Anthropometry as ergonomic consideration for hospital bed design in Nigeria

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Abstract: The aim of this research is to study selected health care workstations to establish the current practices with reference to the use of anthropometry. Also to re-design the work station, if necessary, in order to improve productivity, health safety and comfort of the patients and staffs using the work stations. Anthropometric dimensions of the patients in the examined health care system were used to design intensive care unit bed (ICU) and medical/surgical bed which can accommodate 5% - 95% of patients male and female. The work stations were examined and analyzed under the combination of different anthropometric parameters. The analysis of the results indicates some deficiencies in the design of the workstations based on the design parameters and standard values from the literatures. Based on the analysis of these results the patients and their care givers may likely be exposed to back pain, fatigue, poor blood circulation and other related diseases. For demonstration of the application of the extreme design approach, a hospital bed work station (health care system) has been re-designed as a real case. It is hope that the new design will contribute to improvement in productivity, health safety and comfort of the patients and staffs using the workstations. In the proposed extreme design approach, I suggest to every health care organization operating, before any decision on making or buying equipment, industrial engineers are to be consulted depending on the design factor, for proper guidance. Anthropometric dimensions of the workers should also be considered for any category of hospital bed design.

Keywords: Ergonomic, Workstation, Anthropometric Data, Design for Extreme, Health Care and Intensive Care Unit (ICU)

1. Introduction

The health care environment is a high-tech environment with frequent changes in technology. And it is often a three-shift, multi-user environment in which three different people may utilize the same workstation and doing the same job on different shifts [10]. Health care environment can be very stressful environment both physically and mentally, with tight deadlines and patient's well being at risk [10]. It is potentially hazardous, due to possible exposure to contagious diseases and toxic chemicals. It is also highly regulated environment where compliance failures can cost the organization money and put the jobs of staff in jeopardy [10].

Major changes that occurred in health care systems have affected the working conditions of employees as well as raising the potential for injuries [10]. 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 [10]. The health workers that mostly develop injuries are those with jobs that require them to lift or move patients. There are many other tasks in the health care that can cause or contribute to injuries. Exposure to environmental and work-related stressors in health care workplaces can result in a variety of disorders referred to as musculoskeletal disorder (MSDs). The occupational health and safety Administration (OSHA) [13] defines MSDs as ''injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilages and spinal disc''. MSDs generally develop gradually overtime. They affect different areas of the body including upper limbs, head and neck, upper and lower back. The work environment, technology and individual physiology are risk factors that may contribute to MSDs. 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.

According OSHA [13], the average cost per incidence of an MSD is estimated to be $12000, which includes 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.

Recent attention in health care has been on the actual architectural design of a hospital facility, including its technology and equipment, and its effect on patient safety [11]. To address the problems of errors in health care and serious safety issues, fundamental changes of health care processes, culture, and the physical environment are necessary and need to be aligned, so that the caregivers and the resources that support them are set up for enabling safe care. The facility design of the hospital, with its equipment and technology, has not historically considered the impact on the quality and safety of patients, yet billions of dollars are and will be invested annually in health care facilities. This provides a unique opportunity to use current and emerging evidence to improve the physical environment in which nurses and other caregivers work, and thus improve both nurse and patient outcomes.

There is a need for ergonomic consideration in patient bed and other health care system facility design [1]. The word "Ergonomics" comes from two Greek words "ergon," meaning work, and "nomos" meaning laws [4]. It is the interaction among man, machine and environment which focuses on the interactions between the works demand and worker capabilities [2]. Anthropometry is one of the basic parts of ergonomics that refers to the measurement of human body. It is derived from the Greek words “anthropos” means man and “metron” means measure [4]. Anthropometric data are used in ergonomics to specify the physical dimensions of workspaces, equipment, furniture and clothing to “fit the task to the man” [8] and to ensure that the physical mistakes between the dimensions of equipment and products and the corresponding user dimensions are avoided.

Recent studies have concentrated on identifying the primary risk associated with wrong and poor design of health care bed facility [1]. Improper design of health care system beds is responsible for many types of psychological and physical problems like back pain and it hampers to sleep [2]. Other prevailing problems of poor design of health care systems beds include, but not limited to fatigue, blood circulation problem and discomfort in sleep [2], which may lead to a lot of problems and even diseases like osteochndrosis, radiculities, arthritis, insomnia, allergy, asthma etc [2].

Optimizing the anthropometric data for health care system facilities design can be stressful due to number of design parameters involved, this problem has recently been made much easier as a result of the development of some design principles like design for adjustable range, design for average sizes and design for extreme [1]. Using these designs, one can conveniently predict the level of safety in term of comfort of care givers and patients, and thus increasing the performance level of workers in the system.

The research paper aimed at study the ergonomic trends in the design of the selected health care work station with reference to the use of anthropometry. To re-design the work station, if necessary, in order to improve the productivity, health safety and comfort of the users.

2. Literature Review

2.1. Human Error and Cognitive Functioning by Design

Cognitive psychologists have identified the physical environment as having a significant impact on safety and human performance [16] [[17]. Understanding “the interrelationships between humans, the tools they use, and the environment in which they live and work” is basic to any study of the design a health care facility and its effect on the performance of the nurses and other caregivers who interface with the facility and its fixed (e.g., oxygen and suctioning ports on the wall of a patient room) and moveable (e.g., a patient bed) equipment and technology [18]. Humans do not always behave clumsily and humans do not always err, but they are more likely to do so when they work in a badly conceived and designed health care setting [19].

Organizational/system factors that can potentially create the conditions conducive for errors are called latent conditions. According to Reason [16], latent conditions are the inevitable “resident pathogens” that “may lie dormant within the system for a long time, only becoming evident when they combine with other factors to breach the system’s defenses. Latent conditions can be identified and remedied before an adverse event occurs.” Examples of latent conditions are: poorly designed facilities, including the location of technology and equipment; confusing procedures; training gaps; staff shortages or improper staffing patterns; and poor safety culture. A specific example of a latent condition effecting patient safety would be the impact of low lighting levels in the medication dispensing areas that are associated with some medication errors but not others [20]. These and other conditions are what Reason describes as the “blunt end,” where administrators, the work environment, and resources determine the processes of care delivery. Latent conditions are present in all organizations and can be unintentionally created by those who are responsible for designing systems, ensuring adequate staffing, creating and enforcing policies, and so on.

The design of a facility/structure with its fixed and moveable components can have a significant impact on human performance, especially on the health and safety of employees, patients, and families [21]. In a review of more than 600 articles, researchers found that there was a link between the physical environment (i.e., single-bed or multiple-bed patient rooms) and patient (e.g., fewer adverse events and better health care quality) and staff outcomes (e.g., reduced stress and fatigue and increased effectiveness in delivering care) [22]. Efforts to improve patient and staff outcomes can target latent conditions for clinicians by using evidence-based designs to decrease distractions, standardize locations of equipment and supplies, and ensure adequate space for documentation and work areas. The research done by Reason [16] and Leape [17] describes the value of practices based on principles designed to compensate for human cognitive failings. Thus, when applied to the health care field, human factors research (i.e., an area of research that includes human performance, technology design, and human-computer interaction, “A Human Factors Framework,” by Henriksen et al [23], which has emphasized the need for standardization, simplification, and use of protocols and checklists, can be used to improve health care outcomes.

By targeting human factors through facility design and ensuring that latent conditions and cognitive failures that lead to adverse events are minimized, patient safety will improve. This requires a multifaceted approach, including developing a strong safety culture, redesigning systems or facilities with their equipment and technology, focusing on eliminating the conditions of cognitive errors, and helping caregivers correct/stop an error before it leads to harm or mitigate it if it occurs.

2.2. Principles and Practice of Anthropometry

For ergonomic product design with better safety, comfort and health consideration, three-dimensional anthropometry is very important as it gather rich information. Chang et al. [5] have used three-dimensional anthropometric measurements that offer much more surface information than traditional dimension measurement and proposed methods for low cost portable hand-hell laser scanner along with a piece of glass used as a hand support to reduce scanning shadow areas. Engineering design is a strong determinant of workplace ergonomics.

The anthropometric measurement can be used as a basis for the design of workstations and personal protective equipments that can make work environments safer and more users friendly. Currently, there is increasing demand for this kind of information among those who develop measures to prevent occupational injuries and increase the level of satisfaction. Anthropometric measurements among 1805 Filipino workers in 31 manufacturing industries showed data for standing, sitting, hand and foot dimensions, breadth and circumference of various body part and grip strength that was the first ever comprehensive anthropometric measurement of Filipino manufacturing workers in the country which is seen as a significant contribution to the Filipino labor force who are increasingly employed by both domestic and foreign multinationals and was published in 2007 [14]. This study helps Filipino working population for the ergonomic design of workstations, personal protective equipments, tools, furniture and interface systems that aid in providing a safer, effective, more productive and user friendly workplace. Das, Shikdar and Winters [7] demonstrated the beneficial effect of a combined work design and ergonomics approach, specially for the redesign of a workstation for a repetitive drill press operation that increase both the production output and operator satisfaction. The result showed significant improvement in production quantity (22%) and quality (50%) output as a consequence of applying work design and ergonomics principles.

Hedge, James and Pavlovic-Veselinovic [9] have optimized the implementation of healthcare information technology considering risk of work related musculoskeletal disorders in ways that will benefit user performance while minimizing their injury risks. In the patient transportation study, the use of a steering lock reduced the number of adjustments and decreased perceived physical demands during bed maneuvering. Additionally, the adjustable push height reduced shoulder moments during an in-room bed start-up task. The contour feature reduced patient sliding distance with repeated bed raising/lowering, which can potentially reduce the demands placed on healthcare workers to reposition them. Metha et al. [12] have suggested that proactive ergonomic considerations in hospital bed design can reduce physical demands placed on healthcare workers. Widanarko et al. [15] have described the prevalence of musculoskeletal symptoms in New Zealand where a sample of 3003 men and women aged 20-64 were randomly selected. Musculoskeletal symptoms experienced during 12 months in 10 body regions were assessed in telephone interviews using a modified version of the Nordic Musculoskeletal Questionnaires. The highest prevalence was for low back (54%), neck (43%), and shoulder (42%). Females reported a statically significantly higher prevalence of musculoskeletal symptoms in the neck, shoulder, wrist/hands, upper back and hips/thighs/buttocks regions compared to males while males reported more symptoms of elbows, low back and knees. There were no statistically significant differences in prevalence among age groups.

Adeodu and Anyaeche [1] also studied the ergonomic trends in the design of an open plan computer operator workstation, using some cyber cafes in Nigeria. The analysis of the result shows that most users of the workstation may likely suffer from musculoskeletal diseases due to not putting anthropometry into consideration in the initial design of the work station. The anthropometric dimensions of the users are used to re-design the workstation (Chair and Table) for adjustable range that can carter for 5%-95% of the user. The re-design of the workstation reflected on the improvement of the user's productivity, comfort and health safety.

3. Methodology

3.1. Field Experiment

A random sample of thirty patients was selected from the clinic of Afe Babalola University and Ekiti State Teaching Hospital, Ado, Ekiti in Ekiti-State in equal sex proportion. The study was divided into two phases. A survey was conducted using questionnaire and observation method, focusing on the demography and anthropometric dimensions of the patients. These were done to identify the level of ergonomic awareness and implementation of ergonomic programmes in the design of the hospital bed work station. The second phase of the study was the ergonomic re-design of the hospital bed work station using data from the anthropometric dimensions of the patients and the standard parameter from the literature.

3.2. Anthropometric Dimensions for Hospital Bed Design

The survey was conducted at the two locations simultaneously in equal proportion. Seven males and eight females were given forms at Afe Babalola University Clinic, while eight males and seven females at Ekiti State Teaching Hospital. The data were collected under the following body dimensions:

Stature: In sleeping mode, the distance between the centre of the head and the sole of the feet

Elbow Span: This is the distance between the two elbows

Popliteal Height: In sitting position, the distance between the floor to the knee level

Vertical Grip Reach: In sitting or standing position, the distance between the tip of the middle finger to the back of the shoulder blade.

ISSN 2229-5518

4. Results

Table 1. *Demographic Factors of the respondent (patient).*

PARTS	PROFILE	CATEGORY	FREQUENCY	PERCENTAGE
Demographic Factor	Gender	Male	15	50
		Female	15	50
	Age Limit	Below 20	11	37
		20-30	10	33.33
		30-40	5	17
		40-50	2	7
		50 and above	2	7
	Weight	30-45 kg	11	37
		45-75 kg	15	50
		Above 75 kg	4	13
	Height	Below 1.5m	18	60
		1.5-1.7m	12	40
		Above 1.7m	0	0
Ergonomic awareness and implementation	How often does any form of pain and discomfort is experienced using the bed	Always	15	50
		Sometimes	10	33.33
		Rarely	5	16.67
		Not at all	0	0
	Does any pain or discomfort is experienced in any part of the body	Spinal cord	20	23.53
		Thigh	5	5.88
		Upper abdomen	30	35.29
		Lower abdomen	10	11.76
		Shoulder	10	11.76
		Neck region	10	11.76
	Can you evaluate the existing design of the health care system?	Strongly confirmed	0	0
		Moderately confirmed	5	16.67
		Slightly confirmed	5	16.67
		Not confirmed	20	66.67
	How can you rate the productivity of the care giver interacting with the workstation	Excellent	0	0
		Good	8	26.67
		Average	12	40
		Poor	10	33.33

Table 2. *Mean Values and Standard deviations of the Patients Anthropometric Dimensions.*

Anthropometric Dimension	Stature (inch)	Elbow Span (inch)	Popliteal Height (inch)	Vertical Grip Reach (inch)
Mean Value	66.59	35.16	17.41	80.35
STD	4.24	1.53	0.64	5.66

4.1. Result Analysis

The exercise was 100% response with equal gender respondents. The age limit of most of the respondents fell in between below 20 years with a percentage of 37%, followed by the age limit between 20-30 years with a percentage of 33.33%. Age 30-40 years was 17%, 40-50 years above shared the same percentage of 7%. Majority of the respondents were 50% and 60% in weight and height respectively.

From the analysis of ergonomic awareness and implementation, half of the respondents consented to be experiencing discomfort and pain always, while 33.33 agreed to sometimes. Virtually all the respondents experience pain and discomfort in certain parts of their body, especially from the upper abdomen and spinal cord when using the bed. Two-third of the respondents rated the existing design as not conformed to ergonomic standard. 16.67% agreed to moderately and slightly conform. None of the respondent agreed to strongly conform to ergonomic standard. The productivity rating of the existing design by both the care givers and the patients was on the average with 40%, followed by poor with 33.33%. 26.67% of the respondents agreed that the productivity was good.

4.2. Analysis of the Anthropometric Dimensions for the Patient's Bed

Table 3. *Comparison of Existing Design with Ergonomic Design Standard for ICU Bed.*

Bed Specifications	Specification Dimension for Existing Design	Stryker EPIC II Standard	Hill-Rom Total Care Bed Standard
Bed Length	82''	89''- 91''	92'' (without bumper) 93.5'' (with bumper)
Bed Width	36.5''	40''-42.5''	36'' (side rail down) 40''(side rail up)
Bed Height	34'' (Fixed)	18'' – 32.5''	17.5''-36.5''
Back rest rotation	0^0 - 90^0	0^0 - 90^0	0^0 - 75^0

Knee Gatch/Elevation	0^0 - 30^0	0^0 - 30^0	0^0 - 20^0
Trend/Lower leg elevation rotation	14^0/-14^0	12^0/-12^0	15^0/-15^0
Weight	Undefined	500lb (maximum)	400 – 500lb
Electronic	N/A	115 Volt, 7Amp rating, 60Hz frequency and current leakage (100µA	115 Volt, 7Amp rating, 60Hz frequency and current leakage (50Ma
Chair Positioning	N/A	N/A	Seat – 0^0 – 10^0 Foot – 30^0 – 70^0 Head – 50^0 - 65^0
Wheel Track	N/A	N/A	20'' head 23.5'' foot
Under Bed Clearance	N/A	N/A	0.75''
Advance ergonomic special features	N/A	Zoom technology with motor driven Built in electronic scale for weighing Radiolucent bed for X-Ray Manual release control features	Point of care control mechanism Shearless pivot patient position mechanism Retractable foot mechanism and overriding feature for CPR during emergency.

Table 4. *Comparison of Existing Design with Ergonomic Design Standard for Med/Surgical Bed.*

Bed Specifications	**Specification Dimension for Existing Design**	**Stryker GO BED II Standard**	**Stryker Secure II Bed Standard**
Bed Length	79.5''	94.25''	93''
Bed Width	36'' (maximum) 20'' (minimum)	39'' (side rail down) 40'' (side rail up)	40'' (side rail down) 42.5''(side rail up)
Bed Height	34'' (Fixed)	14.5'' – 29''	16''-30''
Back rest rotation	0^0 - 90^0	0^0 - 60^0	0^0 - 60^0
Knee Gatch/Elevation	0^0 - 30^0	0^0 - 28^0	0^0 - 40^0
Trend/Lower leg elevation rotation	14^0/14^0	14^0/14^0	12^0/12^0
Weight	Undefined	500lb (maximum)	500lb (maximum)
Electronic	N/A	120 Volt, 4Amp rating, 50 - 60Hz frequency and current leakage (100µA)	115 Volt, 7Amp rating, 60Hz frequency and current leakage (60 µA)
Caster Diameter	N/A	6''	6'' Standard 8'' Optimal
Side Twist	0^0 - 90^0	0^0 - 90^0	0^0 - 90^0

From tables 3 and 4 which compare the existing bed designs with ergonomic standards for both intensive care unit bed and medical/surgical bed. For instant, bed length is 82'' and 79.5'' respectively for the existing design which is totally deviated from the ergonomic standards of 89''-91'' (Stryker Epic II); 92'' without bumper and 93.5'' with bumper (Hillrom total care) for ICU. Also 94.25'' (Stryker GobedII) and 93'' (Stryker secure II bed) for medical/surgical bed. The bed length was design using the stature anthropometric dimension, in which the poor design will lead to back pain and fatigue for the patient [1]. Bed width was design using elbow span. From both tables, the existing design is smaller compare to ergonomic standards for both work stations. This poor design will cause poor blood flow circulation in the body system of patients. Bed height was designed with popliteal height anthropometric dimension. For good ergonomic design, popliteal height for any hospital bed height design should not be too high. The lower bed height permits the patients to enter and exit the bed very easily and without damaging any medical procedure that they have undergone. Otherwise, the legs will be suspended in air when sitting thus putting tension on the legs and definitely cause poor blood circulation and fatigue to the patient using the work station. Back rest rotation, knee elevation and trend were also design using the combination of other measured anthropometric dimensions, vertical and horizontal reach grips. The poor design of these bed specifications will cause body pain, fatigue and sometimes lead to sleep discomfort in the patient using the workstation. The above discussed specifications for both ICU and medical/surgical beds share the common bond of serving purpose to be patient-friendly and user-friendly [3]. Other listed specifications are design for the comfort and safe working area of both the care-givers and care-takers. The advance features in Stryker Epic II for ICU bed include zoom technology. This is lacking in the existing design ICU bed. The zoom technology is a bed frame that is motor driven to alleviate stress caused to a nurse back by the constant pushing and pulling of the bed during patient transport. The Epic II also features a built-in electronic scale for accurate weighing of a patient no matter what posture the patient may be in. The bed is also radiolucent to allow for X-ray to be taken while the patient is still in bed.

Source: [3]

Figure 1. *Stryker Medicals Epic II ICU Bed*

Also, the advance features in Total care ICU bed standard which are lacking in the existing design render it ergonomic unsafe and musculoskeletal diseases inflicting. The total care ICU bed standard is design with feature, a frame and mattress setting which reduces the back-related injuries and pressure sores associated with patient repositioning, transfer and long term stays. It has easy to use point-of-care controls so that the patient can adjust himself into any desirable position all the way to an upright chair position. To further support the patient in a correct sitting posture, the bed advantageously uses the Shearless pivot patient position mechanism which combines the frame, surface and patient to minimize the patient's migration towards the foot end of the bed. Additionally, there is a retractable foot mechanism which can be placed snug against a patient's feet to reduce the need for additional foot support devices. The Total care ICU bed provides not only stability and easy to use controls for the patient but is also built to satisfy the needs of patient caregivers. The bed reduces the amount of stress on the caregivers' backs when transferring patients from the bed. The bed provides other capabilities such as an overriding feature for CPR which, by the press of a button, overrides all manual and automatic controls to immediately put the bed into a position convenient for resuscitation in case of emergency. Other support for the caregiver includes a line-of-sight angle indicator to provide the caregiver with the proper head and Trendelenburg angle articulation, side rail controls located just out of the patients reach on the outside of the rails which can be activated only by the system's Enable Command which ensures patient safety from the mechanism and a Graphical Caregiver Interface that records the weight of the patient includes patient lighting and preset bed positioning.

Source: [3]

Figure 2. *Hill-Rom TotalCare ICU Bed*

In the case of medical/surgical bed, GoBed II standard possesses many features that were designed with the medical staff's interest in mind which are lacking in the existing medical/surgical bed design. These beds incorporate eight separate poles to be used for IV medicine and fluid bags or for a traction setup to help support proper bone healing. There are also four hooks below the bed to drain and store medical and bodily waste. There are two separate bed controls for the nurse, one on the side rail and one at the foot of the bed. The GoBed II also features one handed side rail releases to allow a nurse to drop the side rail at the same time they are helping the patient. The bed also incorporates a drop down fifth wheel to aide in mobility when the bed must be moved.

Source: [3]

Figure 3. *Stryker Medical GoBed II Med/Surg Bed*

The comparative analysis of the anthropometric dimensions of the patients, existing design of the hospital bed work stations and standards from the literature shows that existing hospital bed work stations are poorly designed. The principle of anthropometry was not considered during the make or buy decision. To design the hospital beds to attain standard ergonomic level of implementation as described in the literatures, the principle of anthropometry must be considered [1].

The re- designed hospital bed work station is presented in the table below.

Table 5. *Table Hospital Bed Work station Re – design.*

Bed Specification	Stryker Standard ICU BED	Stryker Standard MED/SURG BED	Mean Anthropometric Dimensions	Re – Designed ICU Hospital Bed	Re – Designed Med/Surg Bed

ISSN 2229-5518

Bed Length	91'' – 92''	92.5'' – 93''	Stature: 66.59''	91'' (without bumper) 93.3'' (with bumper)	92.5'' – 93''
Bed Width	40'' (side rail down) 42'' (side rail up)	39'' – 40'' (side rail down) 40'' – 42'' (side rail up)	Elbow Span 35.16''	40'' (side rail down) 42'' (side rail up)	39'' – 40'' (side rail down) 40'' – 42'' (side rail up)
Bed Height	18'' (low) 32.5'' (high)	14.5'' – 16'' (low) 29'' – 30'' (high)	Popliteall Height 17''	Adjustable: 18'' (low) 32.5'' (high)	14.5'' – 16'' (low) 29'' – 30''
Litter Positioning	Back rest: 0^0 – 90^0 Knee Gatch: 0^0 – 30^0 Trend: $12^0/12^0$	Back rest: 0^0 – 60^0 (max) Knee Gatch 0^0 – 20^0 (min) 0^0 – 40^0 (max) Trend $12^0/12^0$ (min) $14^0/14^0$ (max)	FIXED	Recommended littering position: Back rest: 0^0 – 90^0 Knee Gatch: 0^0 – 30^0 Trend: $12^0/12^0$	Recommended littering position: Back rest: 0^0 – 60^0 (max) Knee Gatch 0^0 – 20^0 (min) 0^0 – 40^0 (max) Trend $12^0/12^0$ (min) $14^0/14^0$ (max)
Caster Diameter	6''	6'' (min) 8'' (max)	UNDEFINED	Recommended caster diameter: 6''	Recommended caster diameter: 8''
Weight	500lb	500 lb (max) 400lb (min)	178lb	500lb (max)	500lb (max)
Electronics	115 Volt, 7Amp rating, 60Hz frequency and current leakage (60 µA)	115- 120 Volt, 4-7Amp rating, 60Hz frequency and current leakage (50-60 µA)	N/A	Recommended Electronics for special features: 115 Volt, 7Amp rating, 60Hz frequency and current leakage (60 µA)	Recommended Electronics for special features: 115- 120 Volt, 4-7Amp rating, 60Hz frequency and current leak(50-60 µA)

5. Conclusions

1) There was low level of ergonomic awareness and implementation in the observed health care system.
2) The patients using the existing beds design suffer back pain, fatigue, poor blood circulation and discomfort in sleep.
3) There was negative impact on the productivity of the care givers working with the existing designs.
4) The designed hospital bed work stations were not user- friendly and patient-friendly.

6. Recommendations

1) Before any decision on making or buying equipment, industrial engineers are to be consulted depending on the design factor, for proper guidance.
2) Anthropometric dimensions of the workers should be consider for any work station that requires conditioning of posture.

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