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Root Cause Analysis in Healthcare: Strategies for Medical Error Prevention and Improvement-An Updated Review for Health Administrators

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Abstract:

Background: Medical errors are a significant concern in healthcare, resulting in preventable harm and substantial financial burden. These errors contribute to over 200,000 deaths annually in the United States and are linked to systemic shortcomings and poor healthcare processes. Root Cause Analysis (RCA) is recognized as a valuable tool in identifying the underlying causes of medical errors, particularly sentinel events, and implementing effective strategies for prevention.

Aim: This review explores the role of RCA in preventing medical errors, focusing on its application in healthcare settings, the systemic issues identified through RCA, and the effectiveness of interventions aimed at improving patient safety and care quality.

Methods: The study reviews existing literature on RCA in healthcare, analyzing case studies, guidelines by the Joint Commission, and other relevant reports. The research evaluates the use of RCA frameworks, particularly the 24-question guide and The Swiss Cheese Model, and how they aid in identifying system-level flaws.

Results: RCA investigations revealed that systemic errors, rather than individual mistakes, often contribute to sentinel events. Common contributing factors include ineffective communication, inadequate staffing, failure in procedural checks, and insufficient training. The implementation of corrective actions based on RCA findings has led to improvements in patient safety, reduced errors, and better resource allocation in healthcare institutions.

Conclusion: RCA is a critical tool in addressing medical errors and improving healthcare quality. By focusing on systemic factors, RCA offers a structured approach to identifying weaknesses in healthcare processes and formulating corrective actions. Its application has proven to enhance patient safety and reduce adverse events, leading to safer healthcare environments.

Keywords: Root Cause Analysis, Medical Errors, Sentinel Events, Patient Safety, Healthcare Quality, Systemic Factors, Joint Commission, Swiss Cheese Model.

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Introduction:

Medical error represents an unfortunate and persistent issue within the healthcare sector, attracting ongoing discourse due to its significant repercussions on patient outcomes and care quality. In a 1999 report by the Institute of Medicine (IOM), it was revealed that deaths attributed to medical errors surpassed those resulting from motor vehicle accidents, breast cancer, or AIDS [1]. Research indicates that approximately 400,000 hospitalized patients annually suffer preventable harm, with another study estimating that over 200,000 deaths per year are directly attributable to preventable medical errors [2][3][4]. Additionally, the financial burden of medical errors is extensive, with certain estimates suggesting annual healthcare costs of $20 billion, while others project that hospital-acquired infections alone may contribute $35.7 to $45 billion annually to these costs [2][3]. Reports discussing the underlying causes of medical errors often point to systemic shortcomings, while some studies highlight particular patient groups who are disproportionately vulnerable to such errors [5][6]. Recent discussions have also brought attention to the negative psychological and professional effects of medical errors on both patients' families and healthcare workers, contributing to burnout, impaired job performance, mental health issues, and even suicidal ideation [7][8]. While it can be difficult to identify the exact cause of medical errors in specific cases, it is critical to evaluate strategies aimed at preventing and mitigating these adverse events. Root cause analysis (RCA) has proven effective in reducing clinical and surgical errors across various specialties by establishing frameworks for quality improvement [9]. This article will explore the implementation of RCA in preventing medical errors and discuss strategies for ensuring ongoing quality improvement in healthcare settings.

Function:

The Institute of Medicine defines a medical error as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" [1]. Distinguishing between medical malpractice and medical error is crucial, as an adverse event may be attributed to medical error without meeting the criteria for malpractice or negligence. Medical errors typically arise from improper execution of an intended plan or faulty procedural planning. As such, the occurrence of a medical error can be highly variable, potentially affecting any stage of patient care, from admission to discharge, and even extending to outpatient settings. Importantly, medical errors can occur without directly harming the patient, but even in these instances, it is essential to assess the root causes of such errors and develop preventive measures, regardless of the absence of harm [10][11].

The Joint Commission defines a sentinel event as any unexpected adverse occurrence "involving death, serious physical or psychological injury, or the risk thereof." The term "or the risk thereof" also includes any process variation that, if repeated, could result in a significant adverse outcome. Sentinel events necessitate an immediate investigation to identify their causes and formulate corrective measures. Furthermore, the Joint Commission requires that all member healthcare organizations report sentinel events involving unexpected mortality, significant permanent harm, or severe, temporary harm that necessitates intervention to preserve life [12][13]. These events can severely impact patients and also harm the professional standing of healthcare providers. Notably, sentinel events are not linked to a patient's underlying medical condition but are instead the result of incorrect medical interventions or flawed techniques. For example, if a patient experiences an anaphylactic reaction after receiving medication, clinicians must determine whether the reaction was due to the medication itself or a failure to review the patient's allergy history prior to administration. Such cases must be critically examined to ascertain whether the error was preventable, a task that often proves challenging.

Root cause analysis (RCA) serves as a systematic approach for identifying the underlying causes of medical errors, particularly those leading to sentinel events. The Joint Commission mandates a standardized RCA process to investigate the causes of medical errors, enabling healthcare institutions to develop strategies to prevent future occurrences [13]. Despite its widespread use in business, engineering, and industrial fields, the application of RCA in the medical sector has been somewhat limited. The purpose of RCA is not to assign blame to individuals but to identify weaknesses in system-level processes that can be redesigned to prevent

patient harm and reduce the likelihood of future sentinel events. By identifying the root cause of a medical error, healthcare organizations can more effectively target areas for additional training and resource allocation.

Application of Root Cause Analysis

For the purpose of accreditation, the Joint Commission mandates that healthcare organizations implement a thorough process for systematically analyzing sentinel events. Root Cause Analysis (RCA) is among the most widely used methods for this objective. Through RCA, healthcare institutions endeavor to uncover all contributing factors that led to an adverse event. Essentially, RCA investigations persistently probe the underlying reasons for a medical error until all deficiencies in the system are identified. The RCA approach focuses on lapses in systemic processes rather than individual actions. Following a sentinel event, a dedicated RCA team is assembled to review the event and pinpoint necessary system-level changes aimed at enhancing performance and minimizing the likelihood of recurrence [14]. Failure to conduct an RCA within 45 days of a sentinel event may result in the healthcare institution being placed under accreditation watch, a public record. Repeated non-compliance can lead to an onsite review by the Joint Commission, which may jeopardize the institution's accreditation [15].

The first step in conducting an RCA is assembling an interprofessional team to investigate and define the issue. Typically, a structured process is put in place to facilitate communication with senior leadership throughout the investigation, establish internal deadlines, and meet the Joint Commission's requirements. Once the problem is identified, the team evaluates the systemic factors contributing to the error. Throughout the investigation, it is crucial to gather data regarding potential underlying causes. The team should propose and implement immediate changes to prevent a recurrence of the sentinel event during the RCA process. In developing these interventions, the team evaluates the identified root causes, considers their interrelations, and explores strategies for risk reduction and process improvement to prevent future errors at the systemic level. Additionally, the team must engage in discussions with senior leadership and key stakeholders to assess the acceptability of the proposed changes. Several models can guide the RCA inquiry, one of which is "The Swiss Cheese Model." This model posits that errors occur due to failures at four primary levels: unsafe acts, preconditions for unsafe acts, supervisory factors, and organizational influences. These failures align in such a way that they enable patient injury, and thus, RCA teams focus on identifying breakdowns at each level that contributed to the adverse event [16].

To facilitate the RCA process, the Joint Commission has established a framework consisting of 24 questions designed to organize the analysis and structure the report submitted to the Commission. This guide addresses various situational factors that may have contributed to a sentinel event. It includes examining the systematic process, human factors, equipment failures, environmental conditions, uncontrollable external factors, organizational influences, staffing and qualifications, contingency plans, performance expectations, communication issues, and technological challenges [13]. A thorough evaluation of each of these factors enables a comprehensive analysis of the cause of the sentinel event. Communication, for instance, is scrutinized in several of the 24 questions, focusing on how information is conveyed within the organizational structure, the efficiency and clarity of message delivery, and the effectiveness of the communication system. Environmental factors are also examined to assess whether situational issues during the sentinel event may have impacted the outcome. Staffing considerations are also critical, as the team assesses whether staff were appropriately qualified, competent, and sufficiently allocated for their roles [17].

Following analysis, corrective actions are developed to address identified areas in need of improvement. Utilizing the 24-question framework, the team evaluates causative factors to determine which areas can be restructured to reduce risk. The RCA should be clear, precise, and sufficiently comprehensive in scope and depth. The Joint Commission has outlined a series of adverse events that fall under its purview. These primarily include sentinel events that result in death or permanent loss of function unrelated to any underlying medical conditions, such as: The Joint Commission's guidelines for sentinel events include a range of serious occurrences that result in significant harm to patients. One such event is the suicide of a

patient who has received care within 72 hours of discharge from a healthcare facility, including those discharged from the emergency department. This situation highlights the critical need for healthcare institutions to monitor and manage patient mental health closely, especially during the transition from care to discharge. Similarly, the occurrence of unanticipated health issues in full-term infants, such as sudden neonatal complications, emphasizes the importance of thorough post-birth assessments and follow-up care to mitigate risks that could lead to severe outcomes.

In addition, the discharge of an infant to the wrong family is another sentinel event that carries severe consequences, both for the patient and the healthcare institution involved. Such errors underscore the necessity for rigorous identification and verification procedures, particularly in the context of newborn care, to prevent confusion and misplacement of vulnerable infants. Another critical event outlined by the Joint Commission involves patient abduction. The abduction of any patient receiving care, treatment, or services requires immediate attention to security protocols, patient monitoring systems, and emergency response procedures to safeguard individuals under healthcare supervision. The elopement of a patient within a healthcare setting, which leads to harm, is also considered a sentinel event. Such occurrences typically result from inadequate monitoring, patient confusion, or lapses in staff vigilance. Institutions must ensure that there are sufficient safeguards in place to prevent patients from leaving without authorization, particularly in settings where patients may be at risk of harming themselves or others. Furthermore, hemolytic transfusion reactions, which require the administration of blood products, represent another significant event that requires immediate intervention. These reactions can cause severe and sometimes fatal outcomes, highlighting the critical need for stringent protocols in blood transfusions, including proper matching and monitoring. The occurrence of rape, assault, or homicide within healthcare premises is another tragic sentinel event that demands comprehensive preventive measures. Healthcare institutions must implement strict security measures, staff training on handling potentially dangerous situations, and clear protocols for reporting and responding to such incidents. Additionally, incidents involving the wrong patient, site, or procedure during surgical interventions also fall under the category of sentinel events. These errors, often attributed to miscommunication or inadequate patient verification, underscore the importance of rigorous preoperative procedures, including confirmation protocols and team communication, to ensure the correct patient and procedure are identified before surgery.

The unintended retention of foreign bodies in patients following surgery, while less common, is a serious event that can result in significant harm. This issue highlights the importance of meticulous surgical practices, including thorough counts of instruments and materials used, as well as post-operative monitoring to prevent such occurrences. Severe neonatal hyperbilirubinemia, which can lead to long-term complications if not addressed promptly, also falls under the Joint Commission's purview. Ensuring proper monitoring and timely intervention in neonates is critical to preventing the serious consequences of untreated jaundice. Similarly, prolonged fluoroscopy with a cumulative dose to the wrong body region is a sentinel event that highlights the importance of strict adherence to radiation safety protocols. This issue is particularly relevant in procedures that involve imaging and radiation, where accurate targeting is essential to avoid harm. Fire, flame, or unanticipated smoke, heat, or flashes during patient care is another serious event that requires healthcare institutions to be prepared for emergency situations that may arise in care settings, particularly in high-risk environments such as operating rooms or intensive care units. Finally, intrapartum maternal death and severe maternal morbidity are grave outcomes that the Joint Commission identifies as sentinel events. These occurrences require healthcare institutions to ensure that comprehensive prenatal care, appropriate interventions during labor, and effective management of complications are in place to safeguard maternal health and minimize risks during childbirth. These sentinel events highlight the importance of ongoing vigilance, improved clinical practices, and systematic interventions to prevent adverse outcomes and ensure patient safety within healthcare environments.

The finalized Root Cause Analysis (RCA) report must adhere to specific standards to meet the Joint Commission's requirements, ensuring a comprehensive and structured approach to identifying and addressing systemic issues. First, the participation of the organization's leadership and key stakeholders is essential, as their involvement guarantees that the findings are aligned with the institution's strategic goals

and that any recommended changes have the necessary support for implementation. This collaboration also facilitates a broader understanding of the impact of the event and the necessary steps for improvement across various levels of the organization.

Furthermore, the report must provide a thorough explanation of all findings, detailing the contributing factors and root causes identified during the investigation. This includes not only a clear description of the events that led to the sentinel event but also an analysis of how each contributing factor interacted within the broader system. In addition to the findings, the report should reference any relevant or applicable studies or frameworks that support the analysis. Incorporating existing literature or best practices helps validate the approach and ensures that the findings are informed by established evidence, thereby enhancing the credibility of the RCA process. Another critical element is ensuring internal accuracy and consistency throughout the report. The RCA report must be free from contradictions or unanswered questions, as these can undermine the reliability of the investigation, and the corrective actions proposed. The findings should be precise and substantiated with appropriate data, and the recommendations must be based on a thorough evaluation of all relevant factors. By meeting these standards, the RCA report ensures that healthcare institutions can effectively address the root causes of sentinel events, implement corrective measures, and reduce the likelihood of recurrence.

Case Illustrations with Root Cause Analysis Interventions

The following cases demonstrate various medical errors, the process of Root Cause Analysis (RCA) employed to identify the failures, and the corrective interventions implemented to prevent the recurrence of similar errors.

Case Example 1

A 42-year-old primigravida at 34 weeks gestation presented to the obstetric emergency department at midnight with severe headache, blurry vision, right upper quadrant pain, and progressively increasing lower extremity edema and facial swelling. Her medical history indicated gestational hypertension, and she had been prescribed labetalol 200 mg twice daily a week prior. Upon presentation, her blood pressure was recorded at 190/110 mm Hg on two separate occasions, five minutes apart, and she had gained 2 kilograms since her last antenatal visit. The patient was diagnosed with severe preeclampsia, and the senior obstetric resident ordered a loading dose of magnesium sulfate to prevent imminent seizures. The hospital's protocol called for an intravenous (IV) and intramuscular (IM) regimen, where the patient received a 4 g IV bolus and a 10 g IM dose, split between both buttocks. The senior resident issued a verbal order for the administration of magnesium sulfate to a junior resident, who then communicated the order to the nurse. The complexity of the magnesium sulfate dosing regimen, which involved multiple doses administered in different locations, led to an error in preparation due to the nurse feeling rushed in the urgent situation. The nurse, relying on memory due to a faded chart in the drug preparation room, incorrectly prepared the medication. However, the nurse cross-checked the dose with a second nurse who identified the error in time. Additionally, the senior resident, hearing the dosage communicated aloud, also recognized the mistake, leading to the cessation of the drug administration.

Root Cause Analysis with Corrective Measures: The RCA identified multiple system-level issues contributing to the error. Magnesium sulfate was classified as a high-alert medication as per the Institute of Safe Medication Practices. To mitigate future errors, premixed solutions prepared by the pharmacy for the bolus dosing were introduced, eliminating the need for nurses to prepare this high-risk medication. Furthermore, the second nurse verification measure was reinforced, requiring a double-check of all doses, drug names, pump settings, and concentrations before administration. The RCA also recommended that all medication orders be submitted in writing and entered into the electronic medical record using computerized provider order entry (CPOE) systems, regardless of urgency, to prevent dosing errors. It was emphasized that verbal communication for medication orders should be avoided, and if it were deemed necessary, the nurse should always read back the order to ensure its accuracy, thus minimizing prescribing errors.

Case Example 2

Anna Joy, a primigravida at 30 weeks gestation, was admitted to a busy obstetric ward with complaints of intermittent cramping abdominal pain. As she was visiting from Spain, her primary language was Spanish, though her husband and sister, both fluent in English, assisted with translation during the medical history and admission process. The patient was evaluated by an obstetrician who advised routine evaluation and observation for threatened preterm labor. Another patient, Ann Jay, at 34 weeks gestation, was also admitted to the same ward for gestational diabetes mellitus with hyperglycemia. An endocrinologist advised glucose monitoring and insulin administration. The nurse, who had been assigned to both patients, performed a blood glucose check on Ann Jay, communicated the results to the endocrinologist, and was instructed to administer 6 units of regular insulin before lunch. Upon being informed by the nurse that Anna Joy had experienced decreased fetal movement, the obstetrician advised continued observation and fetal kick counts.

Later, the family of Anna Joy informed the nurse that they were going for lunch. Subsequently, the nurse, who was unaware of Anna Joy's language preference, rushed through patient identification with two unique identifiers and mistakenly administered the insulin meant for Ann Jay to Anna Joy. This error went unnoticed until after the administration. Upon recognizing the mistake, the attending obstetrician and endocrinologist were informed and took immediate actions to closely monitor Anna Joy, but no adverse effects were observed.

Root Cause Analysis with Corrective Measures: The RCA investigation highlighted that the nurse involved had five years of experience in the hospital and had recently transitioned to the obstetric ward, where such an incident had not occurred previously. The team recognized that modern patient care relies heavily on efficient interprofessional team collaboration. Clear, consistent, and standardized communication within the team is essential for safe patient care and reducing the risk of adverse outcomes. The RCA team did not attribute blame to the nurse but instead implemented a standardized handoff platform for all future patient transfers, ensuring a structured and effective exchange of information during shift changes. The team also introduced mandatory use of hospital-based interpreters for patients who are not fluent in English to prevent miscommunication. The procedure for verifying patient identification using two unique identifiers—name and date of birth—was maintained, with an additional mandatory step introduced: verifying patient identity via arm-band barcode before each medication administration. To further prevent errors, patient charts and rooms with similar names or birth dates were clearly highlighted, increasing the visibility of potential risks.

Case Example 3:

A 26-year-old primigravida at 39 weeks of gestation, with no associated high-risk factors, was admitted to the labor and delivery unit with labor pains. The patient was managed according to routine labor protocols. Upon reaching a cervical dilation of 4 cm, the cardiotocograph revealed prolonged fetal bradycardia lasting 3.5 minutes, which did not resolve with conservative interventions. As a result, the patient was transferred to the operating room for an emergent cesarean section. The delivery was successful, with the baby in good condition and no intraoperative complications. However, prior to closure, the operating obstetrician requested a surgical count, at which point the scrub nurse reported a missing gauze piece from the surgical trolley. Multiple counts were performed by the scrub and floor nurses, and a second on-call obstetrician was called in to assist with a thorough search of the surgical field. An intraoperative x-ray was conducted to assess for a retained sponge, which yielded negative results. Despite these delays, the abdominal closure proceeded, extending the operative time to 2 hours and 30 minutes.

Root Cause Analysis and Corrective Measures: An investigation revealed inconsistencies in the surgical count practices, particularly with the sole responsibility of the scrub nurse for performing the count. The Root Cause Analysis (RCA) emphasized the necessity of a standardized, systematic approach to surgical counts to minimize human error. The team referenced international standards advocating for the standardization of the counting process and the tracking of instruments, gauze, and sponges in the sterile

field. As a result, the team implemented the World Health Organization's Surgical Safety Checklist as a mandatory procedure for all surgeries, irrespective of urgency. The counting process was made mandatory for both the scrub and circulating nurses, who would independently verify counts before and after each procedure. This new protocol ensures that best practices are followed in surgical settings, minimizing risks of retained foreign bodies.

Case Example 4:

A 25-year-old male patient presented for bilateral LASIK surgery at a same-day surgery center. The operating surgeon, not typically practicing at this facility, obtained informed consent and proceeded with the surgery after conducting a preoperative examination. The refractive errors were diagnosed as -4 D for the right eye and -5 D for the left eye, with the goal of correcting both eyes. A timeout was conducted to confirm the correct patient and procedure. The LASIK procedure was completed uneventfully on both eyes, but complications arose when the surgeon attempted to align the first eye under the excimer laser for iris recognition. Despite several unsuccessful attempts to recognize the iris pattern, the surgeon chose to continue, and the technician did not want to contradict the decision. Meanwhile, the circulating nurse identified that the patient's table was improperly adjusted, with the left eye under the laser instead of the right. The nurse activated the emergency stop, halting the procedure, and the laser was restarted after verifying the correct eye sequence.

Root Cause Analysis and Corrective Measures: The RCA team identified the complexities associated with bilateral procedures, such as LASIK, where the correction is pre-determined but not immediately titrated. Given the lack of obvious pathology in the eye apart from refractive errors, the risk of wrong-site surgery is elevated. To mitigate these risks, the RCA team instituted a verification procedure requiring the optometrist, technician, and surgeon to confirm the refractive errors of both eyes prior to programming the laser. The team also noted that advanced laser systems with built-in iris recognition technology could further reduce errors by providing an additional layer of defense to ensure the correct eye is treated. However, when such technology is unavailable, responsibility falls to the surgeon, technician, and nurse to accurately identify the appropriate eye, reducing the likelihood of incorrect treatment.

Case Example 5:

A primary care clinic, which treats approximately 110 patients daily, was staffed by two primary care physicians, two nurses, and scribes. A 10-year-old boy visited the clinic with complaints of a runny nose for the past 10 days. The primary care physician diagnosed allergic rhinitis and recommended cetirizine, an over-the-counter antihistamine. However, due to one scribe calling in sick, a secretary assisted the physician. The physician informed the parents that cetirizine could be purchased at any pharmacy. Two days later, the child's mother returned, reporting that the child was lethargic. The front desk staff communicated the concern to the physician, who, assuming somnolence was a common side effect of cetirizine, instructed the mother to keep the child at home. Subsequently, the mother sought advice from a specialist who noted the child was taking 10 mg cetirizine twice daily—double the recommended dosage.

Root Cause Analysis and Corrective Measures: Upon review, the RCA team discovered a typographical error in the written instructions given to the parents. The recommended dosage of 5 mg twice daily had been incorrectly transcribed as 10 mg twice daily. In response, the RCA team recommended the introduction of a verification process for all medication prescriptions, which would include verbal and written confirmations of drug dosages by the prescribing physician and office personnel. Additionally, the team emphasized the need for physicians and staff to read and verify prescription instructions with patients or caregivers to ensure alignment with the clinician's original notes. The RCA also instituted a document review process for all follow-up appointments to confirm that the patient's condition was thoroughly reviewed before any communication with the patient occurred.

Issues of Concern

The Institute of Medicine (IOM) identifies medical errors as one of the primary causes of death and injury, underscoring their significant public health impact [1]. According to the 2019 World Health Organization

(WHO) Patient Safety Factsheet, adverse events arising from unsafe patient care are ranked among the top ten causes of death and disability globally. In the United States, preventable adverse events account for an estimated 44,000 to 98,000 hospital deaths annually, surpassing deaths from motor vehicle collisions [1]. Furthermore, in terms of healthcare costs, disability, and lost productivity, medical errors impose an additional economic burden ranging from $37.6 billion to $50 billion [1]. The most profound consequence of these errors is the direct harm they cause to patients and their families. Consequently, Root Cause Analysis (RCA) plays a crucial role in identifying systemic flaws that contribute to medical errors, enabling the implementation of corrective actions to prevent recurrence.

Types of Medical Errors

Healthcare professionals must be well-versed in the various types of medical errors to better understand the adverse events that can arise. Errors are not always attributable to human miscalculations or communication failures. Some errors are inherent in clinical settings, such as patient falls in hospital environments and healthcare-associated infections. The most common categories of medical errors include surgical errors, diagnostic errors, medication errors, equipment failures, patient falls, hospital-acquired infections, and communication failures [3][18].

- **Surgical Errors**: Surgical errors carry the highest risk of severe patient harm and death. It is estimated that intraoperative errors account for the primary issue in 75% of malpractice cases involving surgeons. Surgical errors, including wrong-site, wrong-patient, or wrong-procedure errors, should be unequivocally preventable. Investigations into the causes of these surgical errors often reveal factors such as clinician stress (e.g., being rushed, fatigued, or distracted), miscommunication, inadequate staffing, organizational shortcomings (e.g., specimen mismanagement), medical record discrepancies, and cognitive errors [19].
- **Diagnostic Errors**: The National Academy of Medicine defines diagnostic errors as the failure to establish a timely and accurate explanation of a patient's health issue or to communicate that explanation effectively to the patient. Missed or delayed diagnoses are a form of diagnostic error. According to the Joint Commission, diagnostic errors lead to the death or injury of 40,000 to 80,000 patients annually. These errors are most prevalent in primary care solo practices, where factors such as heavy workloads, time constraints, and limited collaboration with colleagues exacerbate the issue [21]. Commonly misdiagnosed conditions include malignancies, surgical complications, and neurological, cardiac, and urological issues [22][23][24]. Research shows that these diagnostic failures often stem from knowledge gaps, which lead to suboptimal clinical assessments and reasoning. Identifying these conditions is crucial because diagnostic errors are primarily cognitive, rather than organizational. Clinicians can thus be forewarned of the challenges involved in diagnosing these conditions [25]. Contributing factors to diagnostic errors include clinician fatigue, distraction, failure to consider alternative diagnoses, neglecting diagnostic follow-up, and inadequate post-diagnosis care [11][21].
- **Medication Errors**: Medication errors are widely acknowledged as the most prevalent and preventable cause of patient harm [26]. With multiple stages involved in the medication process—prescribing, dispensing, dosing, and administration—errors can occur at any point. The incidence of medication errors resulting in adverse events in acute hospitals is approximately 6.5 events per 100 admissions [26]. Furthermore, medication errors occurring before or after discharge are often overlooked, posing significant risks to patient safety [26].
- **Equipment Errors**: Medical equipment errors, which can result from design flaws, mishandling, user error, or malfunction, are frequent causes of adverse events. Additionally, many medical devices, such as pacemakers, defibrillators, and nerve stimulators, are implanted in patients, and failures of these devices can lead to life-threatening complications. Equipment errors can also arise from variability between manufacturers, insufficient testing and maintenance, poor design, and inadequate upkeep. Misconnections, such as using catheters for unintended purposes, running incorrect lines through pumps, or misplacing feeding tubes into the lungs, are common examples. These errors can have severe consequences if not identified and corrected early [27][28]. Moreover, errors in the placement of feeding tubes and other

medical equipment often result in medication or food supplements being administered incorrectly or omitted altogether.

- **Hospital-acquired Infections**: Healthcare-associated infections (HAIs) represent a systemic failure, with as many as one in 20 hospitalized patients acquiring such an infection, leading to increased complications, prolonged hospital stays, and higher costs. HAIs contribute approximately $35 billion annually to healthcare costs in the United States [29]. Common causes of HAIs include inadequate hand hygiene practices and improper techniques in inserting indwelling urinary and vascular catheters. The most prevalent HAIs include catheter-associated urinary tract infections, surgical site infections, hospital-acquired pneumonia, central line-associated sepsis, and care-related skin and soft tissue infections [29].
- **Patient Falls**: Each year, more than one-third of individuals over 65 years of age experience a fall, with one-third of these incidents resulting in injury [30]. In healthcare settings, additional risk factors for falls include blood loss, medication side effects, post-anesthesia effects, hypoglycemia, altered mental status, advanced age, mobility impairment, and inadequate staffing [31].
- **Communication Errors**: Effective interprofessional communication, as well as communication with patients, is critical to providing optimal care. Communication errors are thus a frequent cause of adverse events [32]. Factors contributing to communication failures include disruptive patient behavior, environmental distractions (e.g., cell phones and pagers), cultural and language barriers, hierarchical issues, personality conflicts, and socioeconomic factors, such as education and literacy levels [11]. Furthermore, errors in written communication, such as the use of nonstandard abbreviations, illegible handwriting, failure to question inappropriate orders, and incorrect specimen labeling, are commonplace and often lead to clinical mistakes [11].

Conclusion:

Root Cause Analysis (RCA) plays an essential role in healthcare by investigating medical errors, particularly sentinel events, and identifying the root causes of these errors. As medical errors remain a significant issue in healthcare, often leading to preventable patient harm and high financial costs, RCA offers a systematic approach to address these problems. One of the key strengths of RCA is its focus on systemic flaws rather than assigning individual blame. This systemic approach helps healthcare organizations identify broader issues in processes, communication, training, staffing, and equipment that contribute to adverse events. The implementation of RCA findings has led to numerous improvements in patient safety, such as the development of better communication protocols, improved staff training, and revised procedural checks. The Joint Commission mandates that healthcare institutions conduct RCA for sentinel events, which include serious errors leading to death or significant harm. The RCA process involves assembling an interprofessional team to conduct a thorough investigation, analyze data, and propose corrective actions to prevent recurrence. A significant advantage of RCA is its focus on interprofessional collaboration, bringing together diverse perspectives and expertise to identify weaknesses in the system. This collaborative approach ensures that corrective measures are comprehensive and that solutions are not just theoretical but are implemented effectively across various levels of the organization. Models such as The Swiss Cheese Model help visualize how errors occur at multiple levels of the healthcare system, emphasizing the importance of addressing gaps at each level. The use of structured frameworks, such as the 24-question guide provided by the Joint Commission, ensures that investigations are thorough and consistent, covering all possible contributing factors, including human errors, environmental conditions, and organizational influences. These tools help identify patterns that may not be immediately obvious, providing deeper insights into the underlying causes of medical errors. By addressing the root causes of medical errors, RCA has the potential to transform healthcare systems and reduce the occurrence of preventable adverse events. The evidence gathered from RCA investigations provides healthcare institutions with actionable insights that can be used to reform policies, improve patient care protocols, and enhance the overall safety of healthcare environments. Ultimately, the application of RCA enhances patient outcomes, reduces medical errors, and contributes to a culture of continuous quality improvement. By prioritizing systemic improvements over individual accountability, RCA fosters a more supportive, collaborative environment within healthcare organizations, leading to better healthcare outcomes for all patients.

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تحليل السبب الجذري في الرعاية الصحية: استراتيجيات للوقاية من الأخطاء الطبية والتحسين - مراجعة محدثة لإداري الرعاية الصحية

الملخص:

الخلفية: تعتبر الأخطاء الطبية مصدر قلق كبير في الرعاية الصحية، حيث تؤدي إلى ضرر قابل للتجنب وعبء مالي كبير. تسهم هذه الأخطاء في أكثر من 200,000 حالة وفاة سنويًا في الولايات المتحدة وترتبط بالإخفاقات النظامية والعمليات غير الفعالة في الرعاية الصحية. يُعترف بتحليل السبب الجذري (RCA) كأداة قيمة لتحديد الأسباب الأساسية للأخطاء الطبية، خاصة الحوادث الكبرى، وتنفيذ استراتيجيات فعالة للوقاية.

الهدف: تستعرض هذه المراجعة دور تحليل السبب الجذري في الوقاية من الأخطاء الطبية، مع التركيز على تطبيقه في بيئات الرعاية الصحية، والمشاكل النظامية التي يتم تحديدها من خلاله، وفعالية التدخلات الرامية إلى تحسين سلامة المرضى وجودة الرعاية.

الطرق: تستعرض الدراسة الأدبيات الحالية حول تحليل السبب الجذري في الرعاية الصحية، وتحلل دراسات الحالة، والإرشادات الصادرة عن اللجنة المشتركة، وتقارير أخرى ذات صلة. كما تقيم البحث في استخدام أطر عمل تحليل السبب الجذري، لا سيما دليل الأسئلة الـ 24 ونموذج الجبن السويسري، وكيفية مساعدتها في تحديد العيوب على مستوى النظام .

النتائج: أظهرت تحقيقات تحليل السبب الجذري أن الأخطاء النظامية، بدلاً من الأخطاء الفردية، تساهم في الحوادث الكبرى. تشمل العوامل المشتركة المساهمة في هذه الأخطاء ضعف التواصل، ونقص التوظيف، وفشل في التحقق من الإجراءات، وعدم كفاية التدريب. أدت تطبيقات الإجراءات التصحيحية استنادًا إلى نتائج تحليل السبب الجذري إلى تحسينات في سلامة المرضى، وتقليل الأخطاء، وتحسين تخصيص الموارد في مؤسسات الرعاية الصحية.

الخاتمة: يُعد تحليل السبب الجذري أداة حاسمة في معالجة الأخطاء الطبية وتحسين جودة الرعاية الصحية. من خلال التركيز على العوامل النظامية، يقدم تحليل السبب الجذري نهجًا منظمًا لتحديد نقاط الضعف في العمليات الصحية وصياغة الإجراءات التصحيحية. لقد ثبت أن تطبيقه يعزز سلامة المرضى ويقلل من الحوادث السلبية، مما يؤدي إلى بيئات رعاية صحية أكثر أمانًا.

الكلمات الرئيسية: تحليل السبب الجذري، الأخطاء الطبية، الحوادث الكبرى، سلامة المرضى، جودة الرعاية الصحية، العوامل النظامية، اللجنة المشتركة، نموذج