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Implementation of Healthcare Failure Mode and Effect Analysis (HFMEA) as an Effort to Improve Patient Safety in Hemodialysis Services in Indonesia

Ariadne Aulia,[1] Arlina Dewi,[1] Elsye Maria Rosa[2]
[1]Master of Hospital Administration, Faculty of Postgraduate Program, Universitas Muhammadiyah Yogyakarta, Indonesia
[2]Master of Nursing Science, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia

Abstract

Hemodialysis patients are at risk of preventable adverse outcomes as a result of the ongoing medical treatments required throughout their life. Minimizing risk is crucial for ensuring patient safety in healthcare environments. Healthcare Failure Mode and Effect Analysis (HFMEA) is a proactive risk assessment method designed to identify potential failures in healthcare processes and improve the quality and safety of patient care. This qualitative descriptive study aimed to identify potential failure modes in hemodialysis services in Nitipuran Hemodialysis Clinic by implementing HFMEA. A multidisciplinary team was involved as the unit of analysis to identify processes and subprocesses for in-center hemodialysis treatment. The study employed purposive sampling, selecting 10 team members who were directly involved in providing hemodialysis services. Data collected were analyzed using the HFMEA worksheet. Over five weeks, the team convened six times to identify Failure Modes (FMs) and Failure Mode Causes (FMCs), conduct a Hazard Analysis, and determine necessary actions to address the FMCs. Five processes, 23 subprocesses, 74 Failure Modes (FMs), 39 Failure Mode Causes (FMCs) were identified. Based on the Hazard Analysis results, 27 FMCs required corrective actions and thirteen actions were proposed to address the FMCs and improve patient safety based on the findings of this study. Further research is needed to evaluate the effectiveness of the implementation of these corrective actions in improving patient safety

Keywords: Healthcare failure mode and effect analysis, patient safety, renal dialysis, risk assessment

Introduction

Patients with End-Stage Renal Disease (ESRD) undergoing hemodialysis represent a high-risk population due to complex clinical conditions and long-term dependence on renal replacement therapy. These patients frequently present with multiple comorbidities, including hypertension, diabetes mellitus, and cardiovascular disease, which substantially increase morbidity and mortality.[1,2] Older patients, particularly those aged 55 years and above with unidentified underlying renal disease, demonstrate poorer survival outcomes.[3] In Southeast Asia, the prevalence of treated ERSD has increased significantly, with hemodialysis being the most frequent Renal Replacement Therapy (RRT) Modality.[4] According to the Indonesian Renal Registry (IRR) Annual Report 2018, a total of 132,142 patients were actively receiving hemodialysis, accounting for more than 2.7 million hemodialysis sessions performed in a single year.[1]

Hemodialysis patients are exposed to medical treatments throughout the remainder of their life, which increases their chance of experiencing an adverse event that could have been avoided. Hemodialysis patient care requires a sophisticated system and organization. To guarantee patient safety, it is essential to reduce those potential risks. Healthcare Failure Mode and Effect Analysis (HFMEA) is a proactive risk assessment tool developed by the Veterans Affairs National Center for Patient Safety to systematically identify potential failure points within healthcare processes before adverse events occur. Since its introduction in 2001,

Corresponding Author:
Arlina Dewi
Master of Hospital Administration, Faculty of Postgraduate Program, Universitas Muhammadiyah Yogyakarta, Indonesia
Email: arlinadewi@umy.ac.id

Healthcare Failure Mode and Effect Analysis (HFMEA) has been extensively utilized in healthcare facilities as a preventative measure in risk management.[5-7] HFMEA is regarded as a more effective proactive risk analysis compared to Root Cause Analysis (RCA). HFMEA examines the system in greater detail and has a broader influence on the entire system.[8]. The study conducted by La Russa et al. (2022) utilized the Failure Mode and Effects Analysis (FMEA) methodology to assess hospitals that offer hemodialysis treatments. Half of the failure modes identified were attributed to the process of attaching the patient to the hemodialysis machine.[9]

The Nitipuran Hemodialysis Clinic in Yogyakarta, Indonesia, provides regular hemodialysis services to more than 100 patients, performing approximately 1,000 dialysis sessions per month over the past three years. A proactive risk assessment was performed using HFMEA to assess the hemodialysis treatment process to enhance the quality and safety of patient care in the dialysis clinic. The HFMEA methodology was selected to detect possible vulnerabilities and investigate potential methods to mitigate their escalation of unanticipated incidents. This study aims to identify potential failure modes in hemodialysis services using the Healthcare Failure Mode and Effect Analysis (HFMEA) approach and determine corrective actions needed to improve patient safety at the Nitipuran Hemodialysis Clinic. By applying HFMEA in a clinic-based hemodialysis setting, this research addresses an important gap in patient safety literature and provides context-specific insights that may support the development of safer and more reliable hemodialysis services in similar healthcare facilities.

Methods

This study used a qualitative descriptive design with the Healthcare Failure Mode and Effect Analysis (HFMEA) approach. The research was conducted at the Nitipuran Hemodialysis Clinic, Yogyakarta, Indonesia, an adult dialysis facility with 18 treatment beds. Data collection was carried out over a five-week period from September to October 2022. It is the largest dialysis clinic in the province and has been treating adult ESRD patients who require regular hemodialysis for the past eight years. The study population was the entire routine hemodialysis service process at the Nitipuran Hemodialysis Clinic with a multidisciplinary team consisting of 10 people as the analysis unit. The sampling technique was carried out purposively based on the direct involvement of respondents in the service process. The analysis was carried out using the HFMEA worksheet and the Hazard Matrix. HFMEA was conducted in accordance with the guidelines issued by The VA National Center for Patient Safety.

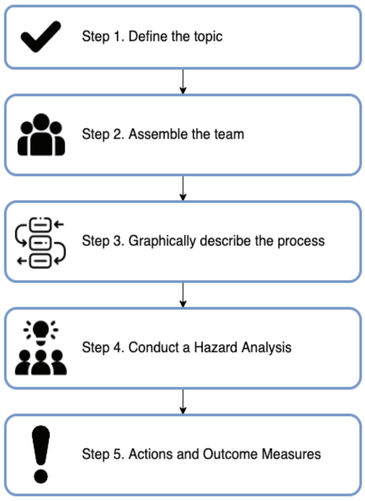

Figure 1 Steps of Healthcare Failure Mode and Effect Analysis based on The VA National Center for Patient Safety

Step 1: define the topic; Since in-center hemodialysis treatment for ESRD patients is the clinic's primary medical service, every step of the patient's visit process—from registration to post-hemodialysis evaluation—was selected to enhance the general standard of care and safety of the patient during hemodialysis treatment. Healthcare Failure Mode and Effect Analysis (HFMEA) approach was implemented in this specific topic.

Step 2: assemble the team; An interdisciplinary group, constituted of individuals (n=10) with varying specialties such as general manager, service manager, executive doctor, hemodialysis nurse, pharmacist, medical recorder, administrative staff, was established to perform the HFMEA procedure. There was no Risk Assessment officer in the clinic and therefore this study had encouraged the clinic to appoint one. The researcher participated as the facilitator for all the HFMEA meetings conducted by the team. All members of the team have received HFMEA training prior to this HFMEA.

Step 3: graphically describe the process. At the first meeting, the team will construct

Table 1 Risk Assessment Hazard Matrix

Probability	Severity of Effect			
	Minor (1)	Moderate (2)	Major (3)	Catastrophic (4)
Remote (1)	1	2	3	4
Uncommon (2)	2	4	6	8
Occasional (3)	3	6	9	12
Frequent (4)	4	8	12	16

a flow diagram detailing a patient's visit to the dialysis clinic for regular hemodialysis treatment. The diagram encompassed processes and subprocesses. Following the meeting, the team will reevaluate the suggested process and subprocess and decide on processes and subprocesses collaboratively through on-site observation.

Step 4: conduct a Hazard Analysis. Based on the team members' specialized knowledge required for each procedure, the team members were divided up into multiple subgroups. The HFMEA team consisted of 10 people, including 1 general manager who is a doctor and a researcher, 1 service manager who is a doctor, 1 executive doctor, 4 hemodialysis nurses, 1 pharmacist, 1 medical recorder, and 1 administrative staff. The team is divided into subgroups according to the team members' involvement in the process to be analyzed. Each team member can belong to more than one subgroup. The team identified five processes and twenty-three subprocesses in patient's visit to the dialysis clinic for regular hemodialysis treatment. The five processes are patient's registration, pre-hemodialysis assessment, preparation of hemodialysis machine, hemodialysis treatment, post-hemodialysis assessment. Each process

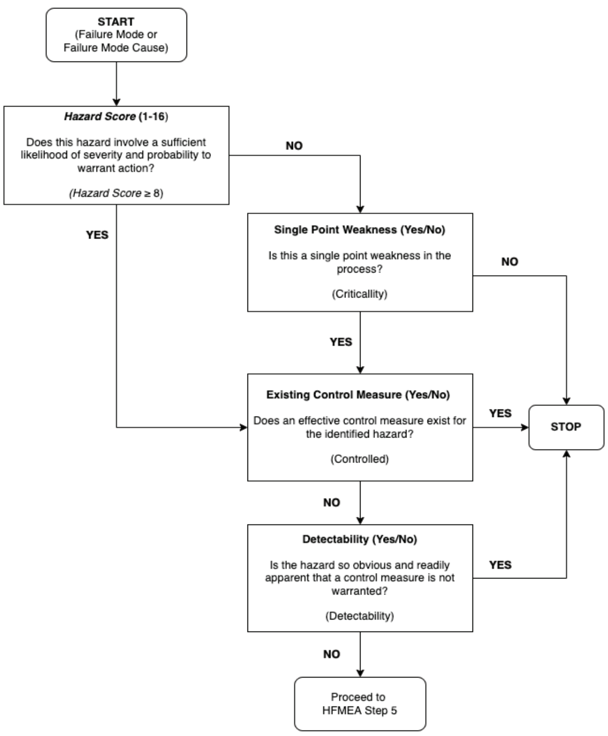

Figure 2 Healthcare Failure Mode and Effects Analysis (HFMEA) Decision Tree Used for Risk Assessment

consists of several subprocesses, with at least 3 subprocesses and at most 8 subprocesses in each process. All processes and sub-processes are visualized in a process flow diagram (Figure 3).

Each team member took part in one or two subgroups to brainstorm and identify possible Failure Modes (FMs) and Failure Mode Causes (FMCs) for each subprocess. The HFMEA Worksheet was utilized to collect data at in-person subgroup meetings. To facilitate team communication, the HFMEA Worksheet was displayed on a TV monitor. First, the subgroup identified the FMs for the subprocess. Based on their perception, each FM's Probability (P) and Severity (S) scores were assigned, rated from 1 to 4. The Hazard Score was computed by multiplying the two variables together (Hazard Score = S x P) by using the Hazard Matrix (Table 1).

The HFMEA Decision Tree was then utilized to do additional analysis on FMs to assess the necessity of finding FMCs. The analysis was based on three criteria: criticality, lack of effective control measures, and detectability (Figure 2).

For every FM, there could be several FMCs found. For each FMC, Hazard Analysis—which includes calculating Hazard Score and employing HFMEA Decision Tree analysis—was also performed to assess whether corrective action was necessary. Identical FMs and FMCs were only examined once to prevent redundant data, even if they were recognized from separate subprocesses.

Step 5: actions and Outcome Measures. If the Hazard Analysis conclusion was to be implemented, corrective actions were determined for every FMC. The team members mutually agree on the specific course of action, which is classified as either control, accept, or eliminate.

Control indicates that an action is required to reduce all future occurrences by incorporating mitigating factors. Accept means that known risks should be recognized and accepted. Eliminate refers to removing the failure point in order to prevent all future occurrences.

Ethical approval for this study was obtained from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta (Approval No. 154/EC-KEPK FKIK UMY/ VII/2022). The study involved process analysis without patient data, and participation of staff members was conducted in accordance with institutional ethical standards.

Results

Five main processes and 23 subprocesses were identified in the patient pathway for routine hemodialysis treatment, encompassing patient registration, pre-hemodialysis assessment, preparation of the hemodialysis machine, hemodialysis treatment, and post-hemodialysis assessment. These processes and subprocesses are illustrated in Figure 3.

Through systematic analysis, a total of 73 failure modes were initially identified. After

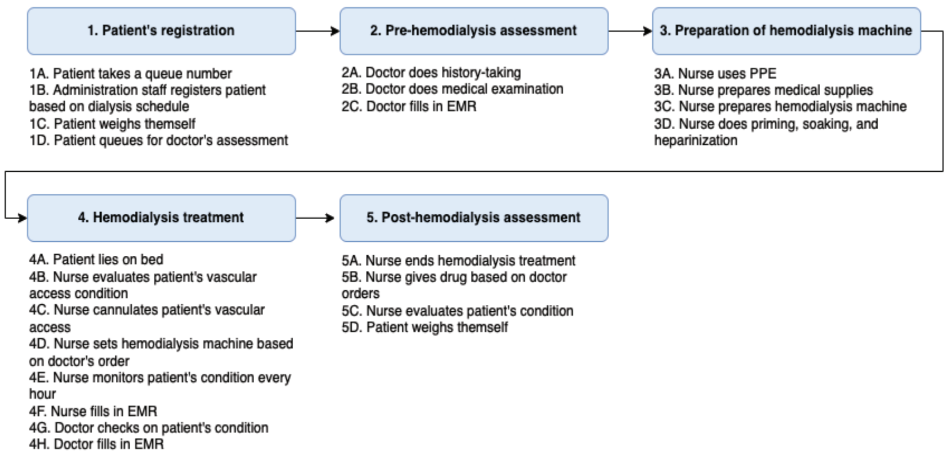

Figure 3 Flow Diagram of Processes and Subprocesses in Routine Hemodialysis Patient Visits

Tabel 2 List of Failure Mode Based on Process and Subprocess

Process		Subprocess	Failure Mode	
Patient's Registration	1A	Patient takes a queue number	1A(1)	Patients do not know where to take the queue number
	1B	Administration staff registers patient based on dialysis schedule	1B(1)	Server down
			1B(2)	Patient arrived but not on the HD schedule
			1B(3)	SIM Clinic error
			1B(4)	Wrong RM number input
	1C	Patient weighs themself	1C(1)	The weight scale is broken
			1C(2)	Scales off
	1D	Patient queues for doctor's assessment	1D(1)	Patient waits outside the waiting room
			1D(2)	Patient goes directly to the HD room
Pre-hemodialysis Assessment	2A	Doctor does history-taking	2A(1)	Patient has difficulty in communicating
			2A(2)	Patient was admitted directly to the HD room
	2B	Doctor does medical examination	2B(1)	Incorrect vital sign recorded
			2B(2)	Patient goes directly to the hemodialysis room
			2B(3)	Examination equipment is not in the examination room
	2C	Doctor fills in E-MR	2C(1)	E-RM cannot be accessed
			2C(2)	Computer is broken
			2C(3)	Incomplete medical record filling Doctor is not
Preparation of Hemodialysis Machine	3A	Nurse uses PPE	3A(1)	PPE runs out
			3A(2)	PPE is not comfortable to wear
			3A(3)	Officers are lazy to use
			3A(4)	PPE is damaged
	3B	Nurse prepares medical supplies	3B(1)	Medical supplies run out
			3B(2)	Medical supplies are damaged
			3B(3)	Medical supplies are not stored in its place
	3C	Nurse prepares hemodialysis machine	3C(1)	The hemodialysis machine is not working
			3C(2)	RO water runs out

Tabel 2 Continued

Process	Subprocess		Failure Mode	
			3C(3)	Medical supplies run out
			3C(4)	Power failure
			3C(5)	Nurses cannot operate the machine
	3D	Nurse does priming, soaking, heparinization		HD machine broken
			3D(2)	Power failure
			3D(3)	Medical supplies run out
Hemodialysis Treatment	4A	Patient lies on bed	4A(1)	Dialyzer switched
			4A(2)	Patient falls while occupying bed
	4B	Nurses evaluates patient’s vascular	4B(1)	Insufficient lighting
			4B(2)	Nurse forgot to wear glasses
			4B(3)	Patient's clothes were difficult to remove
	4C	Nurse cannulates patient’s vascular access	4C(1)	The AV fistula is dissappeared
			4C(2)	Access area swollen
			4C(3)	Access area has infection
			4C(4)	Access leaking
			4C(5)	Patient's clothes are difficult to open
			4C(6)	Fistula discharged
	4D	Nurse sets hemodialysis machine based on doctor’s order	4D(1)	Nurse is unaware of doctor’s order
			4D(2)	Machine touchscreen monitor is broken
			4D(3)	Nurse set up the HD machine incorrectly
	4E	Nurse monitors patient’s condition every hour	4E(1)	Medical equipment is broken
			4E(2)	No nurse available
			4E(3)	Patient is sleeping
			4E(4)	Examination tool not available
	4F	Nurse fills in E-MR	4F(1)	E-RM cannot be accessed
			4F(2)	Computer is broken
			4F(3)	Doctors have not filled out the initial examination medical record
			4F(4)	Patient monitoring is not done
	4G	Doctor checks on patient’s condition	4G(1)	Patient is sleeping

Tabel 2 Continued

Process	Subprocess		Failure Mode	
			4G(2)	Doctor is absent
			4G(3)	There is an emergency patient
	4H	Doctor fills in E-MR	4H(1)	E-RM cannot be accessed
			4H(2)	Computer is broken
			4H(3)	Patient monitoring is not done
Post-hemodialysis assessment	5A	Nurse ends hemodialysis treatment	5A(1)	Equipment not available
	5B	Nurse gives drug based on doctor orders	5B(1)	Doctor forgot to instruct the administration of erythropoietin injection
			5B(2)	Nurse forgot to give erythropoietin injection
			5B(3)	Erythropoietin dose administration was not appropriate
			5B(4)	Patient's blood pressure was high
			5B(5)	Pharmacist did not prepare erythropoietin injection
			5B(6)	Erythropoietin injection ran out
	5C	Nurse evaluates patient's condition	5C(1)	Medical equipment is damaged
			5C(2)	Medical equipment not available
			5C(3)	No nurse available
			5C(4)	Patient was discharged without post hemodialysis examination
	5D	Patient weighs themself	5D(1)	The weight scale is broken
			5D(2)	Scales are off

eliminating duplicate entries, 55 unique failure modes remained for further evaluation. The subprocesses associated with the highest number of failure modes were cannulation of the patient's vascular access (n=6) and administration of medications according to the physician's orders (n=6).

From the identified failure modes, 39 failure mode causes were determined. The most frequently occurring failure mode cause was nurses' failure to adhere to physician orders, which accounted for six identified causes. Following hazard analysis, 27 failure mode causes were classified as requiring corrective actions. The subprocesses requiring the greatest number of corrective actions were preparation of the hemodialysis machine and setting the machine according to physician orders, each accounting for five corrective actions. All failure modes and failure mode causes requiring corrective actions are presented in Figure 4.

Corrective actions were subsequently developed for the 27 identified failure mode causes. A total of 13 corrective actions were agreed upon, all of which were categorized as control measures. The relationship between each corrective action and its corresponding failure mode cause is summarized in Table 2.

Table 3 Corrective Actions and Failure Mode Causes

	Failure Mode Causes	
Standardization of routine medical equipment maintenance procedures	1C(1)a	Old weight scale
	2B(1)a	Faulty medical equipment
	2B(1)b	Old medical equipment
	3C(1)a	Old hemodialysis machine
	3C(1)b	Machine is not routinely checked
	3C(1)c	Machine is damaged due to an electrical short circuit
Provide more seating in the waiting room	1D(1)a	Unadequate seating in the waiting room
Improve EMR features as needed by medical personnels	2C(3)a	Electronic medical record doesn't support specific data input
	4C(1)a	Patient is frequently hypotensive
Evaluate medical supplies procurement procedure	3B(3)a	The warehouse is full
Standardization of medical supplies storage management	3B(3)b	Consumable medical supplies are not placed in its proper space
Standardization of new nurses training	3C(5)a	No specific training for new nurse
Standardization of reporting broken equipment	3C(5)b	Hemodialysis machine monitor is damaged
	4A(2)b	Bed lock is broken
	4A(2)c	Bed side rail is broken
Standardization of moving patient's bed procedure	4A(2)a	Bed is not locked
Ensure patient education about AV fistula care by providing dialysis handbook	4C(1)b	Patient performs heavy lifting activities using the arm with the AV fistula
	4C(1)c	Patient sleeps with their AV fistula arm getting pressed
	4C(1)d	Blood pressure is measured on arm with AV fistula
Provide tablet for nurses to facilitate easier acces to electronic medical records	4D(1)a	Nurse doesn't check on doctor order in the computer
	4D(1)b	EMR are inaccessible
	5D(3)b	Nurse ask the patient about the doctor order
Standardization of initiating dialysis treatment procedure	5D(3)a	Two different nurses are taking turn in attending one patient
	5D(3)c	Nurse forget to set the machine
Standardization of code blue procedure in dialysis unit	4E(2)a	Nurse is attending emergency patient
Standardization of erythropoetin injection procedure	5B(2)a	Drugs are not immediately given to the patient after taken from the pharmacy
	5B(2)b	Nurse does not check on doctor prescription

Failure Mode		Potential Causes		*Scoring*			Decision Tree Analysis				Action Type (Control, Accept, Eliminate)
				Probability (P)	Severity (S)	Haz Score	Single Point Weakness?	Existing Control	Detectability	Proceed?	
1. Patient's registration											
1C. Patient weighs themselves											
1C(1)	The weight scale is damaged	→	→	3	2	6	Yes	No	No	Yes	
		1C(1)a	Old weight scale	3	2	6	Yes	No	No	Yes	Control
1D. Patient queues for doctor's assessment											
1D(1)	Patient waits outside the waiting room	→	→	4	2	8		No	No	Yes	
		1D(1)a	Unadequate seating in the waiting room	4	2	8		No	Yes		Control
2. Pre-hemodialysis assessment											
2B. Doctor does medical examination											
2B(1)	Incorrect vital sign recorded	→	→	3	2	6	Yes	No	No	Yes	
		2B(1)a	Faulty medical equipment	4	2	8		No	No	Yes	Control
		2B(1)b	Old medical equipment	2	2	4	Yes	No	No	Yes	Control
2C. Doctor fills in EMR											
2C(3)	Doctor is not filling out medical records comphrehensively	→	→	4	2	8		No	No	Yes	
		2C(3)a	Electronic medical record doesn't support specific data input	4	2	8		No	No	Yes	Control
3. Preparation of hemodialysis machine											
3B(3)	Nurse can't find consumable medical supplies	→	→	4	2	8		No	No	Yes	
		3B(3)a	The warehouse is full	4	2	8		No	No	Yes	Control
		3B(3)b	Consumable medical supplies are not placed in its proper space	4	2	8		No	No	Yes	Control
3C. Nurse prepares hemodialysis machine											
3C(1)	The hemodialysis machine is not working	→	→	4	2	8		No	No	Yes	
		3C(1)a	Old hemodialysis machine	4	2	8		No	No	Yes	Control
		3C(1)b	Machine is not routinely checked	4	2	8		No	No	Yes	Control
		3C(1)c	Machine is damaged due to an electrical short circuit	1	2	2	Yes	No	No	Yes	Control
3C(5)	Nurses can't operate hemodialysis machine	→	→	2	2	4	Yes	No	No	Yes	
		3C(5)a	No specific training for new nurse	4	2	8		No	No	Yes	Control
		3C(5)b	Hemodialysis machine monitor is damaged	2	2	4	Yes	No	No	Yes	Control
3D. Nurse does priming, soaking, and heparinization											
3D(1)	The hemodialysis machine is not working	→	→	4	2	8		No	No	Yes	Same as 3C(1)

4. Hemodialysis treatment											
4A. Patient lies on bed											
4A(2)	Patient falls while trying to lie down	→		1	3	3	Yes	No	No	Yes	
		4A(2)a	Bed is not locked	3	3	9		No	No	Yes	Control
		4A(2)b	Bed lock is broken	3	3	9		No	No	Yes	Control
		4A(2)c	Bed side rail is broken	3	3	9		No	No	Yes	Control
4C. Nurse cannulates patient's vascular access											
4C(1)	The AV fistula dissappeared	→		3	2	6	Yes	No	No	Yes	
		4C(1)a	Patient is frequently hypotensive	3	2	6	Yes	No	No	Yes	Control
		4C(1)b	Patient performs heavy lifting activities using the arm with the AV fistula	3	2	6	Yes	No	No	Yes	Control
		4C(1)c	Patient sleeps with their AV fistula arm getting pressed	3	2	6	Yes	No	No	Yes	Control
		4C(1)d	Blood pressure is measured on arm with AV fistula	2	2	4	Yes	No	No	Yes	Control
4D. Nurse sets hemodialysis machine based on doctor's order											
4D(1)	Nurse is unaware of doctor's order	→		3	2	6	Yes	No	No	Yes	
		4D(1)a	Nurse doesn't check on doctor order in the computer	4	2	8		No	No	Yes	Control
		4D(1)b	EMR are inaccessible	4	2	8		No	No	Yes	Control
4D(3)	Inaccurate setting of hemodialysis machine	→		2	2	4	Yes	No	No	Yes	
		5D(3)a	Two different nurses are taking turn in attending one patient	4	2	8		No	No	Yes	Control
		5D(3)b	Nurse ask the patient about the doctor order	4	2	8		No	No	Yes	Control
		5D(3)c	Nurse forget to set the machine	2	2	4	Yes	No	No	Yes	Control
4E. Nurse monitors patient's condiiton every hour											
4E(1)	Medical equipment is damaged	→		2	2	4	Yes	No	No	Yes	Same as 2B(1)
4E(2)	No nurse available	→		3	2	6	Yes	No	No	Yes	
		4E(2)a	Nurse is attending emergency patient	2	2	4	Yes	No	No	Yes	Control
5. Post-hemodialysis assessment											
5B. Nurse gives drug based on doctor's order											
5B(2)	Nurse forgets to give drugs (erythropoetin)	→		2	2	4	Yes	No	No	Yes	
		5B(2)a	Drugs are not immediately given to the patient after taken from the pharmacy	2	2	4	Yes	No	No	Yes	Control
		5B(2)b	Nurse does not check on doctor prescription	2	2	4	Yes	No	No	Yes	Control
5C. Nurse evaluates patient's condiiton											
5C(1)	Medical equipment is damaged	→		2	2	4	Yes	No	No	Yes	Same as 2B(1)
5C(3)	No nurse available	→		3	2	6	Yes	No	No	Yes	Same as 4E(2)
5D. Patient weighs themselves											
5D(1)	The weight scale is damaged	→		3	2	6	Yes	No	No	Yes	Same as 1C(1)

Figure 4 HFMEA Worksheet consisting Failure Modes and Failure Mode Causes That Needed Corrective Actions

Discussion

As a proactive risk assessment, HFMEA has proven effective in determining which activities are appropriate for each FMC. Actions are thought of as a means of enhancing organizational or clinical procedures. An in-depth analysis of risk assessment by HFMEA revealed where resources should be allocated to minimize risks and enhance the current system. According to this study, HFMEA requires a lot of time, particularly when compared to other methods of risk assessment like Root Cause Analysis. Other studies that implemented HFMEA in their facilities reported similar experiences.[5–7] Members of the HFMEA team must receive the necessary training to have a solid comprehension of the HFMEA process and be able to complete it efficiently.

Thirteen corrective actions were identified, reflecting diverse risk domains within the hemodialysis process. Several actions addressed medical equipment management, including standardization of routine maintenance and reporting of damaged equipment.. Some of them related on equipment management, such as standardization of routine medical equipment maintenance procedures and standardization of reporting broken equipment. It is essential to ensure the best performance and durability of medical devices in healthcare environments. Standardization in this context refers to the process of implementing and adhering to precise criteria for the maintenance and upkeep of medical equipment. This includes activities such as cleaning, testing, and calibration. Uniform protocols guarantee consistent maintenance of all equipment, irrespective of the brand or model, hence minimizing errors and ensuring optimal operational status at all times.[10] Reporting faulty equipment in healthcare institutions is also essential in order to promptly address repairs and reduce potential threats to patient safety. This entails providing training to the personnel to rapidly identify and report any damages, as well as ensuring that the reports are promptly examined and acted upon. Alshehri et al.[11] found that the implementation of standardized protocols can greatly enhance the operational efficiency and safety of healthcare services.

Other corrective actions focused on medical supply management, including evaluation of procurement procedures and standardization of storage systemst. The acquisition of medical supplies is an intricate and vital procedure to guarantee the accessibility of essential equipment and resources for healthcare services. Assessing the efficiency entails examining the velocity and precision of the process of obtaining and receiving medical supplies. Contemporary procurement processes frequently employ digital tools to optimize these tasks, hence minimizing delays and errors.[12] Efficient storage management is essential for preserving the integrity and ensuring the availability of medical supplies. Alabdali and Salam found that implementing digitized storage management, specifically through the use of labeling and categorization, can greatly enhance supply chain efficiency.[13]

Improving EMR features as needed by medical personnels and providing tablet for nurses to facilitate easier acces to EMR are two corrective actions related with EMR. Adapting EMR features to meet the requirements of medical personnels can significantly enhance efficiency, security, and the quality of patient care. Medical personnel necessitate a straightforward and intuitive interface to effectively access patient data without facing technical barriers or uncertainty.[14] Integrating tablets into the workflow of nurses can greatly enhance their ability to access electronic medical records (EMRs), resulting in improved patient care and increased productivity. Rahal et al. found that the use of mobile technology in healthcare enhances the precision and availability of data for healthcare practitioners. This is essential for optimizing clinical workflows and improving patient outcomes. Tablets provide immediate access to patient data, minimizing mistakes and enhancing the efficiency of decision-making procedures.[15]

Enhancing the overall patient experience in healthcare institutions involves a crucial focus on improving patient comfort. One of the corrective actions identified is an uncomplicated yet efficient approach, which is to offer supplementary seating in the waiting area. This intervention can effectively mitigate patient anxiety and enhance overall patient contentment during periods of waiting.[16]

Standardization of new nurses training is one of the corrective actions needed in the preparation of hemodialysis machine. Efficiently training newly hired nurses is crucial for preserving exceptional levels of patient care. Alabdali and Salam suggest commencing digital transformations by focusing on procurement processes, which entail intricate engagements with both internal and external parties. Training programs for novice nurses can enhance their preparedness and efficiency in a contemporary healthcare setting by integrating digital technologies and processes.[13]

Several corrective actions are related to standardization of medical procedure such as initiating dialysis treatment, code blue in dialysis unit, and erythropoetin injection. Establishing a standardized protocol is crucial to ensure uniform and secure patient care. Using consistent protocols to start dialysis improves patient outcomes by minimizing variations in therapy administration. Moreover, the implementation of optimal methods in dialysis centers, such as standardized initiation protocols, can significantly enhance patient outcomes and increase survival rates.[17] Code Blue situation, particularly in a specialized environment such as a dialysis unit, it is essential to assign predetermined responsibilities to each member of the team. This minimizes ambiguity and improves the effectiveness of the response. Regular training sessions and simulated exercises are crucial for ensuring the preparedness of the Code Blue crew. Research has shown that teams who regularly engage in realistic simulations are more adequately equipped to handle genuine crises, resulting in enhanced patient outcomes.[18] Erythropoetin injection technique include verifying that the medications are appropriately labeled to prevent abuse and guarantee the safety of patients. Ensuring awareness among healthcare providers regarding the accurate dosage and administration protocols for erythropoetin is crucial for ensuring uniformity in patient treatment and eliminating any instances of misuse.[19]

Securing patient beds during movement is a crucial safety precaution. Standardization of moving patient's bed procedure entails providing training to staff members to consistently inspect and secure the wheels both prior to and during the relocation of a patient's bed. This approach serves to mitigate accidents and guarantee the safety of patients. The study conducted by Zehir and Zehir emphasizes the importance of regular procedural training and strict adherence to safety procedures in healthcare settings as essential elements of Total Quality Management (TQM). These practices have been found to significantly enhance patient outcomes and operational performance.[20]

Lastly, providing patients with information on how to care for their arteriovenous (AV) fistula is crucial in order to avoid problems and maintain the long-term functionality of the access site. Supplying a detailed dialysis manual helps equip patients with the necessary information to manage their fistula. This includes guidelines for everyday maintenance, identifying indications of infection, and comprehending the significance of cleanliness. A study conducted by Alshehri et alhighlights the significance of patient education in the management of chronic illnesses, as it can result in improved health outcomes and decreased hospital admissions.[11]

The clinic may have been exposed to several of these safety hazards due to its absence of accreditation. According to a previous study, healthcare facilities without accreditation experience higher rates of patient safety events than those with accreditation.[21] Another study that conducted failure mode evaluations (FMEAs) at hemodialysis facilities reports that connecting the patient to the dialysis machine accounted for almost half of the failure modes discovered throughout the hemodialysis process.[22] This is similar to the finding in our study, where 8 out of 27 FMCs that required actions were associated with cannulation of vascular access and setting the hemodialysis prescription on the machine.

This study may provide some fresh perspectives on the priorities that other hemodialysis facilities should establish to enhance patient safety. It may assist other managers of healthcare facilities in implementing HFMEA since it provides step-by-step instructions for doing so. However, this study has some limitations. The HFMEA approach's greatly depends on the team members' combined memory of what has happened and their ability to anticipate potential problems in such procedure. Additionally, when brainstorming, the participants might perform with bias. The team may overlook system vulnerabilities, or the severity and likelihood scores of FMs or FMCs may be misinterpreted.

The conclusion of this study is that HFMEA has proven to be effective in identifying potential failures and corrective actions needed in hemodialysis services. Implementation of recommended corrective actions need to be carried out consistently in order to significantly improve safety.

Further research focusing on the efficacy of this HFMEA should be conducted to see if the quality and safety of patient care during hemodialysis treatment are improved after the suggested actions are implemented, as this study does not evaluate the effectiveness of corrective actions identified by HFMEA.

References

1. PERNEFRI. 11th Report of Indonesian Renal Registry 2018. Jakarta: Perhimpunan Nephrologi Indonesia; 2018.
2. Bello AK, Okpechi IG, Osman MA, Cho Y, Htay H, Jha V, et al. Epidemiology of haemodialysis outcomes. Nat Rev Nephrol. 2022;18(6):378–95. doi:10.1038/S41581-022-00542-7
3. Afiatin, Agustian D, Wahyudi K, Riono P, Roesli RMA. Survival Analysis of Chronic Kidney

Disease Patients with Hemodialysis in West Java. Indonesia, Year 2007–2018. Majalah Kedokteran Bandung. 2020;52(3):172–79. doi:10.15395/mkb.v52n3.2124
4. Thurlow JS, Joshi M, Yan G, et al. Global epidemiology of end-stage kidney disease and disparities in kidney replacement therapy. Am J Nephrol. 2021;52(2):98–107. doi:10.1159/000514550
5. DeRosier JM, Hansemann BK, Smith-Wheelock MW, Bagian JP. Using proactive risk assessment (HFMEA) to improve patient safety and quality associated with intraocular lens selection and implantation in cataract surgery. Jt Comm J Qual Patient Saf. 2019;45(10):680–5. doi:10.1016/J.JCJQ.2019.06.003
6. Dehnavieh R, Ebrahimipour H, Molavi-Taleghani Y, Vafaee-Najar A, Noori Hekmat S, Esmailzdeh H. Proactive risk assessment of blood transfusion process, in pediatric emergency, using the Health Care Failure Mode and Effects Analysis (HFMEA). Glob J Health Sci. 2015;7(1):322-331. doi:10.5539/gjhs.v7n1p322
7. Tiao CH, Tsai LC, Chen LC, Liao YM, Sun LC. Healthcare failure mode and effect analysis (HFMEA) as an effective mechanism in preventing infection caused by accompanying caregivers during covid-19 - experience of a City Medical Center in Taiwan. Qual Manag Health Care. 2021;30(1):61–8. doi:10.1097/QMH.0000000000000295
8. Utami AS, Fahmy R, Putri ZM. Peran metode failure mode and effect analysis (FMEA) terhadap mutu pelayanan rumah sakit: systematik review. Jurnal Ilmiah Universitas Batanghari Jambi. 2020;20(3):932. doi:10.33087/jiubj.v20i3.1080
9. La Russa R, Fazio V, Ferrara M, Di Fazio N, Viola RV, Piras G, et al. Proactive risk assessment through failure mode and effect analysis (FMEA) for haemodialysis facilities: a pilot project. Front Public Health. 2022;10: 823680. doi:10.3389/fpubh.2022.823680
10. Umbelino V, Coutinho F, Fonseca I, Monteiro I. Standards about medical equipment maintenance – a survey. IEEE 6th Portuguese Meeting on Bioengineering (ENBENG). Lisbon, Portugal; 2019. p. 1-4. doi: 10.1109/ENBENG.2019.8692460.
11. Alshehri A, Balkhi B, Gleeson G, Atassi E. Efficiency and resource allocation in government hospitals in Saudi Arabia: a casemix index approach. Healthcare (Switzerland). 2023;11(18):2513. doi:10.3390/healthcare11182513
12. Creuza Borges De Araújo M, Hazin Alencar L, Maria C, Mota M. Project procurement management: a structured literature review. International Journal of Project Management. 2017;35(3):353-77. doi:10.1016/j.ijproman.2017.01.008
13. Alabdali MA, Salam MA. The impact of digital transformation on supply chain procurement for creating competitive advantage: an empirical study. Sustainability. 2022;14(19): 12269. doi:10.3390/su141912269
14. Tutty MA, Carlasare LE, Lloyd S, Sinsky CA. The complex case of EHRs: Examining the factors impacting the EHR user experience. J Am Med Inform Assoc. 2019;26(7):673–7. doi:10.1093/jamia/ocz021
15. Rahal RM, Mercer J, Kuziemsky C, Yaya S. Factors affecting the mature use of electronic medical records by primary care physicians: a systematic review. BMC Med Inform Decis Mak. 2021;21(1):67. doi:10.1186/s12911-021-01434-9
16. Rockstroh K, Sykes D, Kachur M. Acoustic comfort in health care facilities: perspective of FGI-Facility Guidelines Institute. J Acoust Soc Am. 2022;151:A70–1. doi: 10.1121/10.0010689
17. van Eck van der Sluijs A, Vonk S, van Jaarsveld BC, Bonenkamp AA, Abrahams AC. Good practices for dialysis education, treatment, and eHealth: A scoping review. PLoS One. 2021;16(8):e0255734. doi:10.1371/journal.pone.02557344
18. McIsaac S, Wax RS, Long B, Hicks C, Vaillancourt C, Ohle R, et al. Just the Facts: Protected code blue-cardiopulmonary resuscitation in the emergency department during the coronavirus disease 2019 pandemic. CJEM. 2020;22(4):431–4. doi:10.1017/cem.2020.379
19. Tu H, Carrick K, Potts R, Hasselberg M, Verdecia M, Burns C, et al. A reference standard for analytical testing of erythropoietin. Pharm Res. 2022;39(3):553–62. doi:10.1007/s11095-022-03213-1
20. Zehir S, Zehir C. Effects of total quality management practices on financial and operational performance of hospitals. Sustainability. 2023;15(21):15430. doi:10.3390/su152115430
21. Dewi A, Seftaviani N, Rochmawati E. Patient safety incident differences between accredited and not accredited primary health center. Jurnal Medicoeticolegal dan Manajemen Rumah Sakit. 2019;8(3):215–

23. doi:10.18196/jmmr.83109
22. La Russa R, Fazio V, Ferrara M, Di Fazio N, Viola RV, Piras G, et al. Proactive Risk assessment through failure mode and effect analysis (FMEA) for haemodialysis facilities: a pilot project. Front Public Health. 2022;10:823680. doi:10.3389/FPUBH.2022.823680/BIBTEX