FAILURE MODE AND EFFECTS ANALYSIS (FMEA) ON LINEN AND LAUNDRY SERVICES, IN ONE OF THE LEADING HOSPITALS IN KERALA

C.Mohana Priya[1], Albin Varghese[2]

[1]Assistant Professor, Department of Hospital Administration, Dr.N.G.P Arts and Science College
[2]Student, Department of Hospital Administration, Dr.N.G.P Arts and Science College

---

Abstract- *Linen and laundry service is a most important support service in hospital which is responsible for providing, clean, safe, adequate and timely supply of linen to user departments of hospital at right time, right place. Linen is a common term used to describe all textile products. In order to ensure the patient's comfort and safety, an adequate supply of clean is needed. FMEA (failure mode and effect analysis) is one of the most effective methods for identifying possible reliability issues in the development cycle, allowing hospital to take swift action and avoid failure. This paper tries to identify potential failures that could affect linen and laundry service within the selected hospital. The intent of this paper is to strengthen current linen and laundry process and design. The result should also pave way for further studies in the future.*

Keywords: Failure mode and effect analysis, hospital, linen and laundry, FMEA, laundry service

1. INTRODUCTION-

The aim of linen and laundry service in a hospital is to provide adequate quantity of the quality and sterile linen at the right time at right location. Textile goods are often referred to as linen. It includes everything used in hospital, including bed sheets, towel, mattress, bed pad, pillow cover and curtains. In the hospital, criticism of linen is a common concern. The presence of clean and bedding and clothes has a relaxing effect on the patient's mind , Dirty linen, on the other hand, tends to cause psychological discomfort with the operation, which in turn cause a chain reaction that affect other part of the hospital and result in a bad or negative perception of the entire facility. The paper aims to include recommendations such that a sufficient supply of clean linen is available for the comfort and safety of patients.

1.1Function of line and laundry service in a hospital

- Collection of soiled and infected linen from various places
- Sorting of linen, disinfecting, washing and ironing/pressing of linen:
- Repair of damaged linen, distributing clean linen to the respective user departments

Classification of linen and laundry service in a hospital includes:

- Clean linen (Clean and fresh linen)
- Contaminated linen (linen which are exposed to blood, body fluids)
- Soiled linen (linen which are used by patients and staffs)

1.2. FMEA (failure mode and effect analysis)

Failure mode and effect analysis is the process of reviewing as many components, assemblies, and subsystems as possible to identify potential failure modes in a system and their cause and effect. For more than 40 years, FMEA has been used in variety of development sectors, including nuclear power, automotive, aerospace, chemical, electronics and food. An FMEA is used to structure mitigation for risk reduction based on either failure (mode) effect severity reduction or based on lowering the probability of failure or both. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) attempts to adapt this approach for healthcare system in the name of Health Care FMEA or HFMEA in 2002 led to the implementation of this method in healthcare system.

To improve laundry process and design there are two types of FMEA: Design FMEA (DFMEA) and Process (PFMEA)

The FMEA is a 10 step process which involves:

- Step 1&2 :Review the process / design, and Brainstorm potential failure
- Step 3:List potential effect of each failure mode

- Step 4,5 &6 : Assign a severity rating for each effect, assign a frequency (occurrence) rating for each failure mode and assign a detection rating for each failure mode
- Step 7: Calculate the risk priority number (RPN) for each effect
- Step 8&9 : Prioritize the failure modes for each action and action plan recommendation
- Step 10: Calculate the resulting RPN as the failure mode are reduced or eliminated.

The objectives of the study include:

- To identify potential risks/problems in the existing design & process in linen and laundry service
- To suggest action plans to resolve the identified problems
- To improve the linen and laundry process in the hospital

2. LITERATURE REVIEW

Tai-Wu Chang, Kai-Ying Chen (2019) has mentioned in his study that failure mode and effects analysis (FMEA) is a risk assessment method that effectively diagnoses a product's potential failure modes. It is based on expert experience and investigation to determine the potential failure modes of the system or product to develop improvement strategies to reduce the risk of failures.
According to Bockmühl DP, Schages J, Rehberg L (2019), considering the laundering process, it is crucial to be able to control the transmission of infections in healthcare facilities as well as domestic environments. Inactivating or removing microorganisms from textiles achieved by means of temperature, detergents or mechanical action can help to break the chain of infection. Since the majority of microorganisms found on textiles are also part of the human micro biome or the environment, they mostly should not pose human health risk.

According to D.H Stamatis (2003), the most important reason for conducting an FMEA is the need to improve. To receive all or some of the benefits of an FMEA program, the need to improve must be ingrained in the organization's culture. If not, the FMEA program will not succeed. Therefore, a successful FMEA is both a company and a supplier requirement for world-class quality.

3. METHODOLOGY

This is a descriptive study that uses FMEA methodology to define and analyze failure in laundry process and design in a proactive manner. Moreover, this is a qualitative case study in which the research participants as FMEA team members were chosen on the basis of their expertise from the laundry, nursing department and quality department.

3.1Data Collection Tools:

Using qualitative approach of FMEA, research data was collected through observation and brainstorming session with FMEA team members. Laundry manager, laundry supervisors, engineers from civil, nursing supervisor and quality control experts were among the FMEA team members.

Data collection involved

- **Process and design reviewing:** in this stage process and design of laundry service were studied and the process is drawn into flow chart in detail.
- **Failure identification:** Potential failures modes and effect were identified in each laundry activity and listed in FMEA table.
- **Failure Assessment:** FMEA team members rated all the failures based on three criteria: severity(S), occurrence (0), and detectability (D); all of which were assigned 1 to 10 scores based on the studied process characteristics. Then, by multiplying all three criteria scores together, RPN (Risk priority number) for failure mode were determined
- **Failure prioritizing and action plan recommendation:** Based on the RPN, all evaluated failures were prioritized and failure with less RPN was neglected.

4. ANALYSIS

Data were quantitatively analyzed using FMEA methods and obtained RPNs, which are 1<RPN<1000. In fact, all failures were prioritized at the base of RPN.**Table1**. Shows the Severity, Occurrence and Detectability criteria used for scoring of each failure (mode).

SCORE	SEVERITY	OCCURRENCE	DETECTABLITY
10	Dangerously high	Very likely to occur	None
9	Extremely high	Almost likely	Almost certain not to detect
8	Very high	Very frequent	
7	High	Frequent	Low likelihood
6	Moderate	Highly possible	
5	Low	Possible	Moderate likelihood
4	Very low	Occasional	
3	Minor	Rare	High likelihood
2	Very Minor	Very rare	
1	None	None	Very likely to be detected

4.1Process and Design reviewing stage:

In this stage the FMEA team identified 25 activities in the linen and laundry service, which is starting from collection of soiled linen from department to delivering fresh linen to each department. Moreover the design of the laundry department was studied for identification of design related potential failures and its relation to laundry process.

4.2Failure identification and failure assessment stage:

During failure identification stage the FMEA team has listed and defined all potential failure modes and its effect into FMEA table , in this stage 27 failures were identified in which 21 of were process related an 6 of them were design related.

During this failure assessment, the team assigned severity, occurrence and detectability scores for each failure mode according table 1. And the RPN was calculated by multiplying severity, occurrence and detectability.

4.3Prioritizing and action recommendation stage:

After RPN were obtained, the FMEA table with failure modes was sorted based on RPN in descending order. Along with that FMEA suggested best action plan to mitigate these failures. **Table2**. Shows RPN table which include major finding and recommendation that is actions recommended.

Process Step	Potential Failure Mode	Potential Failure Effect	Potential Causes	RPN	Action Recommended
Collection of linen	Detection of items like band aids, bandages needle caps etc. along with the linen.	Cross contamination , Chance of needle stick injury to laundry employees	Failure in following biomedical waste management protocols.	216	1. Regular checking of linen for band aids, bandages, needle caps, etc. while changing, awareness to staff

	Mixing up of contaminated and non-contaminated linen	Cross contamination	Accidently putting contaminated line into non-contaminated linen bin.	210	1. Regular checking of contamination in linens while changing. 2.Awareness to be given to concerned staff.(BSA/ Housekeeping)
Washing and Drying	Over time usage of machines.	Damage to the machine, Reduced equipment life, Poor performance	Lack of machines to satisfy daily laundry processes in hospital.	162	1. Install adequate machine in laundry department, 2. Reduce the usage of machines to 8-12 Hours per day.
Delivery	Delivery of stained and damaged linens.	Poor customer satisfaction	Improper washing, Missed quality checks	160	Adherence to quality checks after drying process and calendaring process.

5. FINDINGS AND RECOMMENDATION

Other major failures:

- Lack of machines to satisfy daily linen needs in hospital with RPN score of 150 and best way to mitigate is to plan new equipment purchase.
- Temperature is high in laundry department which can cause fire hazard and fatigue among employees with RPN score of 140, the best action plan is to install strong enough ventilation, air condition or relocate dryer flatbed and calendaring machine where proper ventilation can be achieved.
- Excessive lint in laundry department is another failure that was identified by this study which can cause fire hazards and health hazard for employees, the best action plan for the same is to install strong enough ventilation and lint filtration system.

6. CONCLUSION

FMEA is a proactive, team based and systematic approach for identifying the way in which a process or design fail why it might fail and how it can avoided. It shows systematic prospective approach to develop action plans that can mitigate the identified failure modes. Using FMEA, this paper attempted to identify all process and design related failures modes in linen and laundry service in a hospital, as well as recommend best action plan for each identified problems. Implementing these action plans will help the linen and laundry service to improve and optimize its process and design.

7. REFERENCES

[1] Employer and laundry Guidance for covid-19(2020), TRSA, Association for Linen, Uniform and Facility Services Industry, Alexandria, VA.

[2] Tai-Wu Chang, Huai-Wei Lo , Kai-Ying Chen and James J. H. Liou(2019), A Novel FMEA Model Based on Rough BWM and Rough TOPSIS-AL for Risk Assessment, Department of Industrial Engineering and Management, National Taipei University of Technology, 1, Sec. 3, Zhongxiao E. Rd., Taipei 10608, Taiwan

[3] Bockmühl D.P, Schages J, Rehberg L (2019), Laundry and textile hygiene in healthcare and beyond, Microb Cell. 2019; 6(7):299-306.

[4] Mohammad Hayati, Mohammad Reza Abroshan(2017), Risk Assessment using Fuzzy FMEA (Case Study: Tehran Subway Tunneling Operations), Indian Journal of Science and Technology, Vol 10(9)

[5]Heudorf U, Gasteyer S, Müller M(2017), Handling of laundry in nursing homes in Frankfurt am Main, Germany, 2016 - laundry and professional clothing as potential pathways of bacterial transfer. GMS Hyg Infect Control.

[6] Marina Aucamp (2016), Housekeeping and Linen Management Chapter 23 , FIC Basic Concepts of Infection Control, 3rd edition, 2016 .

[7] U.S. Department of Labour (2009), Hospital Etool Occupational Safety and Health Administration, U.S. Department of Labour, Hospital Etool /Nursing Home Etool/ Laundry Module.

[8] D. Singh, G. Qadri, M. Kotwal, A. Syed, and F. Jan(2009), "Quality control in linen and laundry service at a tertiary care teaching hospital in India," International Journal of Health Sciences, vol. 3, no. 1, pp. 33–44, 2009.

[9] D.H Stamatis(2003), Failure Mode and Effect Analysis- FMEA from Theory to Execution,Second Edition, American Society for Quality, Quality Press, Milwaukee 5320.