rooms (TVPR) on Day Duty

| Number of samples | Correlation coefficient | Significance probability | Judgment |
|-------------------|-------------------------|--------------------------|----------|
| SONU*5            | 9                       | -0.006                   | 0.494    | Uncorrelated |
| ROSR*6            | 9                       | 0.656                    | 0.027    | Correlated   |
| FAPB*7            | 9                       | 0.097                    | 0.402    | Uncorrelated |
| NON*8             | 9                       | 0.498                    | 0.086    | Uncorrelated |
| NOP*9             | 9                       | -0.042                   | 0.457    | Uncorrelated |
| RABP*10           | 9                       | 0.057                    | 0.443    | Uncorrelated |

2.3 Results on Influential Factors

Table 4. The Results of the Uncorrelation Test against the Impact of Six Influential Factors on the Total Times of Visits to Patients' Rooms (TVPR) on the Evening and Night Duties

| Number of samples | Correlation coefficient | Significance probability | Judgment |
|-------------------|-------------------------|--------------------------|----------|
| SONU*5            | 9                       | -0.471                   | 0.1      | Uncorrelated |
| ROSR*6            | 9                       | -0.23                    | 0.276    | Uncorrelated |
| FAPB*7            | 9                       | -0.394                   | 0.147    | Uncorrelated |
| NON*8             | 9                       | 0.375                    | 0.16     | Uncorrelated |
| NOP*9             | 9                       | -0.042                   | 0.457    | Uncorrelated |
| RABP*10           | 9                       | -0.566                   | 0.049    | Correlated   |

2.4 Results on Influential Factors

Table 5. The Results of the Uncorrelation test against the Impact of Six Influential Factors on the Total Time Spent in Patient Rooms (TSPR) on the Evening and Night Duties

| Number of samples | Correlation coefficient | Significance probability | Judgment |
|-------------------|-------------------------|--------------------------|----------|
| SONU*5            | 9                       | -0.016                   | 0.484    | Uncorrelated |
| ROSR*6            | 9                       | -0.741                   | 0.011    | Correlated   |
| FAPB*7            | 9                       | -0.507                   | 0.082    | Uncorrelated |
| NON*8             | 9                       | 0.08                     | 0.005    | Correlated   |
| NOP*9             | 9                       | -0.042                   | 0.457    | Uncorrelated |
| RABP*10           | 9                       | -0.642                   | 0.031    | Correlated   |

Table 6. The Proportion of the Total Time Spent in Patient Rooms (TSPR), for all Nurses who Worked Full Shifts on the Investigation Day

| Specialty | Proportion | Proportion |
|-----------|------------|------------|
| Medical Ward |            |            |
| NU-A      | 23.10%     | 27%        |
| NU-B      | 40.30%     | 28%        |
| Surgery ward |          |            |
| NU-B      | 24.30%     | 24%        |

*1) The source of the data of previous research: Reference 1
** The calculation included two parts: one is the total time spent in patient rooms of all nurses on duty based on the fixed-point observation survey; the other is the total time spent in patient rooms of all nurses on evening and night duties based on the follow-up observation survey.
duty. On day duty, the number of TVPR is increasing with the ROSR. The results of the uncorrelation test on the TVPR and the amount of TSPR for evening and night duties are shown in Tables 4. and 5. It appears that both the TVPR and the amount of the TSPR for evening and night duties are decreasing, while the RABP is increasing. It shows that the workload of nurses is approaching the limit on evening and night duties.

Furthermore, the ratio of all the nurses working full work shifts on the survey day is shown in Table 6. In NU-C, mixture injections to be used on the following day are prepared by pharmacists between 3:00pm-5:00pm. In this particular ward, nurses do not prepare mixture injections and consequently, the ratio of the time spent by nurses for patients in this ward is longer than in other wards. Yet, on the whole, we cannot affirm that the total TSPR, i.e. the degree of "direct nursing services", is higher than that indicated in previous studies.

2.2 Times of Visiting Patients' Rooms (TVPR) by Patient Attention Level (PAL)/Time Spent in Patients' Rooms (TSPR) by Patient Attention Level (PAL)

Data concerning single-bed patient rooms are extracted and analyzed with regards to the Patient Attention Level (PAL)\(^{Note 2}\). The TVPR and the TSPR according to the PAL during the day duty in the NU are shown in Fig.2. The TVPR and TSPR according to the PAL in each duty in NU-B/NU-C are shown in Figs.3. and 4.

It is observed that the TSPR by nurses and the TVPR differ greatly according to the PAL. The two factors were observed to be high for level A patients, and weak for level C patients in each NU.

Furthermore, it is observed that level B and level C patients in the NU-C received less attention as compared to the other NU, whereas in the same ward, the level A patients seem to be receiving more attention. In the NU-C, nurses are busy caring for critically ill patients, thus time for caring for other patients seems to be compromised. Also, this could be an indication that the workload of the nurses in the NU-C is approaching the limit.

Usually nurses give priority to critically ill patients who are in survival crisis over the patients who only need of assistance for daily life activities. The TVPR for level C patients can be seen as an index indicating the workload of the nurse. That is, when the nurses pay many visits to level C patients, it means that the nurses have a leeway\(^{Note 7}\). In contrast, when the nurses are too busy, they have no time to care for these patients. From this viewpoint, the data shows that in NU-C, level C patients are visited 8.4 times on day duty and in NU-C, they are visited 7.3 times. Compared to previous studies (level C patients, 10.7 times on day duty, medical NU)\(^{R5}\), it is considerably less, which indicates that nurses have become busier. Alternatively, the data from the surgical NU-B and NU-D (which both show that level C patients are visited 11.7 times on day duty) surveyed this time is considered intermediate compared to the surgical NU\(^{R5}\) (level C patients, 11.2 times on day duty) and the orthopedic NU\(^{R5}\) (level C patients, 13.2 times on day duty) surveyed previously. It appears that the busyness of nursing activities seldom changes in surgical NU. One reason is that staffing in the NU-B (the ratio of the NON on day duty to the NOP is 12.5:45) is higher than observed in previous surveys, which showed a ratio of 8:44. Another reason is that a surgical HCU\(^{Note 6, Note 3, Table 1}\) for critically ill patients is set between ICU and the NU-D. But it is a problem that busyness cannot be eased in medical NU although NU-A/ C has carried out the same measures as the NU-B/D.

2.3 Number of Trips (NOT)

During the follow-up survey, 1,145 trips by 8 nurses on day duty and 3,392 trips by 20.5 nurses on evening and night duties were recorded. The rooms of the nursing units were classified into 5 groups\(^{Note 5}\), which are: the staff station (SS), patient rooms (PR), treatment working rooms (TR), patients related rooms (PRR), and outside NU (ONU). The data relevant to the ratio of trips between the groups classified above are shown in Figs.3, 5. and 6. Amongst the data collected, the times of visiting SS is most significant. Based on the data from day duty (Fig.5.), trips between the SS and PR are the most, occupying 49.2% of the total number of trips. The second is the trips between PR (16.9%) and the third is the trips between SS and TR (11.3%). The tendency is the same on evening and night duties. Because of a regular round of visits on evening and night duties, the trips between PR occupy 32.4% of the whole (Fig.6.) and near double that of the trips made on day duty.

It is concluded that trips between PR and SS are
intense, even based on the comparison with the previous results\textsuperscript{8,4}. The trips to ONU occupy only 3.5\%, and represent half of what was shown in precedent studies\textsuperscript{8,4}. The trips between PR decreased from 23\% to 16.9\%, and on the other hand the trips between SS and PR increased from 44\% to 49.2\%. It is thought to be an after effect of the change of the nursing delivery system described later in this report.

2.4 Distance of Nurses’ Circulation (DNC)

Table 7 shows the distance of nurses’ circulation (DNC). The distance\textsuperscript{Note\textsuperscript{5}} traveled per nurse is 3.53km on day duty, and 3.68km on evening and night duties. The results from this research show that this number is 1.5 times compared to results from previous studies\textsuperscript{8,3}, which showed a distance of 2.5km.

Table 7. Distance of Nurses’ Circulation

| Duty                  | Ward/speciality            | Number of nurses followed | Distance per nurse |
|-----------------------|----------------------------|---------------------------|--------------------|
| day                   | NU-A/ medical ward         | 2.00                      | 3417.5m            |
|                       | NU-B/ surgery ward         | 2.00                      | 3646.4m            |
|                       | NU-C/ medical ward         | 2.00                      | 3217.8m            |
|                       | NU-D/ surgery ward         | 2.00                      | 3830.2m            |
| evening and night     | NU-A/ medical ward         | 4.75 (Note6, table1)      | 4220.4m            |
|                       | NU-B/ surgery ward         | 4.75 (Note6, table1)      | 4406.9m            |
|                       | NU-C/ medical ward         | 3.00                      | 3079.6m            |
|                       | NU-D/ surgery ward         | 6.00                      | 3191.2m            |

*This is the result of the follow-up observation survey

Based on the breakdown of the distances traveled between room groups (Fig.7.), the distance of the trips between PR and SS is the most significant, occupying 53.4\% of all trips on day duty. Next is the distance of the trips between PR (14.4\%). The distance of the trips between SS and TR was marked at 9.5\%. It is concluded that the distance between SS and PR affects greatly on the DNC.

3. Discussion

The following discussion will be carried out on 4 factors affecting nurses’ activities.

3.1 Physical factors

The main changes in floor plans include the dispersed location of toilets, the increase in the floor area of the NU, the length of the corridor and the ROSR. The standard floor area per bed is 38m\textsuperscript{2}, and is 1.7–3.5 times that of the area found in previous studies (14–22m\textsuperscript{2}) as shown in Table 2. The expansion of the area of the NU ensured sufficient working space and allowed work to be carried out easily. In contrast, both the distance and the time of the nurses’ circulation became longer.

Since the SS was opened up, it is easy now for nurses to overlook the NU from the SS. On the other hand with the area and the ROSR increasing\textsuperscript{10}, new problems emerged, thus supervision became more difficult and it became impossible for nurses to supervise all the activities. For example, if one nurse is in one of the corridors, he/she cannot grasp the situation of other nurses in other corridors. Otherwise, the supervision of the PR by means of senses such as sight or noise made by patients falling, especially when these are located far away from SS became difficult. The introduction of monitors and sensors for ambulation is increasing. But the alarms located too far away are also out of audible range. Additionally, as the floor area of NU becomes larger, there are also many passages being introduced, thus where the sound of the alarm is coming from is at times unclear.

With the expansion of the area, the number of corridors is also increasing. The spatial intelligibleness is becoming scarcer. Moreover, in order to secure privacy, the room number and the name of patients are displayed on a panel when touched. In the NU-A, there are 12 single rooms in a row, nurses spend more time trying to confirm their location. The spatial intelligibleness should be improved by a simplification of the configuration of corridors or the look of walls in the corridor where a distinctive design should help wayfinding in the NU.

From the nurses’ viewpoint, a dispersed distribution of toilets has both merits and demerits. Waste and removal of drains can be performed easily in the toilets inside the PR. But, in order to record all the amount of excretion and to take urine samples, it becomes necessary to go to each and every PR. In previous studies, patients visited the centralized toilets frequently and had to walk through the corridors. But now patients can do everything in their own rooms. Consequently, the contact with nurses and patients has decreased.

3.2 Patients factors

With the progress of aging, it turns out that the inpatients’ average age went up considerably. While it was 49 in 1982 in the surgical ward\textsuperscript{9}, it became 58.6 in 2002 in the NU-B. Also in the medical ward, it went

![Fig.5. Breakdown of Trips on Day Duty](image)

![Fig.6. Breakdown of Trips on Evening and Night Duties](image)

![Fig.7. Breakdown of Distance](image)

*Figs. 5-7 were made based on the results of the follow-up observation survey.*
up from 50 in 1982 to 64.9 in 2002 (NU-A). Because of a decrease in physical and cognitive abilities with aging, in addition to previously existent diseases, the ability of performing activities of daily living (ADL) has reduced, and nurse supervision is always needed. Moreover, the demands for ADL care are increasing greatly; also, an informed consent for operation or examination for elderly people requires more time.

Fig.8. shows the breakdown of the patients according to the severity of their symptoms divided by the PAL (A, B, or C) and the degree of ADL (I, II, III, IV)\footnote{1}. In comparison with previous studies, the percentage of level A patients and level B patients being looked after extended to 60\%, and is double the results found in previous studies\footnote{2}.

The rate of critically ill patients is increasing as described above, and there are constantly 4-6 patients in the terminal phase placed in the medical ward. To cope with this, aside from the special rooms planned for critically ill patients near the SS, a part of the general single-bed PR is also used for critically ill patients. Nurses demand that critically ill patients must be located near the SS; but in that case, single rooms near the SS become insufficient. It is thus concluded that a number of single-bed patient rooms around the SS should be ensured.

With the rate of critically ill patients increasing, the patients under monitoring have increased. Although nurses can be notified quickly, there are too many alarm sounds and nurses say it is difficult to check them all carefully.

Based on the results of the questionnaire, it is concluded that:
1) The time needed for preparation, clean-up, and material storage is increasing.
2) The time spent on security measures in order to prevent medical accidents is increasing.
3) The amount of medical informatization and general office routine mentioned below are increasing.

In sum, the amount of indirect nursing functions is increasing. The same results were found from this observation survey. The time for preparation, clean-up, and material storage extended to 19.2\%, while it was 17.3\% in previous studies\footnote{2}.

In order to respond better to the elderly and critically ill patients, direct nursing services must be enhanced. However, the ratio of the TSPR, which represents the degree of fullness of "direct nursing" has reduced, which remains a severe problem.

3.3 Management factors

In a previous study performed in 1986\footnote{1}, the average length of hospital stay was 29-38 days. The average length of stay was found to be around 15 days (Table 1.) in this survey, in which the medical NU-C is an exceptional case. With the shortening of the hospitalization period, the amount of medical informatization and general office work such as preparation of care plans for patients', along with admission and discharge has increased. The number of new inpatients that nurses see every week has been increasing considerably. Thus, nurses spend more time reading and memorizing patients' information.

The Personal Hospital Communication system (PHC), Support Process Delivery system (SPD), and electronic medical chart system are introduced into hospitals, which are expected to greatly promote efficiency and rationalization of hospital management. But based on the fact that the proportion of the total TSPR is not increasing (Table 6.), it is known that the fullness of "direct nursing services" cannot be fulfilled simply by the introduction of IT.

After the IT system was introduced, it became possible for information exchange to be carried out on the computer. In this follow-up survey, visits to ONU for information were not taken into account. Yet it is assumed that the spatial proximity from NU to diagnosis and treatment as well as the administrative department is less important, as always.

3.4 Nurses' factors

In the last 20 years, the nursing provision system has changed greatly. A role nursing delivery system along with a team nursing delivery system was widely introduced in the 1980s. Nurses also continuously visit the PR once their preparations are completed. So the work can be performed efficiently. But in this system, the patients tend to be regarded as the object of busyness. In recent years, that nurses can take a whole perspective on each patient becomes the essential point of nursing care. Meanwhile, a primary nursing delivery system\footnote{11} was introduced from the 1990s. The result of this observation survey also shows that the number of trips between the PR is fewer and the number of trips between the SS and PR is more than before. With the progress from the "functional" era to the "patient-centered" era, efforts are required to help shorten the distance between the SS and all the PR.

4. Conclusion

4.1 Reconsideration of previous design guidelines

1) Nurses’ circulation and arrangement of the staff station (SS)

The fact that trips between the SS and PR are intense has remained unchanged. The distance between the SS and PR is an important factor affecting the total DNC. So when the SS is located in the center of the PR it is most efficient. Even in cases where there are two units on one floor, locating the SS at the center of the PR
is better than locating it near to the entrance, for the reduction of walking distance and operation efficiency.

It is clear that visits still focus on the rooms of critically ill patients. The position of the SS must be laid out in the center of the whole PR with special attention given to the position of the critically ill patients. Moreover, it appears that, in principle, it is better for the SS to be an open shape for ease of observation and communication.

As mentioned above, the most fundamental portion is in agreement with previous studies. The most fundamental point of "care by nurses' hands" does not change even with the progress of IT.

2) Response to the change of patients, the increase of single-bed PR and the introduction of IT

Elderly patients suffering from senile dementia are increasing. It will become more important to secure those patients inside of a NU, i.e. it will be required to locate a check point at the entrance of the NU as a SS. Ideally, the position of the SS should be where it is near both the center of the PR and the entrance of the NU.

In a general NU, if there are 1-2 patients who need continuous observation, it is difficult to treat the other patients, especially on evening and night duties. HCUs for critically ill patients is set between the ICU and general NU in T hospital in order to reduce the workload of the general NU. Success is proven in the surgical NU-D based on the results of this survey. However, more effort needs to be made in medical NU where there are 4-6 patients in the terminal phase.

With the RABP increasing, the important influential factors on the layout of the NU are not only the position of the few critically ill PR, as it used to be, but also the zoning corresponding to the ratio of critically ill patients.

In principle, in the past, the NU usually consisted of as small a number of PR as possible in order to minimize the distance between the SS and PR, and finally to minimize the distance of nurse circulation. Recently, there has been a noticeable rise of single-bed PR due to the demands of treatment/care, patients' individual taste, turnover rate of beds, privacy and the improvement of the environment based on the results of interviews.

With the increase of the floor area both in single-bed PR and multi-beds PR, treatment has been carried out in PR, not in treatment rooms, on the condition that no special medical equipment is required and that the procedure does not emit odor and/or noise. So it is less important than before that treatment must be near the staff station, excluding some specialized NU, such as ENT (Ear Nose Throat) NU.

With the increase of floor area, the distance between dirty utility rooms and PR became longer. It is better to locate dispersed dirty utility rooms in NU, rather than to locate a centralized dirty utility room.

Because of increasing informatics in hospitals, the number of trips out of the NU will be decreased. However, a considerable amount of transportation of patients from the NU to diagnostic and treatment departments can be expected. It is still required to shorten the distance between the NU and those departments.

3) New Problems

Other issues are:

a) Spatial recognition seems to be more difficult.

b) Ease of observation of patients by nurses is still an important issue. Not only observation by eyesight, but also recognition of accidents by sounds must be ensured to provide the nurse with ample scope for observation.

c) Improvement of the nursing work environment, especially focusing on shortening the nurses' circulation distance.

d) The enhancement of direct nursing services is still an important subject, which becomes increasingly important with the aggravation and aging of acute inpatients.

4.2 Proposals for ward planning

Improvement of the environment in the NU must be discussed from both the management level and the point of view of the physical environment based on the above-mentioned discussion. The proposals for ward planning of acute hospitals from the standpoint of nurses are concluded as follows.

1) Sufficient attention must be paid to the different needs of treatment and nursing depending on the medical conditions of the patients when planning an acute hospital. In the early stages of planning, firstly, patients' information including the percentage of critically ill patients must be analyzed carefully. The composition of the acute ward must be discussed considering staffing and the efficiency of operation, along with the highest level of nursing care. The zoning corresponding to the ratio of critically ill patients also needs to be fully considered when arranging the layout of nursing units.

2) Even if the HCU and the palliative care units are set up in hospitals, there are still 5-6 patients in the terminal phase in the wards. Sufficient attention must be paid for terminal care patients who are placed in a general ward, especially in medical wards.

3) The patients' rooms must be arranged in a situation where nurses can hear the sounds from the patients. Special attention must be paid to the planning in order to cope with the number of nurses on evening and night duties.

4) Efforts must be made in order to improve the spatial recognition.

5) Based on the "2-8 Arbitration", one nursing unit usually has about 50 beds in Japan. With the area per bed increasing, the above-mentioned questions have emerged. A small sized nursing unit, such as a 20–30-bed nursing unit, seems to be the answer to all the questions. It can shorten the nurses' circulation, ensure a sufficient number of single-bed patient rooms near the staff station.
for all critically ill patients, allow the supervision of all the activities, make it possible to hear all noises and alarms easily, and enhance the direct nursing services. Now seems to be the time to discuss what should be the optimal size of nursing units in acute hospitals.

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Notes

1) With the change of disease structures involving the aging population, combined with the diminishing number of children in Japan, the patients who need care over a long period of time is increasing. Various patients were intermingled in one nursing unit before revision. After revision, acute beds were assigned to acute patients, and chronic beds to patients who need care over a long period of time.

2) Patient Attention Level (PAL) is commonly described at three levels. First, level A patients who are seriously ill require continuous observation; Second, level B patients require intermittent observation every 1-2 hours; and third, level C patients require only a general observational control. Patients' Activities of Daily Living are usually labeled as four levels as follows: I) bedfast, II) able to sit on a bed, III) able to get out of bed and move within the bedroom, IV) largely able to look after themselves. Below is a chart that indicates the changes of patient structure according to the PAL (A, B, C) and Patients' Activities of Daily Living (I, II, III, IV), with the average length of stay in acute wards becoming shorter (the data of a acute hospital). Critically ill patients are defined as AI, AII, and BI patients according to the categorizations.

3) The relatively high level of amenities of patients' lives in wards due to the enhancement of living space, the move to single-bed rooms, the move to single-bed rooms: 1 visit is recorded even in the case that a nurse goes out for a short time and comes back soon to the patients' room on a series of nursing activities.

4) The times of visiting the patients' rooms: 1 visit is recorded even in the case that a nurse goes out for a short time and comes back soon to the patients' room on a series of nursing activities.

5) The following table shows that the ward composition of an acute hospital consists of three levels. The units surveyed are general care units. Table 8. Facilities Criteria

| Criteria                        | ICU (at least) | HCU (at least) |
|---------------------------------|----------------|----------------|
| The number of patients : the number of nurses | 2 : 1 (at least) | 1.5:1 (recommended) |
| Unit Area per Bed              | more than 75m² | -              |
| Area of patients' room          | -              | -              |
| Area per bed in multi-beds room | more than 20m² | -              |
| Area per bed in single-bed room | more than 25m² | -              |

6) There is a nurse who works from 12:30am to 9:00pm. In the fixed-point observation survey on day duty (8:00am-5:00pm), the nurse is recorded as 0.5 person. In the follow-up observation survey on the evening duty (2:45pm-12:00pm), the nurse is recorded as 0.75 person.

7) The nursing manual in medical wards is different from that in surgical wards. For example, the conditions of surgery patients always need to be observed by two nurses. So the comparison between surgical wards and medical wards is inappropriate.

8) The categorization of the rooms:

| SS | Staff Station | PR | Patients' Room |
|----|---------------|----|----------------|
| TR | Treatment Working Rooms | Staff rooms, disposal utility room, instrument room, storage for wheelchair and stretcher, butler's pantry, nurse's corner, garbage room |
| PRR | Patients Related Rooms | Family anteroom, interview room |
| ONU | Out of Nursing Unit |

9) It is assumed that a nurse starts from the center of one room, goes through the middle point of entrances and corridors and stops at the center of the destination room. The distance the nurse walked is defined as distance between rooms. The distance of nurses' circulation is calculated based on a table of “distance between rooms”.

10) The doors of single-bed PR are always closed while multi-beds PR are usually opened. It is hard to observe patients through the small window on the door. If something happened, the roommates can help call nurses in multi-beds patients' rooms. When a patient cannot push a nurse call in a single-bed room, nurses take notice of abnormality later.

11) Nurses who are in charge of special roles, such as injections, dispensing of drugs, temperature taking and assisting in doctor's round respectively.

12) A particular nurse in charge of a small number of patients from admission to discharge and visits the other patients only for support.

13) HCU (High Care Unit): Step down care unit, functioned as a place between ICU and General Care Units (Note 6, Table 1.). The number of nurses on both evening duty and night duty must be more than 2 persons, and the total times a nurse works on evening or night duty must be less than 8 times a month.

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