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CHALLENGES ASSOCIATED WITH POST-OPERATIVE CANCER CARE AND IMPLEMENTATION OF DIGITAL TECHNOLOGY FOR IMPROVED OUTCOMES: A NARRATIVE REVIEW

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Abstract
Cancer diagnosis and subsequent treatment have a profound effect on the lives of patients and their families**.** Post-surgical care is a critical phase in the cancer treatment continuum, and significantly influences recovery, quality of life, and long-term outcomes. There are multiple challenges associated with post-surgical cancer care. This review aimed to identify barriers to post-surgery cancer care management, particularly in low-resource settings. Additionally, it aims to understand the importance of integrating digital healthcare technologies for efficient healthcare delivery to patients after cancer surgery. A literature search was conducted using PubMed and Google Scholar databases. Several medical, psychological, and logistical challenges have been identified as barriers to accessing healthcare for patients with cancer. In low- and middle-income countries (LMICs), the main obstacles are financial constraints, lack of accessibility to specialized care, lack of resources and awareness, and the gap in patient-provider communication. The advancement of digital health technology has resulted in the creation of technology-driven approaches to delivering healthcare. It is beneficial in overcoming some of the challenges associated with post-operative cancer care in LMICs. Integrating technology-enabled solutions such as smart mobile applications, remote monitoring tools, telemonitoring, telemedicine platforms, artificial intelligence, and digital therapeutics can transform patient care. Recently, India has seen a surge in the adoption of digital health technologies that are aimed at improving the quality and continuity of care for cancer patients. Although digital technologies have the potential to revolutionize postoperative cancer care in India, strategic implementation focusing on infrastructure, education, policy, and ethical considerations is essential.

Keywords: Cancer, digital technology, healthcare, LMICs, post-operative complications, surgery, telemedicine

1. Introduction

Cancer is one of the leading causes of death worldwide, accounting for an estimated 10 million deaths in 2020. According to the World Health Organization (WHO) projections, the number will increase to 13 million by 2030, with over 35 million new annual cases by 2050, suggesting a 77% increase in

new cases. [1, 2]The rapidly increasing global cancer burden results from a combination of population growth, aging, and shifts in exposure to various risk factors, many of which are linked to socioeconomic development [2, 3]. A sharp increase in cancer incidence and mortality has been reported in low-income countries (LICs) and low- and middle-income countries (LMICs), accounting for over 70% of the global cancer burden. By 2030, these regions are expected to contribute to approximately 75% of all cancer-related deaths worldwide [4, 5]. Cancer is a leading cause of morbidity and mortality in India. According to GLOBOCAN, there will be 2.08 million cancer cases in India in 2040, and as per the National Cancer Registry Program, the incidence of cancer cases is likely to increase from 1.46 million in 2022 to 1.57 million in 2025 in India [3].

As the number of patients living beyond a cancer diagnosis increases, improving patient quality of care during and after cancer treatment has become extremely important [1]. Surgical resection remains the mainstay of cancer treatment across all resource settings and plays a vital role in both diagnosis and treatment in low-resource settings [6]. According to a recent estimate, more than 80% of all cancer cases require surgery, leading to a projected global need for 45 million cancer-related surgeries by 2030 [7]. However, only 25% of cancer patients worldwide have access to safe, affordable, and timely surgery, with 20% in LMICs and 5% in LICs [8].

Surgery may cure or alleviate cancer; however, post-operative complications may arise, potentially increasing morbidity, mortality, hospital stay, and healthcare costs [9]. Post-operative care is considered more important than surgery itself in determining outcomes and post-operative complications [9]. This review aimed to identify the key challenges associated with post-surgery cancer care, focusing on LMICs. Additionally, it aims to comprehend the role of technology-enabled tools and their integration for effective healthcare delivery following cancer surgery.

2. Methods

An exhaustive literature search was conducted using PubMed and Google Scholar on post-surgery cancer care, its associated challenges, and the implementation of technological tools in cancer care. Articles published in the last 10 years were retrieved by using keywords such as “cancer,” “cancer management,” “surgery,” “postoperative complications”, “post-surgery care,” “challenges,” “LMICs,” “healthcare delivery”, “ERAS”, “digital technology”, “telemedicine”, “telemonitoring, “wearables”, “healthcare apps, “integration”, and “IoMT” Only published articles in the English language were considered. The cross-references from the retrieved articles were scanned for additional evidence.

3. Post-operative cancer care and associated challenges in LMICs

The post-operative phase is a critical factor for the long-term success of cancer surgery worldwide [10]. This is determined not only by the success of the surgery itself but also by the improvement of the patient's functionality, autonomy, and overall quality of life (QoL). Despite advancements in surgical procedures, the use of minimally invasive techniques, anesthesia, and perioperative care, post-operative complications play a significant role in morbidity. Complications affect physical and psychological well-being due to prolonged recovery and hospital stay. Moreover, for elderly patients with multiple comorbidities, the risks that can negatively impact post-operative outcomes tend to increase [11]. These factors contribute to difficulty in postoperative recovery and a significant reduction in the functional ability and QoL of patients [11]The challenges in post-surgical cancer care can be broadly categorized into medical, psychological, and logistical issues.

3.1 Medical challenges

3.1.1. Pain management

Postoperative cancer pain, an immediate and persistent challenge following surgery, imposes severe problems. The occurrence of acute pain is maximal in the first 24 h after surgery [12]. Poorly managed post-operative pain is related to poor clinical outcomes such as delayed mobilization, reduced oral intake, cardiopulmonary complications, prolonged hospitalization, higher risk of chronic post-

surgical pain, and sleep disturbances [10, 13]. Pain management without causing opioid dependence is another challenge. According to the American Society of Clinical Oncology guidelines, opioids should be offered to adults with moderate-to-severe cancer-related pain, unless contraindicated, with early assessment and frequent titration to balance the effective relief of cancer pain with safe and responsible opioid use [14]. Moreover, recent enhanced recovery after surgery (ERAS) guidelines suggest avoiding opioids in open surgery for colorectal cancer [13].

3.1.2. Monitoring post-operative complications

The most common complications following cancer surgery are surgical site infections, lymphedema (especially after breast cancer surgery), and delayed wound healing (after breast and abdominal surgeries) [15]. Timely identification and management of these complications are essential for recovery. However, in low-resource settings or remote areas, this becomes challenging owing to inadequate follow-up systems and a lack of access to specialized care, leading to poor post-operative recovery. Moreover, perioperative nutritional intervention is urgently needed to improve clinical outcomes after cancer surgery. [16]. Malnutrition contributes to the high global burden of cancer surgery and is an independent predictor of post-operative complications in LICs and LMICs. Globally, malnutrition is an independent risk factor for surgical-site infections and 30-day mortality after gastric and colorectal surgery [16].

3.2 Emotional and psychological challenges

3.2.1 Anxiety and depression

Emotional and psychological challenges due to fear of recurrence, body image issues, and the physical limitations imposed by surgery, as well as financial burden, can impact the well-being of patients undergoing cancer surgery [17, 18]. An estimated 20–30% of patients with cancer suffer from a mental disorder, with adjustment disorders, depression, and anxiety disorders being the most common. The experience of individual patients varies considerably based on socioeconomic and cultural factors and the country's healthcare system [19]. It has been reported that mastectomy without breast reconstruction is associated with enhanced psychological disorders such as depression, anxiety, and insomnia in patients with breast cancer, leading to reduced physical function and increased mortality rates [20]. These emotional burdens are often underdiagnosed and undertreated in routine clinical care, especially in low-resource settings that lack specialized care resources.

3.2.2 Lack of psychological counselling and social support

Accurate diagnoses and, consequently, prompt and efficient therapies can arise from regular monitoring of mental health and the use of validated evaluation tools in patients with cancer. Medical professionals must understand the results of these assessments and offer their patients appropriate psycho-oncological support. Customized mental health interventions and support systems are recommended to improve patient outcomes. By prioritizing mental health, clinicians can markedly improve the overall well-being and QoL of their patients [17]. However, the availability of psychological support services varies, particularly in high- and low-resource settings, as well as in urban and rural areas [19]. Many patients are ill-prepared for the mental and lifestyle changes that follow surgery because they do not receive adequate pre- and post-operative counselling.

3.3 Logistical challenges

Emerging economies face the dual burden of lifestyle- and poverty-related cancers. Rapid urbanization, lifestyle factors, and increasing life expectancy significantly influence cancer incidence rates in LMICs [21]. Although LMICs face similar clinical challenges with post-operative cancer care as high-income countries (HICs), the financial constraints and logistical challenges in cancer care vary significantly between HICs and LMICs, which manifest as inequalities in healthcare infrastructure, resource availability, and access to specialized services [22].

3.3.1 Financial constraints

Cancer imposes a significant toll on a country's economy. According to a decision analytical modelling study, the estimated global economic cost of cancer between 2020 and 2050 is $25.2 trillion in international dollars. The relative contribution of treatment costs to the total economic cost of cancers is greater in HICs than in LICs and LMICs; however, due to their large population size, LMICs bear the highest absolute health burden. China and the United States incur the greatest economic burden of cancer, followed by India. [12]. In LICs and LMICs, cancer surgery costs are mostly paid out-of-pocket at the individual level, which leads to disastrous spending and financial toxicity [6]. In India, most of this expenditure is usually incurred out of pocket, creating an immense financial burden on patients [23]. Health insurance coverage has been linked to a reduced likelihood of treatment discontinuation. However, even with insurance coverage, approximately 30% of expenses may be out-of-pocket, particularly outpatient visits and post-operative rehabilitation in LMICs [6].

3.3.2 Lack of accessibility to care

The accessibility and affordability of surgical care cause substantial disparities in operative outcomes between HICs and LMICs. It has been reported that more than 90% of perioperative mortalities occur in LMICs [6]**.** The discrepancies in accessibility to cancer care between high- and low-resource settings may be due to the lack of infrastructure and trained human resources [6]. Access to appropriate resources is essential for recovery. Timely follow-up and monitoring of postoperative complications and adverse events (AEs) are crucial for initiating necessary measures. Hospitals with advanced infrastructure and resources, with facilities for remote monitoring technologies, have better outcomes after cancer surgery [24]. In LMICs, access to hospital care is often limited and expensive, indicating that patients rely primarily on home-based care. Moreover, a long travel distance to cancer centers is another challenge to access post-operative care, as evident from a cross-sectional study on 100 patients with cancer and 48 caregivers [25].

3.3.3 Lack of resources and infrastructure

The lack of basic tools for surgery, chemotherapy, and palliative care has been reported in many LMICs. GlobalSurg 3, a multicenter, international, prospective cohort study of patients who underwent cancer surgery, indicated that the number of patients undergoing surgery in hospitals with reduced resources and weak care processes is higher in LMICs. Owing to the lack of essential components of post-operative and critical care, pain management, and palliative care, the management of post-operative complications is challenging, putting these patients at additional risk [24]. In India, government-funded public cancer centers provide subsidized care for those unable to afford private treatment, but the centers often face shortages in clinical resources and treatment options to meet high patient demand [26]. Moreover, the availability of infrastructure and human resources for optimal care delivery varies substantially between rural and urban populations [27]. Given the unequal distribution of cancer care resources and oncology specialists in LMICs, there is an urgent need for policymakers and HCPs to optimize resource usage to reach more patients.

3.3.4 Lack of trained workforce

There is a shortage of specialized oncology workers, such as trained cancer surgeons, and a wide disparity in the distribution of the surgical workforce in different regions of the world, leading to nonspecialists delivering cancer care in certain settings [6, 28]. The lack of a skilled oncology workforce considerably hampers cancer care in LMICs [6]. In several LMICs, general surgeons with limited expertise in breast cancer often perform breast surgeries [22]. A disproportionately small share of the specialist surgical workforce serves in Africa and Southeast Asia, even though these regions account for one-third of the global population [29]. India ranks low in the number of oncologists relative to the population [24]. Additionally, there is a shortage of trained rehabilitation professionals. Hence, there is an urgent need to develop an evidence-based global curriculum for surgical oncology training that is country- and resource-specific [6].

3.3.5 Gaps in healthcare provider–patient communication

Patient-provider communication is a crucial component of cancer care. A considerable number of complications arise after hospital discharge, particularly following certain procedures such as those for gastrointestinal cancers. Following discharge from hospitals, patients and their caregivers are mostly responsible for managing the recovery process; if complications arise during this period, they must often take the initiative to seek appropriate care [30]. An Indian cross-sectional study on the exploration of the journey of patients accessing cancer care in India and their caregivers has identified the gap and disruptions in cancer care due to problems in communication and decision-making. The findings suggested that improved communication between patients and HCPs is crucial, and culturally sensitive training in communication skills should be provided to HCPs [25].

This underscores the need for thorough patient education before discharge, ensuring that patients can recognize typical recovery patterns, distinguish between normal and abnormal developments, and identify warning signs that may require prompt attention from the healthcare team. Hence, structured discharge planning and proper communication among HCPs, patients, and caregivers before discharge from the hospital are crucial for optimal post-operative care [30].

4. Optimizing post-operative cancer care management

4.1. Role of a multidisciplinary team

The multidisciplinary team (MDT) approach is key to providing holistic care to cancer patients and is widely accepted as a critical resource for patient management [31]. Effective post-operative cancer care requires a structured, multidisciplinary approach wherein trained providers and skilled personnel deliver appropriate therapies within a well-functioning system, minimizing the financial and logistical burdens on patients [22]. In HICs, MDTs play a significant role in determining patient care strategies. Moreover, adjunct services such as nutrition, physical therapy, psychiatry/psychology, and social services are essential components of care that can be effectively delivered using the MDT approach [22].

4.2. Enhanced Recovery After Surgery: Implementation and Impact

The ERAS program, originally proposed by Prof. Henrik Kehlet and Prof. Jorgen Dahl in early 2000, is an evidence-based multimodal approach developed to reduce post-operative complications, accelerate early recovery after surgery, and improve overall patient outcomes by minimizing physiological stress and reestablishing homeostasis and organ function [1]. The ERAS program has been adopted as the standard of care and best practice in many surgical specialties [1, 32]. Preoperative counselling, nutritional supplements, and multimodal pain management are the different components of ERAS. Although full compliance with the ERAS protocol is important for optimal surgical care, standardized management still offers consistent benefits, even with partial adherence, owing to the variability in surgical procedures [32]. ERAS protocols in patients undergoing cancer surgery have markedly improved perioperative care and reduced non-surgical complications and respiratory problems, along with economic benefits, including reduced hospital stay, leading to per-patient cost reduction and improved QoL compared to those receiving conventional care [11, 33]. With reduced operating theatre capacity and bed availability during the pandemic, together with financial constraints faced by global economies, the stage was set for ERAS to flourish and deliver high-quality care at reduced costs [34]. Additionally, the integration of ERAS with multidisciplinary collaboration has highlighted significant advantages for patients undergoing colorectal cancer surgery [33].

4.3. Role of digital health technology in post-operative care

The engagement of numerous groups and service providers makes cancer care coordination challenging and frequently results in fragmentation. This is particularly true for LMICs due to inadequate infrastructure and high disease burden [35]. Moreover, an early postoperative period in patients with cancer is often linked with high morbidity, leading to marked concern among patients and HCPs. Data are increasingly supporting early discharge as part of ERAS programs; however, it

is still difficult to recognize and address suboptimal patient recovery and possible problems. Digital health interventions are being developed more frequently to provide remote patient monitoring following surgery as mobile and wireless technology become more capable and accessible globally [36].

Technological advancements in remote health monitoring systems, smart devices, telemedicine (TM) platforms, electronic medical records, mobile health apps, electronic patient-reported outcomes, and robotics have significantly strengthened healthcare systems [37, 38]. These innovations play a key role in disease prevention by supporting screening, early diagnosis, effective management via monitoring and consulting patients remotely, providing reminders and support during decision-making, and assisted living [35, 38]. Evidence from around the world suggests that digital health can significantly enhance the experience of cancer patients [35].
Thank you for reaching out.
The integration of these novel health technologies into cancer care has considerably enhanced the quality and personalization of post-surgical management, leading to improved patient outcomes and overall healthcare delivery [37]. Digital health has a diverse scope, including the use of wearable devices, mobile health, telehealth, health information technology, and TM [35]. Moreover, reducing the need for physical visits and readmissions can lower the overall cost of care for both patients and healthcare systems, increasing access to healthcare services, indicating that digital interventions may be a favorable option in terms of cost and health outcomes [39, 40]. However, in remote areas, due to limited skills as well as a lack of access to software among HCPs and patients, underutilization of technology can occur [35]. Therefore, appropriate training should be provided to HCPs on how to integrate and interpret digital health data, as well as to patients, to obtain the best use of digital technologies [37]. The benefits of the implementation of digital technology in post-operative cancer care are outlined below:

4.3.1. Virtual follow-ups, telemedicine, and remote monitoring

Telemedicine is the most common medium to diagnose, treat, and support patients, especially to ensure healthcare access to patients residing in remote locations by using various telecommunications technologies [35, 41]. In India, TM has seen a remarkable transformation and is progressively integrating into the healthcare system in recent times. The National Centre for Disease Informatics and Research recently launched the "Framework for Telemedicine to Manage Cancer, Diabetes, Cardiovascular Diseases, and Stroke.

" This has opened the door for the integration of tele-health technologies, which was prompted by the COVID-19 pandemic. A new dimension has been given to TM by the widespread usage of cameras in handheld mobile phones, messenger apps, and videoconferencing [41].
The use of remote or at-home telemonitoring after oncological surgery to track patients' physical activity, vital signs, and overall well-being through electronic wearables, activity trackers, mobile apps, symptom surveys, and video consultation platforms has been reported to be useful in providing timely access to oncologists, surgeons, and support staff, especially for those in low-resource settings [42]. Particularly for rural patients who would otherwise have to deal with travel difficulties and unequal access to healthcare, teleconsultations help reduce geographic inequalities. Telemonitoring programs such as Project ECHO (Extension for Community Healthcare Outcomes) can even create a workforce in places where there is a lack of oncologists and other cancer providers [37].

4.3.2 Use of Artificial Intelligence

The automatic and intelligent quantification of biomarkers from histopathology images is an additional benefit of a digital pathology technique based on artificial intelligence (AI). Because of this, it is becoming more and more crucial to help patients choose better cancer treatments [39]. The rapid adoption of cloud computing and AI-enabled sensors in smartphones and wearables, such as

smartwatches with digital biomarkers, has greatly benefited oncology research. These devices detect changes in patients' vital signs through skin contact and transmit biofeedback in real-time. Similar applications have shown promise in the management of patients with breast and lung cancers [43].

4.3.3. Mental health and psychological support

It is crucial to focus on the psychological well-being of patients following cancer surgery, as psychological distress can negatively impact their QoL. Cancer patients can benefit from increased autonomy and self-acceptance through digital health. Digital technologies provide a platform for remote delivery of evidence-based psychosocial interventions.

Therefore, the integration of digital psychological health interventions can be beneficial for cancer survivors [44]. Questionnaire-based tools for systematic monitoring of the mental health of cancer patients [45], facilitating clinical decision support, self-reporting, and self-management (e.g., the PROMPT Care system) [46], or for enhancing patient–physician communication (e.g., the LOOP system) [47] are currently available.

4.3.4. Real-time alerts and decision support

Systems connected with clinical workflows can identify anomalous patterns in patient data and assist physicians in making decisions. A hospital electronic health record-integrated electronic patient-reported outcome system that alerts clinicians and provides patient self-management advice has been developed to improve the detection and management of post-surgical complications after discharge [48]. Programs known as Cancer Hospital at Home (HaH) have been presented as a way to provide high-quality cancer care at a cheaper cost while also improving patient satisfaction. It has been demonstrated that the web-based application Remote Self-Reporting of Symptoms by Patients with Palliative Care Needs (RELIEF) is a practical and acceptable way for patients to self-report their symptoms [39].

4.3.5. Digital therapeutics for rehabilitation

Digital therapeutics (DTx) are emerging as valuable tools in cancer care. They provide evidence-based software interventions to support symptom management, mental health, and treatment adherence. These tools are integrated with clinical records to guide lifestyle changes and preventive care. Moreover, DTx can act as a rehabilitation center, providing counselling sessions and recommendations on lifestyle activities and diet charts under the supervision of a physician, whereas automated medication management systems provide daily feedback through a remote care team [43].

4.3.6. Collaboration among professionals via a virtual platform

Integrated care requires collaboration among professionals from diverse backgrounds and organizations and is often facilitated through virtual platforms. Information and communication technology play a crucial role in facilitating this team-based approach, allowing real-time information sharing with and about the patient to deliver high-quality, coordinated, and individualized care [49]. Rigorous planning is required when implementing new healthcare technologies to ensure that this adoption can mitigate current inequities and not create new concerns [37].

Overall, digital health technologies offer promising solutions to address critical barriers in post-operative cancer care across LMICs, as illustrated in Figure 1.

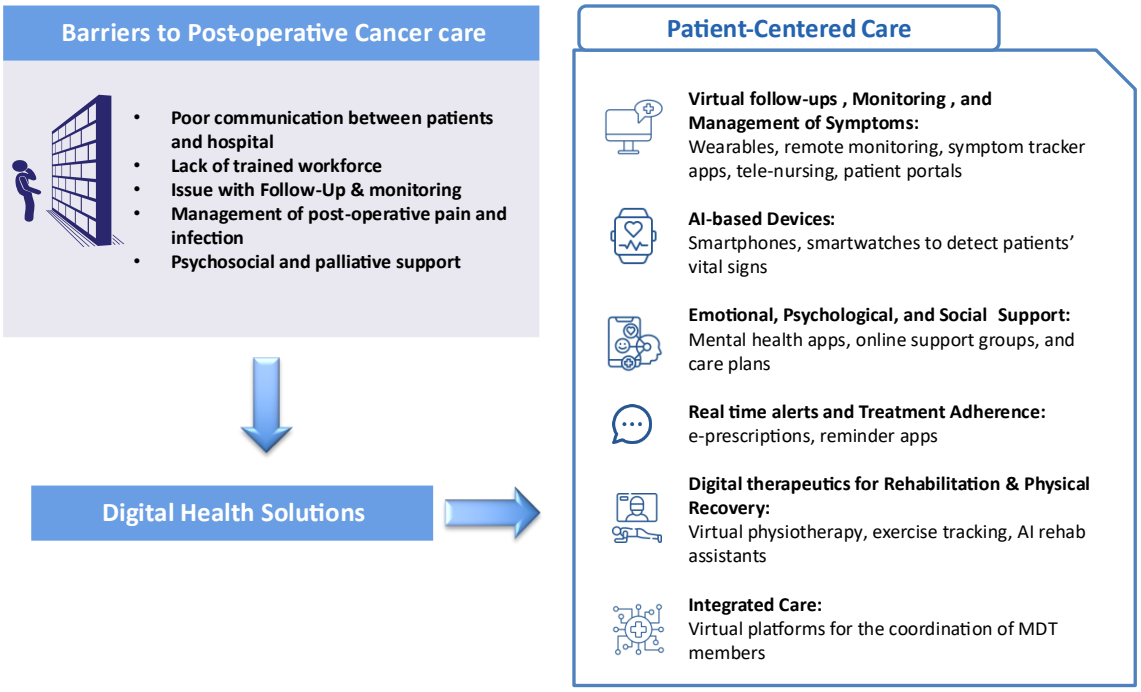

Figure 1: Overcoming barriers of post-surgical cancer and integrating digital health technology in overcoming these challenges in LMICs.

AI: Artificial intelligence; MDT: Multidisciplinary team

5. Role of IoMT in oncology care

After the COVID-19 pandemic, continuous health monitoring across patient groups has become essential [38]. The Internet of Medical Things (IoMT) comprises biomedical tools and software that connect with healthcare data systems. It helps reduce unnecessary hospital visits and eases the burden on medical practices by strengthening patient-physician relationships and enabling secure sharing of medical records [50]. IoMT has enabled effective remote monitoring, screening, and treatment in real-time via telehealth, benefiting both patients and providers [38]. The lowest tier of IoMT, known as the perception layer, includes data sources, such as smart objects, health monitoring devices, and sensor-integrated mobile apps, such as infrared sensors, medical sensors, radiofrequency identification cameras, and global positioning systems. These sensing systems detect environmental changes, identify objects and locations, and convert this data into digital signals via robust wired or wireless network transmission, thereby acting as a high-performance transport system [51]. Recently, a multisensory low-power necklace called NeckSense was introduced, which captures information on an individual's daily eating quality, quantity, and frequency to facilitate food counsellors in providing appropriate real-time interventions [33]. Although IoMT smart devices have proven impactful, healthcare remains one of the most challenging sectors for large-scale IoMT implementation, owing to its high demand [38].

We propose a framework to assess the post-surgery cancer care and to identify and select the parameters to be tracked through the remote monitoring system (**Figure 2**). Once the parameters are identified, a set of associated wearables can be assigned to patients. These wearables capture and share data by using a smartphone application. The application will translate these data into cognitive alerts defined as per the ERAS to family physicians or caregivers associated with patients, allowing

them to make timely decisions and report AEs, if any. This cloud-based multimodal application will allow physicians to closely monitor their patients as they go about their daily activities.

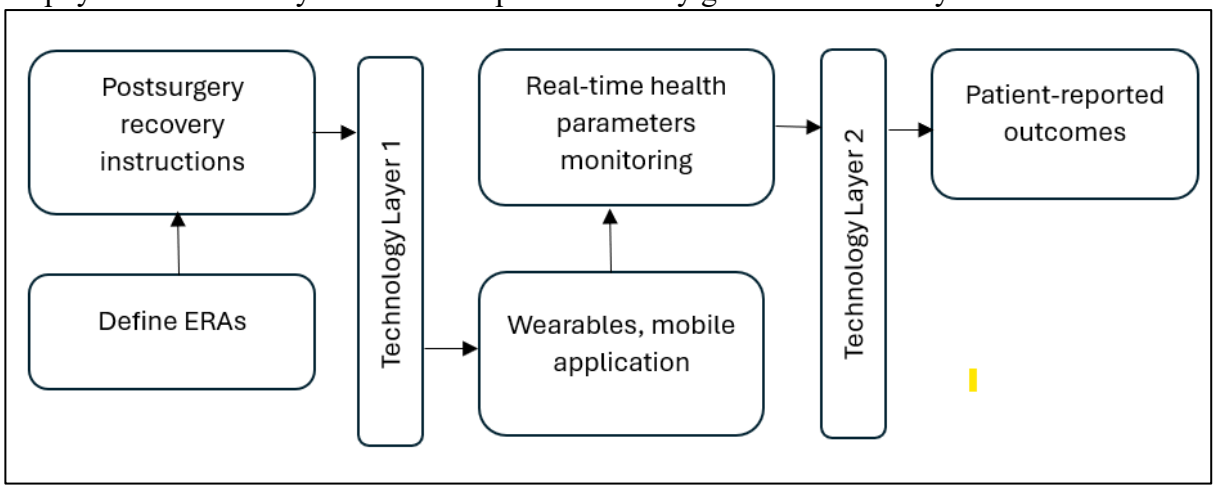

Figure 2: Proposed Internet of Medical Things framework for the care management of post-surgery patients.

ERAS: Enhanced recovery after surgery

6. Role of digital twin technology in surgical oncology

Digital twin (DT) technology is an emerging concept that has earned widespread attention in oncology [52]. It is a virtual replica of a real-world physical object, system, or process based on collective data and is continuously updated with real-time data, aiding in evaluation, prediction, monitoring, control, and optimization [53, 54]. Any change in the physical object will be immediately mirrored in the virtual counterpart [53]. DT technology has the potential to accurately simulate tumor molecular dynamics and treatment responses using multiscale models and cutting-edge machine learning algorithms, in addition to combining genetic information, clinical history, and imaging data to produce highly customized cancer DT models [52].

DT is an innovative tool that can revolutionize surgical procedures by offering a personalized and multimodal dynamic approach to preoperative planning, intraoperative navigation, and postoperative care [52]. By creating a high-fidelity virtual replica of a patient's anatomy based on data from imaging, pathology, and other clinical sources, DT technology allows surgeons to practice complex surgeries virtually in a controlled but realistic environment and also assess the risks. The real-time synchronization of the digital model with the operative field supports precision and decision-making that are essentially impossible in real life, especially for complex cases [53]. DT also helps to predict post-surgical complications and monitor recovery. Due to the real-time updated information in DT technology, cancer surgeries can be performed more precisely, making high-risk procedures much safer [53].

7. Implications of digital health technology in clinical practice and future direction

Digital health technologies have the potential to improve the support for successful cancer screening, symptom management following surgery, and provide support for effective communication between patients and HCPs before and after surgery. A considerable improvement in global health has been noted with the implementation of digital health technology [40]. In India, digital health technology is considered to be promising in cancer treatment, along with postoperative cancer care. However, their strategic deployment requires careful consideration of infrastructure, policy, education, and ethical issues. To address the issue of cancer care in the nation, India has started several policies and initiatives. Through the National Program for the Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS), the Indian government most recently mandated

screening for three types of cancer—breast, cervical, and oral—at Primary Health Centers in 100 districts to identify cancer early [40].

Despite the promise, several limitations prevent India from utilizing digital health to its full potential. Large-scale adoption of digital health in Indian healthcare settings is a major barrier owing to socio-ecological challenges, including age and gender divide, literacy rate, geographical divide (urban versus rural populations), and socio-cultural and socio-economic norms. The reach of technology is limited among rural and low-income people by low smartphone usage, internet access, and digital literacy. Besides, the lack of adequate critical skills and capacities among HCPs, managing data via electronic health records, regulatory issues, data quality issues, and data privacy due to inadequate regulatory frameworks are the other challenges [40]. Furthermore, the implementation of IoMT in healthcare has other challenges, such as cost, network stress, interoperability issues, ethical limitations, policy intricacies, and security concerns [55]. To mitigate these concerns, it is essential to develop guidelines for the use of digital health technology, standardize processes, and establish measures to safeguard patient privacy and ethical considerations in the future, as well as considerable investment, advanced infrastructure, and strong cybersecurity measures [40, 55].

Additionally, DT technologies are still in their infancy; therefore, despite their advantages in oncology, they face several technical, ethical, and regulatory challenges, which hinder their application in clinical practice [53, 54]. For successful clinical translation of DTs, it is essential to address all these challenges and make DT models more reliable in practice [53, 54]. Inter and multi-disciplinary collaboration, strengthening ethical guidelines to promote the use of DT technology, as well as considerable investment by industries in robotics and AI, will be crucial for the integration of DT technology in oncology management [52-54].

8. Implications of digital health technology in research and future research

The traditional healthcare system has been revolutionized by digital health, enabling patients to make personalized, well-informed decisions [40]. The integration of digital health technologies in cancer care presents significant research opportunities in LMICs, since these regions face distinctive challenges, such as limited oncology infrastructure, delayed diagnoses, and fragmented follow-up care. To assess the effectiveness, affordability, and scalability of digital interventions in LMIC contexts, more research is required. Future studies are warranted to understand the digital literacy barrier, user accessibility, socio-cultural barriers, and measures to overcome them in the Indian scenario. Furthermore, real-world evidence data is also required to demonstrate how digital health might improve patient engagement in cancer care pathways, lower inequities between MICs and LMICs, and affect clinical outcomes.

9. Limitations of the review

This review had a few limitations. The literature search was not performed in a systematic manner, which can introduce selection and author bias. Moreover, without quantitative analysis, the conclusions are less generalizable, and the inclusion of varying evidence quality can reduce the overall reliability of the findings.

10. Conclusion

In conclusion, post-surgery cancer care remains a significant challenge, especially in LMICs, owing to limited access to specialized care, inadequate infrastructure, and financial constraints, highlighting the urgent need for sustainable, context-specific interventions. The integration of digital health technology is a promising approach to care after cancer surgery. Smart technologies not only enhance clinical decision-making but also improve patient engagement and satisfaction by providing personalized support outside the traditional care setting. Additionally, educating patients, empowering caregivers, and building multidisciplinary care models can strengthen post-surgical care delivery. A comprehensive health economics analysis is essential for advancing this approach, ensuring that patients receive the best treatment they deserve at an affordable cost. With thoughtful

implementation and ongoing innovation, the digital tools can considerably improve recovery pathways and contribute to personalized cancer care.

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