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Approaches and Solutions to Hospital Emergency Department Overcrowding Including Failure Mode and Effect Analysis as a Risk Assessment Technique of Real-time Locating System

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ABSTRACT

Emergency Departments (ED) are highly dynamic environments comprising complex multi-dimensional patient-care processes. In recent decades, there has been increased pressure to improve ED services, while taking into account various aspects such as clinical quality, operational efficiency, and cost performance. Overcrowding has become a major barrier to receiving a proper and timely emergency care in many acute hospitals throughout the world. Patients often face long waiting times to be seen and treated. Those who require admission may even wait longer. The scope of this research is to focus on ED factors that lead to overcrowding and their management. Technology is being cited as one of the management tools, specifically the utilization of Radio Frequency Identification (RFID) for tracking patients as their journey progresses through anED.

Like any technology, RFID has potential and pitfalls. The author chose to use Failure Mode and Effect Analysis (FMEA) as a tool to explore the possible failures of RFID technology as it is utilized in one of the ED in Riyadh Military Hospital (RMH). This particular ED has been used as a case study to explore those failures and, with the use of FMEA, propose a set of recommendations to address those failures and improve the design and implementation of RFID. The experience of RMH-ED was explored through interviews and a survey in which 100 participants took part. The survey touched upon various aspects of this experience. This was due to the various roles of the surveyed staff who were involved with this technology. These roles ranged from front line clinical staff to administrative staff, management staff and technical support staff. Data analysis showed convincing evidence of the positive impact RFID had on managing ED overcrowding. However, and as expected, there are some pitfalls and failures that FMEA helped identifying and suggested potential solutions to them. RFID is a small link in the chain of other technological innovations and solutions. It is by no means capable of solving the problems associated with ED overcrowding by itself. Most of the search carried out by the author identified large variation in approaches to dealing with the issue of ED overcrowding. Those ranged from applying more human resources to altering the pathways of managing patients journey through healthcare system to applying more intermediate layers of management to ease the pressure of the Emergency departments. Other approaches included some aspects of technology such as development of early warning systems that have not been widely adopted and remained as isolated efforts.

1. Introduction

Emergency Departments (ED) are highly dynamic environments comprising complex multi-dimensional patient-care processes. They provide acute care to patients who present without prior appointment, either by their own means or by ambulance. (Lancet vol. 2, part 2)

An ED is, typically, located on the ground floor of a hospital. EDs manage a variety of conditions and illnesses by prioritization of cases based on clinical need through triage. The list includes, but not limited to heart attacks, trauma, mental illnesses, and acute exacerbations of respiratory illnesses like asthma. Less severe illnesses and conditions managed in Minor Illnesses and Injury Unit(Aacharya, Gastmans, Denier 2011).Overcrowding is a common occurrence in emergency departments which compromises patient care and, is considered to be one of the most challenging problems. Patients often face long waiting times to be seen and treated. Those who require admission may even waitlonger.

Extensive research has been undertaken to identify causes of overcrowding, and attempts were made to develop solutions that could deal with and eliminate such causes. Main causes of overcrowding are-non-urgentvisits, frequently attendingpatients, seasonal illnesses likeinfluenza, inadequatestaffing, long staying patients due to socialreasons and hospital bedshortages (Cowan et al 2004).ED overcrowding results in negative impact such aspatientmortality, transportdelays, treatmentdelays, ambulancediversion, patientswalk-out and financialimpact (McCabe2001).

It is therefore necessary to view ED overcrowding as a reflection of the larger problem of supply and demand chain

mismatches in most healthcare systems, rather than an isolated ED problem. The entire delivery system must be assessed by using reliable methods to understand, measure, and monitor system capacity. When this has been achieved, it likely toreduce the degree of supply-demand mismatch, not just in ED but also in the system as a whole. In response to the problem of overcrowding in ED, a number of solutions have been proposed and implemented with varying degrees of success. Such solutions include (Wilson et al.2004):

Patient flow coordination and facilitation:This could be achieved by establishing the role of a "bed czar" or patient flow manager. This person would be responsible for ensuring timely transfer of ED patients to assigned inpatient beds. Assigning a dedicated nurse with admissions/discharge/transfer duties who is specifically responsible for facilitating discharges to accelerate available beds for admissions. Furthermore, development of accelerated triage and registration processes based on patient's acuity could reduce waitingtimes.

Early discharge:This can be achieved through a number of schemes such as,initiation of preliminary discharge by designating patients for early discharge the next day, establishing a discharge room/lounge for inpatients who have been discharged and are awaiting transportation, medications or education,establish a discharge coordinator position to coordinate procuring information that is required to discharge the patient and implement monetary incentives (bonuses) and nonmonetary incentives (movie tickets or cafeteria vouchers) for physicians and nurses to promote efficient and early discharge of patients who are ready to gohome.

Diversion management and reduction: Develop a hospital-wide diversion response protocol to focus existing resources on facilitating all appropriate patient discharges in a timelier manner. Creation of a community-wide diversion plan in collaboration with local hospitals and the community's emergency medical services unit to establish a common protocol for hospitals going on and off diversion or bypass.

The main objective of this research is:

"To investigate the use of technology in health care, especially RFID supplemented by FMEA, as a tool for tracking and management in Emergency department overcrowding".

Methodology: An online service (Survey Monkey)was used to gather data from the participants.Respondents were presented with a total of 29 statements which, have been divided in to areas such as:Causes of EDOvercrowding, effects of EDOvercrowding, management of EDOvercrowding, applied and implemented solutions to EDovercrowding, RFID as a solution to easingovercrowding.Participants were asked to give their points of views through pre-defined options for each of these statements. Table 1 shows areas discussed above and the breakdown on the statements as put to the participants.

Table (1): Survey Statements

Causes of ED Overcrowding
I believe overcrowding is caused by inappropriate visits made by patients who do not require emergencycare I believe ED overcrowding is caused by lack of appropriate number and skills level of staffing inthe department I believe ED overcrowding is caused by Access Block (ED patients needing admission, cannot be admitted due to lack beds in the department ofdestination) I believe ED overcrowding is caused by poorly designed facilities and lack of space in thedepartment I believe ED overcrowding is caused by overcomplicated management policies and carepathways I believe ED overcrowding is caused by out-dated clinical patient trackingsystems
Effects of ED Overcrowding on Patients
I believe ED overcrowding causes extended pain andsuffering I believe ED overcrowding is a risk for pooroutcomes I believe ED Overcrowding causes ACTUAL pooroutcome I believe ED overcrowding causes dangerous delayed diagnosis andtreatment I believe ED Overcrowding causes significant patientdissatisfaction
Management of ED Overcrowding
I believe ED overcrowding can be reduced when the issue is viewed with the context ofoverall pressure on the entire healthcaresystem I believe ED overcrowding can be reduced by increasing the number and expertise of EDstaff I believe ED overcrowding can be reduced by better design of the way patients flow throughthe department (forms and paperwork) I believe ED overcrowding can be reduced by educating the public about the proper use of ED resources I believe ED overcrowding can be reduced by applying/implementing technologicalsolutions
Applied and implemented solutions to ED overcrowding
I believe ED overcrowding can be reduced by having a dedicated bed-management team to tackle the issue of AccessBlock. Consultant or Senior ED nurse lead triage could help making an impact on EDovercrowding Diverting some of the emergency calls to advice help lines enabling Paramedics to assessand discharge at the scene could help reduce EDvisits An early warning system that could alert to the development of overcrowding could help management prepare and apply resources to preventovercrowding I believe ED overcrowding can be solved by implementing technological innovations such asRadio Frequency Identification of patients andassets
RFID Tagging as a potential solution in easing ED Overcrowding
I found the RFID system too complicated touse The RFID system does not always function the way it is supposedto The RFID system made our department less crowded than before we started using it 25.The RFID system should not be relied upon as the

only solution to ED Overcrowding 26.The training I received on using the system wasadequate
27.The technical support I received/continue to receive was adequate 28.The ED patients did not like wearing the RFID tags
29.The RFID should be extended throughout the whole hospital system

Author identified a number of personnel at the ED department at the Riyadh military hospital and pursued their consent to conduct semi- structured interviews with them. The total number of interviewees is 10; they include the head of the ED department. The nature and scope of the questions dealt with during the interviews are similar to those shown to participants when they respond to the online survey.

Studysubjects:A sample of 100 subjects (ED clinicians, nurses, para medical staff and technical staff) from the Military hospital had constituted as study subjects of this survey.All these subjects have participated in the online survey.

Pilotstudy:A pilot study was carried out using 20% of the sample, so as to observe the correctness of the responses and test and retest correlation was calculated to assess the initial validity of an instrument.

Statisticalanalysis:Descriptive statistics (mean, standard deviation and proportion) are used to summarize each item of an instrument. Pearson chi-square test was used to compare the difference in the distribution between observed responses and expected responses for 29 items of 5 factors. Scale reliability was assessed using Cronbach's alpha statistic. Construct validity of the instrument was assessed through convergent and discriminate validity by using correlation matrix. A p-value of < 0.05 considered as statistically significant. Bar diagrams was used to show the distribution of 5-point scale responses of each of the items of the 5 factors.All statistical analysis will be carried out using SPSS Pc+ version 19.0 statisticalsoftware.

Results: Author achieved the validity and reliability by using Factor analysis and Cronbach's alpha for the whole scale and each dimension of the instrument.The correlation among the 29 items of an Instrument showed highly statistical significant correlation.

2. Data Analysis ofResponses

The data of 90 (out of 100) study subjects who were responded using an on online accessible survey and unstructured interviews was analyzed. The online data gathering and survey system assigns a unique identification number to each participant and personal computer so that it insures one response by one user. Also, the author has been able to assign a number of automatic rules that control data gathering, collating similar data and obtain basic statistical data in rawformat.

The survey covered 29 items; these were grouped under five main headings including:

- Causes of EDovercrowding
- Effects of overcrowding on EDpatients
- Management of EDovercrowding
- Applied and implemented solutions to EDovercrowding
- RFID as a potential solution for EDovercrowding
- The responses were on a 5-point scale.

Causes of EDOvercrowding:Analysis of the six items covered under this heading shows that, the first reason of ED crowding had the distribution of responses, where 33.3% of study subjects had responded as "possibly", 30% as "one of the reasons" 17.8% as definitely and 18.9% as not sure. The distribution of these responses was not statistically significantly different (X^2 = 6.62, p = 0.085). The second reason of ED overcrowding responses of study subjects were, 10% as "not correct", 26.7% as "not sure", 53.3% as "possibly" and 10% as "one of the reasons", and there is highly statistically significant difference in the distribution of these responses(X^2= 45.2, p <0.0001). The third reason of factor ED crowding responses were distributed as 14.4% "not sure", 45.6% "possibly", 33.3% "one of reasons" and 6.7% definitely. There is statistically significant difference in the distribution of responses(X^2 = 38.822, p <0.0001). Similarly, the distribution of responses for the fourth reason, the fifth reason and the sixth reason were statistically significant different (X^2 = 33.11, p <0.0001; X^2 = 17.22, p =0.002; and X^2 = 24.33, p <0.0001). For reason four, 41.1% of study subjects had responded as "one of the reasons", for reason five, 31.1% had responded as "possibly", whereas for reason six, 33.3% had responded as "possibly". From the above analysis, it can be inferred that the reasons for ED overcrowding were due to deficiencies in infrastructure, lack of manpower, inappropriate management of skills and partly due to inappropriate visits by patients who do not require emergency care.

Effects of ED overcrowding onpatients:It shows the distribution of the responses of 90 study subjects. The distribution of responses measured on a 5-point scale for all the 5 items are highly statistically significantly different (X^2 = 34.0, p <0.0001; X^2 = 49.911, p =0.002;X^2 = 54.267, p <0.0001;X^2 = 33.644, p <0.0001 and X^2 = 43.244, p <0.0001).

For the first reason, 45.6% had responded as "one of the reasons", for the second reason, 55.6% had responded as "possibly", for the third reason, 57.8% had responded as "possibly", for the fourth reason, 48.9% as "possibly", whereas for the fifth reason, 52.2% as "one of the reasons".

Management of EDovercrowding:The distribution of responses measured on a 5-point scale for all the 5 items are highly statistically significantly different (X^2 = 31.778, p <0.0001;X^2 = 40.111, p <0.001;X^2 = 29.733, p <0.0001;X^2 = 40.578, p <0.0001 and X^2 = 11.667, p <0.0001).For the firstitem, 34.4% had responded as "possibly", for the second item, 35.6% had responded as "possibly", for third item, 38.9% had responded as "possibly", for fourth item, 44.4% as "possibly", whereas for fifth item, 50% as "one of thereasons".

For this, factor of "Management of ED overcrowding" the study subjects had responded in higher proportion as "possibly" to the 4 ways (items) and as "one of reason" to the fifthmethod of managing overcrowding of ED. Here, the study subjects were not "definite" in their views, because all the 5 items, under this factor were related to administrative feasibility of managing EDovercrowding.

Applied and implemented solutions to EDovercrowding:The distribution of the responses of the 90 study subjects to the 5 items under this heading was measured on a 5-point scale for all the 5 items and were found to be highly statistically significantly different (X^2 = 67.778, p <0.0001;X^2 = 53, p <0.001;X^2 = 21.378, p <0.0001;X^2 = 41.333, p <0.0001 and X^2 = 54.467, p<0.0001).For the first item , 47.8% had responded as "possibly", for the second item , 40% had responded as "possibly", for the third item, 37.8% had responded as "possibly", for the fourth item, 40% as "possibly",whereas for the fifth item, 70% as "one of the reasons".

For this, factor of "Applied and implemented solutions to ED overcrowding" the study subjects had responded in higher proportion as "possibly" to the four solutions (items) and as "one of the reason" to the fifth solution (item) of Applied and implemented solutions to EDovercrowding.

Here, the study subjects were not "definite" in their views, because all the 5 items, under this factor were related to hospital management system, which includes adequate infrastructure, administrative feasibility, and availability of appropriate manpower with efficient management skills.

RFID Tagging as a potential solution in easing ED Overcrowding: The distribution of responses measured on a 5-point scale for all the 8 items are highly statistically significantly different (X^2 = 70.444, p <0.0001; X^2 = 22.622, p <0.001; X^2 = 44.933, p <0.0001; X^2 = 61.222, p <0.0001; X^2 = 43.444, p <0.0001; X^2 = 66.778, p<0.0001; X^2 = 59.667, p <0.0001; and X^2 = 109.9, p <0.0001).For the first item, 52.5% had responded as "Not sure", for the second item (The RFID system does not always function the way it is supposed to), 40% had responded as "Not sure", for the third item (The RFID system made our department less crowded than before we started using it), 51.1% had responded as "one of the reasons", for the fourth item (The RFID system should not be relied upon as the only solution to ED overcrowding), 45.6% as "possibly", for the fifth item (The training I received on using the system was adequate), 38.9% as "one of the reasons" for the sixth item (The technical support I received/continue to receivewas adequate), 45.6% as "possibly" for the seventh item (The ED patient did not like wearing/using the RFID tags), 40% as "one of the reason" and for the eighth item (The RFID should be extended throughout the whole hospital system), 72.2 % as " Notsure".

For this, factor of "Radio frequency identification (RFID) tagging" the study subjects had responded in higher proportion as "Not sure" to the 4 items, as "one of the reason" to 2 items and as "possibly" to the remaining 2 items. Here, the study subjects were not "definite" in their views, because all the 8 items, under this factor were related to the knowledge application, and utility of RFID in managing EDovercrowding.

The confirmatory factor analysis shows the construct validity of an instrument used in this study is having good validity. Regarding the reliability, the internal consistency of each of the items of 5 factors, shows significant level of cronbach's α for all the 5 factors (Reason for ED overcoming, Effect of ED overcoming on patients**,** Managing ED overcoming, Applied and implemented solutions to ED overcoming, and Radio Frequency identification (RFID) tagging) indicates that the study subjects have responded appropriately to all the items of aninstrument.

3. Discussion

ED overcrowding is a global issue that is featured almost everywhere in the world and the Kingdom of Saudi Arabia is no exclusion.The FMEA tool which was used in the survey has provided good internal consistency with average measure of Cronbach's α value of all the 29 items is 0.805 and having good validity as all the 29 items fall under the 5 constructs (Factors). From the responses of the study subjects on a 5-point Likert scale towards the on-line survey, the author discussed the following points:

Six potential causes of ED overcrowding in RMH were identified. The first reason relates to the inappropriate visits made by patients who do not need ED services, was responded by 33.3% as possible and 17.8% as definitely. This particular cause appears to be universal among almost all EDs. In fact, none of the respondent surveyed disagreed with this observation, while almost half of them agreed either completely with it as a basis for overcrowding in ED. One third (30%)of them cited this as one the reason as possible while only about one fifth (18.9%) of the respondents were not sure.

The same situation can be seen in almost all EDs in the city and probably around the country. In most cases, this is explained by the fact that, it is difficult to obtain timely appointments with primary care and other specialty physicians. Hence, many patients use the ED as a quick short route to access the healthcare system and perhaps attain a referral to an outpatient department. Another benefit of attending ED, as perceived by the patients, is the much needed and additional reassurance offered by emergency care physicians.

A similar pattern of response was noted in 2nd reason that states overcrowding is believed to be due a shortage of skilled staffing in the ED. This question was responded by 53.3% of subjects as "possibly" which seems to be a global and chronic issue. It is especially true in Saudi Arabia. Where it is believed the country needs to surmount several obstacles to achieve self-sufficiency with medical staffing. The second reason - could be simply attributed to a tremendously high number of patients attending the ED with an inadequate number of resources to meetsuch demand which is another commonly encountered and a chronic issue at the RMH ED as well as most other large and innercities.

Lack of beds in the departments of destination in the hospital follows a similar pattern as in the case with the first three reasons and still carries significant weight with almost two fifth of subject citing that as one of the reason.

The issue of over complicated management policies and care pathways ranks second as a cause of overcrowding in the surveyed study subjects. Again, a vast majority of these subjects cited this as partially or totally the reason for overcrowding in the ED. While only less than 10% of

respondents were not sure, but none disagreed with the statement. The author attributes these responses to the general complexity of policies and procedures and, on occasions, the poor communication style and efforts of management at the RMH. This impedes an effective flow of communication. Another, but less significant, factor as noted by the participants is that a number of patients do not need to be seen at ED but they are permitted to do so by management due to favoritism and other similarfactors.

None of the respondents disagree with the statement of this question, however almost half of subjects consider it as a possible reason, possibly because evidence of such response lies in the hands of another section in the ED or in the admission office hands.

In summing up results of this question, it is obvious that the vast majority of the study subjects consider each of the six reasons as a possible; the reason or definite reason for the overcrowding at the ED is the RMH. While a relatively very small rate of subjects were not sure of these reasons as cause almost none of the subjects disagreed with these reason as causes of overcrowding. The author tends to believe that these reasons individually and collectively can be considered as valid and true reason for overcrowding at theED.

Main reasons that effect of ED overcrowding on patients were: Reason #1 that states ED overcrowding causes extended pain and suffering, only 6.7% of subjects disagreed with this statement and the vast majority 45.6% considering the statement as possible one of the reasons, or definitely a reason for extended pain and suffering. In fact this sort of response follows normal expectations. For the second reason (I believe ED overcrowding is a risk for poor outcomes), 55.6% had responded as “possibly”, for the third reason (I believe ED overcrowding causes actual poor outcomes), 57.8% had responded as “possibly”, for the fourth reason (I believe ED overcrowding causes dangerous delayed diagnosis and treatment), 48.9% as “possibly”, whereas for the fifth reason (I believe ED overcrowding causes significant patient dissatisfaction), 52.2% as “one of the reasons”.

However, the rest of the respondents stated it was possible and agreed totally with it as a reason for more pain and suffering in patients attending ED at the RMH. Pain and suffering can be seen as having a direct relationship with ED.

Overcrowding with them brings insecurity and uncertainty that patient and their families experience while waiting to be seen and diagnosed and a prognosis is provided by healthcare professional at ED can be a serious suffering to this population and may represent continuous pressure on the healthcare team as they become pressed by questions and attempts to get them to attend to these patients, while they are busy treating other cases. Reason #2 that states ED overcrowdings is a risk for unfortunate outcomes and can be seen as a natural continuity to reason #3 with a pattern of agreement that spans over two thirds of subject only2 (2.2%) subject disagreed with it is as a reason but a good 31% were not sure whether it is a good reason or not. It can be seen that when ED overcrowding is a reason for extended pain and suffering, it follows that it can hinder proper diagnosis, medical interference and treatment outcome. In many situations direct and instant decisions and measures are required to be taken and implemented to stop ailment and prevent complications or even mortality.

Overcrowding can delay this process and patients can experience severe consequences as a result for such delay in ED. Majority of study respondents believed ED overcrowdings is a basis of actual poor out comes and causes significant patientdissatisfaction.

In fact, dissatisfaction is an associated and result of overcrowding and is a vital measure for quality cure delivery but client dissatisfaction has been cited in large number of studies across all industries, is a significant criteria for quality service. The researcher strongly believes that this question has yielded a consistent agreement with its 5 items as effect of overcrowdings in ED. The problem can be magnified in special circumstances or crisis where massive groups of patients are brought to the ED in a short period of time. The problem however does not only include patients and their families, but can add pressure on healthcare professionals and deter them from utilizing their full capacities and efficiency as the problem turn out to be chronic and acknowledged as a fail.

Towards the management of ED overcrowding, and for the first item (I believe ED overcrowding can be reduced when the issue is viewed with the context of overall pressure on the entire healthcare system), 34.4% had responded as “possibly”, for the second item (I believe ED overcrowding can be reduced by increasing the number and expertise of ED staff), 35.6% had responded as “possibly”, for third item (I believe ED overcrowding can be reduced by better design of the way patients flow through the department (forms and paper work), 38.9% had responded as “possibly”, for fourth item (I believe ED overcrowding can be reduced by educating the public about the proper use of ED resources), 44.4% as “possibly”, whereas for fifth item (I believe ED overcrowding can be reduced by applying/implementing technological solutions), 50% as “one of thereasons”.

For the factor of “Management of ED overcrowding” the study subjects had responded in higher proportion as “possibly” to the 4 ways (items) and as “one of reason” to the fifth method (item) of managing overcrowding of ED. Here, the study subjects were not “definite” in their views, because 4 out of 5 items, under this factor were related to administrative feasibility of managing ED overcrowding. The responses to the first 4 reasons (as one of the reason) because these 4 reasons (items) are completely related to the administrative measures towards the management of ED overcrowding. Whereas the 5th reason (I believe ED overcrowding can be reduced by applying/ implementing technological solutions), the study subjects has responded as definite. This indicates that the study subjects were willing to adopt technological solutions in the management of ED overcrowding.

For the factor of “applied and implemented solutions to ED overcrowding” and its 5 reasons responses by the study subjects, for the first reason (I believe ED overcrowding can be solved by having a dedicated bed-management team to tackle

the issue of Access Block), 47.8% had responded as “possibly”, for the second reason (Consultant orSeniorED nurse lead triage could help making an impact an ED overcrowding), 40% had responded as “possibly”, for the third reason (Diverting some of the emergency calls to advice help lines enabling paramedics to assess and discharge at the scene could help reduce ED visits), 37.8% had responded as “possibly”, for the fourth reason (An early warning system that could alert to the development of overcrowding could help management prepare and apply resources to prevent overcrowding), 40% as “possibly”, whereas for the fifth reason (I believe ED overcrowding can be solved by implementing technological innovations such as Radio Frequency Identification of patients and assets), 70% as “one of thereasons”.

For this, factor of “Applied and implemented solutions to ED overcrowding” the study subjects had responded in higher proportion as “possibly” to the four solutions (items) and as “one of the reason” to the fifth solution (item) of Applied and implemented solutions to ED overcrowding. Here, the study subjects were not “definite” in their views, because all the 5 items, under this factor were related to hospital management system, which includes adequate infrastructure, administrative feasibility, and availability of appropriate manpower with efficient management skills. The feasibility of implementing technological innovations particularly, Radio frequency identification of patients, could be considered as a possible solution to ED overcrowding because 70% of the study subjects was responded “as one of thereasons”.

In the analysis of responses for the 5th factor (RFID Tagging as a potential solution in easing ED overcrowding) of an instrument, in which for the first reason (I believe the RFID is too complicated to use), 52.5% had responded as “Not sure”, for the second reason (The RFID system does not always function the way it is supposed to), 40% had responded as “Not sure”, for the third reason (The RFID system made our department less crowded than before we started using it), 51.1% had responded as “one of the reasons”, for the fourth reason (The RFID system should not be relied uponas the only solution to ED overcrowding), 45.6% as “possibly”, for the fifth reason (The training I received on using the system was adequate), 38.9% as “one of the reasons” for the sixth reason (The technical support I received/continue to receive was adequate), 45.6% as “possibly” for the seventh reason (The ED patient did not like wearing/using the RFID tags), 40% as “one of the reason” and for the eighth item (The RFID should be extended throughout the whole hospital system), 72.2 % as “ Not sure”.

For this, factor of “Radio frequency identification (RFID) tagging” the study subjects had responded in higher proportion as “Not sure” to the 4 reasons, as “one of the reason” to 2 reasons and as “possibly” to the remaining 2 reasons. Here, the study subjects were not “definite” in their views, because all the 8 reasons, under this factor were related to the knowledge application, and utility of RFID in managing ED overcrowding.

4. Conclusions

ED overcrowding is a negative phenomenon of healthcare that has been described abundantly globally. Factors that have been found to be associated with it range from the nature of the healthcare systems themselves, demographic reasons, lack of suitable technological infrastructure and similarly suitably equipped and trained clinical manpower.

Contribution of the work has been clarified as identifying the impact of RFID as RTLS technology in ED in the RMH for managing and controlling overcrowding. This research also identified potential failure modes of this technology in ED overcrowding using FMEA analysis. Therefore, the outcomes of this work would provide an important contribution to the limited body of literature, on the technological solutions of overcrowding in ED. Most of the search carried out by the author identified large variation in approaches to dealing with the issue of ED overcrowding. Those ranged from applying more human resources to altering the pathways of managing patient’s journey through healthcare system to applying more intermediate layers of management to ease the pressure off of the EDs. Other approaches included some aspects of technology such as development of early warning systems that have not been widely adopted and remained as isolatedefforts.

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