

AVAILABILITY AND USE OF MEDICAL INFORMATICS IN TEACHING
HOSPITALS IN NIGERIA

BY

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Abstract

This paper examined the usage of medical informatics (MI) and its difficulties in Nigerian teaching hospitals. It emphasizes how important MI is to enhancing patient management, clinical decision support, and healthcare efficiency through the integration of information technology. The important role that medical informatics plays in improving healthcare delivery in Nigerian teaching hospitals was also explored. The study's main goal is to evaluate how integrating IT into healthcare might enhance patient care and operational effectiveness. The study emphasizes the difficulties teaching hospitals in Nigeria have in implementing medical informatics, despite the fact that it is becoming more and more essential for contemporary healthcare. The authors evaluated the state of medical informatics today and its influence on healthcare delivery by reviewing case studies from different teaching institutions and available literature in order to address these concerns. The results show that medical informatics has a number of important advantages, such as better patient care through data management, increased operational effectiveness, and easier access to vital health information. However, the report also finds a number of barriers that prevent efficient adoption, including poor infrastructure, restricted access

to technology, and inadequate training for healthcare personnel. The results of this study imply that removing these obstacles is essential to medical informatics adoption success. Technology integration, such as electronic health records (EHRs), has shown potential in enhancing patient care procedures. The study's result highlights the necessity of implementing medical informatics to improve healthcare delivery at teaching hospitals in Nigeria. To make this integration easier, the authors advise strengthening IT infrastructure, offering thorough training to healthcare personnel, and advocating for laws that will help. In summary, the study highlights how medical informatics can significantly improve Nigeria's healthcare system.

Keywords: Informatics; Medical informatics; Teaching Hospitals; Information Technology

Introduction

Informatics is the creation, storing, retrieval, manipulation, and exchange of information. It incorporates elements of computer science, information science, and several domain-specific knowledge fields, spanning a wide range of subjects and applications. According to Hersh (2011). Informatics is the discipline focused on the use of information, aided by technology, to improve individual health, healthcare, public health, and research in biomedicine and health. It is more about information than technology and is sometimes regarded as activity at the intersection of people. Medical informatics is the application of computer technology to all fields of medicine, including medical care, teaching, and research (Shortliffe & Cimino, 2014). In other words, it is the application of informatics and information technology to deliver healthcare services. Medical informatics is a discipline that has received much attention in recent years and has flourished with the development of information technology (Han, Han, Zhou, & Zhu, 2022). Medical informatics is an area concerned with managing and using the required information in the fields of health and biomedicine. In a study carried out by Okoromah and Afolabi (2008), they defined medical informatics as a process involving the use of computer system analytic tools to support patients of public health care and this forms the basis of hospital information systems. However, Hersh (2011) prefer to use the term 'Biomedical and health informatics' (BMHI) and defined it as the field concerned with the optimal use of information, often aided by technology, to improve individual health, healthcare, public health, and biomedical research.

Medical education in Nigeria is regulated by two federal parastatals: Nigerian Universities Commission (NUC) which regulates academic aspect of the training and Medical and Dental Council of Nigeria (MDCN) which regulates the professional aspect of medical education. A medical school must be successfully accredited by both entities to graduate medical doctors. Although the availability of medical informatics and its competencies in medical curricula is critical to healthcare success, there is insufficient informatics competencies in the medical education curricula in Africa (Azadmanjir et al., 2015; Bhebe, 2019). Besides, most studies on medical informatics are in the context of developed countries (Darvish et al., 2014). In their study, (Akpabio & Ella, 2015) discovered that graduate doctors knowledge of medical informatics is just fair. Most of the doctors did not know the scope or the components of medical informatics. For the majority, their computer literacy level is only fair, as they are yet to embrace the notion of informatics.

Teaching hospitals are at the apex of the health care system with the provision of advanced health care, serve as a training ground for undergraduate and post graduate training in the medical profession and undertake research into health issues for the purpose of improving the condition of health of people in the country (Wartman, 2015; Ludmerer, 2012). The Federal Ministry of Health states that there are twenty (20) federal teaching hospitals, twenty two (22) federal medical centres and thirteen (13) specialty hospitals in Nigeria (Federal Ministry of Health, 2023). However, the Medical and Dental Council of Nigeria has 115 approved teaching hospitals spread throughout the six (6) geographical zones of the country for internship training of medical doctors (Medical and Dental Council of Nigeria, 2020). Nigeria's tertiary hospitals have faced public criticisms over substandard services and poor infrastructure reported in the mass media during early to mid-2019.

A teaching hospital, or academic medical center, is a hospital that partners with medical and nursing schools, education programs and research centers to improve health care through learning and research. There is often a research program associated with a Teaching Hospital. As part of the training and education process, residents (doctors who have graduated medical

school and are in intensive training for a specific specialty) and medical school students provide patient care under the direct supervision of either the patient's attending doctor or the resident physician responsible for training the next generation of physicians (Michigan, 2023). Teaching hospitals tend to have longer lengths of stay, less ICU use, and lower failure-to-rescue rates. The value of teaching hospitals is concentrated among patients at different levels of mortality risk upon admission, with most benefits accruing for high-risk patients.

Information and Communication Technologies (ICT) as defined by Liep (2017) is a diverse set of technological tools and resources used to transmit, store, create, share or exchange information while Bennett and Segerberg (2012) described ICT as a tool that is radically altering the balance of power between institutions, governments and people by broadly disseminating important information. ICT in the health context is unlikely to alter the balance of power between institutions, but it is assuredly a tool that can aid dissemination of information through electronic media. Advancements in Information and Communications Technologies (ICTs) have profoundly impacted on healthcare delivery in Nigeria. ICT has benefited the health sector both in developed nations and developing nations, the benefits affect the hospital's stakeholders: management of the hospital, health personnel and patients. The use of ICT in health sector reduces the cost of running hospitals (Scalvini et al., 2014). For example, The NHS in UK has its own network known as NHSnet which has benefited all parts of NHS.

For doctors to perform better for improved healthcare and safety of the populace in the 21st century, considering the fast growth of information technology, Stoumpos et al., (2023) opines that "doctors must incorporate IT into healthcare delivery by crossing the border of regular traditional medical practice". Despite the importance of technology in effective healthcare, it was reported that only 5% of healthcare facilities in Africa have access to ICT resources (Abayomi et al., 2020). All areas of medicine have been touched by the advent of information and communication technologies in healthcare delivery in developed countries. Information Technology solutions are used to (1) minimize the human resource required for labor-intensive or time-consuming tasks by automating them, (2) benefit from the intelligent

software solutions that not just store the data in electronic format but also ease the decision-making process, (3) accelerate the business processes by providing services simultaneously, and (4) provide maintainable and consistent services. Despite all of these advantages, health care industry spends only 2% of its revenues on technology, which is very limited when it is compared to other industries that spend around 10% (Kabakuş & Kara, 2016). Technology advances in healthcare provides opportunities for effective collection, analysis and leveraging data more effectively.

Statement of the Problem

The problem of this study stems from the fact that no country in the world can have an effective health delivery system without a conscious effort at improving the availability and use of health informatics. Use of medical informatics in teaching hospitals especially in Nigeria, is a sine qua non to making progress in health treatment outcomes. The healthcare system in Nigeria faces significant challenges, including limited access to quality care, fragmented health data systems, and inefficiencies in patient management. The lack of widespread adoption of medical informatics has compounded these issues, leading to poor data integration, inadequate tracking of patient histories, and delays in decision-making processes. As a result, healthcare providers struggle with accurate diagnoses, treatment planning, and resource allocation. The implementation of medical informatics could streamline healthcare delivery, enhance the coordination of care, and improve overall patient outcomes, but the current barriers, including infrastructure limitations, inadequate training, and regulatory hurdles, hinder its effective use.

Objectives of the Study

The broad objective of this study is to investigate the availability and use of Medical Informatics in Teaching Hospitals in Nigeria. However, the specific objectives are as follows to:

1. Examine the benefits of Medical Informatics (MI) in Teaching Hospitals in Nigeria.
2. Discuss how MI is used in Teaching hospitals in Nigeria.
3. Review case studies and examples of the use of MI in Teaching Hospitals in Nigeria
4. Espouse challenges encountered in the use of MI in Teaching Hospitals in Nigeria
5. Proffer Strategies for improved use of MI in Teaching Hospitals in Nigeria.

Use of Medical Informatics in Teaching Hospitals

Medical informatics is a rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical data, information, and knowledge for problem solving and decision making. Medical Informatics comprises the theoretical and practical aspects of information processing and communication, based on knowledge and experience derived from processes in medical and healthcare (Shortliffe & Cimino 2014). Medical informatics is a general term encompassing key theories, concepts, and techniques applied to manage and use information in health and biomedicine. In recent years, the healthcare industry has seen a rapid growth in medical and healthcare data, which can be used to improve facilities and public health care utilization and implementation by modern healthcare units using novel treatment and diagnosis methodologies, which gives citizens confidence in using the best public healthcare services available and aids governments in developing better healthcare policies (Yogesh & Karthikeyan, 2022).

The history of medical informatics in Nigeria started in the late 80s when a collaborative research project between the Computing Centre of the University of Kuopio, Finland and Obafemi Awolowo University, and Obafemi Awolowo University teaching Hospital (OAUTHC), Nigeria was initiated and this initiative was part of INDEHELA (Informatics Development for Health in Africa). In the late 1990s, the Finnish/Nigerian research team decided to expand their rudimentary hospital information system with the aim of developing a comprehensive system suitable for use in all Nigerian teaching hospitals and medical centres.

The plan then was that by 2001 all the teaching hospitals in Nigeria would have Health Informatics units which could make use of standardized software (Idowu, 2015). Development of the commercial software ‘Made in Nigeria Primary Healthcare and Hospital Information System’ (MINPHIS) ran alongside the doctoral programme of one of the staff of the Department of Computer Science & Engineering, Obafemi Awolowo University, and was completed in 2004. Unfortunately, the system was not tested at OAUTHC and only five teaching hospitals and medical centres used the system as of 2007. The primary reason for this limited use is the cost of purchasing the commercial software. As Finnish/Nigerian research team were working on primary healthcare and hospital information system, a Norwegian and South African team focused on a district-level information management system (Mursu, 2002). Presently most Nigerian teaching hospitals have to generate money by billing patients for the services rendered to them, so as to augment the money received from the government to run the hospital and pay staff salaries. Meanwhile, it is believed that if the use of ICT is adopted, the cost of running the hospital in the long run will be reduced and the health care delivery system may be as efficient and effective as it is in the developed world (Idowu, 2015).

There has been a growing trend for information and communication technology tools adoption and utilization for hospitals to handle critical and complex cases, manage health information systems and data processing in delivering effective healthcare and social wellbeing inclusion. However, majority or all public hospitals in sub-Sahara Africa and Nigeria has under-utilized these technologies due to lack of maintenance and performances in the Hospital workplaces. This has become a big concern in the African continent, especially Nigeria. The Nigerian National Health Services in 1998 had reorganized the significance of ICTs in the future that Nigeria Health workers will require to be computer literate in order to function and apply ICTs in health care delivery and administrative functions (Ewoh, 2020). Some areas of ICT application in a teaching hospital include but not limited to: coding and indexing of clinical diagnosis, maintenance and records keeping, information processing and informed decision making thereby reducing medical costs. Undoubtedly, the increased use of ICT resources in

hospitals has helped improve the knowledge level of the patients. This is because through the use of computers or monitors, digital ICT tools, the patients have a chance of grasping the visual perspective of their health status. Moreover, the ICT integrated system is critical to patients' diagnosis and the reduction of medical errors has gone a long way in holistically improving the level and quality of healthcare outcomes and patients' safety (Addo & Agyepong, 2020). Going further, Ewoh (2020) revealed that some teaching hospitals do not have internet and functional internet facilities, no maintenance plan available and there was also no significant training to utilize the operation of available technologies. Telephone mobile, Computer and manual medical records were in place and functional.

The application of Medical Informatics (MI) by medical doctors has different goals in developed and developing countries. The main objective of MI is to reduce healthcare cost and budget as well as to provide effective healthcare delivery to people irrespective of their origins and colours (Yogesh & Karthikeyan, 2022). However, the application of technology to healthcare in Nigeria are largely rudimentary to nonexistent despite the tremendous benefits for improving health care. The benefits of using medical informatics in teaching hospitals include: Electronic health records (EHR), Telehealth and telemedicine, Clinical Decisions support systems, public health informatics, Health data science, Bioinformatics and computational biology. Informatics is changing the face of healthcare delivery. Ushie et al., (2013) report that not less than 44,000 to 98,000 patients died annually from medical errors in countries like the US, while over 13% to 43% of the instances where stroke has been misdiagnosed are due to lack of access and use of medical informatics tools (Imam, 2004).

Medical informatics is, therefore, vital for the efficient discharge of medical duties in healthcare facilities. Across the United States, few physicians have access to a comprehensive EHR that contains all of a patient's medical information (regardless of how many doctors have provided care) and communicate care gaps and potential medical errors before they happen. As difficult and expensive as it may be to integrate this kind of system across a community, doing so

is the best way to maximize quality of care for all patients (Pearl, 2017). There will always be customized applications that are more desired by a single specialty and more specific to its practice, but the power of the EHR derives from the totality of the information it provides. Patients benefit the most through the sharing of information across specialties, rather than the depth or ease of documentation within each. Unlike many office-based stand-alone systems that focus on a single clinician's needs, a comprehensive EHR begins with the totality of the patient, and communicates their information to every physician who provides care. The incorporation of medical informatics for improved service delivery for the citizenry has gained wide acceptance in most developed countries (Dowding, 2013). However, this is not the case in developing countries such as Nigeria. It is suggested that doctors must be information and computer literate in the present information technology era. Unfortunately, doctors' education does not prepare them for today's practice environment, leaving them with inadequate competencies to operate in the modern-day technology-rich healthcare environment (Akpabio & Ella, 2015).

Doctors spend quality work hours on information-related activities to enhance their clinical decision-making for effective patient-centred healthcare delivery (Daniel, 2013). Hence, doctors need current, precise, and reliable information for patients and access to healthcare's best practice. Adoption of medical informatics in Nigeria hospitals will help to reduce fatal and costly medical errors and improve patient management orders. MI can help Doctors respond to new developments in healthcare delivery, as it combines Medical science with computer and information sciences to manage patients' data (McGonigle D, 2012). Dugar (2019) listed the following areas where electronic health records improve the quality of care to include: Quick access to patient records; Increased treatment effectiveness; Recommends potential treatment options; Patient portals give patients access to their medical details; Makes patient-physician communication better and improves preventive care. The benefits accruing to health institutions through the adoption of medical informatics as listed by Oyegoke (2009) include: health management information system, improved access to information, enabled connected care,

linking patients and service users with information and support networks and improved monitoring of patients condition.

Medical informatics tools include computers, clinical guidelines, formal medical terminologies, and information and communication systems. It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health, occupational therapy, and (bio)medical research (Kabakuş & Kara, 2016). In recent years, the number of medical informatics tools with the potential to significantly improve delivery of healthcare services has grown tremendously. However, the use of these tools in large, complex health systems remains comparatively limited. The adoption and implementation of medical informatics tools in health care system remain a challenge; few strategies exist to help tools cross the chasm from clinical validation to integration within the workflows of a large health system (Marwaha et al., 2022). Other medical informatics tools and systems used by hospitals include Electronic Health Records, Referral Trackers, Patient Portals, Remote Patient Monitoring, Computerized Provider Order Entry (Tools & Care, 2021). Developed countries have long imbibed the use of technology in healthcare practices. There are technologies like immunization registers, electronic health records, e-prescribing software. In the early 2000s the Kaiser Permanente in the United States embarked on an ambitious initiative to digitize its health records and transition from paper-based documentation to EHRs. They integrated patients' records, including medical history, test results and prescription and treatment plans into a unified electronics system accessible to healthcare providers. Currently, China's medical information industry is focusing on the construction of smart hospitals, including intelligent systems supporting doctors' scientific research, diagnosis-related group intelligent operation systems, and office automation systems supporting hospital management, single-disease clinical decision support systems assisting doctors' clinical care, and intelligent internet of things for logistics (Zhang et al., 2022).

Benefits of Medical Informatics in Teaching Hospitals

Medical informatics is important for its role and contribution to improve healthcare services by employing information technology. Its importance can be deducted from its nature as a multidisciplinary study, its contribution to society, and its future directions that open up many possibilities (Hansun, 2021). The need and importance of medical informatics cannot be overemphasized. Better patient-physician relationships and health outcomes have been made possible by medical informatics (Hersh, 2002; Blumenthal, 2010). Furthermore, medical informatics has revolutionized the health system through better overall healthcare management, the superior quality of care, higher productivity due to more focused and streamlined workflows, higher administrative efficiency, fewer medical errors, better communication with the patient, and lower costs. Adler-Milstein, Green, and Bates, (2014); Buntin, Burke, Hoaglin, and Blumenthal, (2011) listed the following as the importance of health informatics: Patient knowledge - Patients who have electronic access to their health records are aware of what was done as well as what prescriptions they may have to take. Shared knowledge - Medical informatics allows important health information to be shared throughout the chain of care, from the patient right to health administrator and pharmacist. Better overall outcome - It also eliminates a lot of manual jobs, which saves an additional amount of time in clinics, hospitals and even for the patient thereby providing better overall outcome for everyone involved. Decreased costs – With medical informatics and a connected infrastructure, medical professionals can access the patient’s medical records online and become instantly aware of what procedures the patient has had done as well as any comments or diagnosis that may have been made on the patient. This can save money for the patient, the insurance company and the healthcare providers (Anan, 2021).

Teaching hospitals tend to provide many advantages which include: improved quality of care, new treatments and cures, state-of-the-art technologies, shorter hospitalizations for major illnesses and procedures, better outcomes and survival rates, specialized surgeries and experimental medical procedures, and the expertise of highly trained physicians and surgeons, available 24-hours a day (Michigan, 2023). Many doctors consider teaching the new generation

of doctors as one of the most important ways that they, themselves, stay current in medicine and innovations in the field. So, “teaching hospitals” are sought out by doctors who want to practice medicine in an environment that is committed to best-in-class care, learning and innovation.

Teaching hospitals are beneficial to patients because they get the added benefit of having several doctors involved in their care so all the possibilities can be considered (Smith & Johnson, 2021). Traditionally, teaching hospitals as opined by World Health Organization (2021); Federal Ministry of Health, (2018) see their main function as undergraduate and postgraduate teaching, research, and specialist care of the sick and injured. The benefits of using teaching hospitals are enormous such as: For general surgery patients, teaching hospitals had a 0.95% lower mortality rate compared to non-teaching hospitals although this is achieved at an added cost (Glickman, 2020).

Apart from data networking and Internet, the NHS spends millions of pounds each year on telephone services across England to aid patient transport services and emergency ambulance because the two areas help the NHS to deliver good health care facilities (Carter, 2018). ICT introduces potential of sharing of patients’ files easily without any threat to patient privacy. It is used for hospital management such as admission and appointment management. ICT improves the efficiency of medical personnel by reducing waiting times and minimize paperwork. Hospital staff can get information in an easily understandable way because of ICT. As soon as the test results are available, they can be uploaded to the patient's case file. ICT helps patients find medical staff and facilities, provides them with round-the-clock access to health information, and helps preserve patient privacy by encrypting and password-protecting data (Idowu 2015).

Case Studies and Examples

ICT has made it easier for electronic payment to be used for medical treatment in The Good Shepherd Specialist Hospital (TGSSH) Uwani-Enugu, Enugu, Nigeria where debit card is used by patients for service payment. This enables faster bill payments, induce cost savings,

better transaction tracking, transparency, promotes trusting relationship between the patient and the staff of the hospital (Harold-Juwah, 2022). E-payment systems provide a crucial support service in the digital economy due to its efficiency and reliability. However, E-payment still comes with some negativity, patients get discouraged in using the e-payment system for the payment of medical services because of the difficulties experienced in getting a strong network to complete the payment or where they must wait for a long time to make payments (Harold-Juwah, 2022).

At the university teaching hospital Ituku Ozalla, patients no longer carry cash around for bills payment, rather the management has initiated a means through modern technology where the patients deposit money into their e-wallets via their commercial bank account, so that at the point of consultation and treatment the bills are automatically deducted from the e-wallets. Previously, patients who come for consultation are made to wait long hours for their physical folders to be searched out from the numerous folders in the store rooms. However, technology has made it easy for patients to have e-folders where the doctor keys in the patient's PT number into the connected computer or laptop, this automatically brings up the patient's details. Kogi State Specialist Hospital is one of the few health centers in Nigeria operating an integrated electronic health record system. The system operates such that ongoing consultations can be accessed by other sectors of the hospital real-time (Alobo et al., 2020).

Lagos University Teaching Hospital (LUTH), one of the largest teaching hospitals in Nigeria, successfully implemented an EHR system to improve patient care and operational efficiency. The EHR system enabled LUTH to digitize patient records, streamline workflows, and enhance communication among healthcare professionals. As a result, LUTH experienced improved data accuracy, reduced waiting times, and enhanced patient satisfaction. Shehu et al., (2017) in their study investigated the acceptance of EHRs for improving Quality of Health Service Delivery at Aminu Kano Teaching Hospital where study participants accept and use EHRs in order to enhance their job performance and believed that the system is very useful in their work. They reiterated that EHRs improves Service Quality and most of the antecedents of

technology adoption (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions).

Challenges encountered in the implementation of medical informatics

The Nigerian healthcare system is organized into primary, secondary and tertiary healthcare levels. The Local Government is responsible for providing secondary care while the Federal Government is responsible for policy development, regulation, overall stewardship and providing tertiary care. The LGA level is the least funded and organized level of government and therefore has not been able to properly finance and organize primary healthcare, creating a very weak base for the healthcare system (PharmAccess Foundation, 2015). Years of under investment in health systems has resulted in poor infrastructure, inadequate modern equipment and technology and an inadequate number and mix of healthcare workers. These have resulted in absence of key specialist services, poor quality of care and loss of confidence in general health services especially the management of non-communicable diseases. The federal government is responsible for the tertiary healthcare facilities such as federal teaching hospitals and federal medical centres. The general and tertiary hospitals provide various healthcare facilities for all cases referred to them from primary healthcare centres (Federal Ministry of Health, 2014).

Both Federal and State governments manage the teaching hospitals. However, the federal government is responsible for providing the policies and regulations that guide healthcare professionals' operations and training in Nigeria (Oyegoke, 2009). Though tertiary care institutions are funded mostly by the federal government, an analysis of the federal annual budget from 2010 to 2014 shows that, on average, over 60% of the federal annual health budget goes to personnel costs, leaving little for infrastructural development, expansion, acquisition of new equipment and scaling up of services. This has resulted in run-down of tertiary hospitals, a key contributor to the huge medical tourism being experienced in Nigeria. To overcome the budgetary constraints to capital investments in the tertiary hospitals, the Federal government has over the years, adopted a "special projects" approach to fund major upgrade. Outside of the

regular budget, money is set aside for these initiatives, and occasionally additional financing is obtained from partners (PharmAccess Foundation, 2015).

The Nigerian healthcare industry is facing challenges associated with outbound medical tourism, deteriorating medical infrastructure, low government budget allocation, and poor compensation and subsequent emigration of skilled healthcare workers. The federal government allocated 5% of its budget to health in 2021, compared to the 15% it pledged as part of the 2001 Abuja Declaration (*Nigeria - Country Commercial Guide Healthcare Overview*, 2023). The Nigerian health system is weak and has been evolving over the years with misplaced priorities and the focus on health inputs rather than outputs. The design and adoption of several policies have contributed little to strengthening the health system towards improvement in health outcomes. Decentralization and fragmentation of the health system with duplication of responsibilities among the three tiers of government have affected effective health service delivery and accountability. While some modest gains and improvements have been recorded over the decades, maternal mortality, child mortality, immunization coverage, access to basic health services and life expectancy remain poor. Nigeria needs to strengthen its health system (Aregbeshola, 2021).

Peer-reviewed studies in the medical literature have painted similar pictures of poor healthcare quality at most of the nation's public hospitals. For instance, studies have revealed tertiary hospitals lacking vital equipment needed for emergency care of acute asthma and obstetric hemorrhage, while hospital administrators complain of insufficient personnel made worse by inadequate electricity from the national grid, poor government funding and bureaucratic bottlenecks undermining staff recruitment and training (Alkali & Bello, 2020). A health care system comprises all medical care services involved in the prevention, diagnosis, treatment, and rehabilitation (services for the restoration of function and independence); the institutions and work force that provide the services, and the government, public and private organizations and agencies that fund the service delivery (Emmanuel, 2014).

Many obstacles stand in the way of medical informatics' effective use and integration into Nigeria's healthcare system. One of the main challenges is users' unfamiliarity with technology, which is made worse by concerns about cultural appropriateness. Additionally, a large number of clinicians lack basic computer skills, underscoring the critical need for Information and Communications Technology (ICT) training programs to provide them with the skills they need (Al-Sakkaf, 2018). One other significant issue is Nigeria's erratic electric power supply. Medical informatics operations are frequently disrupted by frequent power outages in Nigerian hospitals, in contrast to affluent nations where uninterrupted electrical supply is ensured. In addition, the government's view of ICT has not made it a priority to use technology as a crucial instrument to improve healthcare delivery. Research institutes could make headway if they were encouraged to develop software and take up international best practices, especially when it came to using a lot of open-source programs. Even government organizations find it challenging to make the necessary investments due to the high expenses of purchasing ICT infrastructure, peripherals, and telecommunications equipment. In order to solve this, the government could set up an intranet in hospitals to promote communication and reinstate the efficient landline telephone infrastructure, which is less expensive to operate. Bad internet access is also another obstacle. While the 2007 launch of the NIGCOMSAT-1 communication satellite attempted to address issue, more funding for hospital fiber optics is still required. Because of the widespread resistance to new technology, hospital staff members must receive government-led training instead of being laid off to make room for individuals with ICT abilities.

Furthermore, it can be harmful for ICT systems to lack a maintenance culture. This problem could be resolved by an ICT strategy requiring maintenance agreements for imported equipment (Idowu, 2015). The environment is made more difficult by a number of obstacles, including the need for uniform user interface designs, the necessity of constant learning due to new technology, and the high expenses associated with deployment and upkeep. Resistance to change is also important since it can take a lot of effort to modify old procedures in order to adapt to new systems. Additional problems include cultural boundaries, poor IT literacy, quality

data management, and regulatory issues. Nigeria's healthcare industry has challenges in developing its capacity due to insufficient infrastructure and a severe scarcity of medically qualified personnel. In remote locations with limited access to medical personnel, this scarcity is especially acute. Opportunities for ongoing professional development are crucial for enhancing healthcare personnel' performance and quality of care (Okunade et al., 2023).

Strategies for enhancing MI in teaching hospitals.

Artificial Intelligence applications can deal with the enormous amounts of data generated in the medical field and discover valuable knowledge that would otherwise be hidden in big medical data. Healthcare stakeholders may use AI-based computational tools to harness the power of data to review historical data, anticipate prospective outcomes, and identify the optimal actions for the current context. As a result, AI is becoming more essential to healthcare stakeholders in decision-making. When putting privacy protection measures in place inside a specific system, this service represents a possible privacy breach that must be considered. End users are now more concerned than ever with the privacy of their health data due to increasing awareness among them. New types of cyber-attack will be made possible by advances in AI. These attacks may use AI systems to do specific tasks more effectively than humans could or exploit flaws in AI systems that humans cannot control (Almalawi et al., 2023). Due to its sensitivity and high value, healthcare data is the target of cyberattacks resulting in the healthcare industry being highly regulated through specialized legislation such as the Health Insurance Portability and Accountability Act (HIPAA) (Cocoara, 2024). To safeguard medical records and comply with regulations, healthcare organizations must build a comprehensive data security strategy to ensure compliance and avoid fines and other costs associated with data breaches. Effective data security directly impacts patient care, as it ensures the confidentiality and integrity of patient health information and this can be achieved by healthcare institutions dealing with internal threats, restrict access to data and control removable devices.

In order for health workers to provide quality care and meet their communities' changing health care needs, they must become lifelong learners dedicated to updating their professional knowledge, skills, values, and practice. Continuing Professional Development (CPD) encompasses all of the activities that health workers undertake—both formal and informal—to maintain, update, develop, and enhance their professional skills, knowledge, and attitudes. CPD is a systematic and ongoing process of education, in-service training, learning, and support activities that build on initial education and training to ensure continuing competence, extend knowledge and skills to new responsibilities or changing roles, and increase personal and professional effectiveness (Giri et al., 2012). One component of CPD is continuing education or training opportunities held in formal educational environments for professional health workers, such as physicians, nurses, and dentists, as well as allied workers such as dental, laboratory, and pharmaceutical technicians.

Formal CPD should focus on “enhancing roles and competencies...and organization of work..., communication, medical ethics, teaching, research and administration” (Federation & Medical, 2003). While CPD is often achieved through systematic learning opportunities integrated into health facility protocols and on-the-job training, less structured mechanisms for learning and development are also available to health workers. Informal opportunities for learning via spontaneous interactions with colleagues, professional reading, and reflections on one's own experiences are essential aspects of a health worker's professional development. These informal opportunities can be heavily influenced by location and working conditions. For example, a health worker in a remote, rural clinic with no other professional colleagues nearby will not have the same opportunities for spontaneous professional dialogue as a peer working in an urban or semi-urban area.

Recommendations

It is recommended that the following steps be taken to promote MI in teaching hospitals in Nigeria. These are: Adoption of medical informatics to help improve hospital administration and

quality of programmes which will help create a culture of accountability and safety for staff and patients.

- Adoption of medical informatics to help the hospital administration improve on their quality of programs and create a culture of safety and accountability for staff and patients alike.
- Implementing medical informatics to improve clinical decision support by care givers thus minimising medical errors and misdiagnoses.
- Adoption of medical informatics in hospitals to assist in improving the quality of care and also enable health care givers to spend more time with their patients.
- Utilisation of Medical Informatics to assist health care givers to locate and record relevant information in order to improve the patients' experience and minimise mistakes.
- Adoption of medical informatics in Nigerian hospitals to enhance effective service delivery.

Conclusion

This article has been able to review the availability and use of MI in teaching hospitals in Nigeria, bringing out the crucial benefit accruing to this. The article has further established and investigated the numerous benefits of MI generally in teaching hospitals. It further investigated how MI is used on a broad scale across the globe in teaching hospitals and thereafter reviewed some case studies and examples from Nigeria. The challenges of the use of MI were brought to the fore and were succinctly discussed, while some critical strategies for improvement of the use of MI were proffered. In conclusion, the integration of medical informatics in hospitals has the potential to revolutionize healthcare delivery. By improving data management which will allow personalized care, enhancing patient safety, and enabling better decision-making through real-time access to patient information, medical informatics streamlines hospital operations and fosters a more efficient healthcare system. As hospitals continue to adopt and optimize these

systems, the long-term benefits will be seen not only in improved patient outcomes but also in reduced operational costs and a more resilient healthcare infrastructure. The future of healthcare depends on the continued embrace of technological advancements like medical informatics to meet the ever-growing demands of modern healthcare.

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