JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2024, VOL 7, NO S9

A Comprehensive Review of Technology in Nursing: Bridging Care and Innovation

Huda Salaf Falah Alharbi [1], Modhi Mohammed Alhumaydhan [2], Fawzia Saeed Saad Al-Otaibi [3], Sulaiman Abdulaziz Ibrahim Al-Mahna [4], Nada Saleh Saad Alqirit [5], Norah Saleh Soliman Alboti [6], Shahalil Abdullah Alshubramy [7], Nuruh Eawad Alzafiri [8], Maha Homoud O Alshammari [9], Aqbal Farhan O Alshammari [10], Asma fahad Mnaheey ALshammar [11], Radea Ayad Essa Alshammari [12], Rabia Farhan Hilal Al-Anzi [13], Fadh Mazeed Saad Alshammri [14], Bashayer Batah Al-Harbi [15].

[1]Midwify Technician, Health Promotion and Health Culture Change Management, Ministry of Health, Kingdom of Saudi Arabia. Halharbi41@moh.gov.sa
[2]Nurse, Maternity and Children Hospital Buraidah, Ministry of Health, Kingdom of Saudi Arabia. mmalhomidan@moh.gov.sa
[3]Nursing Technician, King Fahad Specialist Hospital in Buraidah, Ministry of Health, Kingdom of Saudi Arabia. fsalotiby@moh.gov.sa
[4]Laboratory Technician, Primary Care in Al-Iskan District in Buraidah, Ministry of Health, Kingdom of Saudi Arabia. Salmohna@moh.gov.sa
[5]Nurse, Hom Visit, Ministry of Health, Kingdom of Saudi Arabia. nalkeered@moh.gov.sa
[6]General Nurse, Maternity and Children's Hospital (MCH), Ministry of Health, Kingdom of Saudi Arabia. nalboty@moh.gov.sa
[7]Nursing Medwife, Khadra Health Center, Ministry of Health, Kingdom of Saudi Arabia. Salshubramy@moh.gov.sa
[8]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. naaldhfeeri@moh.gov.sa
[9]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. malshammiri@moh.gov.sa
[10]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. aqalshamri@moh.gov.sa
[11]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. Asfalshammari@moh.gov.sa
[12]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. Radeaa@moh.gov
[13]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. rabiaha@moh.gov.sa
[14]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. Fmalshmmry@moh.gov.sa
[15]Technician Nursing, Hafar Albatin Health Cluster, Ministry of Health, Kingdom of Saudi Arabia. Bashayrba@Moh.gov.sa

Huda Salaf Falah Alharbi, Modhi Mohammed Alhumaydhan, Fawzia Saeed Saad Al-Otaibi, Sulaiman Abdulaziz Ibrahim Al-Mahna, Nada Saleh Saad Alqirit, Norah Saleh Soliman Alboti, Shahalil Abdullah Alshubramy, Nuruh Eawad Alzafiri, Maha Homoud O Alshammari, Aqbal Farhan O Alshammari, Asma fahad Mnaheey ALshammar, Radea Ayad Essa Alshammari, Rabia Farhan Hilal Al-Anzi, Fadh Mazeed Saad Alshammri, Bashayer Batah Al-Harbi

ABSTRACT

The integration of technology in nursing has revolutionized healthcare delivery, with electronic health records (EHRs) serving as the foundation for innovative technologies. This comprehensive review explores the impact of various technologies on nursing practice, including EHRs, clinical decision support systems, computerized provider order entry, mobile technologies, wireless voice-over Internet phones, radio frequency identification data tags, smart pumps, and telehealth. The adoption of these technologies has been driven by the Health Information Technology for Economic and Clinical Health (HITECH) Act and the meaningful use program, which incentivize healthcare providers to utilize certified EHRs. While EHRs offer advantages such as improved time efficiency, cost savings, and enhanced data confidentiality, challenges remain, including variability among vendors, security risks, and high implementation costs. Clinical decision systems and computerized provider order entry have been associated with improved adherence to evidence-based practices and reduced medication errors. Mobile technologies, such as wireless phones and patient tracking boards, have enhanced communication and workflow efficiency. Smart pumps, equipped with drug libraries and safety features, have contributed to reducing medication errors and adverse drug events. Simulation training has emerged as a valuable tool for developing critical thinking and prioritization skills among nurses. Telehealth, mobile health, and remote monitoring have expanded access to healthcare services, particularly for rural populations and seniors. However, the efficacy of electronic intensive care units remains inconclusive. As technology continues to advance, it is crucial for nurses to embrace these transformative technologies while prioritizing compassionate care.

Keywords: Nurse, Electronic Health Records, Technology In Nursing, Telehealth, Mobile Technology

Introduction

The role of nurses in patient care has undergone significant transformation with the integration of technology to enhance health care delivery (Carrington & Tiase, 2013). The rapid progression of technological advancements is becoming the standard in health care settings rather than the exception. Modern hospitals now function as high-tech environments, with electronic health records (EHRs) paving the way for innovative technologies. These include EHRs, personal health records, clinical decision support systems, computerized physician order entry (CPOE), mobile technologies, wireless voice-over Internet phones (VOIP), radio frequency identification (RFID) data tags, smart pumps, and telehealth, which are discussed in this article.

The Health Information Technology for Economic and Clinical Health (HITECH) Act, a provision of the American Recovery and Reinvestment Act (ARRA) of 2009, incentivizes health care providers to be meaningful users of EHRs. Starting in 2015, health care service reimbursement has been tied to the adoption and use of EHRs. Additionally, health care technology has been identified as essential for improving patient safety and cost-effective care, as highlighted in the 2010 Institute of Medicine report, The Future of Nursing: Leading Change, Advancing Health (Fujino

& Kawamoto, 2013). Nurses play a pivotal role and are instrumental in the ongoing transformation of health care in the United States using health information technologies.

Information and communication technology has become integral to patient care, enabling nurses to collect and disseminate large amounts of information efficiently and quickly (Ball et al., 2011). Nurses are traditionally seen as compassionate caregivers and are therefore expected to employ technology in ways that enhance the quality and safety of patient care. The integration of care and technology by nurses is demonstrated in an online survey where 72% of registered nurses reported improvements in medication safety, with 30% attributing these improvements to information technology (Hogan & Kissam, 2010). In the dynamic health care environment, the fusion of compassionate care and technology is essential to foster a nursing culture that embraces emerging transformative technologies.

Meaningful Use

"Meaningful use" is defined as the utilization of certified EHRs to enhance quality, safety, and efficiency while reducing health disparities. The key data elements targeted under meaningful use include patient demographics, vital signs, charge changes, medication and allergy lists, current diagnoses, and smoking status. Financial incentives for early adopters and penalties for noncompliance under the Centers for Medicare and Medicaid Services have accelerated compliance with the meaningful use program. The HITECH Act of 2009 outlines the certification and criteria health care providers and organizations must meet to qualify for these incentives. The regulations prioritize core objectives, such as providing patients and primary care providers access to EHR information, electronic prescription ordering, evaluating drug interactions, tracking compliance and quality improvements, and safeguarding the privacy and security of EHRs (Rabius et al., 2014).

A 2014 systematic review of 236 articles on health IT with a focus on meaningful use revealed the following points (Rabius et al., 2014):

1. The number of health IT evaluation studies is increasing.
2. Most evaluations concentrate on clinical decision support and computerized order entry.
3. Positive effects on quality, safety, and efficiency are reported by most studies.
4. Insufficient information exists to explain the varying success of health IT implementation programs.
5. Greater emphasis is needed on measurement, analysis, and reporting of health IT effects.

Electronic Health Records

An EHR is a digital version of the traditional patient chart, enabling instant and secure access to information by authorized users and facilitating sharing across health care organizations. EHRs contain patient demographics, medical history, diagnoses, medication records, treatment plans, immunization dates, allergy

information, radiology images and reports, and test results. EHRs also provide tools to assist providers in making clinical decisions and streamline workflows.

Despite these advantages, a 2012 survey revealed that only 44% of hospitals used at least a basic EHR system. Furthermore, only 42.2% met stage 1 meaningful use criteria, while 5.1% met stage 2 criteria. Urban hospitals were more likely to have EHRs in place compared to rural and nonteaching hospitals. Stage 2 criteria include granting patients access to their clinical data, often through portals allowing test result viewing, medication refill requests, and appointment scheduling. However, barriers such as security risks and lack of broadband Internet access in rural areas impede the full implementation of these features. While financial incentives under ARRA/HITECH have driven adoption, further infrastructure development is necessary to enable smaller and rural hospitals to meet stage 2 meaningful use criteria (DesRoches et al., 2013).

EHRs offer various advantages, including integration with other technologies and digital processes, transforming health care delivery and compensation. Quick and remote access to patient records enhances the quality and convenience of care for providers and patients. A national survey of physicians indicated that EHRs improved time efficiency through rapid record retrieval and heightened data confidentiality. Additionally, large hospitals reported savings ranging from $37 million to $59 million over five years, alongside incentive payments. These savings were attributed to tracking resource utilization, reducing errors, and supporting evidence-based care.

Nevertheless, challenges remain. Variability among EHR vendors and security risks hinder information sharing between organizations, patients, and providers. Costs associated with hardware, software, implementation, maintenance, training, IT support, and updates are significant. Productivity may decrease during implementation, and features like autofill or copy-and-paste, intended to save time, can lead to documentation errors and compromise patient safety.

While EHRs have their limitations, their permanence in health care is undeniable. Awareness of their challenges and thoughtful planning can mitigate issues related to purchase, implementation, and maintenance. Notably, recent studies have not consistently linked EHR use to improved hospital performance. For example, a randomized control study of 325 hospitals found no significant association between EHR adoption and outcomes such as acute myocardial infarction outcomes, risk-adjusted 30-day mortality, length of stay, or payment per discharge (Adler-Milstein et al., 2014). However, studies at the patient level have demonstrated positive effects on quality and reduced medical errors. Experts agree that widespread and meaningful adoption of EHRs can significantly benefit patients and society (Menachemi & Collum, 2011).

Clinical Decision Systems

Clinical decision systems (CDSs) are electronic tools designed to use individual patient data to create patient-specific practice recommendations. CDSs

support health care providers by offering guidance for patient care decisions. Common features of CDSs include alerts, alarms, reminders, order sets, performance feedback dashboards, drug-dose calculators, and informational aids. Examples of CDS platforms include UpToDate, Epocrates, and ClinicalKey (Bright et al., 2012).

CDSs, such as physician reminders, have been linked to improved adherence to evidence-based practices and clinical guidelines. For instance, reminders for physicians to order influenza and pneumococcal vaccinations have increased adherence rates from 0% to 35%-50% in hospitalized patients. In a similar outpatient study involving patients with rheumatoid arthritis, the rates of influenza vaccination rose from 47% to 65%, while pneumococcal vaccination rates increased from 19% to 41%. These outcomes are consistent with other studies showing improved vaccination rates when computerized reminders are utilized. A 2012 systematic review of 160 articles concluded that CDSs are effective in various settings, demonstrating positive impacts on treatment prescribing, preventive care services, and clinical study orders. However, further research is needed to determine the type of information that should be delivered by CDSs and to address potential unintended consequences (Bright et al., 2012).

Computerized Provider Order Entry

Computerized Provider Order Entry (CPOE) is a system that enables physicians or providers to directly input orders into a computer system, which then routes the information to the relevant department. Historically, handwritten orders were associated with a 90% error rate during the ordering or transcription phases. By eliminating the transcription stage, CPOE reduces these risks and provides support for order entry, thus improving accuracy. For example, when a physician enters a medication order into a CPOE system, the dosage recommendations are reviewed, and the order is transmitted to the pharmacy, where a medication administration record (MAR) is created. The MAR informs the pharmacist of the required medication and guides the nurse in its administration. CPOE systems are often paired with CDSs to complement their functionality.

CPOE has been associated with a 55% reduction in serious medication errors. Additionally, a study in outpatient settings reported a decrease in error rates from 18.2% to 8.2% with the use of CPOE. However, other studies have identified an increase in errors attributed to poorly designed systems, insufficient training, complex menus, or inadequate integration. A 2014 systematic review of 19 studies focusing on CPOE and medication errors found that CPOE reduced medication-related patient injuries by over 50% in hospital settings. These findings highlight CPOE's potential to improve public health outcomes (Nuckols et al., 2014).

Bar Code Medication Administration

Bar Code Medication Administration (BCMA) involves the use of IT systems that interface with EHRs and often CPOEs to enhance medication administration. By scanning the medication's bar code and the patient's wristband, the process is automatically documented in the MAR, ensuring the correct medication is delivered in the right dose, at the right time, and to the intended patient. Despite these

advantages, some issues arise from nurse workarounds, such as bypassing scanning technology (Poon et al., 2010).

A quasi-experimental study conducted over nine months observed 14,041 medication administrations before and after implementing a bar-code MAR system. The results showed a 41.4% reduction in timing errors, supporting the use of bar-code technology to improve safety by minimizing medication and transcription errors (Poon et al., 2010).

Personal Health Records or Patient Portals

A personal health record, also known as a patient portal, is a secure online platform that provides patients with 24-hour access to their health information from any location with internet access. By using a secure username and password, patients can view details such as recent doctor visits, discharge summaries, medications, allergies, immunizations, and laboratory results. Portals also allow patients to schedule office visits, request medication refills, send inquiries, make payments, and access educational materials (DesRoches et al., 2013).

Patient portals offer benefits to both patients and health care teams. These platforms are user-friendly and help alleviate patient frustration caused by difficulties in reaching clinicians. Portals facilitate communication with patients without disrupting busy clinic workflows, as secure messaging can replace phone calls. Patient portals also support meaningful use compliance by enabling secure messaging and providing patients with access to their health records. These portals are available 24/7 through a secure, HIPAA-compliant website (Louiselle, 2012).

A significant feature of patient portals is secure messaging, which has been reported to increase clinician efficiency and productivity while reducing phone calls and mailing costs. Proponents of patient portals highlight potential improvements in patient satisfaction, operational efficiency, and clinical outcomes. However, limited evidence exists to substantiate these claims, necessitating further research. In one study of type 2 diabetes patients, the use of patient portals and secure messaging enhanced care access, improved the quality of office visits, and led to better patient satisfaction and clinical outcomes (Wade-Vuturo et al., 2013). Nonetheless, barriers such as security risks and limited broadband internet in rural areas remain challenges to widespread portal adoption (DesRoches et al., 2013).

Mobile Technology

Nurses often manage care for multiple patients, making mobile technology particularly crucial in their work. Mobile tools reduce errors and redundancy, allowing nurses to spend more time with patients instead of returning to the nurses' station for information or communication. Mobile charting facilitates electronic documentation, saving time and enhancing efficiency. As point-of-care technologies become increasingly common, mobile devices that provide convenient access to information are essential. Examples of these tools include electronic handoffs, task alerts, documentation of hourly rounding via wireless tracking, electronic medication records

with integrated safety alerts, and synchronized wireless vital sign collection. A scenario involving point-of-care technology might involve a wireless glucometer that synchronizes with a network. The technician inputs the blood sugar level, which is automatically transmitted to the patient's EHR, and if the results are abnormal, the nurse receives an alert on a mobile device.

The use of EHRs necessitates accessible computers for nurses. In the past, limited access to computers and reliance on stationary systems at nursing stations led nurses to batch chart, postponing documentation until they had time to complete it. Mobile charting devices, such as roving computers, enable nurses to chart in real time and access current patient information. A 2013 survey of 1,000 U.S. nurses revealed that 56.1% of nurses used computers located at the nurses' station, 53.5% used roving computers, and only 31% had computers in each room. Tablet use for charting was rare (9.6%), despite 46% of nurses owning personal tablets (Hader, 2013).

A 2012 motion study found that nurses spent similar amounts of time charting regardless of whether they used EHRs or handwritten nursing notes. However, a 2014 survey of hospital nurses indicated that many believed electronic charting took longer than paper-based methods. Some challenges cited included insufficient devices, a lack of comfort or confidence in electronic documentation, and perceived inefficiency. Advantages reported by nurses included time savings, increased bedside time, improved interdisciplinary communication, and enhanced documentation accuracy. These findings highlight the need for more accessible mobile charting devices and point-of-care technologies (Hirsch, 2014).

Mobile Wireless Voice-over-Internet Protocol Phones

Traditional nurse call systems require patients to press a bedside call button that activates a light at the nurses' station, where staff then notify the nurse via intercom or pager. This process delays nurse responses to patient needs. Mobile wireless VOIP phone systems make nurses more reachable and responsive by providing information such as the patient's room number, call priority, and name, while enabling the nurse to respond directly. Some systems include software that alerts nurses when physiological parameters, such as monitored vital signs or ECG rhythms, are breached. These systems may also track the nurse's location. Nurses have expressed concerns that calls can interrupt patient care, but certain systems allow calls to be redirected to another nurse based on proximity to the patient (Unluturk et al., 2015).

Radio Frequency Identification

Traditional bar-code patient management systems use wristbands for patient identification and tags for equipment or supply tracking. While effective for tasks like medication administration, bar-code readers require a line of sight, making them unsuitable for locating lost items or people. RFID technology addresses these limitations by using electromagnetic or electrostatic connections in the radio frequency spectrum to uniquely identify objects, animals, or individuals. RFID systems consist of three components: tags, readers, and antennas (Ajami & Carter, 2013).

RFID tags can be passive, which communicate only when within range of a reader, or active, which use battery power to transmit signals to readers over wireless networks. Passive RFID tags are primarily used for patient identification and medication administration, while active tags are utilized for tracking purposes. RFID is employed to monitor at-risk patients, such as newborns in nurseries or wandering Alzheimer's patients, and to study nurse traffic patterns and time spent on patient care by shifts, days, and months.

RFID tags are often combined with wireless phone systems to locate the nearest nurse. Hospitals use both RFID and bar-code tags as a fail-safe mechanism in case one system becomes unreadable. A systematic review of RFID studies found improvements in patient safety, tracking, surgical item verification, operational efficiency, and workflow for clinical staff. However, the high cost and complexity of RFID systems are notable disadvantages. Despite this, the long-term benefits, such as enhanced care quality, make these systems cost-effective (Ajami & Carter, 2013).

Security concerns remain significant for wireless communication systems, including RFID. Risks include data interception (identity theft), system interruption (performance degradation), data modification (injecting false information), and tag duplication (fabrication of valid tags). Strategies to mitigate these risks include limiting access, physical security, coupling RFID with bar codes, reducing transmission ranges, and using middleware systems with secure protocols. Ongoing research is essential to address these security issues.

Electronic Patient Tracking Boards

Traditionally, areas such as emergency departments (EDs) and surgical units have used dry-erase boards to track patient status. Electronic whiteboards, or patient tracking boards, integrate traditional whiteboard data with EHR systems, allowing information to be displayed across multiple boards, saved for future use, and used to streamline communication and coordination of care. These boards provide quick status updates, improve communication, and support patient flow monitoring. RFID tags and real-time location systems transmit data to these boards, displaying patient locations and statuses in real time.

A literature review of 21 studies on electronic whiteboards highlighted both positive and negative impacts on ED workflows (Rasmussen, 2012). Concerns included data accuracy and the boards shifting from clinical tools to administrative tools.42 Positive findings included improvements in patient satisfaction, length of stay, and financial and administrative efficiency. A study by Hertzum and Simonsen found that nurses spent more time with patients and less at the control desk when using electronic boards, while physicians did not report similar benefits (Hertzum & Simonsen, 2013).

Despite their limited use, electronic patient tracking systems are gaining popularity, particularly in EDs and surgical units. Efficient management of ED patients is crucial, as nearly half of hospital admissions originate there, while surgical units

rely on smooth operations for financial health. Although the return on investment for these systems is not well-documented, studies have shown benefits such as reduced length of stay, improved resource utilization, time savings for nurses, faster revenue generation, decreased paper costs, enhanced staff morale, improved record-keeping, and reduced liability.

Smart Pumps

Historically, the administration of intravenous (IV) fluids in hospital settings began with a manually calculated drip rate measured in drops per minute, followed by the advent of infusion pumps approximately 40 years ago. IV fluid administration carries a significant risk of adverse drug events, necessitating the incorporation of safety features in basic infusion pumps, which have since evolved into smart pumps. These smart pumps are equipped with built-in software designed to reduce drug errors by incorporating a drug library with predefined parameters. Drug libraries are customized with tailored, preloaded lists specific to the facility and patient care area, ensuring accurate dosing for individual drugs and minimizing medication errors and miscalculations. These systems include hard limits, which are non-negotiable and cannot be overridden, and soft limits, which are less restrictive and allow for manual adjustment. Additionally, smart pumps record all activities for quality improvement purposes (Ohashi et al., 2014).

Despite their advanced capabilities, smart pumps do not negate the need for meticulous adherence to the "five rights" of medication administration: the right dose, time, drug, patient, and route. Nurses must continue to monitor patients' vital signs and IV sites for signs of complications such as phlebitis, infiltration, or extravasation. Errors in programming and administration remain a concern, as the software depends on the accuracy of the data entered the pump. Reports to the Food and Drug Administration (FDA) have documented cases where errors occurred due to incorrect programming by pharmacists or administrators, as well as instances of pump malfunction. Work-arounds, or nonstandard solutions used by nurses to address technical problems, pose additional risks. These work-arounds may involve bypassing critical safety features, potentially endangering patients. Nurses may face charges of negligence if improper use of a smart pump results in harm.

Since 2005, the adoption rate of smart pumps has doubled alongside advancements in related technologies, such as electronic health records (EHRs), computerized physician order entry systems, and bar-code medication administration. In facilities where smart pumps are available, their use is considered the standard of care to enhance patient safety. The benefits of smart pumps include reducing medication errors related to incorrect rates, doses, and settings, as well as lowering the incidence of adverse drug events, improving cost-effectiveness, and enhancing practice protocols. Additional advantages include minimizing calculation errors, issuing warnings, and providing alarm systems (Harding, 2013). Challenges, however, include low compliance with proper use, frequent overriding of soft alerts, unaddressed errors, and the potential use of incorrect drug libraries. The integration of smart pumps with other healthcare technologies is expected to continue evolving in the future.

Simulation

High-fidelity simulation is becoming more widely used in hospital settings (Arora, 2013). As healthcare delivery becomes increasingly complex, nurses are tasked with critical decision-making in caring for highly acute patients. This necessitates strong critical thinking, prioritization, and clinical decision-making skills. Effective clinical judgment involves understanding the current situation, anticipating the effects of actions and events, and ensuring alignment with patient goals. Nurses must not only gather and interpret information but also prioritize care urgency, provide safe care, detect symptom changes, communicate concerns, and respond promptly. With a significant portion of the current nursing workforce nearing retirement, there is a growing need to train newer nurses in critical thinking and prioritization skills.

High-fidelity simulation provides an ideal platform for improving teamwork in high-acuity, high-stress scenarios, thereby mitigating human error risks. To maximize effectiveness in specific training areas, the simulation environment should closely resemble real clinical settings. Incorporating multiple professional roles in simulations can further enhance interdisciplinary communication. Cost remains a significant barrier, as the equipment and setup for simulations are expensive. However, virtual simulations and applications can serve as supplemental training tools to reduce preparation time for live simulation scenarios. Major healthcare institutions could benefit from offering advanced simulations focused on clinical judgment, management, and organizational issues tailored to senior staff members.

Telehealth and Mobile Health

Technological advancements have enabled new ways to educate and access patients through telehealth, mobile health (mHealth), and remote monitoring. Telehealth facilitates electronic communication between patients and healthcare providers, enabling real-time interactions. mHealth leverages mobile devices for health-related communications and applications, while remote monitoring uses technology to track environmental and behavioral changes, often benefiting seniors seeking independence.

Telehealth

Telehealth offers cost-effective healthcare through devices such as laptops, tablets, and smartphones, reducing the need for expensive face-to-face consultations via videoconferencing capabilities. Available services include video consultations, asynchronous medical image transfers, and remote monitoring of vital signs and medical history for diagnosis and tracking. Medicare reimburses telehealth services provided as part of home healthcare, including video and remote monitoring. The American Telemedicine Association defines telehealth as technology-enabled remote healthcare delivery, distinct from telemedicine, which involves clinical services. Telehealth is especially beneficial for rural populations, the elderly, and those with chronic illnesses. For example, the Veterans Administration has documented reduced hospitalizations among patients receiving telehealth services for mental health and

chronic conditions. In nursing homes, telehealth has significantly reduced the need for in-person consultations (Goldwater & Harris, 2011).

Remote Monitoring

Remote monitoring enhances quality of life through sensors, motion detectors, and wireless technology that record behavioral changes and transmit data to healthcare providers. Passive sensors monitor conditions like vital signs, motion, and stove temperature continuously, promoting autonomy for seniors while occasionally causing frustration due to false alerts. Active monitoring involves patient interaction with technology, such as logging vital signs or glucose levels and sending the data to providers. These systems can also provide reminders for medication or other tasks. By enabling seniors to age in place, remote monitoring offers increased autonomy, emotional well-being, and quality of life (Goldwater & Harris, 2011).

Mobile Health

Mobile health (mHealth) employs mobile devices to access medical information and communicate with healthcare providers. mHealth is recognized among the top consumer applications for healthcare and includes various health-related apps, such as medication reminders and smoking cessation aids. For instance, some apps provide notifications for medication schedules or offer real-time support for withdrawal symptoms during smoking cessation. A systematic review of 75 randomized controlled trials evaluating mHealth interventions revealed mixed results, with some apps demonstrating clinical significance for smoking cessation but marginal benefits for diabetes management, medication reminders, and diet/exercise programs. Further research is needed to optimize mHealth interventions (Free et al., 2013).

Electronic Intensive Care Unit

The electronic intensive care unit (eICU) is a telehealth service enabling remote monitoring of intensive care units (ICUs) from centralized locations staffed by intensivist physicians. Data such as vital signs, test results, and medications are transmitted in real time, and audio-visual links can be activated for immediate consultation during emergencies. Implementation and operational costs remain barriers to widespread adoption. Feedback from 10 eICU programs highlighted the benefits of eICU software, particularly in emergencies. Studies in developing countries demonstrated significant improvements in mortality rates in ICUs utilizing eICU systems. However, other studies have found no statistically significant differences in outcomes such as fall rates, mortality, and lengths of stay after implementing eICUs. Currently, only 9% of ICU beds in the United States utilize eICU technology, with limited research on its efficacy (Berenson et al., 2009).

Conclusion

The integration of technology into nursing practice has profoundly transformed patient care delivery, highlighting the essential role of nurses in utilizing and managing these advancements. Smart pumps, simulation training, telehealth, mobile health, and eICU systems exemplify how technology enhances safety, efficiency, and patient outcomes. However, these innovations also pose challenges, including cost barriers, programming errors, workarounds, and inconsistent

compliance with safety protocols. Effective use of technology in nursing requires ongoing training, adherence to evidence-based practices, and addressing barriers to accessibility and usability. As technology evolves, nurses must balance compassionate care with technical expertise, ensuring that the human element remains central to healthcare delivery. This dual approach ensures that technological advancements enhance, rather than detract from, the quality and safety of patient care.

Recommendations

- Provide ongoing training for nurses on the use of emerging technologies to improve proficiency and minimize errors.
- Foster teamwork between nurses, IT professionals, and clinicians to improve technology integration and resolve challenges.
- Ensure technology use aligns with best practices to improve care quality and reduce medication errors.
- Overcome cost, access, and usability issues by investing in affordable, user-friendly technologies, especially in underserved areas.
- Improve tracking and reporting of health IT outcomes to guide improvements and decision-making.
- Balance technological use with compassionate care, ensuring patient needs remain central to treatment.
- Conduct continuous research to evaluate the long-term impact of health IT on patient outcomes and identify successful implementation strategies.

References

Adler-Milstein, J., Woody Scott, K., & Jha, A. K. (2014). Leveraging EHRs to improve hospital performance: The role of management. *The American Journal of Managed Care*, *20*(17), SP511–SP519. Scopus.

Ajami, S., & Carter, M. W. (2013). The advantages and disadvantages of Radio Frequency Identification (RFID) in Health-care Centers; approach in Emergency Room (ER). *Pakistan Journal of Medical Sciences*, *29*(1 SUPPL.), 443–448. Scopus. https://doi.org/10.12669/pjms.291(Suppl).3552

Arora, M. (2013). A cry still unheard: A menace of female foeticide societal attitude towards female foeticide. *Journal of Social Sciences (COES&RJ-JSS)*, *2*(1), Article 1. https://doi.org/10.25255/jss.2013.2.1.1.4

Ball, M. J., Douglas, J. V., Walker, P. H., DuLong, D., Gugerty, B., Hannah, K. J., Kiel, J., Newbold, S. K., Sensmeier, J. E., Skiba, D. J., & Troseth, M. R. (2011). *Nursing Informatics: Where Technology and Caring Meet*. Springer Science & Business Media.

Berenson, R. A., Grossman, J. M., & November, E. A. (2009). Does Telemonitoring Of Patients—The eICU—Improve Intensive Care? *Health Affairs*, *28*(Supplement 1), w937–w947. https://doi.org/10.1377/hlthaff.28.5.w937

Bright, T. J., Wong, A., Dhurjati, R., Bristow, E., Bastian, L., Coeytaux, R. R., Samsa, G., Hasselblad, V., Williams, J. W., Musty, M. D., Wing, L., Kendrick, A. S., Sanders, G. D., & Lobach, D. (2012). Effect of Clinical Decision-Support Systems. *Annals of Internal Medicine*, *157*(1), 29–43. https://doi.org/10.7326/0003-4819-157-1-201207030-00450

Carrington, J. M., & Tiase, V. L. (2013). Nursing informatics year in review. *Nursing Administration Quarterly*, *37*(2), 136–143. Scopus. https://doi.org/10.1097/NAQ.0b013e3182869deb

DesRoches, C. M., Charles, D., Furukawa, M. F., Joshi, M. S., Kralovec, P., Mostashari, F., Worzala, C., & Jha, A. K. (2013). Adoption Of Electronic Health Records Grows Rapidly, But Fewer Than Half Of US Hospitals Had At Least A Basic System In 2012. *Health Affairs*, *32*(8), 1478–1485. https://doi.org/10.1377/hlthaff.2013.0308

Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, V., & Haines, A. (2013). The

Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review. *PLOS Medicine*, *10*(1), e1001362. https://doi.org/10.1371/journal.pmed.1001362

Fujino, Y., & Kawamoto, R. (2013). Effect of information and communication technology on nursing performance. *CIN - Computers Informatics Nursing*, *31*(5), 244–250. Scopus. https://doi.org/10.1097/NXN.0b013e3182842103

Goldwater, J., & Harris, Y. (2011). Using Technology to Enhance the Aging Experience: A Market Analysis of Existing Technologies. *Ageing International*, *36*(1), 5–28. https://doi.org/10.1007/s12126-010-9071-2

Hader, R. (2013). Technology at the bedside: How connected are you? *Nursing Management*, *44*(2), 18. https://doi.org/10.1097/01.NUMA.0000426136.37915.b2

Harding, A. D. (2013). Intravenous smart pumps. *Journal of Infusion Nursing*, *36*(3), 191–194. Scopus. https://doi.org/10.1097/NAN.0b013e318288a1cf

Hertzum, M., & Simonsen, J. (2013). Work-practice changes associated with an electronic emergency department whiteboard. *Health Informatics Journal*, *19*(1), 46–60. https://doi.org/10.1177/1460458212454024

Hirsch, A. (2014). Technology management strategies for nurse leaders. *Nursing Management*, *45*(2), 41–43. Scopus. https://doi.org/10.1097/01.NUMA.0000442645.01325.fe

Hogan, S. O., & Kissam, S. M. (2010). Measuring Meaningful Use. *Health Affairs*, *29*(4), 601–606. https://doi.org/10.1377/hlthaff.2009.1023

Louiselle, P. (2012). Utilizing patient portal functionality within an EMR system. *The Journal of Medical Practice Management : MPM*, *28*(3), 183–186. Scopus.

Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy*, *4*, 47–55. https://doi.org/10.2147/RMHP.S12985

Nuckols, T. K., Smith-Spangler, C., Morton, S. C., Asch, S. M., Patel, V. M., Anderson, L. J., Deichsel, E. L., & Shekelle, P. G. (2014). The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: A systematic review and meta-analysis. *Systematic Reviews*, *3*(1), 56. https://doi.org/10.1186/2046-4053-3-56

Ohashi, K., Dalleur, O., Dykes, P. C., & Bates, D. W. (2014). Benefits and Risks of Using Smart Pumps to Reduce Medication Error Rates: A Systematic Review. *Drug Safety*, *37*(12), 1011–1020. https://doi.org/10.1007/s40264-014-0232-1

Poon, E. G., Keohane, C. A., Yoon, C. S., Ditmore, M., Bane, A., Levtzion-Korach, O., Moniz, T., Rothschild, J. M., Kachalia, A. B., Hayes, J., Churchill, W. W., Lipsitz, S., Whittemore, A. D., Bates, D. W., & Gandhi, T. K. (2010). Effect of bar-code technology on the safety of medication administration. *The New England Journal of Medicine*, *362*(18), 1698–1707. https://doi.org/10.1056/NEJMsa0907115

Rabius, V., Karam-Hage, M., Blalock, J. A., & Cinciripini, P. M. (2014). “Meaningful use” provides a meaningful opportunity. *Cancer*, *120*(4), 464–468. https://doi.org/10.1002/cncr.28436

Rasmussen, R. (2012). Electronic Whiteboards in Emergency Medicine: A Systematic Review. *Proceedings of the 2nd ACM SIGHIT International Health Informatics Symposium*, *1*, 483–492.

Unluturk, M. S., Ozcanhan, M. H., & Dalkilic, G. (2015). Improving communication among nurses and patients. *Computer Methods and Programs in Biomedicine*, *120*(2), 102–112. https://doi.org/10.1016/j.cmpb.2015.04.004

Wade-Vuturo, A. E., Mayberry, L. S., & Osborn, C. Y. (2013). Secure messaging and diabetes management: Experiences and perspectives of patient portal users. *Journal of the American Medical Informatics Association*, *20*(3), 519–525. https://doi.org/10.1136/amiajnl-2012-001253