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Post Discharge Virtual Care for Patients with Postoperative Myocardial Injury after Non-Cardiac Surgery

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Abstract

Cardiovascular events are a leading cause of morbidity and mortality in patients undergoing noncardiac surgery. Inadequate postoperative monitoring is a major factor contributing to postoperative complications. In response to the Covid-19 pandemic, virtual care was widely implemented in Canada to facilitate post-operative patient care. Virtual postoperative care has been shown to be safe and improve postoperative outcomes. As such, postoperative virtual care should be integrated into routine practice beyond the Covid-19 pandemic. Implementation of postoperative virtual care into the Canadian healthcare system will require consideration of key issues pertaining to data security, digital literacy, technological infrastructure as well as the development of a national framework for data sharing and collaboration.

Introduction

Cardiovascular events are a leading cause of morbidity and mortality in patients undergoing noncardiac surgery [1]. Inadequate monitoring in hospital and at home is a major factor contributing to postoperative complications, including death, and unplanned hospital readmissions [2]. In response to the Covid-19 pandemic, virtual care was widely implemented in Canada to facilitate post-operative patient care [3,4,5]. Virtual postoperative care has been widely demonstrated to be safe and effective and improve postoperative patient outcomes in this patient population [6,7].

Key insights gained during the implementation of virtual postoperative care during the covid-19 pandemic have significantly informed clinical workflow training and systems implementation [2]. However, in order to propose a policy for the incorporation of virtual care for routine postoperative monitoring of patients with MINS beyond the Covid-19 pandemic, barriers to widespread implementation of virtual care must be considered. Indeed, an exploration of the role of virtual care in the Canadian healthcare system must be defined, as well as the key foundations of virtual care, such as infrastructure and interoperability. Moreover, rising concerns with regards to data security, equity in access to care, and maintaining the quality of services delivered must be addressed in order to guide recommendations regarding an action plan for the ongoing use and execution of virtual care in Canada.

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Methods

A comprehensive review of published work was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. An electronic search was performed using Google Scholar, Pubmed, and the Medline and EMBASE databases through the OVID platform (title and abstract). Me SH terms, search terms, and Boolean operators with synonyms and plurals in addition to keywords were used. Key search terms included (1) terms related to virtual care i.e. telemedicine, telehealth, ehealth, mobile health). (2) Terms related to Covid-19 i.e. corona virus, covid-19 pandemic, severe acute respiratory syndrome coronavirus 2, (3) Perioperative medicine descriptors i.e. perioperative care/medicine, preoperative care/medicine, postoperative care/medicine, ambulatory assessment/consultation, and (4) Outcome measures i.e. hospital mortality, morbidity, 30 day outcomes/morbidity/mortality, peri/postoperative complications, prognosis.

The search terms were used in combination with the Boolean operators AND and OR. The final review of all data bases was conducted on October 4th, 2022. The search was limited to studies published in English and French. Conference abstracts were excluded. Two reviewers (AAC and KS) screened the titles and abstracts of studies identified. Potentially relevant articles were examined to determine eligibility for inclusion in the review. Studies were included if they: (1) related to the virtual care in perioperative medicine (2) virtual care implement in the setting of the covid-19 pandemic. Studies were excluded if they were (1) specific to telemedicine for the care of remote populations (2) case reports, letters or editorials, and (3) specific to a particular brand or company or considering only the technical/engineering aspect of medical devices/technologies. The reference lists of included studies were then reviewed individually to identify additional relevant studies.

Scoping review of literature

Myocardial injury after non-cardiac surgery

Cardiovascular events are a leading cause of morbidity and mortality in noncardiac surgery [1]. Over 200 million adults per year will undergo a noncardiac surgery, and of these, at least 5% will experience a major cardiac complication within 30 days [1,8]. In patients over 45 years old considered at-risk for Myocardial Infarction (MI), 2.2% will have an asymptomatic MI, and up to 4.6% will have evidence of myocardial injury without meeting the diagnostic criteria for MI [8,9]. Both groups have been shown to have a 30-day mortality rate of 7-12.5% [9].

Serum troponin correlates to the degree of myocardial damage, and postoperative troponin elevation is predictive of 1 year mortality [OR 6.7%; 95% CI 4.1-2.3] [9,10,11]. With evidence supporting the clinical significance of elevated troponins, an umbrella term has surfaced for postoperative myocardial injury: Myocardial Injury after Noncardiac Surgery (MINS). In contrast to an MI with myocardial necrosis, MINS refers to any myocardial injury due to an ischemic etiology within the first 30 days of noncardiac surgery [12,13].

Importantly, only 42% of patients with MINS meet diagnostic criteria for MI, yet MINS is an independent predictor of postoperative mortality after correction for confounding variables (HR 3.87, CI 2.96-5.08) [1,9]. As such, MINS is a broad term for myocardial damage. This important, and often asymptomatic complication remains underappreciated without routine postoperative troponin screening [14,15].

Post-operative virtual care during covid-19, and beyond

The covid-19 pandemic continues to have a far-reaching impact on the global population, economy, and healthcare systems [16,17,18,19]. Efforts to optimize hospital resources and reduce the spread of infection have limited access to in-person postoperative follow ups. Driven by the urgent need to implement practical solutions to address the limitations to in person clinical assessments, hospitals have adopted models of virtual care as a feasible alternative.

In response to Covid-19, virtual care has been widely implemented in Canada to facilitate patient care [3,4,5]. Virtual care is defined as an interaction occurring remotely between a patient and any member of their healthcare team, via communication or information technology [20,21,5]. The term remotely here inrefers to any care which is not delivered in-person, and virtual care refers to "a medical service provided remotely via information and communication technology" in accordance with the definition by the Federation of Medical Regulatory Authorities of Canada (FMRAC) used in the recent Canadian Medical Association (CMA) Virtual Care Task Force [21,22]. Virtual care can include secure text-based messaging or email, and video or teleconferencing [21]. Often, post-operative virtual care involves a combination of the above, including virtual visits via videoconferencing using a personal device which is internet-enabled [7].

Postoperative virtual care has been shown to be safe and effective [6,7]. Moreover, virtual care has been demonstrated to be noninferior for preoperative and postoperative surgical consultations [23]. Interestingly, while initially studies indicated both patients and care providers prefer in-person visits [24], in light of the hospital avoidance behavior seen amongst patients during the pandemic, recent studies reveal a shift in patient preference towards virtual care and telemedicine. Indeed, Irarrazaval et al. showed that while early in the COVID-19 pandemic as many as 70% of patients preferred in-person postoperative assessment, only 40% preferred in-person visits by the end of the study, with most patients favoring virtual visits. (Irarrazaval et al., 2020).

Patients undergoing emergency surgery represent a high-risk population with increased incidence of surgical complications (Nikolian et al., 2018). Irarrazaval et al. (2020) published a single institution prospective study of 219 patients which compared post-operative outcomes for postoperative patients followed by telemedicine vs standard in person visits. In their study, 55% of enrolled patients had undergone emergency/urgent surgery. In the virtual care group, the postoperative complication rate was similar to those receiving in person postoperative care (5.7% vs 8%) (Irarrazaval et al., 2020). Moreover, of the patients followed by virtual care, only 2.8% needed a subsequent in-person visit.

Virtual care in canada pre-covid-19

Canada was among the first countries to popularize the use of virtual care in the 1970s when Dr Maxwell House established a telephone consultation service to provide virtual care to remote sites in Newfoundland [25]. Since then, Canada has been surpassed by other world leaders in virtual care, and England, France and Australia all have recently released promising strategy documents focusing on national implementation goals for digital health technologies [26,27,28]. The most recent Canadian Telehealth Report from 2015 estimates that videoconferencing represented just 0.15% of the 270.3 million billable health

services reported by the Canadian Institute of Health Information for the 2015-2016 year (Canada health Informatics Association, 2015 Telehealth Report). While the numbers have grown in response to increasing demand over the years, with over 1 million clinical videoconferences reported in 2018 in Ontario alone, the percentage of virtual care relative to the total volume of health services provided remained low [29].

Ongoing challenges in providing equitable access to healthcare throughout the country in light of an aging population and a shortage of healthcare professionals drives the demand for virtual care in Canada [3,22]. Another important driver underlying this movement towards upscaling virtual care is consumer expectation in light of the ubiquitous virtualized communication in our daily lives [21]. Accordingly, a Canadian survey in 2018 by the Canadian Medical Association revealed that 8% of respondents had experience with virtual care [30]. (Ipsos Survey for the CMA, 2018). Of that group, 69% reported they would opt for virtual care over an in-person visit if it were available, and 37% indicated they would prefer this method for all or more than half of their physician visits [30].

Another recent survey from the Canadian Health Infoway in 2019 further demonstrated the discrepancy between the demand compared to the current available access to virtual care in Canada. The survey demonstrated that while 71% of Canadians expressed a desire to book virtual care appointments, only 9% of family practitioners currently offered the service [31]. (Corroborating this, a 2019 Physician Workforce Survey by the CMA revealed less than half of all Canadian healthcare providers, across all specialities, offer interactive electronic services to their patients [32].

At the provincial level, medical associations were in the process of taking steps towards proposing strategies for the upscaling of virtual care. For example, the New foundland and Labrador Medical Association had produced policy papers on the topic of virtual care [33], and in the fall of 2019, the Ontario Medical Association (OMA) reached an agreement with the provincial government to fund videoconference virtual visits with a fee-for-service rate equivalent to in-person visits when using the Ontario Telehealth Network (OTN) platform [33]. (OMA 2019).

Virtual care in canada after covid-19

Canada mirrored the rapid adoption and implementation of virtual care in medicine in light of the covid-19 pandemic. Indeed, the pandemic led to an exponential increase in the use of virtual care services in Canada, and it is estimated that an unprecedented 3 million virtual visits took place in 2020 (Canada Infoway 2020). By May of 2020, 80% of all outpatient visits were virtual in primary care practice in Canada, and 89% of patient communication was conducted via telephone, virtual consult, or text-based messaging [34]. Virtual care provided means to minimize in-person interactions, protect healthcare workers, limit the spread of the virus, and spare the use of limited personal protective equipment resources while facilitating access to healthcare services. The services implemented in Canada included asynchronous text-based communication such as messaging services and email, real-time messaging, telephone or video conferencing, as well as virtual triage, self-assessment, scheduling, documentation, and reporting services [34].

As a result, several published resources were created to establish guidelines and recommendations for the implementation of virtual care. The Health Standards Organization (HSO) is the body which develops standards used by Accreditation Canada to ensure the continued quality of the health care provide by clinical practitioners in Canada. During the pandemic, HSO issued a timely standard for virtual healthcare services which emphasized the role of the patient central to the operation of virtual services, which in turn must be designed to optimize patient engagement, the patient/ clinician relationship, and quality of care [35,21]. Moreover, the Royal College of Physicians and Surgeons of Canada issued a joint statement with the CMA regarding the integration of virtual care into practice during the pandemic [21]. In addition, to accommodate the rapid upscaling in virtual care services, provinces and territories revised or generated new billing codes to allow clinicians to be compensated for virtual communications [63,64,65,66]. (Baumgart et al, 2020).

Legislative and policy accommodations also had to be made with regards privacy laws and health information statues regarding the use of digital health technology during the pandemic [36,37]. Enforcement discretion was implemented for virtual care communication technology, allowing clinicians to use tools which were not previously compliant with the Health Insurance Portability and Accountability Act of 1996 in order to provide services which were more widely accessible to patients [38,39]. In the United States, the Office for Civil Rights issued a statement encouraging providers to notify patients of potential privacy risks, and to “enable all available encryption and privacy modes when using such applications” [39].

However, with these more relaxed legal measures to protect personal data and health information, there are concerns have grown regarding issues around cyber security and financial exploitation of health data [74] [Baumgart et al, 2020; Hardcastle et al, 2020]. In response to these concerns, the European Union passed legislation for tighter regulation of personal health information and virtual care via the General Data Protection Regulation [36,37]. Baumgart et al, 2020; Similarly, in Canada, the Federal Personal Information and Protection of Electronic Documents Act (PIPEDA) governs the collection, use or disclosure of personal information by private sector organizations [40,41]. With a global expansion of virtual care, this legislation applies to personal information which crosses provincial, territorial and national borders [41].

Nevertheless, ensuring data security remains a challenging aspect of virtual care. Privacy laws and policy to protect patient health information are evolving as virtual care has upscaled and become commoplace in global healthcare systems. Questions, however, concerning the management of virtual care data, sharing of patient health information, and data security remain important barriers to widespread implementation of virtual care into routine practice beyond the covid-19 pandemic.

Expanding post-operative virtual care for mins beyond Covid-19

Inadequate monitoring in hospital and at home is a major factor contributing to postoperative complications, including death, and unplanned hospital readmissions [2,42,43,44,45, 46]. Moreover, patients with postoperative myocardial injury after noncardiac surgery are known to be at increased risk of adverse events within 30 days of surgery [9,1,8]. Insights gained during the implementation of virtual postoperative care during the covid-19 pandemic have significantly informed clinical workflow training and systems implementation and identified

key stakeholders (**Table 1**). As such, given the known benefits for this at-risk population, post-operative virtual care should be integrated into routine practice for patients with documented MINS after non-cardiac surgery beyond the Covid-19 pandemic.

Key Stakeholder	Interest
Community • Patients and their families • Rural and remote communities, including First Nations communities	• Improved post-operative outcomes • Increased satisfaction with postoperative care • Reduced emergency visits • Reduced need for home care services • Improved access to care
High risk post-operative patients • Patient population of Canada • High risk post op patients	• Improved 30-day postoperative outcomes, including morbidity and mortality • Decreased length of stay in hospital • Decreased missed postoperative cardiac events
Perioperative Care Team • Physicians: Anesthesiologists, Surgeons, Internists, Cardiologists • Nurses • Allied Care Teams • Wounds Care, Home Care	• Improved 30-day postoperative outcomes • Decreased missed postoperative cardiac events • Preserved caseloads • Practitioner satisfaction • Closer follow up of high-risk patients • Potential for renumeration for virtual visits
Regional Health Care System • Local hospitals • Emergency departments • Home care services • Family physicians	• Reduced emergency visits • Reduced need for home care services • Decreased cost to regional health care services • Decreased volume of patients would reduce wait times and burden on emergency services
Provincial Government	• Decreased cost of health care services (due to decreased length of stay, decreased home care requirements)

Table 1: Key Policy Stackholders.

Barriers to expanding virtual care

Licensing restrictions

The Canada Medical Act was passed in 1912, which led to the establishment of the Medical Council of Canada as well as a pan-Canadian standard for medical licensure [47]. Current licensing standards for the faculties of medicine in Canada were created in 1992 [48]. The system remains challenging to navigate for Canadian physicians. A 2019 CMA Physician Workforce Survey revealed 62% of Canadian physicians who sought licensure in an additional Canadian jurisdiction identified significant obstacles such as process complexity, length of process, and cost [32]. There are increasing demand for a pan-Canadian license beyond the covid-19 pandemic, and in the 2019 CMA survey, 91% of respondents were supportive of broader licensure allowing for practice in all provinces/territories, and 74% expressed the belief that this would improve access to healthcare in Canada [32].

Thus, it is critical to re-evaluate the provincial model of licensure in order to reduce barriers to expansion of virtual care on a national scale [49,50]. As such, in accordance to the Canadian Medical Association Virtual Care Task Force Recommendations from 2019, the efforts of the Federation of Medical Regulatory Authorities of Canada (FMRAC) to simplify the registration and licensure of qualified clinicians must be supported in order to allow for the delivery of virtual care across provincial and territorial boundaries. Provincial and territorial governments and medical associations must also finalize a long-term renumeration plan for virtual encounters that goes beyond the Covid-19 pandemic.

Interoperability

In order to successfully integrate virtual care on a national level, the exchange of health information between provinces, territories, and regions must befacilitated. Indeed, there must be integrated communication between clinicians, virtual walk-in clinics, national public databases, and individual care providers access to a national digital healthcare continuum [21,38,ITAC 2018; Baumgart et al, 2020). An individual's health information should, in theory, be available as a digital file accessible to their entire circle of care irrespective of their geographical location at the time.

More broadly, patients should have digital access to their health information. Re-defined policies are therefore needed to uphold custodianship, autonomy and security of patient's health information in order to support the implementation of virtual care into routine practice long-term. The CMA 2019 Taskforce for Virtual Care recommends drafting a national Charter on Patient Health Information Rights and Responsibilities to support the development of a pan-Canadian Health Information Network [21]. (National standards for health information access and a framework for interprofessional collaboration are necessary for the development of a functional Canadian virtual care platform.

Privacy and data security

Data security and protection are critical for the successful implementation of virtual care [51,52]. Federal and provincial governments, alongside the digital health industry, must invest in national privacy and security standards. The current patchwork model of federal and provincial data security laws are unconducive to a national digital health technology expansion. In fact, the current model is a major barrier to ongoing growth and implementation of national initiatives [21,38] [Baumgart et al, 2020]. Solutions and strategies must be shared between provinces and territories in order for the country as a whole to benefit from collective experiences at a larger scale. Patient data must be accessed on a national level, through the use of national public patient data sets, in order to further promote growth and facilitate access to care, while guaranteeing data privacy and access protection [51].

Implementation of virtual post-operative care

A 3-step process has been suggested to ensure successful implementation of virtual care on a national level beyond the covid-19 pandemic (ITAC 2018,) [21]. This includes an initial execution phase, where emerging technologies are tested, troubleshooted, and matured until they ready to upscale at provincial or national levels. A thorough study of current technologies implemented in Canada is needed to determine which are most suitable for rapid deployment, and which require further maturing (ITAC 2018) [38]. Regardless, maintaining the accelerated scale of development seen during the covid-19 pandemic must remain a priority beyond the pandemic.

Next, longitudinal development and deployment of new technologies is essential to build on the momentum created by the pandemic [21] [Baumgart et al, 2020]. Many new emerging technologies remain in experimental stages, and these must be advanced to readiness for deployment in order to ensure ongoing improvement of the digital health technology industry (ITAC 2018). Indeed, new technologies are required to bridge gaps identified in the industry, such as data security and encryption, and secure patient health information database to ensure continuity of care [36,37].

Finally, the third phase of implementation represents a dedication towards research and development, securing the future of digital health technology in areas such as artificial intelligence, automated diagnostics and triage, and advanced analytics (ITAC 2018, Baumgart et al, 2020) [38,]. This will require ongoing study of these advanced processes to better appreciate their applicability and limitations, as well as foster long-term

growth of the industry.

Implementation considerations

There are several social, organizational, and technological factors which will impact the implementation of virtual postoperative care. Implementation will require collaboration between private and public sectors of the health technology industry, models of information and technology sharing, and a plan for funding the growth of health literacy and infrastructure. Moreover, implementation of virtual postoperative care will require attention to the ongoing quality of care, and a re-evaluation of the regulation process for virtual care beyond covid-19 (**Table 2**).

Interplay between private and public sectors

Several key players in the Canadian health technology industry recommend that both private and public sectors of this industry collaborate with federal and provincial governments to take concrete steps to accelerate the development and implementation of digital technologies [3,4,29]. Moreover, dependencies between public and private actors should be reinforced, and all major public sector decisions should be supported by all stakeholders, including advisory panels, vendors, and patient advocates [21] (Baumgart et al, 2020). The private sector should be incentivized and encouraged to share information and technology in order to promote mutual growth of the industry.

Industry and government should make long-term commitments to funding digital health initiatives and emerging technology, with transparent recording and tracking of expenditures. There should be a collaborative effort towards standardized, effective public procurement practices, with transparent reporting of costs of procurement. Some procurement risk can be further mitigated by transferring the fiscal responsibility to the private sector [3,37,38,53]. In addition, collaborations between public and private sectors encourages shared models of information, communication and technology development, which enhances mutual growth and supports the development of a specialized and skilled labor force [53]. This labor force is critical to meet the demands associated with expanding and implementing digital health technologies on a national scale.

Health literacy and infrastructure

Expanding the use of virtual care in Canada will necessitate an investment in access to digital services. Indeed, there must be a national effort to ensure sufficient access to broadband capacity in order to promote equity and access to care throughout the country [52,54]. Adequate bandwidth must support transmission of sound, images, and video [52,55]. Indeed, it has been shown that a poor connection quality decreases uptake of virtual care technology by patients and clinicians, and reduces satisfaction with the service [49]. Funding will be required to develop virtual software platforms, supply equipment to hospitals and clinicians, provide access to information technology support, and hardware tools [56].

In addition, digital literacy will need to be promoted at both national and provincial levels, and this will require funding to promote outreach programs and educational.

Implementation	▯ Implementation at tertiary care hospitals in Canada ▯ Implementation will take place prospectively over 1 year. ▯ All patients over the age of 18 undergoing surgery at these sites will be invited to participate. ▯ Exclusion criteria: unable to provide informed consent, lack of internet/cellular access, patients undergoing cardiac surgery.
Structure of Follow Up Visits	▯ Weekly virtual interactions with the perioperative care team who will review vital signs, survey responses, and perform a follow up visit with metrics relevant to the surgery performed. ▯ Team members can escalate care to a physician (i.e. surgeon, cardiologist) or to an in person visit if indicated. ▯ Remote monitoring technology will include monitoring at home with a pulse oximeter, blood pressure cuff, thermometer, and weight scale. ▯ Patients will record vital signs and keep a log. They will also be complete a symptoms and recovery survey at each visit.
Education	▯ Patients will receive a teaching session and a handout prior to discharge in order to instruct on the use of the remote monitoring equipment and the video platform for the virtual care visits. ▯ Perioperative Care Team will receive training sessions for the standardized use of remote monitoring technology, recovery and symptoms surveys, as well as indications to escalate care. Several education sessions will take place over the implementation year, with a team of site experts designated at each hospital responsible for troubleshooting/educational resources. ▯ A website will be available with additional information
Funding	▯ Funding for this initiative will be provided via the Perioperative Medicine Department's Quality Improvement Grant. ▯ A budget for the estimated cost for a year of implementation will be drafted by the Quality Improvement Research team within the department. ▯ Additional funding can be obtained from the Hamilton Health Sciences Department of Patient Safety.
Data Collection and Program Evaluation	▯ Postoperative outcomes and patient demographics will be prospectively collected with informed consent ▯ Effectiveness of the program will be measured at 3, 6, and 12 months following implementation ▯ A group of blinded investigators will evaluate the data and compare 30-day outcomes compared to a control cohort receiving standard postoperative care ▯ Practitioner and patient satisfaction will also be assessed via surveys ▯ Outcome of the program evaluation and review of the budget at 3, 6, and 12 months will inform whether this policy recommendations and the potential for province-wide implementation.

Table 2: Expanding Postoperative Virtual Care: Proposed Action Plan.

Initiatives to ensure patients are aware of the virtual tools available to them, as well as their benefits and limitations [57,58]. Training will also need to be provided to clinicians, and digital technology will need to be incorporated into the undergraduate medical curriculum on a national scale [52,59,60]. Indeed, there is significant evidence to suggest that infrastructure must include training and technical support to support the adoption and upscaling of virtual care [61,62].

Quality of care

Patients and funding bodies both need to be assured of the quality of the virtual care provided. As such, stakeholders must work together to determine key short- and long-term goals for the program, outcomes of interest, and determine quality and performance metrics to monitor the program over time [53]. Ongoing research is needed to ensure virtual care continues to meet patient needs and expectations, as well as the standards of care. This will require both federal and provincial funding for research.

Conclusion

Patients with postoperative MINS after noncardiac surgery are known to be at increased risk of adverse events within 30 days of surgery. The global covid-19 pandemic resulted in the rapid upscaled adoption of virtual care in Canada, creating a new model of healthcare delivery which can be expected to continue to evolve and mature beyond the scope of the pandemic. Virtual care technologies have been shown to improve postoperative patient outcomes, and key insights gained during the implementation of virtual postoperative care during the co-

vid-19 pandemic have significantly informed clinical workflow training and systems implementation. Post-operative virtual care should be integrated into routine practice for patients with documented MINS after non-cardiac surgery beyond the Covid-19 pandemic.

The future of postoperative virtual care will be guided by the experience from the rapid implementation of virtual health care services in light of the covid-19 pandemic. Consumer demand, and the ongoing need to improve access to care accross the country further supports the ongoing use of virtual care in the Canadian healthcare system. However, a pan-Canadian frame work is needed to establish standards for high quality virtual care and support interoperability, data security, and equitable access to care. Moreover, there are important considerations including revised models for physician licensure and renumeration, bandwidth and technological infrastructure, as well as the promotion of digital literacy which must be incorporated into an actional plan for continued use of postoperative virtual care.

Conflicts of interest: The authors declare no conflict of interest.

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