# Research on the requirement extraction for the design of the bed for medical treatments

Subtitle: Aimed at a nurse's reduction of incidence and the move increase in efficiency in a hospital.

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Abstract: In this research, the present condition of performing patient movement by a bed by one nurse is regarded as questionable, and the new bed for medical treatments to which at least one nurse can make it move without a burden is proposed. The present bed for medical treatments has the bad mobility at the time of carrying by one person. The reason was concluded that it was in lack of the operativity of a bed front wheel, so I insist that it making possible a front wheel steering and a front-wheel drive as requirements for a design of the new bed for medical treatments.

Key words: Medical bed, Medical treatments, nurse, co-medical

## 1. Introduction

The bed for medical treatments which eases a nurse's burden is indispensable in future. When putting a patient on the bed for medical treatments and carrying him, you generally have to carry out by two nurses[1][2]. This is promoted also a nurse's bed use manual and the appeal of the Ministry of Health, Labour and Welfare. However, as a result of taking a questionnaire to the nurse who works in Nagoya City University Hospital, the actual condition of carrying by one nurse depending on departments became clear. The bed for medical treatments is large-sized apparatus which exists 100 kg or more, and can be set to 150 kg or more by the case when a patient joins. The situation when it is carried by one woman exists. It is clear that this is a big burden for a nurse. Such a burden of a nurse as this is accumulated and may disturb the efficiency of nursing business. It will lead to the fall of consideration of a patient, and the fall of safety as a result. It judges that it is necessary to design the new bed for medical treatments which incorporated the nurse's viewpoint for solving the above problem, and extracts the requirements for a design.

#### 2. Present data analysis

# 2.1 Patient movement

In recent years, patient movement by the bed for medical treatments is increasing[3]. The two reasons exist. The 1st point, it is an omission that a patient change to a stretcher from the bed. After the patient was moved from the bed to the stretcher in the sickroom, he was conveyed in the operating room and the inspecting room until now. However, since the burden on a nurse was heavy, this process was skipped, and it came to be carried with the bed. The 2nd point, it is substantial precautions against infectious disease.

Patient conveyance by the bed for medical treatments continues to increase. It is clear by the investigation of the Ministry of Health, Labour and Welfare that 49.3% of the whole is aged 65 and over[4]. The result that 55% of

an inpatient's people are aged 60 and over has come also out of the questionnaire which was carried out in Nagoya City University Hospital this year to the inpatient[5]. As a result of actually carrying out a hearing for a nurse, it turned out that patient movement with a bed is performed almost every day. Japan is an aged society[6].

# 2.2 Mobile environment of a bed

## 1) A sickroom and its entrance

I observed the environment to which a bed is moved in Nagoya City University Hospital, digestive surgery, and a respiratory organs surgery. There are two type of a sickroom (a single room and a large room). Four beds are placed at the large room. Both of the rooms are the sizes which a bed can move barely(Figure.1). Especially the entrance of a single room is small and has only about 1200 mm to about 940 mm in width of a bed. A gap in case a bed passes is only 250 mm. Therefore, the marks which the bed rubbed remain in the entrance of a sickroom, and the wall of the single room(Figure.2).



Figure.1 Relationship of the bed for medical treatments, and an entrance



Figure.2 The crack by the bed for medical treatments

#### 2) A passage, its corner

Since there is about 2095 mm of width of a passage, it is sufficient size for one bed to pass. However, the cautions to a collision are required because a patient, people of a visit, a sheet wagon pass along the same passage. The problem is a time of taking a bed in and out of the room. If a bed is leaned, sufficient width for a passage will be lost.

## 2.3 The questionnaire to a nurse

In order to clarify relationship of bed movement and a nurse burden, the questionnaire was carried out for 24 nurses (23 years old  $\sim$  54 year-old woman) who work in Nagoya City University Hospital. The following is the contents and result.

- Q1. When you move the bed for medical treatments, have you thought that it is a burden?
- Q2. What is the reason which it feels for a burden?

Q3. Do you move the bed for medical treatments by one person until now?

Q4. How is the frequency to which the bed for medical treatments was moved by one person compared with the frequency to move it by two persons?



Table 1. Result of Question1

Table 2. Result of Question2

A bed is heavy.	A bed will be thrown at a wall.	It is hard to bend.	It is hard to move a wheel.
A code is obstructive.	Business overlaps.	Axle part is bad.	Because it carries out alone.
Stopping is serious.	It is hard to push straight.	It pays on the waist.	It is hard to change the course.

Table 3. Result of Question3

Table 4. Result of Question4



The questionnaire showed that mostly of a nurse was having the burden to the mobility of the bed for medical treatments(Table 1). The item which there was the most as the reason was "A bed is heavy".Subsequently, it was A bed will be thrown at a wall.", "It is hard to bend.", and "It is hard to move a wheel(Table 2)." Moreover, all nurses answered that they have moveed the bed for medical treatments alone(Table 3). The person that answered "There being much the frequency" or "There is slightly much the frequency" was 62.5%(Table 4). It was over the majority. Guidance about a nurse manual or bed operation is recommended making it move by two persons, but the inconsistency of the operating organization and the present condition which should be performed became clear.

This questionnaire survey was conducted for digestive surgery and a Department of Pneumology (internal medicine and surgery are included). I would like to observe one's post at which a nurse who answered "there being many" or "It is slightly large" works. 70 % or more which answered "much" or "slightly much" were a nurse who

works to digestive surgery. As opposed to it, about 80 % of the nurses that answered "slightly little" or "little" belonged to the Department of Pneumology. That is why, it turned out that the movable system of the bed for medical treatments has a gap of each post[7]. Since the problem of the bed operation for medical treatments by one nurse had arisen not per hospital unit but per department, had not it surfaced until now.

#### 3. Main point consideration of design intervention

As a result of conducting hospital investigation about movement of a bed this time, it turned out that the move form in a bed has the present condition which is not performed as the manual, and the nurse is having the big burden by it. There is the shortage of nurses as the background. Although a maker of the bed is designing the product on condition of carrying by two nurses now as the manual of a hospital, the product will have been used in a different form from the intention.

That is why, the inconsistency has arisen between an actual hospital movable system and a recognition of bedmaker, and the mismatch of human and a product has happened by it. Although such a situation has not arisen in all hospitals, there is a ward with such reality. It is necessary to propose the new bed for medical treatments which suited the mobile environment in a hospital for the reduction of incidence to a nurse, and the patient.

# 4. A nurse's motion analysis

#### 4.1 Analytical purpose

The purpose of this analysis is consideration of the range which should be assisted by electric movement. The range which should be assisted is the limit which should be supported by electric power for a nurse action of movement.



Figure.3 The direction of movement of the bed for medical treatments

In this motion analysis, I designate above-mentioned (Figure.3) about the part name of a bed. That's because that a nurse must stand by the back of the head side of the patient, and assume the foot part side of the patient a line when she perform the bed movement of the patient alone. In this research, it is discussing focusing on movement of a bed, and a bed is moved in many cases where a patient is picked up. Therefore, let the wheel in a patient's leg side be a front wheel, and the wheel in a patient's head side be a rear wheel.

#### 4.2 Method of analysis

I get two nurses (the woman for nurse history three years, and woman for nurse history ten years) who work in Nagoya City University Hospital to cooperate, and have straight line movement and curvilinear movement performed alone(Figure.4). The distance to analyze is the following three points. i ) When going a passage straight on ii) When turning at a passage iii) When enter or leaving a sickroom

The single sickroom which cannot enter a room easily is made applicable to analysis although there are two type sickrooms which are single room and large room. Moreover, in order to conduct more concrete analysis, I borrowed the general sickroom bed (Figure.5) of the old model from Nagoya City University Hospital, and the straight-line motion and curvilinear motion of it were performed alone. In addition, although performance is



Figure.4 The situation of movement



Figure.5 The borrowed bed for medical treatments

inferior compared the bed of the old model which I borrowed with it used now, basic structure is almost equivalent by a JIS standard[8]. However, since the weight of a side rail and a patient is not contained, it is slightly lightweight.

# 4.3 Result of analysis

# i) When going a passage straight on

Since the bed for medical treatments has large weight and length, it is difficult to make it progress straight. Correction of direction needed to be performed in the straight line several times like car driving. In the case of a car, by a steering power assist facility, handle operation is easy and at least one person can perform correction of direction easily. In the case of the bed for medical treatments, the nurse who stand by the front wheel side usually controls a direction when they change direction of bed, but it becomes difficult when carrying by one person. Therefore, the nurse has to go the headboard and side rail side back and forth, and has to correct a direction. Although the control only by the side of a headboard is not impossible, the burden on an arm of nurse is quite heavy. Since it is not used to a newcomer nurse making it progress straight, there is much frequency where the headboard and side rail side is gone back and forth. The tendency which a veteran nurse controls only by the headboard side was seen. However, according to the talk of Ms.Itou, chief nurse (veteran nurse beyond nurse

history 8 year) of digestive surgery, she said, "Since time and effort will be taken if it moves to the side rail side at the time of deflection correction, even if it applies a burden to an arm, it has controlled by the headboard side."

#### ii) When turning at a passage

This movement is performed after straight line movement, so it is difficult for a nurse to bent by fixed power. Since it is a big turn compared with straight line movement, to carry a bed by one person, a veteran nurse also needs to go the headboard and side rail side back and forth. For bending well only by the operation by the side of a headboard, she once stop a movement of bed and just to rotate a rear wheel centering on a front wheel. However, the act to stop at the time of patient conveyance once takes a burden to the arm of the nurse. In addition, the figure which bent without stopping was frequent because the conveyance speed became slow.

#### iii) When enter or leaving a sickroom

In this case, the bed is carried out a right angled motion because there are no space to curve at sick room and passage facing it. A nurse cannot control the direction of the wheel of the bed which is located a nurse's position symmetrically, so they have to go back and forth the headboard, footboard, and side rail to carry the bed alone. It is impossible to carry by a fixed position. The method at the time of entering a room is like this. At first, a bed is leaned and it unites with an entrance and parallel. Next, after rotating a rear wheel centering on a front wheel, a bed is put in to the back of a single sick room. Then, a nurse moves to the side rail or headboard side, and fit a rear wheel with the position of bed fixation. Furthermore, a nurse moves to a side rail or the footboard once again, and is completion. At the time of leaving, the movement almost same is performed.

## 5. Consideration of the requirements for a design

As a result of analyzing the operation at the time of carrying a bed by one nurse in Chapter 4, it turned out that she operate the bed not only from a headboard side but also from a sideboard and a footboard. The reason is that the control of bed's front wheel is difficult and environmental of hospital is not suited for movement of the bed. Therefore, I enable it to move the new bed for medical treatments smoothly only by the operation from the headboard side, and think that a nurse's reduction of incidence should be carried out. It is not necessary to move the circumference of a bed repeatedly. Specifically, I propose the new function of the bed which is the front wheel steering and the front wheel driven. The direction of movement of a front wheel is controllable by the grip at hand. If this function is carried, the bed is abled to avoid collision with a wall at Passage or sick room. When entering a sickroom, the bed is abled to enter smooth by a front wheel drive. Moreover, the burden on the nurse is heavy at the time of stopping and of beginning to move before force of inertia work to a bed, so These should be assisted(Figure.6).

However, a drive function is an assistance grade. The power which a nurse pushes is supported. It is not perfect automation. I judged that it was desirable to interlock a nurse's act and operation method of usual bed operation, because there are many elderly people and patients in a hospital and the possibility of a collision cannot be denied, either. About a rear wheel, a freewheel is used as usual. Since the rear wheel side is a position which a nurse operates, it is easily controllable by a nurse's own power(Figure.7).



Front wheel steering function

Front wheel drive function

start and stop assistance

Figure.6 Range which should be assisted



Figure.7 The new bed for medical treatments proposed

# 7. Omni wheel

The wheel carried in the front wheel of a new bed is used as the Omni wheel(Figure.8)[9]. The wheel came to attract attention in care or the robot field in recent years[10]. Movement in the many directions is enabled with the combination of rotation of the wheel on an axis, and rotation of the small wheel attached on the circumference(Figure.9). Although the wheel which carries out the motion same otherwise exists, the number of the reasons for using the Omni wheel is three below. 1. Since the principal axis is sideways, it can respond to a low-floor bed. 2. Noise is small. 3. Application is progressing in the medical field[11].



Figure.8 the Omni wheel

Figure.9 Structure of the Omni wheel

## 8. Conclusion

The purpose of this research was to carry out a baseline assessment about the move form of the bed for medical treatments in a hospital, to clarify the element of the nurse burden which poses a problem in it, and to perform requirement extraction for a design of the bed for medical treatments for the problem solving.

First, about the elucidation of the element of the nurse burden which poses a problem, the inconsistency has arisen between the present hospital movable body system and recognition of a bedmaker, and it is concluded that the mismatch of man and a product had happened by it. Although the bed for medical treatments is to be carried by two persons generally, at the movable body system of the actual hospital, it was carrying by one nurse. In connection with it, since the relationship of the bed for medical treatments and its mobile environment was unsuitable, the vicious circle that the collision at the time of movement also occurred had been induced.

And about the requirement extraction for a design of the bed for medical treatments for this problem solving, it could carry by one nurse and it was judged that the design of the bed for medical treatments which can ease the shock of a collision in preparation for emergency was desirable. As this conclusion, I propose the front wheel steering and front-wheel drive function whose control is enabled by the grip at hand in the new bed for medical treatments with omni wheel.

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