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Working Environment at Accident and Emergency Department: An Engineering Approach Solution

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Abstract. Accident and Emergency Department serves as the front line in any hospitals. Here, patients are triage according to the severity of illness before being send to respective zone, green, yellow or red. This study focuses on red zone of accident and emergency department with an objective to assesses the physical condition at accident and emergency department and suggest engineering recommendation to solve the problems found during the assessment. The study is conducted at one of Malaysian hospital, after the ethical has been obtained. During the assessment, lighting at the red zone, monitor height, bed area and body postures of two procedures are assessed and recorded. Results is compared with existing guidelines and suggestions are made on how to overcome the problem identified.

1. Introduction

Accident and emergency department is one of the main departments of any hospitals, regardless secondary or tertiary hospitals. The department receives patients twenty-four hours per day. This department consists of green zone, yellow zone and red zone. Green zone is for non-critical patients, while yellow zone is for moderately ill patients. The study is conducted at the red zone, where critically ill and life-threatening patients are treated. Researchers that showed interest on accident and emergency department showed focus on needle stick injury violence [1-2] and overcrowding [3]. The interest related to WRMSD have been showed by [4, 5, 6]. The same interest about musculoskeletal disorder at emergency department has been shown by Hignett et al. [7]. The objective of the study is to evaluate the current condition at accident and emergency department and to suggest engineering approaches in order to minimize the risk of hazards.

2. Methodology

The study is done at one of the hospitals in Malaysia. Ethical approval is obtained from the ethical committee before the study can be done. The objective of the study is to assesses the physical condition at accident and emergency department and suggest engineering recommendation to solve the



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problems found during the assessment. During the assessment, the luminance, bed area and monitor height are measured and recorded. One procedure is selected for assessment, which is cardiopulmonary resuscitation (CPR). This procedure is selected because CPR is one of common procedure done at accident and emergency department. The assessment of procedure will allow understanding on how the body postures of health care workers in the existing working environment. Flux meter is used to measure the luminance, while conventional measuring tape is used to measure the bed area and height of the monitor. As for body postures, rapid entire body assessment (REBA) is selected due the nature of health care industry, which categorized as sensitive [8] that need to maintain the confidentiality of patients. Recording is not allowed during the assessment process.

For lux measurement, lux meter was placed on the patient's bed in the red zone. This is due to, in the red zone, all procedures are conducted on the bed. As for this hospital, no curtain is available, thus data collected for curtain around the bed is not available. Each patient's bed is separated using partition. Bed area is space around the bed, which as usually placed with numbers of equipment, some are under used [9] and increased of equipment due to new technology in health care [10]. As for monitor, the height of monitor is measured and compared to Malaysia anthropometric data.

3. Result and discussion

After assessment has been made, results are tabled below. Table 1 shows the luminance on each of bed at the red zone. The highest luminance is 190.3 lux and the lowest is 142.3 lux. The lighting at red zone must be changed immediately. Working in stress and critical condition with luminance less than 300 lux is not acceptable. Preferably, the whole red zone lighting must be increased to at least a minimum of 300 lux as suggested by the Guidelines on Occupational Safety and Health for Lighting at Workplace 2018.

Table 1. Result for luminance at red zone of hospital A.

Hospital A	Luminance – without curtain (lux)
B1	142.3
B3	191.6
B3	190.3

Table 2 shows the monitor height at red zone. Placing a monitor at higher position will cause the workers to tilt and placing lower than that, causes them to bend their necks. This will induce discomfort during working because health care workers need to read from patient's monitor from time to time. According to Malaysia anthropometric data, average stature of men for Malaysian population is 1636.50 mm (1.636 m), with average standing eye height 1521.04 mm (1.521 m) and average stature of women for Malaysia population is 1636.09 mm (1.636 m), with average standing eye height 1520.66 mm (1.520 m) [11]. Therefore, this hospital has positioned the monitor at the suitable height.

Table 2. Result for monitor height at red zone of hospital A.

Red Zone	Height of monitor (m)
Hospital A	1.51

Table 3 shows the working space health care workers have around the patient's bed. The length measurement does not achieve the suggested measurement which is 4.724 m [12]. This result shows, the current bed space at red zone of emergency department is rather small and is not adequate for the

healthcare workers to perform task, especially resuscitation procedure, which has been confirmed by Hignett and Keen [12]. The existing space is too small and crowded with equipment. Bed space must be increased. A small working area, crowded with equipment and team members, indirectly will force the workers to work in awkward position, resulting in discomfort.

Table 3. Result for bed area at red zone of hospital A.

Hospital	Bed space width (m)	Bed space length (m)	Bed space areas (m ²)
Hospital A	1.7	2.45	4.2

Cardiopulmonary resuscitation (CPR) is an emergency procedure performed when heart has stopped beating or breathing has stopped. The aim of this procedure is to keep pumping the heart to continuously supply oxygen to the brain. Inadequate supply of oxygen to brain will result in devastated effects such as brain damage. REBA scores confirmed the worst body posture belongs to the one who conducted the CPR. Every cycle of CPR requires 100 to 120 chest compression. It means continuous and repetitive motion of chest compression without stop for 60 seconds. Observably, at least a minimum of 30 minutes are required for patient that need CPR. Sometimes, this life saving procedure can take up to 1 hour or more, depending on the situation. The worst REBA scores belong to the health care workers that performed the CPR, as shown in table 4.

Table 4. REBA score for CPR.

Task	Body postures	REBA score
CPR	<ol style="list-style-type: none"> 1. Neck is bend 2. Truck is bend 3. Legs are straight 4. Shoulder is raised 5. Upper and lower arm is not in normal condition 6. Wrist is not in normal line 7. Repetitive motion (rapid: 100 to 120 movements per minutes) 	High

Patients lifting and patient transferring actively occur at red zone of accidents and emergency department. Patients are lifted and transferred from stretcher to bed and from wheelchair to bed. Although lifting and transferring patients seems like a less complicated task, observations prove differently. Patients who arrived at red zone of accident and emergency department are mostly unconscious or partially conscious. When lifting them, the health care workers used a lot of energy and awkward body postures are clearly seen. The worst case is when patient needs to be transferred from wheelchair to bed. This is even harder and risky when patients are obese or overweight. Table 5 proves the REBA score of health care body postures while doing these activities are high.

Table 5. REBA score for patient lifting and transferring.

Task	Body postures	REBA score
1.Patient lifting	<ol style="list-style-type: none"> 1. Neck is bent 2. Neck is side bent 3. Trunk is bent 4. Legs are opened 5. Load is heavy 6. Shoulder is raised 	High
2.Patient transferring	<ol style="list-style-type: none"> 1. Trunk is bent 2. Legs are opened. 3. Load is heavy 4. Load is pushed more than one minute 	High

As for suggestions to improve the current condition of red zone at accident and emergency department of Hospital A, Table 6 shows the recommendation that can be considered.

Table 6. Recommendation for Hospital A.

Measurement	Hospital A	Recommendation
Load	Manually done	Use mechanical lifting devices or at least a slide board.
Posture	Poor Posture	Use of mechanical devices for CPR such as LUCAS and Auto Pulse.
Lux	191.6	300 lux (minimum requirement for treatment)
Bed space (m ²)	4.2	17
Monitor height (m)	1.51	1.521 m

4. Conclusion

In order to improve the working condition at red zone of accident and emergency department of Hospital A, it requires the approach from the whole health care system involved. The health care workers need to know they are working not in optimum condition and the top management need to address the complaint and suggestion from the health care workers.

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