



Ergonomic analysis of bed for bedridden patient- An interdisciplinary overview

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ABSTRACT

This review paper mainly focuses on ergonomics problem which is mainly related to bedridden patients and caretaker of those patients. A bed plays a key role in the patients' life, if ergonomically bed is not suitable for patients then he can't recover fast and also the person who takes care of the patient they go through some injuries or accident. Designing a healthcare facility without giving sufficient consideration to the users who will perform their activities in it may lead to dysfunctional workplace. Like assisted living facilities, nursing homes, outpatient clinics, as well as in home health care services, the design of hospital bed depends largely on users' anthropometric characteristics to ensure comfort, safety, and productivity of health care service. In attempting to meet the patients' needs, a survey paper was studied for many cases (patients and caregivers point of view) which aimed at proposing a new prototype to provide their needs.

Keywords— *Bedridden patients, Healthcare facility, Anthropometric characteristics*

1. INTRODUCTION

Nowadays, ergonomics aspect in bed design has huge importance because of bed plays an important role in the patient as well as in nurse or care takers life. If bed design is not proper then patient recovery rate falls down. The patient feels uncomfortable physically then he can't give a proper response to treatment. After 65-70 age, person those who can't carry out day to day life without support or care taker. Lifting and transferring patients from one place to another place is mostly carried out the activity which can cause low back problem among nurses. According to the Centre for Diseases Control and Prevention, the rate of occupational injury in the health care field has risen over the past ten years. The health workers that mostly develop injuries are those with jobs that require them to lift or move patients. Lifting and transferring patients affect different areas of the body including upper limbs, head and neck, upper and lower back.

Other risk factors include repetitive motions, holding one position for long periods, awkward postures, and pressure on muscles, tendons and nerves. The combination of these factors will increase the likelihood of developing MSDs.

The Occupational Health and Safety Administration (OSHA) defines MSDs as "injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilages and spinal disc". MSDS generally develop gradually over time.

The average cost per incidence of an MSD is estimated to be Rs 12000, which includes the cost of work with full wages, replacement wages, cost of productivity and medical treatment (surgery not inclusive). But beyond that, the cost of suffering and diminishing quality of life for the workers cannot be calculated. The below figure 1 shows the percentage of the population over the age of 65[1], which shows that the percentage of population increase over the periods.

The bed is a unique invention of human kind devised to ease the problem encountered in the process of sleeping. The case of a hospital bed is not an exemption with beds that are designed for in-patients and individuals who give priority to some forms of health care.

Unsafe medical care has led to the increasing suffering of millions of patients on a yearly basis. Good health is directly influenced by the way one sleeps since the quality of life depends on the quality of sleep. Awkward posture and improper sleep may cause a lot of medical disorders and other diseases like arthritis, blood supply disturbance, insomnia, allergy, asthma, sleep.

In this review paper around ten papers were studied for getting the current scenario regarding awareness of ergonomics in bed design. Recently huge development is carried out to fulfil the patients' needs and which will ease the activities of patient carried out by nurses or care taker.

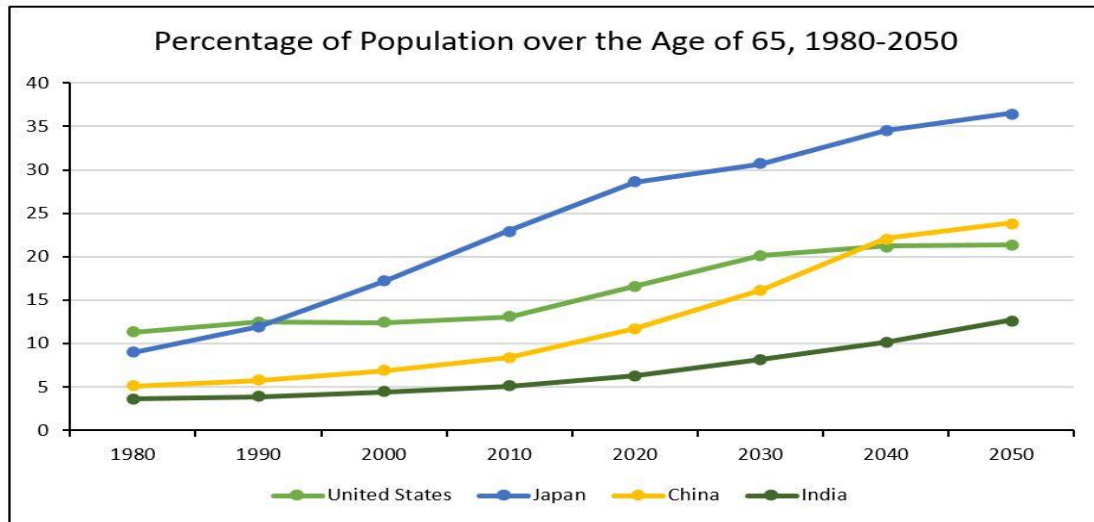


Fig. 1: Percentage of population over the age of 65

2. LITERATURE REVIEW

Gunther Paul, Marisol Quintero [2] told how anthropometric data affect the ergonomically on the object is mentioned. In this paper, Siemens JACK simulation software is used which creates an actual working scenario on the basis of inputs. In this study, 4 peoples are considered who belongs to 5% and 95% by height and weight. The author first uses simple techniques such as Ovako Working Posture Analysis (OWAS) and Rapid Upper Limb Assessment (RULA). These two techniques are static who do not consider the dynamic nature of the task. This study types gives comforts of posture and gives some score which indicates the level of risk. The results show that the posture of the body affects the ergonomics of stretcher height. But in day to day life, in hospital handle height is not adjustable. It is always fixed in specific height which can affect person position and may come in an awkward position which leads to MSD's. Fig 2 shows the postures of a working nurse while pushing the stretcher. The 95% heighted person want to bend and exert the force in a downward direction while 5% of heighted people exert the force somewhat in the upper direction.

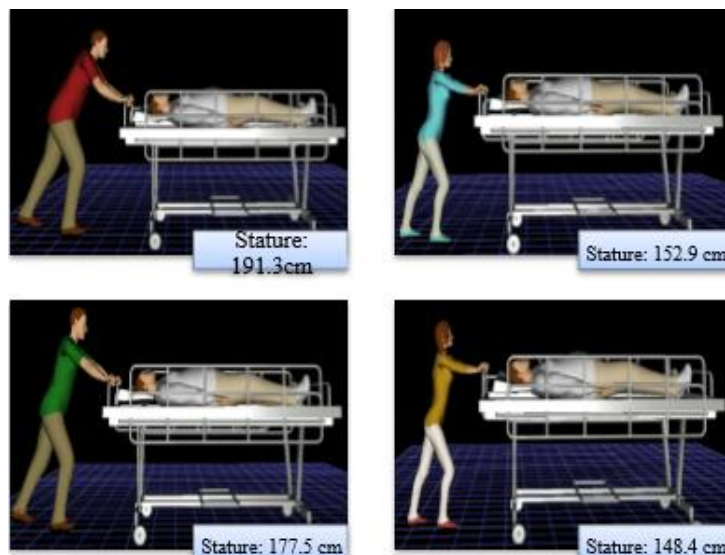


Fig. 2: Watermark embedding algorithm Block Diagram

Sheryl S. Ulin, Don B Chaffin [3] mainly focuses on Low back pain problem among nurses. In this study, six different transfer methods are carried out by two female nurses. In this paper 3, transferring methods are manual and 3 methods are mechanical. By National Institute for Occupational Safety and Health i.e. NIOSH, low back compression design system should apply maximum 3400N force but in manual transfer method, it will be 10000N which is more than by 6400N approximately. But when the mechanical lifting system is used, the back compression force is smaller than the back compression design limit. In manual methods pivot, gait belt and sliding board is used and in mechanical methods drives, ball bearings and screw activated drive, hydraulic lift and electric lift is used. Mostly carried out activity is transferred the patient from bed to a wheel chair so this working condition is considered to get maximum results. When nurses perform tasks in manually transferred condition 50% to 100% of patients weight applied to the nurse while in lifting devices it is only 10 to 40%.

Fajobi M.O., Awoyemi E.A. [4] focus on Bed design on the basis of ergonomic consideration. If the bed is not proper to sleep then the human has to sleep an awkward position which leads to medical disorders. And other diseases like osteochondritis, radiculitis,

arthritis, blood supply disturbance, insomnia, allergy, asthma, sleep apian. In this study, 87 different peoples are considered for Participatory Ergonomic Intervention (PEI). In this type of collection of anthropometrics data and ergonomic opinion from peoples are collected and it will be key inputs for observations. The description of body measurement are namely as follows:

- (a) **Stature:** This input is taken while in lying direction. It is nothing but horizontal dist between feet to center of the head
- (b) **Elbow span:** Elbow Span: This is the horizontal distance between the lateral surfaces of the two elbows.
- (c) **Popliteal Height:** Taken in sitting position, the vertical distance between the floor and to the thigh immediately behind the knee.
- (d) **Vertical Grip Reach:** Either in sitting or standing position, the horizontal distance from the back of the shoulder (greatest bulge of trapezium) to the tip of the extended middle finger.

All these measurement criteria are shown in below figure 3.

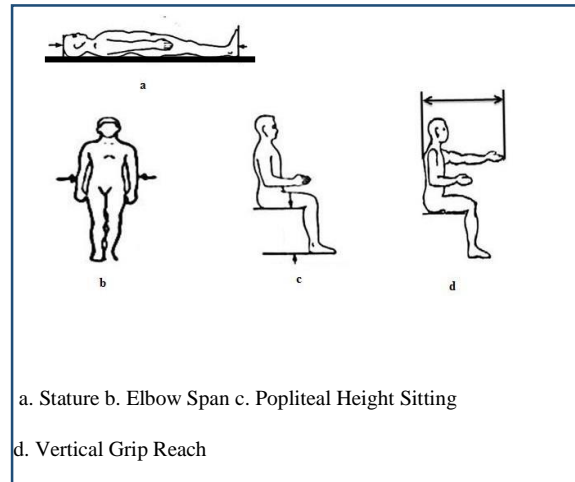


Fig. 3: Description of measured

This paper shows that in Nigeria, awareness regarding ergonomics consideration is very low due to which chances of injuries are more. The hospital equipment is not user-friendly so equipment cannot adopt in day to day life. If the proper and focused study is carried out on this it will give a huge impact on Nigerian people and no of accidents happens in a hospital is reduced.

M.N. Mohammed, N.G. Khrit. M. S. Salleh [5] focuses on the design of such bed and how it will use to the patient is mentioned. The main focus is on to reduce the cost which is incurred during a hospital stay. Mainly peoples live in the hospital for a better facility, but facilities are developed in the home then all the cost incurred during the hospital stay will be reduced. The study is basically carried out by considering bedridden patient and caretaker of that patient. They firstly study all the problems which are faced by the caretaker and patient. And give a proper way of study to encounter that problem with various advancement in the mechanical field. To fulfil the patient’s needs and reduced the work of caretaker which will definitely affect the If the patient is bedridden then caretaker should be always there to carry out day to day activity. The author develops various designs of bed which will be converted into a chair also. It can also affect the quality of life of the patient. If the patient is going to various injuries then he/she can't recover properly so bed plays the main function in the recovering stage. Some survey is carried out by the author to take some inputs for designing of bed. In the market, various types are a bed available which are as follows.

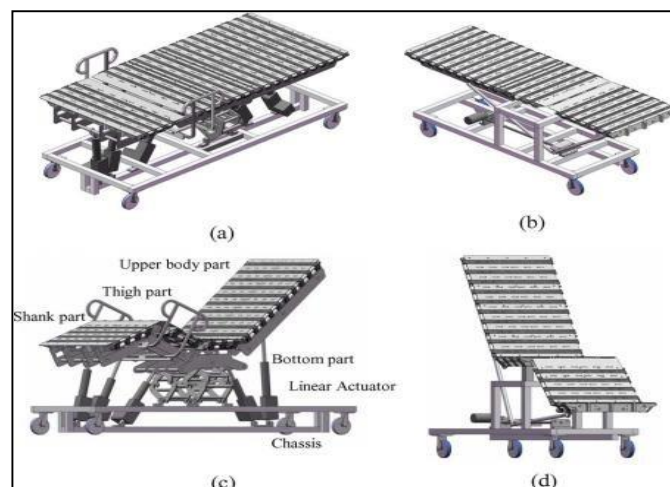


Fig. 4: The simple mechanism of the multi-function main bed and nursing bed (a) main bed before the transformation. (b) Nursing bed before the transformation. (c) Main bed after transformation. (d) Nursing bed after transformation.

The next approach is that of a robotic or automated bed/wheel chair which can be operated by the patients themselves. One such approach was presented by Lin Tan et. al [6] [Figure 5]. They have designed a robotic nursing bed which has the functions of raising back, curling legs and side turning over from left to right separately, and voice recognition control, according to paralyzed patient’s requirements.

- 1: Right backboard
- 2: Clap Board
- 3: Left backboard
- 4: Right hipboard
- 5: Defecate board
- 6: Left hipboard
- 7: Right legboard
- 8: Clapboard
- 9: Left legboard

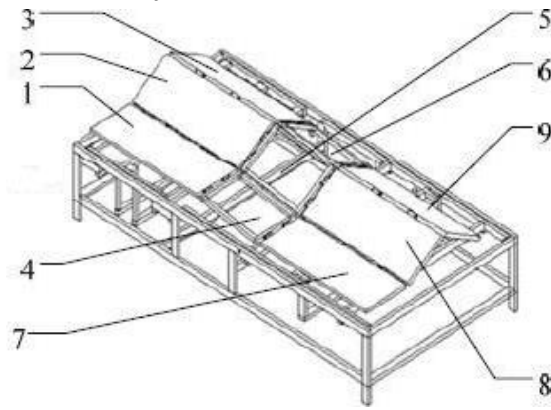


Fig. 5: Structure Of bed surface

Stephen Mascaro et. al [7] developed a hybrid wheel chair cum bed system for bedridden patients. The powered wheelchair could be attached to the bed and reconfigured in flat shape to match with the bed. The main aim was to have easy movement of a patient from the bed to a wheel chair and vice versa. This design was a wheelchair cum bed. To detach the wheelchair from the bed portion, the back of the chair is first raised, the whole body of the chair is then slid off from the end of the bed portion as the foot rest is folded down and the arm rests are raised.

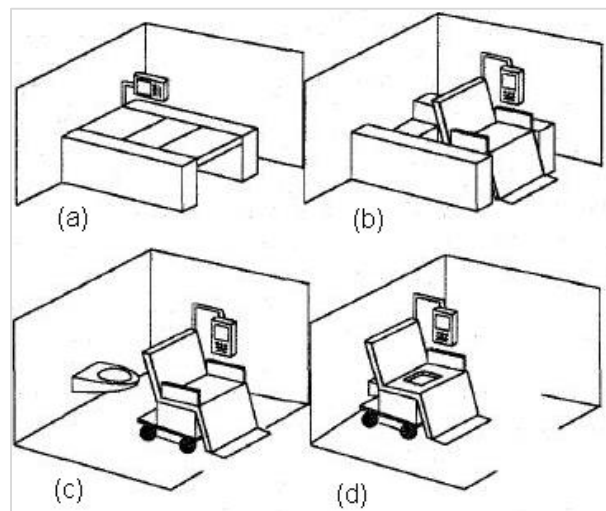


Fig. 6: Wheel Chair cum bed

Tokunaga Kenki et. al [8] in US Patent No 5077845 [Fig.7] used a fixed toilet (1) in bed. The opening (2) above the toilet is covered by balloons (3). The balloons are inflated by compressed air in a normal position. The balloons are deflated as and when required to open the toilet for use. The bed has the provision of backrest and leg rest for the chair position.

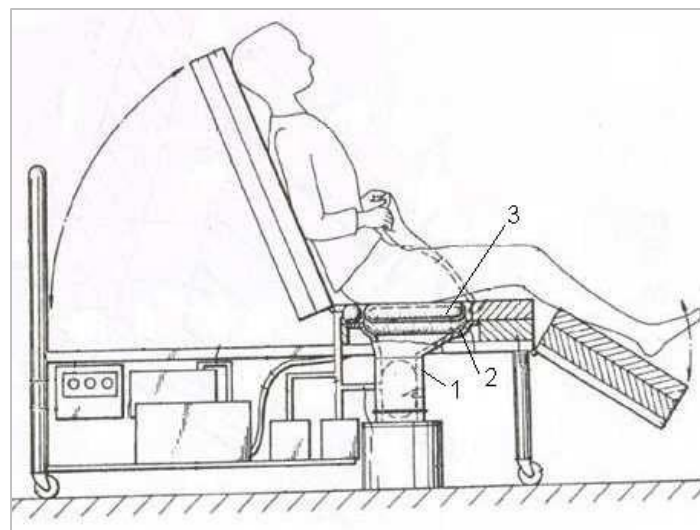


Fig. 7: Bed with built in commode

Kiyoshi Okamoto and Hironobu Nakayama [9] in US PATENT No 5926875 [Fig.8] used commode covered (1) by a rolling shutter (2) which opens horizontally. The commode is covered with a part (3) which is lifted up to buttocks on hinges at its side (4) by the mechanism.

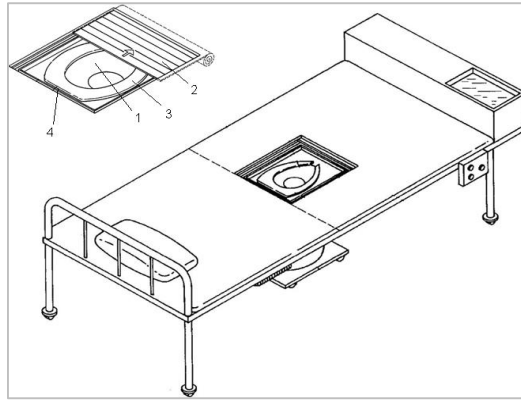


Fig. 8: Nursed person's bed with a flush toilet

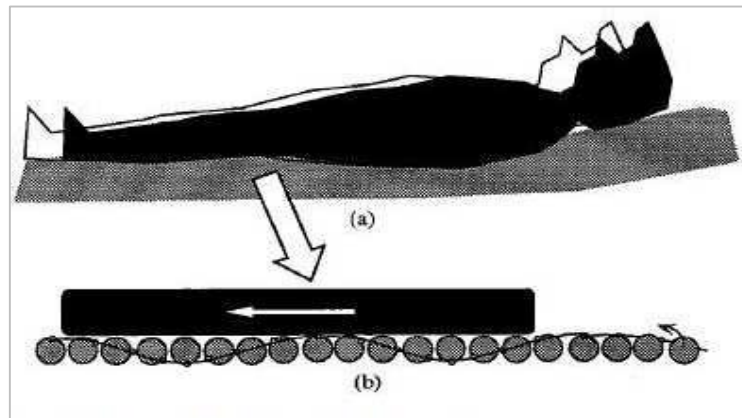


Fig. 9: Surface wave distributed actuation method

Joseph Spano and H. Asada [10] used a surface wave distributed actuation method [figure 9] for transporting bedridden patients. They have discussed design tradeoffs and guidelines for developing a feasible and practical surface wave bed based on the prototyping and experiments.

3. CONCLUSION

In conclusion, it should be noted that the medical sector ergonomist has always tried to find new ways to quantify objectively, and as completely as possible. Hospital equipment needed to design in such a way that both the patient and health care workers feel comfort, safety and convenience. Ergonomics consideration or human factors play an important role in the design of a hospital bed and other furniture. There was a low level of ergonomic awareness and applications to equipment used in the hospitals. The existing hospital bed workstation designs were not found to be user- friendly and they do not conform to ergonomic standards. There was a negative impact on the productivity of the care giver working with the existing design. The patient may suffer back pain, fatigue, poor blood circulation and discomfort in sleep. The hospital bed and equipment must be user-friendly and it will easily be used by the care taker.

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