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Digital tools in cardiac reperfusion pathways: A systematic review

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ABSTRACT

With health and surgery increasingly aided by digital technologies, there exists a growing impetus to understand how such tools must integrate into existing clinical pathways to ensure a positive impact on patient and organisational outcomes. Consequently, this study sought to collate evidence on the use of digital technology in cardiac reperfusion surgeries. We systematically searched three scientific databases for relevant articles. In total, 1,092 articles were retrieved, with 126 screened using inclusion/exclusion criteria, and 21 selected for analysis. Articles reported on the use of virtual reality, mHealth and telehealth in cardiovascular reperfusion procedures, ranging from surgical training regimens to postoperative rehabilitation. Here, despite clinical advantages, limitations were highlighted, including cost, ineffective interfaces and extensive training needed to operate novel digital tools. Nevertheless with further development and input from patient stakeholders, many limitations look set to dematerialise and provide tangible improvements to the benefit of patients and hard-pressed health institutions.

Introduction

Cardiovascular disease (CVD) is the leading cause of worldwide morbidity and mortality.[1] Recent estimates reveal that CVD comprises 31% of total global deaths and it has been predicted that, by 2030, 23.6 million people will die annually from CVD.[2,3]

In 2017 alone, CVD resulted in 330 million years of life lost and 35.6 million years lived with a disability.[4] The financial burden of CVD has also risen over the decades; and is projected to increase from US$863 billion in 2010 to over US$1.044 trillion by 2030.[5,6]

A key pillar of this burden is that of coronary artery disease (CAD), characterised by the accumulation of atherosclerotic plaques and the narrowing of the coronary arteries. The subsequent reduced blood flow produces varying degrees of myocardial ischaemia and results in a clinical continuum, ranging from stable, asymptomatic ischaemic heart disease (IHD) to unstable angina and, ultimately, symptomatic and sometimes fatal myocardial infarction. For those with acute manifestations of this condition, the primary intervention is cardiac revascularisation surgery, typically percutaneous coronary intervention (PCI) for those with single-vessel disease, and coronary artery bypass grafting (CABG) for those with more extensive pathology. These procedures aim to restore blood flow to the infarcted or ischaemic myocardium and have significantly increased survival rates compared with pharmacological interventions alone.

Despite these interventions, the burden of CAD has continued to rise and postoperative rehabilitation has varied success, requiring novel tools to reduce disease burden and improve outcomes. Here, digital technologies, such as data-processing tools, simulation platforms and remote monitoring, provide opportunities to both improve the efficiency of these procedures and support patients in postoperative settings. Consequently, this review aims to consolidate existing literature pertaining to use of digital health technologies in PCI and CABG as surgical cardiac reperfusion interventions. In doing so we aim to explore the benefits and limitations of such tools, and better understand both current barriers to implementation and future avenues of implementation.

Methods

Study design

The identification and reporting of the articles and their data included in this study were done under the guidance of the Preferred Reporting Items for Systematic Reviews and Meta- Analysis (PRISMA) checklist.[4] For the purpose of this study, we defined digital health tools

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as digital programs and devices intended for use within cardiac reperfusion pathways, including but not limited to smartphone applications, telemedicine, wearables and data-processing platforms.

Search strategy and article selection

We searched the PubMed, SCOPUS and Cochrane Library databases for original research articles published since 1 January 2007 describing the use of digital health tools within a cardiovascular reperfusion pathway. Search terms included:

(PCI[Title/Abstract] OR percutaneous coronary[Title/Abstract] OR CABG[Title/Abstract] OR coronary artery bypass[Title/Abstract] OR revascularisation[Title/Abstract] OR reperfusion[Title/ Abstract]) AND ((AI[Title/Abstract] OR artificial intelligence[Title/ Abstract] OR modelling[Title/Abstract] OR ML[Title/Abstract] OR machine learning[Title/Abstract] OR DL[Title/Abstract] OR deep learning[Title/Abstract] OR neural net*[Title/Abstract] OR bayesian[Title/Abstract] OR predictive[Title/Abstract]) OR (smartphone[Title/Abstract] OR mhealth[Title/Abstract] OR ehealth[Title/Abstract] OR mobile[Title/Abstract] OR telephone[Title/Abstract] OR tele*[Title/Abstract] OR video[Title/ Abstract] OR digital[Title/Abstract] OR online[Title/Abstract] OR web[Title/Abstract] OR internet[Title/Abstract]) OR (virtual[Title/ Abstract] OR virtual reality[Title/Abstract] OR VR[Title/Abstract] OR augmented reality[Title/Abstract] OR AR[Title/Abstract] OR simulation[Title/Abstract] OR simulator[Title/Abstract] OR 3-dimensional[Title/Abstract] OR 3D-printed[Title/Abstract] OR simulated[Title/Abstract] OR gamified[Title/Abstract] OR gamification[Title/Abstract]) OR automated[Title/Abstract] OR remote[Title/Abstract]))'. In SCOPUS, this was limited to article title. Abstracts and full texts of returned articles were then screened for relevance and applied against the following inclusion criteria: studies evaluating use of one or more digital tools in a cardiac reperfusion setting and studies providing qualitative or quantitative outcomes. Studies were excluded if: non-English language, full text was unavailable or measured outcomes lacked quantitative data. This was undertaken to ensure such papers could be properly evaluated by study authors, and to ensure objective comparisons between conventional care and interventions, could be made. Article selection was approved independently by two authors of this study.

Results

This search strategy yielded 1,207 articles, with subsequent selection processes depicted in Fig 1. A further 18 articles were identified through searching the reference lists of relevant studies.

Of these, 1,064 were eliminated through abstract screening and a further 132 were eliminated following review of the full text or evaluation of study data. The remaining 19 studies are summarised in Table 1.[7–28] Four of these articles were published in cardiovascular surgery journals, with a further eight published in broader cardiology journals and 10 published in diabetes, nursing, digital health, anaesthesiology and healthcare engineering journals. Three studies included use of simulation/digital models as a digital tool, whereas a further eight included telemedicine/ remote monitoring, six included smartphone applications and two covered artificial intelligence (AI) and other data analysis tools. Of the studies, 16 referred to digital tools as a means of improving postoperative health and compliance, whereas a further two articles considered digital tools predominantly as means of optimising surgical training and one reviewed these tools in the intraoperative setting. All but four included studies found digital tools to have a positive impact on aspects of either clinical or organisational outcomes.

Telemedicine and digital rehabilitation

Eight of the articles reviewed in this study (42%) sought to evaluate the use of telemedicine or digital rehabilitation platforms following cardiac revascularisation. Of these studies, one evaluated telehealth perioperatively, whereas nine evaluated telehealth in the postoperative care setting. For example, work by both Keeping-Burke *et al* and Haddad *et al* sought to compare telemedicine versus standard care in reducing postoperative anxiety.[14,17] In exploring this, Keeping-Burke *et al* randomly allocated 182 patients and their caregivers to either standard care or the VITAL telenursing platform, through which patients received daily home audio video nursing visits post discharge.

Here, a 3-week follow-up questionnaire demonstrated statistically significant decreases in depressive symptoms (p=0.03) and perceived conflict (p=0.04) versus those allocated to standard care. Furthermore, subgroup analysis revealed a significantly greater reduction in anxiety and uncertainty for caregivers of male patients (p=0.0003 and p=0.002, respectively). Similarly, Haddad *et al* sought to compare pre- and postoperative anxiety in 99 patients randomly allocated to conventional preoperative education on PCI versus a nurse-led video-based resource.[14]

In doing so, researchers highlighted significant reductions in mean anxiety score (MAS) for patients receiving video-based interventions at both 2 h pre- and 4–6 h post-PCI compared with those receiving conventional education (MAS 60.88 versus 33.08, p<0.001; MAS 44.17 versus 24.1, p<0.001 respectively).

Four further papers subsequently investigated the role of telehealth tools in postoperative rehabilitation. The first, by Fang *et al*, assessed the efficacy of home-based cardiac telerehabilitation (HBCTR) against standard care in patients post PCI.[12] Here, patients in the HBCTR group received outdoor walking/jogging exercise with real-time physiological monitoring in addition to paper-based educational materials, whereas controls received biweekly outpatient review. At 6-week follow- up, results showed the HBCTR group to exhibit greater exercise capacity compared with controls, as measured using the 6-min walk test (48.20 m versus 34.77 m; p=0.006), and higher quality of life scores (14.18 versus 6.75; p=0.015). Two similar studies by Barnason *et al* evaluated the impact of telehealth interventions on energy expenditure and weight loss post CABG or PCI.[7,8] These studies, including 232 and 43 patients, respectively, randomly allocated patients to standard cardiac rehabilitation (CR) programs or CR plus daily telehealth-mediated symptom or weight management platforms. In these studies, those in the telehealth-augmented groups showed significant improvements in 6-month postoperative weight loss (13.8±2.8 versus 7.8±2.2 lb), although neither study showed significant improvements in physical activity or energy expenditure between 3 weeks' and 6 months' follow-up. Meanwhile, Sanonoi *et al* adopted a quasi-experimental method to consider the impact of a telehealth intervention on the rehospitalisation rates of patients post CABG.[23] Patients in the telehealth group were taught to upload daily health and symptom data via smartphone application, to be monitored by nursing staff. The results showed that the rehospitalisation rates within 28 days of discharge were significantly lower in the telehealth group compared with standard care (0% versus 15.6%; Fisher's exact=0.026), highlighting the role of telehealth tools in delivering effective post-CABG rehabilitation.

In addition to postoperative anxiety and rehabilitation, two articles included analysis on adherence to postdischarge management following cardiac reperfusion. For example, Bikmoradi *et al* studied the effects of telemedicine on medication compliance in 71 patients who had undergone CABG, with patients split into conventional and telenursing groups, in which the latter received weekly two-way video input from nursing staff.[9] Xu *et al* similarly studied the impact of the WeChat video- messaging platform on 100 patients post PCI randomised to either conventional care or digital support comprising daily health advice and two-weekly video lectures.[25] Although Xu *et al* found significant improvements in medication compliance in those receiving telemedical interventions (t=5.482, p<0.001), as well as greater nursing satisfaction

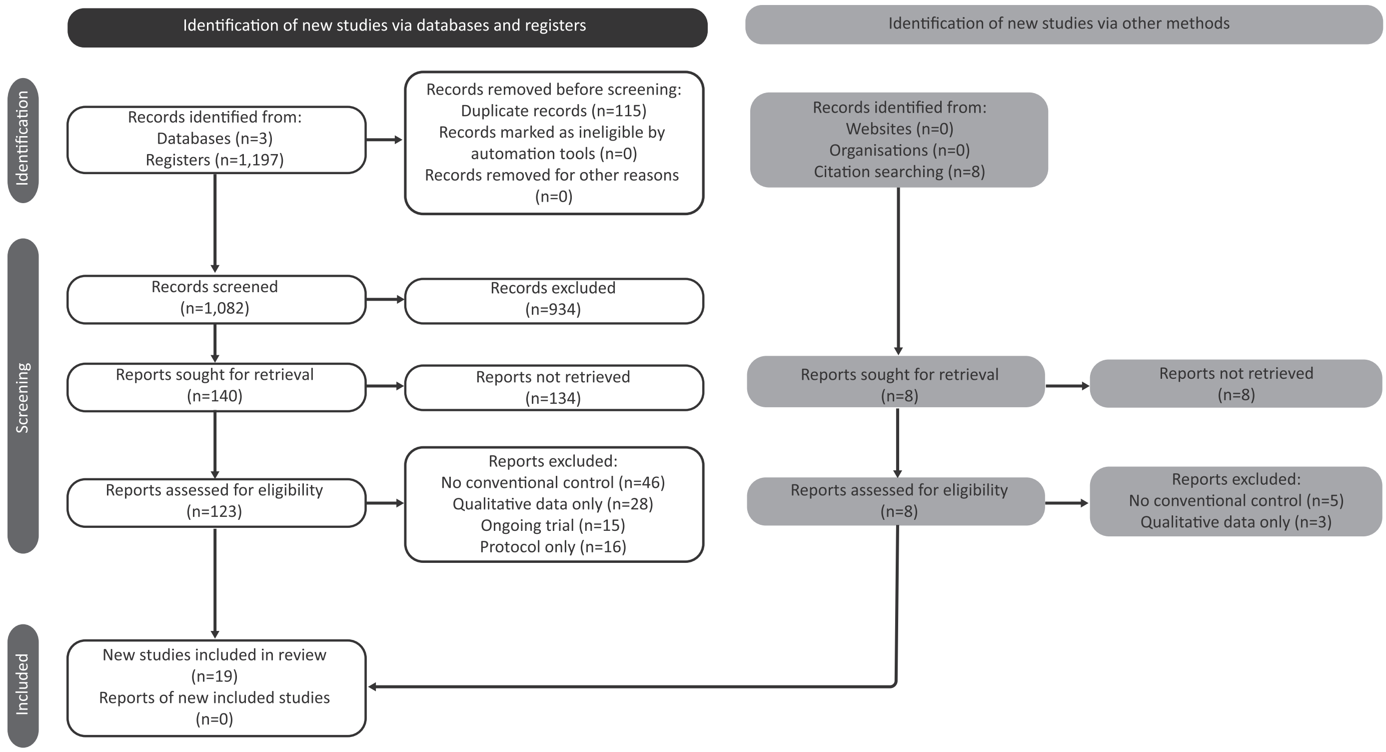

Fig. 1. PRISMA[4] flow diagram describing the inclusion and exclusion process.

(p<0.001) and reduced emotional volatility (P<0.001), data from Bikmoradi *et al* at 4-weeks post discharge demonstrated a lack of significant differences between control groups and telenursing groups in adherence to medication.[9]

Simulation and digital models

Three of the included studies (16%) examined and evaluated the use of simulation and virtual reality (VR) on surgical training in coronary reperfusion procedures. Two such articles evaluated the use of simulation focused on a practical procedure taught in a simulated environment, and compared performance level of these groups to controls receiving standard teaching. Voelker *et al* compared the competency of fellows learning PCI procedures following 7.5 h of practical simulation-based catheter training to fellows receiving 4.5 h training from lectures alone.[24] The study demonstrated the simulation group '[skills score' in performing radial catheterisation increased by 5.8±6.1 points from pre- to post training, whereas the control group score decreased by 6.7±8.4 (p=0.003). However, this study only tested competency on virtual models and not on actual patients; a following study by Bruppacher *et al* examined skills learned from VR simulation on physical patients.[15] Here, study authors tested 20 anaesthesiology trainees in weaning patients from cardiopulmonary bypass (CPB) following either a 2-h simulation programme or 2-h seminar-based teaching and again found that simulation-based training was superior in achieving successful weaning (post-test 14.3±0.41 versus 11.8±0.41 for simulation versus control, respectively). These findings remained significant at 5 weeks' follow-up.

The last of the three studies looked at the effects of VR gaming on patients following CABG surgery. Lima *et al* recruited 56 patients to evaluate whether patients who played VR table tennis on an XBox360 twice daily in addition to conventional treatment recorded better lung function tests 5 days following discharge from an intensive care unit compared with those who did not.[16]

In this study, 25 and 31 patients were assigned to the control and virtual rehabilitation groups, respectively. Although lung function showed significant postoperative decreases in both groups, the intervention group demonstrated significant advantages in mean inspiratory pressure (MIP; p<0.05) and mean expiratory pressure (MEP; p<0.05), although vital capacity was comparable (p=0.22). Consequently, the addition of such interventions could ameliorate the decline in lung function following cardiac reperfusion interventions.

Smartphone applications and mHealth

Of the 22 articles included in this review, a further six (32%) examined the use of smartphone or mHealth applications, largely in the postoperative care setting. For example, Ghorbani *et al* compared a smartphone gamification app, in which patients accessed digital educational resources followed by a scored assessment, with more traditional teach-back methods used to encourage post-CABG medication adherence.[13] Assessing 123 patients randomised to either group, the study authors noted that, although patients showed significant improvement (p<0.001) in postoperative dietary, medication or exercise adherence, there were no significant differences between the intervention or control groups. This was supported by a study by Boyd *et al*, in which patients were randomised to either conventional or app-based care providing patient narratives on the importance of medication adherence to dual antiplatelet therapy for the purpose of postoperative platelet suppression.[10] In comparing usual care with the My Interventional Drug-Eluting Stent Educational App (MyIDEA), the authors did not find any significant difference in platelet suppression between the groups. Meanwhile, Parachuri *et al* evaluated 118 patients randomised to a customised app-based approach providing digital education, tracking, reminders and live health coaches, against matched historical controls to reduce 30-day all-cause readmission post PCI.[20] Here, the authors found no significant difference in 30-day readmission (8.5% app versus 9.6% control, absolute response rate –1.1% absolute difference; 95% CI –7.1 to 4.8, p=0·699), although rates of 90-day cardiac rehabilitation enrolment and 1-month cardiovascular follow-up were greater in the digital intervention group (p=0.394 and p<0.0001, respectively)

Further work by Ni *et al* and Dorje *et al* compared the effectiveness of sending reminders through the WeChat digital messaging service

Table 1
Summary of included studies.

Study	Digital tool evaluated	Area of application	Advantages of tool	Disadvantages of tool
Barnason *et al.*[7]	Telemedicine	Postoperative care	Patients in telehealth group showed higher levels of activity in early recovery (~3 weeks)	Telehealth measures did not increase physical activity or decrease healthcare utilisation compared with control groups
Barnason *et al.*[8]	Telemedicine	Postoperative care	Patients using telehealth weight management intervention (WMI) displayed significantly more weight loss, patient activation and diet and exercise self-management	No significant differences in levels of functioning between control or intervention groups
Bikmoradi *et al.*[9]	Telemedicine	Postoperative care	Telenursing significantly improved adherence to treatment plan in patients discharged after CABG procedures	None described
Boyd *et al.*[10]	Smartphone app	Postoperative care	No significant difference in medication adherence between groups, but older patients were willing to use tablet devices	No significant difference in platelet suppression or medication adherence between groups
Dorje *et al.*[11]	Smartphone app	Postoperative care	Patients in smartphone group showed statistically significant improvements in 6-min walk test at 2 and 6 months	Sample patient population was mostly younger with stable CHD and access to smartphone and WeChat app
Fang *et al.*[12]	Telemedicine	Postoperative care	Patients using tele-rehabilitation post PCI demonstrated significant improvements in blood pressure, fitness and other measures of efficacy of PCI intervention over control groups	Postoperative functioning as measured by cardiac depression scale did not differ between intervention and control groups at 6-weeks' follow-up
Ghorbani *et al.*[13]	Smartphone app	Postoperative care	Significant improvement in dietary and movement regimen post CABG	No improvement in adherence to medication post CABG in patient groups who used app versus conventional teaching methods
Haddad *et al.*[14]	Telemedicine	Perioperative care	Significant reduction in anxiety levels pre and post PCI	None described
Heinz Bruppacher *et al.*[15]	Simulation and virtual reality	Education	Trainees in simulation group showed significantly higher scores in both post-test and retention test group	None described.
Lima *et al.*[16]	Simulation and virtual reality	Postoperative care	Intervention with virtual reality effective in reducing loss of pulmonary function and functional independence after CABG	None described
Keeping-Burke *et al.*[17]	Telemedicine	Postoperative care	Significant reduction in anxiety and uncertainty levels for caregivers of male patients	No significant reduction in anxiety levels in patients themselves or caregivers of female patients as result of telehealth intervention
Ni *et al.*[18]	Smartphone app	Postoperative care	Sending reminders improved medication compliance and blood pressure	No statistically significant decrease in heart rate between intervention and control groups
Niedziela *et al.*[19]	Artificial intelligence	Postoperative care	AUROC in identifying 6-month all-cause mortality following PCI was 0.8422 for neural networks versus 0.8137 for logistic regression ($p<0.0001$); neural networks can incorporate more parameters	AI model was more challenging to build and did not provide data on particular risk factor included in analysis; difference in accurate also slight and might have limited clinical impact
Parachuri *et al.*[20]	Smartphone app	Postoperative care	Increased patient attendance in cardiac rehabilitation	No significant difference in readmission rates
Qu *et al.*[21]	Smartphone app	Postoperative care	Rates of long-term statin prescribing increased in intervention group	Short-term follow-up showed no difference in prescriptions of statins, ACEis or ARBs between control and intervention groups
Rayfield *et al.*[22]	Artificial Intelligence	Postoperative care	AI-BR model had statistically significant increase in prediction accuracy versus ACC-BR score for patients who underwent PCI via radial access and femoral access, as well as patients with GFR <60 mL/ min/1.73 m^2, diabetes mellitus, female gender and age >75 years	AI-BR model did not significantly outperform conventional prediction among patients who had active STEMI or BMI >35 kg/m^2
Sanonoi *et al.*[23]	Telemedicine	Postoperative care	Lower rehospitalization rate and improved functional status post CABG	None described
Voelker *et al.*[24]	Simulation and virtual reality	Education	Simulation-based training improved operator performance of those new to interventional coronary procedures	None described
Xu *et al.*[25]	Telemedicine	Postoperative care	Improvement in medication compliance and quality of life, reduction in postoperative complications	None described

ACC-BR = American College of Cardiology CathPCI bleeding risk; ABG = coronary artery bypass grafting; ARB = Angiotensin receptor blocker; AUROC = area under the curve; ACEi = angiotensin-converting enzyme inhibitor; BMI = body mass index; CABG = coronary artery bypass grafting; CHD = chronic heart disease; GFR = glomerular filtration rate; LGM = longitudinal geographic miss; PCI = percutaneous coronary intervention; R = robotic; STEMI = ST segment elevation myocardial infarction.

in addition to standard educational materials to improve medication adherence and postoperative rehabilitation, respectively.[11,18] Those in the latter group received additional recommendations and targets following weekly review by a cardiac rehabilitation coach. In these studies, patients in the digital intervention groups showed increased medication adherence at both 60 days ($t179=2.04$, $p=0.04$) and 90 days ($t155=3.48$, $p<0.001$), as well as significantly improved functional capacity at both 2 and 6 months, with a mean group difference of 22.29 m (8.19–36.38; $p=0.027$). However, Dorjet *et al* found no differences in other secondary outcomes, including smoking cessation rate, body mass index (BMI), psychosocial wellbeing and quality of life.[11] Qu *et al* focused on a smartphone-based quality improvement intervention aimed at improving prescription of optimal secondary care medication, with rate of statin prescribing as the primary analysis. Here, 10,006 patients with CABG were enrolled in the intervention group, whereas 4,353 patients formed the control. Subsequent analysis did not find evidence of an effect of intervention on statin prescribing in the intention-to-treat analysis (p=0.43) or in key patient subsets,[21] although post-hoc analysis demonstrated a greater increase in statin prescribing over time in the intervention group.

Artificial intelligence and data analytics tools

Two of the included studies (11%) explored the use of AI in post-operative care. Both articles specifically explored the use of neural networks in the prediction of adverse events, including mortality, whereas a third explored the use of these algorithms in the prediction of stent coronary stent underexpansion. For example, Niedziela *et al* retrospectively applied both a neural network and a logistic regression model to 175,895 patients recorded in the Polish Registry of Acute Coronary Syndromes (PL-ACS) between 2009 and 2015.[19] These patients, split into three groups (60% learning, 20% validation and 20% test) were used to model 6-month all-cause mortality rates. Subsequent analysis showed the neural network to have higher accuracy in predicting mortality, with an area under the curve (AUROC) of 0.8103 versus 0.7939 for the logistic regression model (p=0.037). The neural network was similarly demonstrated to have a greater statistical quality, with 0.8422 versus 0.8137, respectively (p<0.0001).

These findings were supported by work by Rayfield *et al* comparing boosted classification trees for prediction of intraoperative bleeding with the American College of Cardiology CathPCI bleeding risk (ACC-BR) model.[22] The authors analysed the outcomes of 15,603 patients with PCI post STEMI included in Mayo Clinic CathPCI registry data between 2003 and 2018, including a test sample of 3900 individuals. The machine learning (ML) algorithm generated an overall accuracy of 77.4% (sensitivity, 77.3%; specificity, 80.1%), with a concordance statistic of 87%. By comparison, the conventional ACC-BR model generated a lower concordance rate of 76.4%, whereas the ML algorithm showed statistically greater concordance in predicting adverse events for those with stage 3 chronic kidney disease (c-score 0.880 versus 0.766; p=0.04), diabetes mellitus (c-score, 0.843 versus 0.757;p=0.04), those over 75 years of age (c-score, 0.887 versus 0.718; P=.046) and those who underwent PCI via both radial and femoral access (c-score 0.866 versus 0.774; p=0.03, and 0.876 versus 0.762; p=0.03, respectively).

Discussion

The studies reviewed here explored the application of various technologies, such as simulation, VR, telemedicine, smartphone applications and AI, within cardiac surgery reperfusion procedures. Although widespread in a variety of industries, digital tools have struggled at times to be adopted into already-defined clinical protocols, or have been limited in use by financial, technical or even behavioural barriers within and between healthcare institutions.

Principal findings

However, in light of the above results, it is clear that recent developments have made inroads in combating these problems. Telemedicine, delivered as physician- or nurse-led interventions, and through either synchronous or asynchronous interactions, has demonstrated statistically significant improvements in postoperative weight loss, medication adherence and readmission rates compared with conventional care, as well as demonstrating reductions in patient and caregiver anxiety. Although not uniformly the case across telemedicine models, the studies reviewed demonstrated these to be cost-effective and sufficiently intuitive to be used by a broad range of both patients and healthcare professionals, such that they could be further integrated into postoperative care protocols in either high-income or low-income settings, and across greater geographical areas than possible using conventional care mechanisms. Particular attention was paid by Barnason *et al* to the fact that many of their study participants accessed the telemedicine intervention from their homes in the rural Midwest, an area typically underserved by cardiac secondary prevention services.[8] Smartphone applications, of which over 350,000 are currently available, have shown similar,[26] albeit inconsistent, potential in improving adherence to medication and rehabilitation regimens post discharge. As suggested by Ghorbani *et al*, the combination of multimedia resources, engaging gamification and human-centric education could result in a more engaging learning experience, faster feedback and more readily available reminders of educational content.[13] These tools show particular promise for those without rapid access to cardiac rehabilitation and secondary prevention services, such as those living in low/ medium income countries (LMICs), although it is clear that further research is required to properly understand the nuances of patient– smartphone interactions.

In the setting of cardiac reperfusion, the high-fidelity and immersive scenarios provided by simulation and VR platforms were found to be superior to orthodox teaching methods for clinical skills as well as potentially reducing the risk of some surgical complications. Bruppacher *et al* considered these technologies to present a significant advantage in providing hands-on experiences in cardiovascular surgical training pathways, particularly in the case of rare or challenging procedures, and that they are likely to reduce intraoperative complications in physical patient care.[15] AI models in their data-processing capability proved superior to conventional clinical algorithms in predicting hospital readmission rates or perioperative morbidity, in part because of their ability to include a far greater number of patient variables in their analysis.[19]

Barriers to implementation

Despite these advantages, shortcomings were noted in the use of digital tools. For example, in the use of ML algorithms, Niedziela *et al* found advantages over existing tools to be slight, and potentially lacking the clinical impact that might justify the greater time, expense and technical knowledge required to develop them.[19] Meanwhile, Rayfield *et al* pointed out that their own ML model failed to show any clinical benefit in significantly obese subgroups (BMI >35 kg/m^2), or for those patients experiencing active STEMI.[22] As such, it could be argued that the often slight benefits in event prediction among other things that such models provide are not justified by the raised costs, time and technical knowledge required to develop them. Regardless of scope and accuracy, VR will inevitably fall short in its replication of hands- on surgical training and, thus, exists to bridge gaps where these opportunities for physical training are in short supply. These tools again rely on significant upfront development costs, which could be considered unnecessary given the often hard-pressed finances of public health institutions. As highlighted by Ghorbani *et al*,[14]

Boyd *et al*[11] and Qu *et al*,[23] smartphone apps sometimes failed to provide a desired benefit, likely because of a multifactorial blend of ineffective interfaces, disengagement or poor integration with existing clinical pathways, particularly in the cases of those patients with pre-existing health conditions, which might impair their ability to use such devices. Despite a huge uptake in its use, telemedicine still faces significant challenges in ensuring equitable access among various age and socioeconomic groups.

Conclusion

Although it is clear that digital tools could offer tangible benefits for patients undergoing cardiac reperfusion interventions, particularly during the postoperative phase, these advantages must be carefully considered against the required time, cost and training required to safely implement them in existing clinical pathways. Furthermore, care must be taken to develop these such that they are able to be used effectively by a wide range of carers, clinicians and patient groups, for whom the use of such tools might be challenging or otherwise inconvenient. If this is achieved, the wider implementation of ML algorithms, telemedicine and mHealth applications could serve to improve the patient experience, cut costs and improve patient quality of life compared with existing services.

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