Chapter

Prevention Strategies for Patient Safety in Hospitals: *Methodical Paradigm, Managerial Perspective, and Artificial Intelligence Advancements*

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Abstract

Patient safety is fundamental to high-quality patient care. Hospitalization has its inherent complications. Medical errors can further comprise patient safety. Hospitals provides an opportunity for practicing preventive medicine. Two important areas are (i) making treatment and hospitalization free from side-effects (ii) obviating medical errors. In hospitals these can have serious consequences. Patient safety compromise can occur at the individual or system level. A methodical model for this should include (i) Intervention design (ii) Intervention implementation (iii) Intervention institutionalization. Managerial perspective important for leadership and team work. Leadership can energize excellence in the coordination and mobilization of the large number of inter-dependent processes and resources needed for achievement of patient safety. Three-dimensional strategy for Leadership is suggested (i) Initiatives appealing (ii) Integrating all (iii) Incremental advancements. The 'Five Es' for Teamwork, and the 'Five Cs' for Organizational Change are elaborated. Artificial Intelligence has the potential to improve healthcare safety. AI enables analysis of data from multiple sources simultaneously using advanced algorithms. This identifies predictors and outcomes. Ensemble learning algorithms, used by advanced practitioners of machine learning, are useful with high final accuracy. Hence in matters of health these should be utilized. All this will make prevention targeted, better, and timely.

Keywords: errors, side effects, hospital design, nosocomial, stress ulcers, pneumonia, management, artificial intelligence, algorithms, prediction

1. Introduction

"To err is human & not to err is not a hype, but an achievable ability"

Delivering the right care at the right time in the right setting is the core mission of Hospitals. Hospitalization has its inherent complications and medical errors can further compromise patient safety. Institute of Medicine's sentinel report "To Err is Human: Building a Safer Health System" is a worldwide inspiration wonderful [1]. The report advanced patient safety and stimulated dedicated research funding to this essential aspect of patient care. Since then, highly effective interventions have been developed and adopted for hospital-acquired infections and medication safety [2]. Progress and perfection in addressing other hospital adverse events is desirable.

Medical errors are a serious public health problem. Patient safety is fundamental to high-quality patient care. Preventive strategies for patient safety are the need of the hour.

Hospitals provides an opportunity for practicing preventive medicine. Two important areas are (i) to make treatment and hospitalization free from side-effects (like bed rest/immobility complications, nosocomial infections, treatment side-effects, etc) (ii) obviate medical errors. Although the scope of preventive medicine in hospitals is wide, we need to focus on important issues on priority.

There is growing awareness of the frequency, causes, and consequences of errors as well as side effects in medicine, all for progress for perfection. All this makes it important that we devise workable solutions – the prevention strategies.

"Trying to ensure the safest possible patient care is as old as medicine itself"
'Primum non nocere' (First, do no harm) is one of the core principles of medical practice.

1.1 Why hospitals?

Hospitals should be on the top of priority list. This is because medical errors may occur in different health care settings, and those that happen in hospitals can have serious consequences [3]. Health care organizations are struggling universally to identify and remediate safety-related challenges.

2. Methodical paradigm

Threats to patient safety result from complex causes. Improvements for safety are possible with analysis of causes of error. With this knowledge we need to design '*Preventive systems of care*' so as to make errors less common and less harmful when they do occur" [4].

The steps for practice of preventive Medicine in Hospitals should be

i. Intervention design: Defining and designing the content and the implementation plan of the intervention

ii. Intervention implementation

iii. Intervention institutionalization

2.1 Defining the problem

Critical steps toward improving the safety of the health care system include ensuring that the system is aware of what errors can occur and thus leading to formulation of effective remedies – Preventive action plan.

Internationally, an important study in this regard has been *The Harvard Medical Practice Study.* This was an interdisciplinary study of medical injury and malpractice, and was conducted in the early 1990s [5].

The first part of this study focused on the incidence of adverse events, defined as injuries resulting from negligent or substandard care. *Brennan et al.* reported that adverse events occurred in 3.7 percent of the hospitalizations (95% confidence interval [CI] = 3.2–4.2). Also, they reported that 27.6 percent (95% CI = 22.5–32.6) of the adverse events were due to negligence. Further, 13.6 percent of the adverse events led to the death of the patient [5].

The second part of the Harvard Medical Practice Study analyzed the records of 1,133 patients who had disabling injuries caused by medical treatment. *Brennan et al.* reported that among these patients, drug complications were the most common type of adverse event (19 percent), followed by wound infections (14 percent) and technical complications (13 percent) [6].

The latest figures are still disturbing. Patient harm due to adverse events is one of the top 10 causes of death and disability in the world [7].

2.2 Prevention strategies: concepts

Modern health care is highly complex, high risk, and error prone. All this makes, not surprisingly, health care errors and consequent adverse events a leading cause of death and injury. Well-documented methods to prevent the occurrence of many of these errors need to be constantly evolved. Safe Practices reducing the risk of harm resulting from the processes, systems, or environments of care are required. Patient safety should be the highest priority for health care providers [8].

2.3 Prevention strategies: environment

2.3.1 Hospital design

> *"We shape our buildings and afterwards our buildings shape us."*
> *Winston Churchill*

Evidence-based design is a term used to describe how the physical design of health care environments affects patients and staff [9]. Key characteristics of evidence-based design in hospital settings include single-patient rooms, use of noise-reducing construction materials, easily accessible workstations, and improved layout for patients and staff [10].

Several scholars highlighted that Evidence based design for built environment can lower the incidence of nosocomial infections, medical errors, patient falls, and staff

injuries [11]. Patient safety can be enhanced through flexibility and adaptability. The following need to be ensured:

1. Ensuring adequate space for work areas improves patient and staff outcomes [12]. More space for staff to provide care ensures safety. Less space more errors likely. More space can accommodate new, advanced procedures and diagnostics.

2. The windows of patient rooms should be adequately sized. Purposes served are improving visibility of patients for monitoring and also providing view of natural surroundings. Monitoring adequate ensures early safety energetically, mitigating errors or side-effects if any.

3. Light sources within rooms mimic natural light, promoting natural feelings, rather than exaggerating adverse feelings associated with hospitalization [13].

2.3.2 Art in art and science of medicine & patient safety perspective

Hospital environment should be pleasing, and art is an added advantage. Hospitalization is stressful, and stress can lead to multiplied side-effect of hospitalization, hence needs to be relieved. Artwork may enhance the effects on patient satisfaction, feeling of self-control and distraction by attractive stimuli. Art has positive effects on well-being and behavior. Natural scenes in patient rooms and diverse art in public areas should be preferred [14]. All this will alleviate the likely problems patients may face.

White coat hypertension needs attention, and recent evidence shows it is not innocent [15]. A Randomized Controlled Trial has shown that landscape photographic art in medical office examination rooms may have the beneficial effect of reducing white coat hypertension. The results show statistically significant difference between the mean arterial pressure, systolic BP and diastolic BP between the control room and the photo room [16].

2.4 Settings and strategies

2.4.1 Intensive Care Units (ICU)

Prevention of Complications of Critical Illness in ICU is important.

a. Venous thromboembolism (VTE)

   This is a serious complication for patients in the intensive care unit (ICU) [17]. All ICU patients are at high risk for this complication given their predilection toward immobility. It includes upper and lower extremity deep vein thrombosis (DVT) and pulmonary embolism (PE). Therefore, all ICU patients should receive some form of prophylaxis against VTE.
   A recent Systematic review and network meta-analysis of randomized clinical trials (RCTs) has concluded that LMWH reduces incidence of DVT, while UFH and mechanical compressive devices may reduce the risk of DVT. LMWH is probably more effective than UFH in reducing incidence of DVT. It should be considered the primary pharmacologic agent for thromboprophylaxis. The efficacy and safety of combination pharmacologic therapy and mechanical compressive devices is unclear [18].

b. Stress ulcers

Currently available data suggest that high-risk patients, such as those with coagulopathy, shock, or respiratory failure requiring mechanical ventilation, benefit from prophylactic treatment.
Prophylaxis against stress ulcers is frequently administered in most ICUs. Typically, histamine-2 antagonists are administered, and are preferred over proton pump inhibitors.

c. Prevention of pneumonia

Intensive care unit (ICU) acquired pneumonia is amongst the most common and morbid health care-associated infections.
Interventions reducing length of ICU stay reduces pneumonia incidence and should be prioritized. Other effective strategies are avoiding intubation, minimizing sedation, implementing early extubation strategies, and mobilizing patients. Dramatic decreases in Ventilator Associated Pneumonia rates occurs with implementation of ventilator bundles (**Table 1**). Best practices for implementation are engaging and educating staff and creating structures that facilitate bundle adherence. Regular feedback on process measure performance and outcome rates leads to improvements [19, 20].

2.4.2 Nosocomial infections

25–50% or more of nosocomial infections are due to the combined effect of the patient's own flora and invasive devices. There is a need for improvements in the use of such devices. Intensive education and "bundling" of evidence-based interventions (**Table 1**) can reduce infection rates through improved asepsis in handling and earlier removal of invasive devices. The maintenance of such gains requires ongoing efforts.

2.4.3 Neonatal ICU

Nosocomial infections are among the leading causes of mortality and morbidity in neonatal intensive care units.

Preventive strategies are (i) hand hygiene practices (ii) central venous (CVC)-related bloodstream infections prevention (iii) judicious use of antimicrobials for therapy (iv) enhancement of host defences with early enteral feeding with human milk (v) skin care.

2.4.4 Surgical safety

Adverse events have been estimated to affect 3–16% of all hospitalized patients. Surgical care contributes to half of these. More than half of such events are preventable [21].

One must be open to learning, embracing, and perfecting new surgical techniques of proven value. These include minimal tissue trauma, short operation times with brief ischemia periods, minimal blood loss etc [22]. Surgical progress with microsurgical techniques is leading the way for precision, perfection, and fewer complications [23].

Surgery has become more complex with more sophisticated technology and patients with more diverse and complex co-morbidities are being operated. Multiple

Central Venous Catheter Infections	*Catheter insertion*	• Training of personnel about catheter insertion and care. • Chlorhexidine for insertion site preparation. • Maximal barrier precautions and asepsis during catheter insertion. • Insertion supplies consolidation (e.g., in an insertion kit or cart). • Checklist to enhance adherence to the insertion bundle. • Halt insertion if asepsis is breached.
	Catheter maintenance	• Cleansing daily with chlorhexidine. • Clean & dry dressings. • Hand hygiene maintenance of health care workers.
	Daily assessment of need of the catheter. Remove catheter if not needed or used.	
Prevention of Ventilator-Associated Events		• Mechanical ventilation use only when absolutely necessary. • Elevation of head of bed to 30–45° • "Sedation vacation": a balancing act of tightly titrating the sedative dose to provide agitation free, comfortable sedation on the lowest dosage possible • Assessment for readiness to extubate daily. • Deep-vein thrombosis prophylaxis (unless contraindicated).
Prevention of Surgical-Site Infections		• Right surgeon for right surgery. • Prophylactic antibiotics within 1 h before surgery; discontinuation within 24 h. • Limit any hair removal to the time of surgery; use clippers or do not remove hair at all. • Surgical site preparation with chlorhexidine-alcohol.
Prevention of Urinary Tract Infections		• Bladder catheters use only when absolutely needed (e.g., to relieve obstruction). • Aseptic equipment and technique for catheter insertion and urinary tract instrumentation. • Manipulation or opening of drainage systems minimized. • Daily assessment of bladder catheter need? Remove if not needed.
Prevention of Pathogen Cross-Transmission		• Hands cleansing with alcohol hand rub before and after all contacts with patients or their environments.
Adapted from: www.cdc.gov/hicpac/pubs.html; www.cdc.gov/HAI/index.html.		

Table 1.
Evidence based "Bundled Interventions" to prevent common health care–associated infections and other adverse events.

team surgeries from diverse sub-specialties are becoming more common. These also entail risk of more errors. Dr. Atul Gawande, Professor of Surgery at Harvard Medical School, argues that using checklists can help surgeons to cope with increasing complexity. Use of a rigorous checklist in this rapidly changing environment will consolidate surgeons' aims to enhance both patient safety and clinical professionalism [24].

Strategy for wrong-site, wrong-patient, wrong-procedure events

Although, such events are rare but the consequences can be devastating. Hence prevention is of utmost importance.

Recent efforts made to address and prevent wrong-site surgery by a team at Naval Hospital, Cherry Point, NC (NHCP), have exemplified this [25]. Surgical verification checklist and its implementation provides for quality, safety, and a commitment to patient care.

2.4.5 Maternal and newborn health

While in most cases having a baby is a positive experience, pregnancy and childbirth can cause suffering, ill health or even death. Every year, women and newborn babies die from complications related to childbirth.

The interventions and approaches that help save the lives of mothers and babies are well documented (**Table 2**). They can work even where resources are poor [26].

Maternal hospital care	• Hygiene and accident prevention (staff) Staff has access to fully equipped hand washing facilities. Sharps are disposed of in a special container to prevent accidents
	• Hygienic conditions (mothers) There are sufficient and adequate toilets which are clean and easily accessible. Mothers have access to running water, soap and to an appropriate space, near the ward, to wash themselves and their child. Mothers have access to a washing facility for washing theirs and their babies' clothes.
	• Rooming in Newborn babies are roomed in with their mothers. Proper place for changing diapers of their babies.
	• Attention for the most seriously ill women These should be cared for in a section where they receive closer attention - close to the nursing station (can be directly observed most of the time).
Nursery	• Separate room for sick newborn babies Mothers of these are allowed to stay with their babies
	• Hygienic services for mothers Toilets are adequate and easily available Mothers have access to running water and to an appropriate space, near the ward to wash themselves and their child
	• Special attention for the most seriously ill newborn babies The most seriously ill infants are cared for in a section near the nursing station for direct observation

Table 2.
Quality mother and newborn care features and facilities.

2.4.6 Hospital laboratories

Medical laboratory test data is increasingly being utilized. Medical laboratory should provide the doctor and the patient accurate, precise, and reliable results. Medical test malpractice can lead to a medical accident. Hence the need of quality and safety assurance with management of the overall processes required to provide high quality medical laboratory results [27]. Results should be transcribed in a reliable way and all necessary information should be provided for the correct interpretation of results [28]. It needs to be ensured that critical and alarming results are communicated to clinicians immediately.

2.4.7 Transitions in care – handing over

In health care organizations patients are subjected to multiple transitions in care. This is inevitable as continuous, 24-hour treatment necessitates the division of labor [29]. These transitions, or "handovers," are potential points of failure, thus making preventive

actions of utmost important. Gaps in handover communication between patient care units, and between and among care teams, can cause serious breakdowns in the continuity of care, inappropriate treatment, and potential harm for the patient. Proper handing over of all information and spending time on this is the best preventive solution.

2.4.8 Radiation risks minimization

Radiological investigation should be ordered after clinical impact assessment by clinicians. These should be individually tailored by the radiologist using the least parameters of exposure. Paediatric patients vulnerability justifies special attention [30].

Radiation therapy acute toxicities can be alleviated by giving gap in the treatment. Chronic toxicities are more serious. Overall clinical outcomes of radiotherapy are optimized when radiotherapy services function along with effective prevention, early detection programs, and quality surgery [30].

2.4.9 Special clinics

Comprehensive treatment in the outpatient setting, including of patients with complex disorders is possible in Special Clinics. This needs encouragement. This has cost advantages as well as reduces the adverse side-effects of hospital stays [31]. Establishing an asthma clinic has been demonstrated to decrease hospitalizations [32].

3. Managerial perspectives

Hospital governance is increasingly encompassing 'improving performance on clinical outcomes'. Coordination of medicine and management across the levels of hospital/department is for quality-effective hospital governance [33]. The managers themselves seem to rely more on personal strength and medical knowledge than on management tools [34]. Medical expertise benefits management evidently. Doctors are increasingly involved in hospital management. This is likely to lead to better implemented quality management systems [35].

Among physicians, there is a growing sense of the responsibility as teachers of better habits of life and work, and hospitals in like manner are becoming more truly educational centers in preventive medicine [36]. Prevention for safety needs to be practiced by all.

3.1 Money matters

It has been shown that patients treated at financially distressed hospitals are more likely to have adverse patient safety events [37]. This suggests that hospitals should be financially sound, ensuring safety of patients. Cost-cutting efforts should be carefully designed and managed, without compromising quality and safety.

3.2 Leadership

With evolution of safety field, there is a growing recognition that organizational leadership plays a role in prioritizing safety [38]. Hospital boards have an important role of in overseeing patient quality and safety. It has been shown that high-performing hospitals have board members who were more skilled in quality and safety issues

and who devoted more time to discussion of quality and safety [39]. Patient safety performance by hospitals adds to good reputation.

We suggest three-dimensional initiatives for Leaders:

i. **Initiatives appealing**: Strategic initiatives are required for quality and safety. Written policies for pertinent workability should be in place. Frequent trainings should be organized.

ii. **Integrating all**: Actions at the ground level should be safe and sound. Leaders should visit clinical units, interact with workers, discuss concerns and provide solutions. Motivation will ensure quality and safety.

iii. **Incremental advancements**: rewards for good results and opposite for the contrary, are required. Leaders should ensure unprofessional or incompetent clinicians do not put patients at risk [38]. Increments for good performance and early intervention for unprofessional behavior by hospital leadership will set the pace for excellence.

3.3 Teamwork – a blueprint

Teamwork is a powerful patient safety tool. The U.S. Department of Defense (DoD) Military Health System provided essential insight for Teamwork development [40]. Teamwork initiatives are effective with a clear blueprint defining the solid steps for building the desired culture. Characteristics for success of the blueprint are clear, detailed, and self-evident. All this should include the 'Five Es'

i. **E**stablish vision of, and for, teams

ii. **E**nvironment planning and preparation

iii. **E**xpectations and behaviours training for implementation

iv. **E**xpertly monitor and coach to sustain behaviors

v. **E**nergetically align and integrate the behaviors [40].

3.4 Organizational change for patient safety initiatives

Patient safety accomplishment requires not only clinical efforts but also organizational. Widespread organizational change for betterment in patient safety is indispensable. The implementation of patient safety initiatives should be done utilizing change management principles, namely the 'Five Cs'

i. **C**ongruent changes targeting multiple components

ii. **C**hange management roles specific for different participants in the care-delivery process

iii. **C**oncrete implementation through dedicated support structures and multiple tactics

iv. **C**omplete institutionalization through enhanced workforce capabilities

v. **C**ontinuous learning and improvements [41, 42].

3.5 Science to Service: tailor made solutions

Progressive evidence on patient safety is increasingly available, and refines practices. The eventual users of these are many and diverse, including administrators and managers, and health care professionals, such as physicians, nurses, pharmacists and laboratory technicians. Research findings and applications of these should be tailor made for different groups for implementation [43].

3.6 Sophisticated management simplified

- **A**venues and attitudes: Identification of problematic areas and orientation in attitudes of the workforce
- **B**etterment and beautification: Building on strengths and beautification for ubiquitous success
- **C**omprehensive with conviction: All aspects need to be considered involving everyone with conviction to act and achieve
- **D**iligence for making a difference: Meticulous efforts for scrupulous results
- **E**nergized for excellence: It requires sustained energy leading to excellence, to achieve the targets, and to stay high on the results [44].

4. Artificial Intelligence advancements

A person working in partnership with an information resource is "better" than that same person unassisted. This is the "Fundamental Theorem" of Biomedical Informatics [45]. Computer Science is making rapid progress and affecting all aspects of human activities. Artificial intelligence (AI) is an interesting domain. It utilizes computers and technology to simulate intelligent behavior and critical thinking comparable to a human being. Its applications for patient safety need to be explored.

The increasing availability of data and emerging technologies needs to be best converged and utilized for better healthcare. A conceptual framework for this leading to AI Patient Safety applications is proposed (**Figure 1**). The AI applications are broadly classified into five categories:

1. AI for proper assessment
2. AI for pertinent treatment
3. AI for progress monitoring
4. AI for prevention applications
5. AI for professional standards

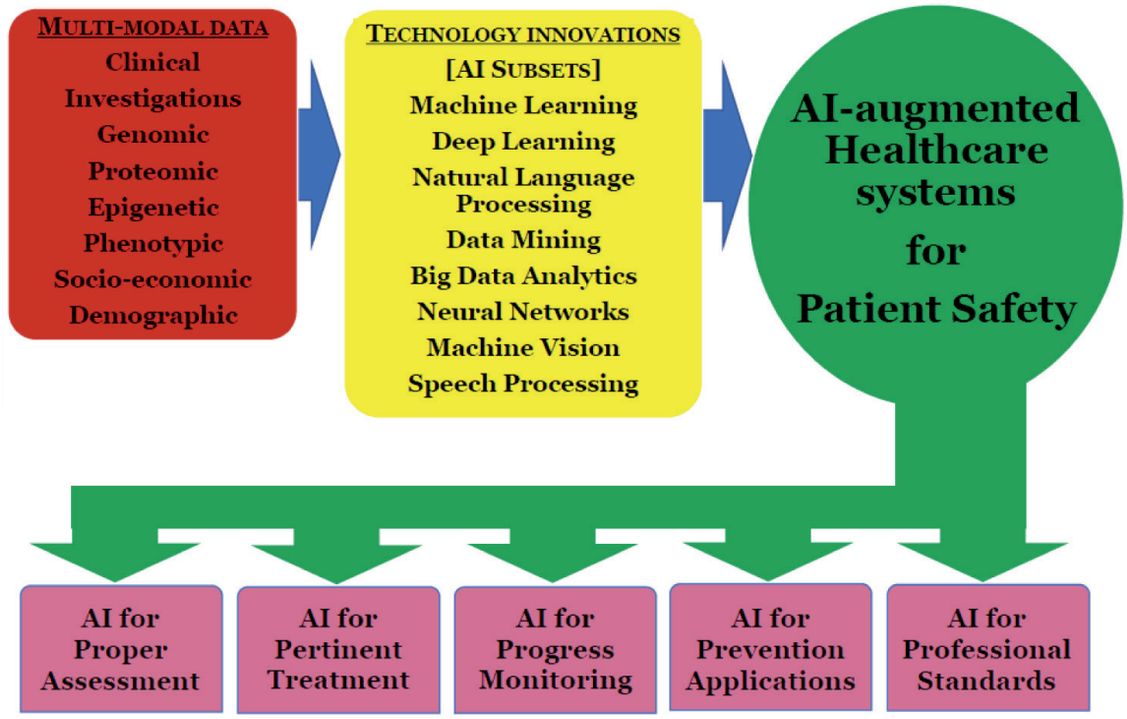

Figure 1.
Conceptual framework for AI patient safety applications.

4.1 AI for proper assessment

Clinical assessment involves history taking, clinical examination, investigations leading to diagnosis. Diagnostic error as an area of patient safety has had insufficient research in spite of the negative health outcomes it can lead to [1]. Evidence is accumulating that computer-based trigger algorithms may reduce delayed diagnosis and improve diagnostic accuracy [46].

4.1.1 Future progress

Diagnostic error causation is very complex and typically occur from the convergence of multiple contributing factors [47]. Lack of medical data can lead to inefficient or inappropriate practice [48]. There are opportunities for improvement using Electronic Health Record (EHR) data sources and AI. ML could help to reduce the frequency of diagnostic errors by improving upon limitation factors of clinicians, namely pattern recognition, bias, and limited capacity [49].

The focus should be on the 'Big Three diseases' which account for about three-fourths of serious misdiagnosis-related harms, namely vascular events, infections, and cancers [50].

4.2 AI for pertinent treatment

Selecting right medications, rightly planned surgeries, right counselling are all benefitted by technology, ensuring patient safety.

Computer-generated prescriptions have many benefits, including links to software that highlights risks from drugs or drug-drug combinations [51]. AI can lead to further improvements and alerts for mistakes.

3D printing is enabling precision surgery. Virtual surgical planning using information regarding patient anatomy and medical devices to be used in surgery increase confidence and knowledge before surgery for better outcomes [52]. Further AI applications can be built with real time image processing capabilities which alert surgeons of any deviations from precision surgery.

4.2.1 Future progress

AI can analysis vast data at lightening fast speed. All EHRs need to be analysed for side-effects of medicines, including correlation with the doses prescribed. Refinements are always needed to minimize side-effects [53].

AI for correct prescriptions should first focus on medications that commonly result in errors (**Table 3**).

Medication	Mechanisms
Antithrombotic agents	Insufficient dosing leading to a thrombotic event like a stroke, excess dosing resulting in bleeding
Cardioplegic solutions	Errors in preparation, team breakdown, lack of technical competence, and poor monitoring of the patient
Chemotherapeutic agents	Administering the wrong dose, wrong drug, wrong number of days supplied, and missed doses). In addition, drug administration errors including wrong flow rate or failure to monitor the site of intravenous (IV) transfusion are often reported with chemotherapeutic drugs administered intravenously.
Dialysis solutions	Administering the wrong medication, wrong dose, infection at the site, hyperkalemia, patient falls, and access-related errors
Epidural or intrathecal medications	Erroneous infusions-administering an IV medication via the intrathecal route, giving wrong medication or wrong dose
Hypertonic solutions	Failure to monitor for renal failure, edema, hyperchloremic metabolic acidosis, coagulation abnormalities
Hypertonic sodium chloride for injection	Failure to monitor for renal failure, confusion, coma, seizures
Hypoglycemic agents	Failure to do dose adjustment with monitoring for hypoglycemic episodes

Adapted from reference Rodziewicz et al. [47].

Table 3.
Medications commonly resulting in errors.

4.3 AI for progress monitoring

Monitoring is required, useful, and remotely done is advantageous. Technology is useful for all this. Fast data transmission for favourable timely actions is the ultimate aim. AI can make all this expertly efficient.

4.3.1 Future progress

The advancements of biomedical sensing and healthcare information technology have resulted in data-rich environments in hospitals. Analysis of all this data for actionable in sights is possible with AI. AI systems need to be developed for real time fast alerts to mitigate crisis leading to increased patient safety. The shortage of doctors, long duty hours for monitoring, right doctors for right patients etc will be all benefited.

4.4 AI for prevention applications

Clinical deterioration in the hospital is common and has to be energetically assessed and prevented.

ICU treatment involves multitude of data, both clinical and laboratory investigations. The Pediatric Logistic Organ Dysfunction (PELOD) score is based on the relative severities among Organ Dysfunctions (ODs) and the degree of severity of each OD using logistic regression [54]. A machine learning model, using random forest classifier, has achieved better performance than this [55]. Ensemble learning algorithms, used by advanced practitioners of machine learning, are useful with high final accuracy. Hence in matters of health these should be utilized.

4.4.1 Future progress

Future work should focus on inferring and predicting based on new categories of data, including biometric sensors like continuous telemetry, motion activity sensors, novel biomarkers, and relevant patient-reported measures [49].

4.5 AI for professional standards

Excellence & competency ensures correct treatment, free from errors and side effects. AI augmentation of human performance is likely to be of widespread use [56]. AI technology can provide decision support to clinicians seeking to find the best diagnosis and treatment for patients [57]. This coupled with doctor's competence should lead to professional standards and patient safety of highest order.

4.5.1 Future progress

Systematic analysis for sophisticated advancements is regularly required [58]. Machine Learning has capabilities of reading, processing, and interpreting the available data (structured and unstructured) at enormous scale and volume. New evidence can be synthesized, all for patient treatment perfect.

New evidence is accumulating at a fast pace. It is difficult for doctors to keep pace. Systematic Reviews and Meta-Analysis requires humongous efforts. AI applications can be developed for automated Systematic Reviews and Meta-Analysis. Concise results of these will be useful for all. Progress features promise exciting future [59].

AI has the potential to revolutionize the teaching and practice of Surgery. The ways for this are (i) AI analysis of population and patient-specific data for improvements in each phase of surgical care (iii) AI enabling and making easy access of surgical experience repositories for sharing of knowledge. This includes collection of massive amounts of operative video and EMR data across many surgeons. This will lead to a future optimized for the highest quality patient care [56].

5. Conclusion

Patient safety is always required and ensures high-quality patient care. The inherent complications of hospitalization can be prevented with strategies suggested. Medical errors diverse causation needs high alert for all factors. Our suggested preventive strategies will ensure excellence. Managerial expertise is required for

high standards for patient safety. Artificial Intelligence has the potential to improve healthcare safety. AI applications will make prevention targeted, better, and timely.

"Clinical excellence, Management methodical, &
Artificial Intelligence advancements,
All for safe and sound patient outcomes perfect"

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Conflict of interest

The authors declare no conflict of interest.

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