Feasibility of the application of multimedia animations as preoperative guides for urgent abdominal surgeries in public hospitals in Brazil

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ABSTRACT

Introduction: Preoperative education helps patients feel less anxious and improve self-care while decreasing hospitalization time and demand for postoperative analgesia. Health literacy, culture and language play vital roles in patients' understanding of health issues and may influence treatment outcomes. Obstacles are more evident in low and middle income countries (LMICs), where inadequate patient education levels are higher and hospital resources lower. **Methodology**: This is a prospective pilot study assessing the feasibility of online preoperative multimedia animations as guides for surgical patients in an LMIC. Patients admitted to a public hospital in Brazil for acute cholecystitis or appendicitis were included. Feasibility was represented by acceptability rate and ease of integration with department protocols. **Results**: Thirty-four patients were included in the study. Twenty-six patients concluded the intervention (feasibility rate of 76.5%). Demographic factors seemed to affect results, indicated by higher acceptability from those with lower education levels, from younger patients and from women. No issues were reported regarding integration to local protocols. **Discussion**: Few studies have evaluated use of multimedia resources for preoperative patients. No studies assessed the use of animations and none analyzed digital patient education resources in an LMIC. This study demonstrated that the use of animations for patient education in LMICs is feasible. A step-based protocol approach is proposed by this study to aid the implementation of patient education digital interventions. **Conclusion**: The implementation of this tool is feasible and presents patients with easier access to appropriate and engaging information, allowing better surgical preparation and recovery. It can be offered online, allowing it to be sustainable while creating the foundations for a modern patient education culture in LMICs.

ABSTRAIT (*French version*)

Introduction: L'éducation préopératoire aide les patients à se sentir moins anxieux et à améliorer leurs autosoins tout en réduisant le temps d'hospitalisation et la demande d'analgésie postopératoire. La littératie en matière de santé, la culture et la langue jouent un rôle essentiel dans la compréhension des problèmes de santé par les patients et peuvent influencer les résultats du traitement. Les obstacles sont plus évidents dans les pays à revenu faible et intermédiaire (PRFI), où les niveaux d'éducation insuffisants des patients sont plus élevés et les ressources hospitalières plus faibles. **Méthodologie**: Ceci est une étude pilote prospective évaluant la faisabilité des animations multimédias préopératoires en ligne comme guides pour les patients chirurgicaux dans un PRFI. Les patients admis dans un hôpital public au Brésil pour appendicite ou cholécystite aiguë ont été inclus. La faisabilité était représentée par le taux d'acceptabilité et la facilité d'intégration avec les protocoles du département. **Résultats**: Trente-quatre patients ont été inclus dans l'étude. Vingt-six patients ont conclu l'intervention (taux de faisabilité de 76,5%). Les facteurs démographiques semblaient influer sur les résultats, indiqués par une acceptabilité plus élevée de la part des personnes moins scolarisées, des patients plus jeunes et des femmes. Aucun problème n'a été signalé concernant l'intégration aux protocoles locaux. **Discussion**: Peu d'études ont évalué l'utilisation des ressources multimédias pour les patients préopératoires. Aucune étude n'a évalué l'utilisation des animations et aucune n'a analysé les ressources digitaux d'éducation des patients dans un PRFI. Cette étude a démontré que l'utilisation d'animations pour l'éducation des patients dans les PRFI est faisable. Une approche de protocole par étapes est proposée par cette étude pour faciliter la mise en œuvre d'interventions digitaux d'éducation des patients. **Conclusion**: La mise en œuvre de cet outil est faisable et offre aux patients un accès plus facile à des informations appropriées et engageantes, permettant une meilleure préparation chirurgicale et une meilleure récupération. Il peut être proposé en ligne, ce qui lui permet d'être durable tout en créant les bases d'une culture moderne d'éducation des patients dans les PRFI.

ACKNOWLEDGMENTS

In the world today, it is vital for healthcare professionals to understand health from a global perspective. It is of the utmost importance that we look beyond what *we* perceive as important issues to address and expand to what populations around the world are in fact urging. We should not assume to know people's needs but strive to truly listen and understand their demands, offering possible solutions that are locally viable and sustainable. We must constantly remind ourselves that the pursuit of a more just and equitable world is a moral imperative, and seeking universal health is indispensable.

This thesis is an attempt to address needs in healthcare, without any conflicts of interest to be declared by the researchers. Indeed, this study was created for the purpose of developing a graduate studies thesis. Nonetheless, the overall goal goes far beyond that. This study proposed to be an actor of change by steadily undertaking issues with a global view, a voice of advocacy, a listening analysis and a humanitarian heart. As such, this project was not funded by any healthcare corporation and all necessary funds for the creation and development of this project were provided by the principal researcher through a researcher fund as a graduate student from McGill University received from the Mitacs Accelerate Program during the years of 2019-2020. Aside from this financial disclosure, the humble contribution of this student-author could not have happened without the help of several people that merit acknowledgments.

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Lastly, I would like to thank my friends and family for their unwavering support. Thank you to my new friends in Montreal, who showed me the warmth of friendship in cold days. Thank you to my friends in Brazil, who were unfortunately far but never distant. Thank you to my sister for being a companion and helping me to overcome obstacles that arose. Finally, thank you to my loving mom and dad. They are my guide through life and without whom none of this would have even made sense.

CONTRIBUTIONS OF AUTHORS

GS contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. DD supervised all stages of the project.

INTRODUCTION

As the world quickly entered into the Information and Digital age, the healthcare community has been forced into a swift transition to a growing globalized healthcare reality. Essential services are still offered locally, since fundamental aspects of health care must be delivered in person. However, people are now able to access information and services in less time and with no distance limitations by connecting to their phones. This is the new world reality and healthcare has been slowly adapting its concepts to integrate functions into this new world era. The growth of *Digital Health* as a specific field of study in healthcare has exponentially advanced its range of influence in the world today, with undeniable implications to practices and protocols worldwide.

Another area of study that has seen increasing importance in the last decades is *Global Health*. As a field of great importance in academia and service delivery today, it has highlighted to the healthcare community that health is a fundamental right for any human being and must therefore be treated essentially as a global issue. Drawing from concepts such as humanitarianism and collective health, the progress offered by this field of expertise in the stride towards achieving equity in healthcare is undeniable.

Lastly, another area of study that has recently been receiving more considerable attention is *Patient Education*. Unlike Global Health, it has not seen an ample acknowledgement worldwide and its dissemination has been less structured. However, it has developed into a crucial element that must be addressed in order to achieve greater universal access to healthcare –therefore equity – and more effective service delivery.

This study attempts to address the importance of improving the education of patients in the context of a globalized world in the digital era. It draws concepts from the three main areas of study mentioned previously to offer an innovative solution for the healthcare community.

Patient Education

The development of patient education as a field of study and its foundation in scientific research is relatively new, and although it is receiving increasing acknowledgement in

medical literature, its effectiveness remains a challenge for every healthcare professional. (1) While attention has indeed been given to the advancement of this field in the recent years, it still lacks organized and strategic global efforts to move forward in a more impactful manner. Notably, there has been much effort put into training healthcare professionals to deliver improved health education with technical capabilities. (2) Through education, professionals are trained to offer help for patients to gain independence, enhancing behavioral change and self-efficacy. (3) However, significantly fewer advancements have been made to allow patients to develop their tools for a better health education, limiting the capabilities of individuals to self-care, decision-making participation and overall comprehension of their own condition. (1)

Difficulties such as health literacy, culture and language have been recognized in the medical literature as significant elements in patient comprehension of health problems and may influence treatment outcomes and follow-up. (4–6) Greater information distribution and availability may empower patients to improve their health and this can be clearly enhanced for target populations, such as individuals with hearing impairments, low literacy levels or minority language speakers. (1,7) Effective tools to help healthcare professionals educate patients are gradually being implemented. However, these tools show relevant limitations, particularly to patients with barriers to traditional instructional methods, as is the case with patients with low literacy levels. (8–10) Inadequate health literacy can result in difficulty following medical instructions, as well as higher morbidity and mortality rates. Patients with inadequate health literacy are more likely to be hospitalized than those with adequate literacy skills. (5,11,12) Additionally, these individuals are more likely to view their general health as poor and even present lower physical and mental health indicators. (11,12) Health literacy might thereby determine a variation of health quality in heterogeneous socioeconomic scenarios, such as in low and middle income countries (LMICs) and may influence the effectiveness of educational tools.

Although the challenge to appropriately educate and inform patients of their own conditions is notable throughout all areas of healthcare, in surgical departments – notably in emergency cases – this challenge is even greater. It is known that preoperative education helps patients to experience less anxiety, prepare for healthcare consultations, take an active role in decision-making process, increase self-efficacy, and support postoperative recovery activities. (13–19)

Research has shown clinical benefits of enhancing preoperative information to patients, which include decreased length of hospital admission, decreased demand for postoperative analgesia and increased patient satisfaction. (4,8,10,15,20) A study of patients submitted to laparoscopic cholecystectomy showed that preadmission education intervention helps reduce postoperative pain levels and significantly increases patients' self-care capacity and complication management. (21) Another study which offered patients with video information sessions demonstrated positive impact on patients' decision making and their diet and exercise after heart surgery. (18)

The shift from postoperative in-hospital care to discharge and home self-care is also an important aspect to consider, as the transition often does not meet the necessities of the patients. (9,13) Pamphlets or handouts are often the only information that is given to patients, sometimes accompanied by short verbal instructions. (22) However, patients often forget what they were told and some have difficulty to comprehend the information contained in these leaflets. (23) Furthermore, the continued physical and psychological effects of surgery at home is not taken into consideration, as postoperative patients may still be in pain or too weak to focus, while caregivers may feel overwhelmed. (9)

Despite the evidence that the current state of patient guidance and education is inadequate, there are still many facilities with no formal policy or program for preoperative education. (20) Healthcare professionals – notably, nurses – have found difficulties to implement an effective formal preoperative teaching protocol that is accomplishable promptly. (24) Currently, it is not even clear for healthcare professionals what are the most effective methods or settings, nor when is the optimal time to deliver such important preoperative information to guide patients in postoperative recovery. (14,19,21) Alongside that uncertainty, the use of new technologies for patient education is often dismissed due to limited resources and could explain why multimedia tools have not been popularized for healthcare professionals worldwide despite its easy access. (14) This is even harder to establish when considering the reality of healthcare in LMICs, where inadequate patient health literacy levels are contextually expected to be higher and hospital resources lower. There remains a need for rigorous research that identifies the best timing and method of delivering preoperative patient information to maximize the positive effects on surgical patients. (25)

Even when efforts are applied directly for effective communication, patients and their families still have great difficulty retaining important medical information during their clinical visits. Patient understanding is often inferred, but formal checking is seldom the case. (22) It has been shown that patients may forget up to 80% of healthcare information discussed during clinic visits, and almost half of the information remembered is recalled incorrectly. (9,26) Studies show that patients understand medical information better when spoken to slowly, simple words are used, and a restricted amount of information is presented. (11) The use of pictures has also been shown to bring benefits to patients and improve communication, with increased benefits for those with low literacy skills. (27) It remains a challenge to develop educational tools that are linguistically appropriate for diverse patient populations. (8) To improve comprehension and compliance, using patient education material at a sixth-grade or lower reading level, preferably including pictures and illustrations, might reach the optimal number of patients. (11)

Multimedia-based education may be an effective solution for patients of all ages. The use of audiovisual multimedia tools can enhance learning which may consequently lead to an improvement in treatment outcomes. (4,7,16) In general, information acquisition and processing for patients is best performed through visual and auditory channels, where a balance between the two without overloading either has been shown to result in the most meaningful learning. (22,28) For instance, Dallimore *et al.* showed that patients who received education via an iPad presented significantly higher satisfaction scores than those who received a paper booklet. (4) To that end, the use of visual instructions through animated multimedia guides could be considered a compelling tool that may help overcome challenges in patient education. (14)

Digital Health

After a great number of digital health tools surged in the late 1990s and early 2000s, the need for a more integrated approach to the development of technologies focused on the dissemination of health information and communication to service delivery and patient care was identified as necessary. (29) The use of information and communications technology in support of health and health-related fields had been frequently defined by the term digital

health and was recently enforced by the World Health Organization (WHO) in its 2019 guideline for digital interventions in healthcare. (7) It has been frequently highlighted that digital health may serve as a significant intervention to advance universal health coverage (UHC) around the world. The relevance this issue has gathered in the present days has been a frequent focal point for global healthcare innovations. However, while it is recognized that digital health may play an essential role in the future of healthcare, one of the most impactful aspects that restrict investments in this field is the inevitable conclusion that it may divert resources from other essential, non-digital aspects of healthcare. (7) This is a graver matter for LMICs that face various financial difficulties and must prioritize resources, limiting their ability to adopt innovations. (30)

An array of digital health interventions to address patient needs have been developed recently, including SMS text reminders, online counselling, test results delivery and scheduling, to name a few. (7,31,32) Some innovations – albeit in smaller numbers – have even come from LMICs, including telemedicine networks in Bangladesh, e-pharmacies in Malaysia, electronic medical records for HIV/AIDS in Kenya and web-based communication tools for maternal health in Peru. (33) These digital services targeted integration to healthcare systems in order to increase efficiency in use of resources, avoiding fragmentation of information and increasing sharing capabilities for improved decision-making. (29) This resulted in the development of many national and regional policies for digital health interventions, however, this was not done strategically to improve global efforts in a unified manner. (29)

Many studies have investigated different aspects of these digital health interventions for clinical purposes. Fewer studies have been done to analyze the application of such tools for preoperative patients, and their reports expressed mainly positive results for the application of various multimedia tools in elective surgery scenarios. (22) However, no studies analyzing the feasibility of freely accessible online preoperative animations were identified. Likewise, no publications were found about preoperative multimedia guides for populations in LMICs or about patients in urgent surgery scenarios.

Studies have identified that patients express positive impressions of digital health interventions. These technologies may improve guidance and access to information and

improvement in knowledge, as well as provide reassurance and motivation by offering a sense of direction and safety. (7,23) Additionally, independence and self-care may be enhanced by providing individual empowerment to patients. (7) The potential benefits from using multimedia-based educational tools to improve healthcare has been acknowledged in the literature. However, these tools are not always accepted by patients for reasons that include poor device usability, insufficient usage orientation, lack of computer skills and low self-efficacy. (7,34,35) Additionally, healthcare professionals are often also reluctant in accepting to implement preoperative multimedia education. Some view digital health interventions as inefficient because they do not equate to a real reduction in workload and may even result in an increase if traditional practices are maintained concomitantly. (7)

By recognizing a need to address the issue of preoperative patient education from a digital health lens and a global perspective, this study aims to assess the feasibility of applying a standardized preoperative multimedia guide for patients in a middle income country, where the context itself may serve as a limitation for the implementation of innovations. A novel solution that may address this matter is the creation of animation videos to deliver patient education. Studies examining patient information retention have concluded that spoken animation is best adapted to communicate complex medical information to all patients with an increased benefit to those of low literacy level. (9,30,36)

Using the web to deliver these animations might assist to an even greater extent, since it allows patients to be able to refer back to information, review repeatedly and have a tangible product. (9) By offering evidence-based medical information in an online multimedia guide, it is possible to display an overview of their disease, treatment options, surgical procedures and recovery. Therefore, online multimedia animations may be an effective innovation in this context and may offer a holistic educational experience to the patients in a preoperative status, as well as for postoperative recovery.

Global Health

Global Health has been defined in several ways, but it generally “implies a global perspective on public health problems”. (37) Its focus is on the public good and health equity in a global

perspective, with a scientific approach and multilevel interventions. (38) While Global Health is still often perceived as international aid and interventions flowing from wealthier countries to LMICs, this perspective has grown into great discredit as the implications of living in a globalized world have become clear. (38) This is very evident in the intersection between Global and Digital Health since the influence of socioeconomic factors in the digital world has less impact. The influential capacity of a nation in the era of the internet has dramatically increased and brought closer together links in global health in an increasingly interdependent world. (37) Technology can serve to empower people even in lower resources settings, and don't necessarily represent an increase in expenditure; to the contrary, it may represent an overall reduction in spending for local governments. Global health programs have been seizing this concept to promote equity and universal health coverage.

The impact of a well-educated patient population as a mechanism of empowerment has been previously described, but it is relevant to point out the importance of education from a global health perspective. There is a powerful connection between health and education in LMICs, and appropriate health behaviors are important determinants of health. (37) However, as nations are forced to prioritize healthcare investments, a dismissal of health education programs is frequently observed in LMICs, where low resources determine the services offered to their population. A malicious cycle is created when less investment in patient education as a socioeconomic determinant of health leads to a decline in healthcare quality, which in turn negatively affects the socioeconomic status of individuals. Therefore, it is important to approach patient education as an essential part of public health with global impact potential, as it addresses issues of equity, inequality and health disparities. (37) These are essential factors in Global Health and should be studied as a driver for strengthening healthcare delivery in LMICs.

In modern times, health systems and delivery of care across all countries have also been challenged by the epidemiological and demographic transition faced by the world in the last decades. Wealthy nations have developed means to overcome these demands, and the potential use of digital technologies has been explored by several countries, while innovative approaches to eliminate the geographic and financial barriers to health are being pursued. (29,39) Nonetheless, in LMICs, healthcare systems continue to face considerable challenges

in providing high-quality, affordable and universally accessible care even with the technological advancements available today. (39)

Some international organizations such as the WHO have incentivized global efforts to use digital tools to strengthen healthcare systems. Since then, a plethora of countries – including many LMICs – have worked on the development of their policies for digital health programs. (29) Many digital solutions for healthcare have appeared in various LMICs, including Ethiopia, Kenya and Nigeria, where the presence of mobile devices grew significantly and allowed its use in healthcare systems. (40) Despite the increased interest, digital health is still relatively incipient in LMICs as few programs presented scaled-up, long-term implementation and have typically been fragmented and uncoordinated. (39,40) Notwithstanding the growth in efforts to advance digital health globally, computer-based patient education is still primarily applied mainly for the English-speaking world. (41) Sustainable national programs to support global actions in digital health are still lacking and no international encouragement strategies are observed. (29)

There is an expectation that Digital Health may offer cost-effective solutions to improve health outcomes and access to health information in LMICs. (37) Digital health platforms present the capability of reaching people wherever they are – namely, it is not limited to the boundaries of healthcare institutions – creating effective coverage for underserved populations. (40) This approach can create valuable programs and interventions to support healthcare professionals and disseminate health education information, especially in countries that face a limited number of human and physical resources. (32) For example, in LMICs, programs in areas related to maternal and neonatal health, HIV/ AIDS and primary care have been adopted with the use of mobile devices and have shown great potential. (32,39) Nevertheless, investments are still limited, and research focused on bringing light to the potential adoption of digital tools for global use are still scarce. To date, the literature on digital health in LMICs has been limited mainly to descriptive studies about the implementation of technologies in healthcare delivery or policy recommendations. In contrast, few global assessments of the current world landscape of these programs have been accomplished. (39)

This study

The literature review of these three areas demonstrated the importance of studying and advancing on the topic of patient education while bringing into the discussion innovative digital concepts that may offer solutions for worldwide innovations and advancements. Digital information accessible with personal devices has become commonplace, leading patients to obtain health information independently and away from the traditional physician–patient interaction. (1)

Amidst the plethora of information and misinformation available via the internet for patients today, a centralized and web-based health education platform has the potential to create a more educated global patient population, with standardized and verified information delivery. The expansion of the span of digital health interventions as educational tools for LMICs may represent a significant path for improvement in the healthcare of populations with limited resources. (7,31)

By taking into account these concepts, this research was created to determine the potential of innovation as a disseminator of patient education in a global level. This study serves to assess the feasibility of applying a new long-term patient education tool in a middle-income country with a patient population from a public hospital. This tool presents patients with trustworthy and standardized access to information, utilizing a sustainable online platform offering content based on established medical literature, adapted to local guidelines and demands, presented in a simple and engaging multimedia animation in the patient's native language.

RESEARCH QUESTION

How feasible is the introduction of a preoperative animated multimedia guide for urgent abdominal surgeries in Brazil?

HYPOTHESIS

The application of preoperative multimedia animation as preoperative guides for urgent surgical procedures in a middle-income country is feasible.

OBJECTIVE

Assess feasibility of the application of preoperative multimedia animation guides for preoperative patients undergoing urgent surgical procedures in public hospitals in a middle-income country.

METHODOLOGY

Study design

This is a quantitative and qualitative prospective pilot study to assess the feasibility of the creation and preoperative application of disease-specific animated multimedia guides for patients in public hospitals in Brazil. To assess the feasibility of a randomized controlled trial for the introduction of this intervention in the context of a LIMC, this pilot study was designed to answer questions about the rate of subject retention and acceptability of this tool in a middle-income country.

For this study, acceptability was defined as usage and adoption, as well as willingness to use the technology. Therefore, feasibility was calculated by the completion rate, which represents the percentage of patients that participated in the study (number of patients in study / total number of surgeries). (42) The intervention can be considered feasible if no major integration issues are reported by the local staff and if more than 50% of the patients are compliant with all steps of the study. An assessment regarding ease of integration to local protocols through individual interviews was also taken into consideration for this analysis as an aspect of the healthcare professional's willingness to use the technology. The analysis of this pilot study is mainly descriptive, and any results from a possible hypothesis tests were treated as

preliminary, (43) since the main objective was to assess the feasibility of the application of this tool in a specific environment. Other aspects of the implementation process that could emerge during the study were also taken into consideration for descriptive analysis purposes.

Participants

This study was carried out through a collaboration between the Centre for Global Surgery of McGill University Health Centre and the Discipline of General Surgery and Trauma of the Department of Surgery at Faculty of Medicine of the University of São Paulo (USP) in Brazil. The Central Institute of USP's hospital complex houses over 900 beds and receives all urgent general surgery cases at that hospital complex. The Emergency Surgery Service at USP's Central Institute admits approximately 10-20 acute cholecystitis and 5-10 acute appendicitis per month. All cases of cholecystitis and appendicitis are admitted by the general surgery team. All patients with inclusion criteria for this study were approached by residents and fellows of the hospital's General Surgery and Trauma Department, who introduced the study to the patients and explained about their participation.

Sample size for this feasibility study was 30 patients, as suggested by Lancaster *et al.* for a pilot study. (43) The inclusion criteria for this study was all patients above 18 years of age, independent of gender or educational levels, admitted to a public hospital in Brazil for acute appendicitis or acute cholecystitis and who would undergo the urgent surgical treatment before discharge. Excluded patients were those who were discharged from the hospital before the surgery occurred, as well as any patient who presented any severe clinical conditions requiring hospitalization in the Intensive Care Unit. Patients were also excluded if presented with any comorbidity that determined a relevant degree of cognitive or audiovisual deficit, such as patients with severe mental or psychiatric illness, advanced Alzheimer's disease, cognitive sequelae of stroke, blindness or deafness. Patients with mild deficits that do not impair the person's ability to watch a video were not excluded. These exclusion criteria of comorbidity were necessary in order to limit the confounding factors in the feasibility analysis as these patients may have presented intrinsic difficulties that run outside the context of the applicability of this intervention and could direct the results into aspects that do not assist in answering the research question.

Materials

The multimedia animations were created for two common urgent abdominal surgical procedures: appendicectomy and cholecystectomy. These videos were universally available without user-fees, accessed via the web. The language used in the animations was prepared in order to avoid use of offensive or discriminatory vocabulary. Every image in the animation was reviewed to maintain the entire production appropriate for all ages. Content and language utilized were based exclusively on up-to-date medical literature with limited jargon use. All content was presented in the local language and animations included closed caption preference. To increase information understanding, the animations were created at a grade 6 level of comprehension and the audio was spoken slowly and clearly.

The preparation of the content for the animations unfolded through a collaboration between the main researchers and the local professionals in order to adapt all information to the department's protocols. The content was reviewed by medical experts to produce an evidence-based approach to the information, while maintaining the didactical aspect and visual essentialities of the animations. The animations were created through a partnership between the Centre for Global Surgery at McGill University and a Canadian company named Precare, Inc. As a company with experience in the development of health-related animations, this cooperation was crucial to the translation of the medical content into an animated video adequate for patient viewing under these circumstances.

In order to offer participants with a completely virtual intervention experience, a website was created to serve as the online platform for the study. This page contained the following resources available for the participants:

(1.) A section consisting of an introduction to the study;
(2.) A registration page for access to the individualized videos;
(3.) An area for visualization of the video;
(4.) An integrated system of data collection and anonymous archive;
(5.) An anonymous contact section.

The platform was developed in partnership with Computadores e Sistemas, Ltda. This Brazilian company has experience with the development of online platforms and offered

services to contribute with the project of a virtual patient education intervention. The platform is available for free access at https://anima.med.br/. A version completely translated to English is available at https://en.anima.med.br/. Images of the online platform can be found in Appendix 1.

Procedures

Patients were contacted by a member of the surgical team who explained the patient's condition and indication for surgery. The patient was then informed about the study and freely offered consent, which could be done in the online platform. Afterwards, patients were guided to beginning of the preoperative guide. Appendix 2 shows the suggested approach for the initial contact with the patient to introduce this research. Appendix 3 shows a flow chart for the stages of the application protocol.

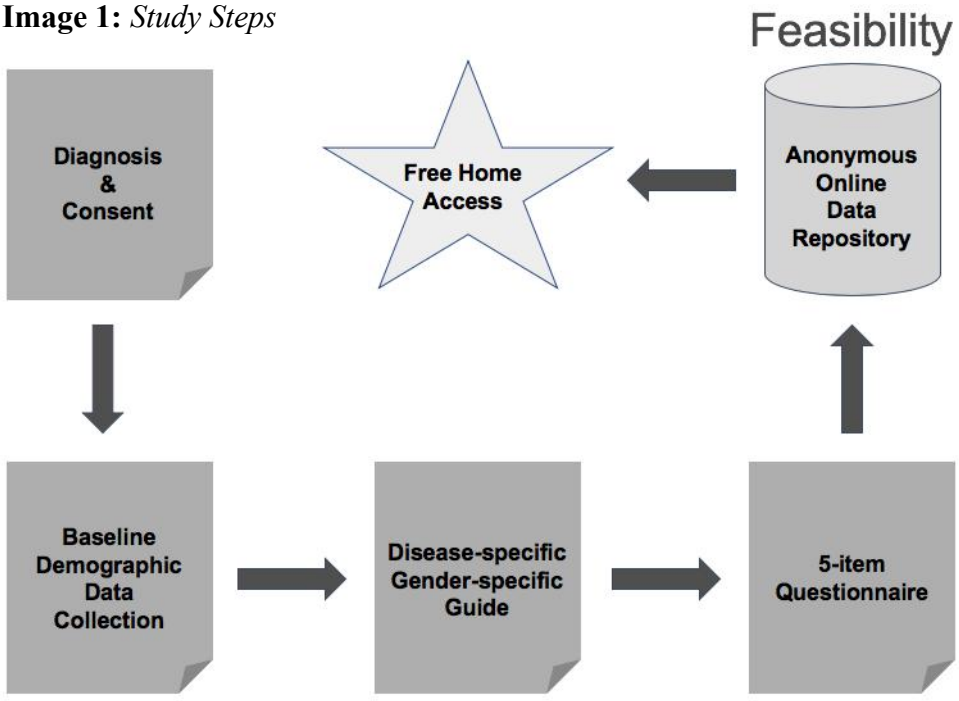
Participation in this study was completely voluntary and participants had the absolute right to withdraw from the study at any stage if they wished to do so. Informed Consent Forms were applied for every patient that chose to participate in the study, and individuals were enrolled in the study on the basis of informed consent, which was obtained from participants before any intervention. Informed Consent Form used for all participants and translated to the local language is shown in Appendix 4. Subject anonymity was preserved at all times, and patient information remained confidential as access to the database was reserved exclusively to the main investigator, who did not participate in the surgical care of the patient.

Following the agreement to informed consent, patients were offered a tablet device by the department to access the platform but were also allowed to use any personal electronic device of their preference if they so desired. They were given the online platform website address where they started the study. The initial page was composed of a registration to the platform, where the patient would choose a random username for login that could be used in future accesses. Additionally, they were asked about their disease (appendicitis or cholecystitis) and baseline demographic information (date of birth, gender and educational level). Then, the platform automatically directed patients to the next page, where they would watch the animation. With the data collected from the registration, the platform showed disease-specific animations and characters were personalized to the gender answered by the patient. After the

video, patients would answer the questionnaire to assess the acceptability of the tool. Subsequently, participants were automatically put into an anonymous secure online repository, accessible only by the main researcher.

After the completion of all the steps of the study, the platform was finalized, and that access was considered a feasible individual intervention. This step would be the mark of feasibility as it divided the two groups of the study with those individuals who completed the entire study – thereby representing acceptability of the intervention – and the group of the individuals who did not complete the study and therefore were considered as not accepting of the tool. Home access was offered to all participants who wanted to visualize the platform at any moment. Post-operative access to the platform served to demonstrate the span to which this tool may expand as a health education intervention. However, this data point was not considered in the feasibility analysis, since the objective is to assess the in-hospital use of this tool. Image 1 demonstrates all of the steps in the study to determine feasibility.

Image 1: *Study Steps*



This study was approved by the Research Ethics Boards (REB) in Canada and Brazil, as it was based on a collaboration between universities of both countries and Certificates of Ethical Approval were obtained prior to any intervention. There were no anticipated physical risks to the participants by entering in this study. Study participants were not subjected to harm in any way, and respect for their dignity was prioritized throughout the entire period of

the study. The content was created to be suitable for all ages, cultures and beliefs so as to limit to a minimum any psychological discomfort that could be caused by the animations. No images that could bring any distress to the participants were depicted.

Instruments

This study used a simple questionnaire to portray the acceptability of certain aspects of this tool by each participant. This survey was composed of a 3-item assessment of acceptability, resulting in 5 total questions. Additionally, there was a section for comments where the participant could write their impressions of this tool freely. The questions presented to patients were the following:

1. Did you understand the information provided to you?
2. Did you watch the animation? If not, why?
3. Did you like the animation? If not, why?

The survey was applied online in the same platform used for other steps of the study. A tab prompted the questionnaire after visualization of the animation. Answers were automatically retained in a secure database and produced a spreadsheet containing all data at the request of the researcher. The complete questionnaire is shown in Appendix 5.

Data collection and analysis

The literature review was done in PubMed and Ovid / Medline. To broaden the search spectrum in order to include regional studies from Latin America, the literature review was also be performed in LILIACS and SciELO. Primary search terms used were *Patient Education*, *Global Health*, *Digital Health*, *Multimedia*, *Surgery* and *Perioperative Period* (*Postoperative* or *Preoperative Period*).

All data was collected prospectively and maintained in a password-protected online database. The principal researcher had the responsibility of maintaining patient confidentiality and preserving anonymity for the survey responses. Protection of participant's privacy was guaranteed, and research data remained entirely confidential, ensured by password-protected online databases, accessed exclusively by the principal investigator. The anonymity of

participants was protected by the data collection process and secured by the main investigator, precluding researchers from having any access to identification information or hospital history of the participant or healthcare professionals from obtaining the research results from each patient.

Data collection and analysis was done with the use of Microsoft Office Excel software licensed version 16.36 and accessed by researchers of the study after the intervention. Database was kept as a password-secure Excel document after being downloaded from the online platform. Descriptive statistical calculations and graphs were also done using this software. Finally, statistical inference tests were performed for the purpose of data analysis by using Fisher's exact test for categorical variables and t-test for continuous variables.

RESULTS

The results presented from this analysis can be divided into five major segments. The first relates to the results of the creation of content and platform development. Next, the results of the general collected data analysis are presented. The descriptive analysis of demographic data contrasted with acceptability rates is detailed afterwards. Lastly, the results of the questionnaire are presented.

Platform development

The creation process of the video content and platform evolved during six months in 2019. The content of the animations was developed through a multidisciplinary task-force that encompassed professionals from the Centre for Global Surgery at McGill University and the Department of Surgery of the University of São Paulo. The content was then adapted as video scripts with the collaboration Precare, Inc. This collaboration allowed for the content to maintain all evidence-based information as per the local protocols, while emphasizing on the importance of creating an engaging animation for the patients.

The scripts for the animations are shown in Appendix 6. The animations were created during a period of four months, developed through this university-industry partnership. The duration

of the videos were 8 minutes and 55 seconds for appendicectomies, while the cholecystectomy animation lasted 9 minutes and 5 seconds. Appendix 7 exhibits still images of some scenes of the produced animated video, depicting the various stages of the patient's journey from diagnosis to recovery at home.

General data overview

The prospective cohort intervention period of this study lasted a total of four months, spanning from December 19, 2019 to April 19, 2020. The Central Institute of USP's hospital registered a total of 198 surgeries performed by the General Surgery Department during this period. Cholecystectomies and appendicectomies totaled 34 surgeries during this time, representing 17.17% of all surgeries done by the department. All of the 34 patients admitted to the hospital during these four months had inclusion criteria and were enrolled in this study. No patients presented exclusion criteria.

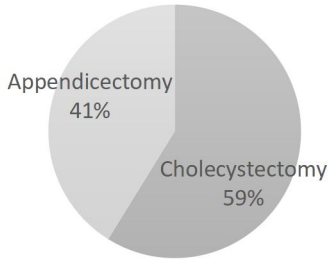
Demographic data from all 34 participants was analyzed. The mean age of the enrolled patients was 45 years, ranging from 23 to 76 years of age and the majority of the population was composed of women (59%). Most participants had a high school degree (44%), but 24% had not achieved that educational level, while 32% had secondary education. The demographic data of the population is shown in Table 1.

Table 1: *Demographic data of the population (n=34)*

Demographics	**Total (%)**
Age	45.2 ± 16.7
Gender	
Male	14 (41%)
Female	20 (59%)
Educational Level	
Below high school degree	8 (24%)
High school degree	15 (44%)
Secondary education	11 (32%)

Out of the 34 patients enrolled in the study during the 4 months, a total of 20 surgeries were cholecystectomies, representing 59% of cases, while 14 were appendicectomies (41%). Graph 1 shows the ratio of the type of surgery of the study population.

Graph 1: *Type of surgery (n=34)*



During the study period, cholecystectomies represented 10% of all surgeries performed by the General Surgery Department, while appendicectomies were 7%. This proportion is compatible with the usual tendencies observed in the department's history. Typically, the most performed surgery in the department is urgent cholecystectomy due to acute cholecystitis, which was indeed confirmed by the number of surgeries identified during the months of this study.

Group demographics

When analyzing the demographic data between the two groups of surgery types, a gender and age difference was observed. Most patients in the cholecystectomy group were women (75%), while men were most commonly submitted to appendicectomy procedures in this cohort (64%). The population in the appendicectomy group tended to be younger in comparison to those in the cholecystectomy group (mean age of 41.9 years compared to 47.6 years). Table 2 shows the difference of the demographic data between the two groups of surgery types performed in this study.

The completion of all steps of the study (as demonstrated in *Image 1*) defined the acceptability rate of the intervention for this study and formed the feasibility group of this research. Out of all 34 patients enrolled in the study, 26 competed all steps, which constituted an acceptability rate of 76.5% for this tool. All patients who did not complete all steps (eight participants) did, however, enroll in the study and proceeded to watch the video guide. The

step that was not completed was invariably the questionnaire, which constituted unfeasibility of the tool by the established methodological criteria. The video was entirely watched by 6 of those 8 participants, representing a total of 32 out of 34 participants (94.1%) who watched the online guides.

Table 2: *Demographic data between the groups of surgery types (n=34)*

Demographics	**Cholecystectomy (*n=20*)**	**Appendicectomy (*n=14*)**
Age	47.6 ± 17.9	41.9 ± 14.9
Gender		
Male	5 (75%)	9 (64%)
Female	15 (25%)	5 (36%)
Educational Level		
Below high school degree	5 (25%)	3 (21%)
High school degree	10 (50%)	5 (36%)
Secondary education	5 (25%)	6 (43%)

The comparative analysis of the demographic data of the two groups of acceptability demonstrated clear differences between them. No statistically significant difference in age was identified between the two groups. The mean age of the 26 participants who completed all steps of the study was 43 ± 15.8, while the other 8 patients who did not complete the study were older, with an average age of 52.6 ± 18.5 years (*p=0.16*). There was no statistically significant difference in gender ratios or educational levels between the groups. Nonetheless, a notable difference was identified in gender ratios between the groups (65% females in the completion group versus 63% males in the non-completion groups with *p=0.23*). The educational level also presented a marked difference between the two groups (*p=0.079*). Out of the 26 participants who completed the study, 8 individuals (31%) did not have a high school degree and 6 people (23%) had secondary studies. Meanwhile, the other group had 63% of individuals with secondary education level but no one without high school diploma. The patients' diagnosis and whether they would be submitted to an appendicectomy or a cholecystectomy procedure did not seem to influence the individual acceptability (*p=0.69*). Table 3 depicts the differences between the demographic data of these two groups.

Table 3: *Demographic data between the groups of study completion (n=34)*			
Demographics	**Completed study (*n=26*)**	**Incomplete steps (*n=8*)**	
Age	43 ± 15.8	52.6 ± 18.5	*p=0.16*
Gender			
Male	9 (35%)	5 (62,5%)	*p=0.23*
Female	17 (65%)	3 (37,5%)	
Educational Level			
Below high school degree	8 (31%)	0 (0%)	*p=0.079*
High school degree	12 (46%)	3 (38%)	
Secondary education	6 (23%)	5 (63%)	
Type of surgery			
Cholecystectomy	16 (62%)	4 (50%)	*p=0.69*
Appendicectomy	10 (38%)	4 (50%)	

The analysis of this data established the acceptability rate of each demographic category, which was represented by the number of participants who completed the study divided by the total number of participants in that category. These rates may serve to determine demographic characteristics that arguably influence the acceptability of this educational intervention in this context. While no statistical significance was identified, the acceptability rate apparently presented a decrease as the educational level increased, varying from 100% acceptability rate for those without a high school degree to 54.5% for those with secondary education. Likewise, gender also determined a difference in acceptability rates, as women presented 85% acceptability, while men remained at a 64.3% rate. The type of surgery did not present an evident effect in the acceptability rate, as the small difference identified could be explained by the fact that more women were in the cholecystectomy group.

Table 4 shows the rate of acceptability for each demographic category. Although no statistical significance was obtained from the results presented, some trends can be identified and should not be overlooked. These elements seem to indicate that this tool may have higher acceptability from those populations with lower education levels, from younger patients and from women.

Table 4: *Acceptability Rate per demographic category (n=34)*			
Demographics	**Total number**	**Acceptability rate**	
Gender			*p=0.84*
Male	14	9 (64.3%)	
Female	20	17 (85%)	
Educational Level			*p=0.8133*
Below high school degree	8	8 (100%)	
High school degree	15	12 (80%)	
Secondary education	11	6 (54.5%)	
Type of surgery			*p=0.71*
Cholecystectomy	20	16 (80%)	
Appendicectomy	14	10 (71.4%)	

Questionnaire results

The results of the questionnaire completed by the 26 patients who formed the feasibility group also demonstrated a high degree of acceptability of this tool by the participants. For the first question ("Did you understand the information provided to you") the totality of participants answered "Yes." This percentage was also true for question three: "Did you like the animation". For question two – "Did you watch the animation" – one of the 26 patients answered "No" because of partial viewing due to internet access issues. Table 5 summarizes the results of the answers the 5-item questionnaire.

Table 5: *Answers to questionnaire (n=26)*			
Question	**Yes**	**No**	**Why**
1. Did you understand the information provided?	26 (100%)	0 (0%)	--
2. Did you watch the animation?	25 (96.2%)	1 (3.8%)	--
3. Why not? (*related to question 2*)	--	--	Internet access
4. Did you like the animation?	26 (100%)	0 (0%)	--
5. Why not? (*related to question 4*)	--	--	--

A total of 12 comments from participants were registered, which represents 46% of all patients who completed the study. Out of these twelve comments, 83.3% were positive reviews of the tool. One of the negative reviews was offered by the first participant enrolled and related to internet connectivity. The second negative comment was associated to anxiety due to the wait time for surgery. Listed below are all comments received in chronological order (directly translated to English):

(1.) Verify the reason why the animation is crashing (internet problem?), because it prolongs the viewing too much.

(2.) I was more relaxed with the surgical procedure. I really liked the video; it helped a lot.

(3.) The video was very clear and easy to understand! It was really enlightening.

(4.) I hope I don't have any complications, neither during surgery, nor in the post-op.

(5.) Excellent video, it really removed all my doubts and fears… besides the great professionals that are giving me much attention.

(6.) It was great to receive all the necessary clarifications regarding my surgery. Thank you for treating me.

(7.) I really liked it. It was clarifying.

(8.) This video is a great idea. I was feeling nervous, without knowing what would happen to me. I am much more relaxed now. Thank you.

(9.) Understood well.

(10.) Despite the whole explanation, the video increased my anxiety. Each hour of wait increases my nervousness.

(11.) It was very good.

(12.) I liked it. Very explanatory.

Assessment regarding ease of integration to local protocols was performed through interviews with the healthcare professionals in the department. During these interviews, a high acceptability was also identified among local staff and department head. The acceptability of this new tool was high amongst most professionals in the department as no issues related to the integration to department protocols or clinical patient care procedures were declared. Additionally, the interest for innovative research seemed to grasp the attention of the department's professionals. This assessment was not accompanied by a quantitative

data analysis, as these interviews were mainly descriptive. However, a large degree of satisfaction with the usage of this tool was observed during these conversations. A higher degree of usage was observed amongst younger professionals, mainly residents, which may have been affected by the role difference in the daily clinical routine of a surgical department.

The only noteworthy difficulty acknowledged by the local professionals was internet access. This corroborates with one patient's comment, where a relevant connectivity issues which imposed difficulties to watch the guide was expressed. A simple technical modification in the online platform significantly improved this issue by allowing participants to watch the video regardless of the internet network quality. The department immediately noticed the result, and no other remarks related to internet access were expressed by patients or professionals.

DISCUSSION

Patient education for surgical patients has long been a topic of debate. Evidences that preoperative education reduces stress levels, pain and anxiety date back to 1970s. (44) Furthermore, literature shows that individualized, formal preoperative session have more positive effects than informal ones. (21) However, the magnitude of its impact on surgical outcomes is still disputed, regardless of the amounting evidence. A Cochrane systematic review on patient education for patients submitted to cholecystectomy argued that due to the low quality of evidence, they could not determine whether formal preoperative education has any benefits to patients. (45)

Patients and professionals, when bound to a dichotomous relation, share information and experience distinct understandings of what was discussed. (41) These two subjects present different demands and needs that must be addressed when sharing information, especially considering the asymmetry of knowledge and peculiar vulnerability that the patient is required to overcome. (22) Patients are in search of learning about their condition, treatment and recovery. On the other hand, healthcare professionals are faced with the dilemma of how to communicate the necessary information better. Patients usually demand more information relating to postoperative expectations, pain management, wound care or food intake. (21)

Meanwhile, those might not be priority topics for professionals who are focused on explaining risks. Even if most patients feel they have been provided adequate education, studies suggest they might have misinterpreted information. (46) The consequence is a dissatisfaction with the doctor-patient interaction, as patients complain about not obtaining enough and reliable information. (23)

Although there seems to be abundant evidence in the literature that preoperative education leads to positive results, healthcare professionals still lack sustained formal programs. (24) Most institutions and governments have limited their span of action to only offering informative leaflets, which are frequently used as an instrument to reinforce consent to a procedure, but lack support from the literature regarding their efficacy and are often difficult to read. (22) A randomized trial comparing different methods of preoperative education showed that multimedia usage resulted in higher patient knowledge recall when compared to pamphlets or verbal instructions, as well as higher satisfaction rates. (47) For effective preoperative education, the information should be available in many forms and preferably be individualized in order to contemplate different learning needs and styles. (24) A possible path forward to achieve those aspirations and optimize efforts is the integration of Digital Health into Patient Education programs, as these interventions may allow more significant interaction and individualization. (22) Multimedia guides are an effective tool for education and has the advantage of delivering large amounts of information that can be constantly reviewed. (22)

The literature review from our literature review identified 24 randomized trials on the use of any multimedia tool in any surgical scenario. (4,10,13–16,18,21,41,47–60) None of these studies analysed the use of a multimedia tool in an LMIC and none assessed the use of animations as guides. The focus of this study was to assess the feasibility of using an online multimedia tool in a low resource setting and no studies were identified addressing the use of animations as preoperative guides in an LMICs.

The use of internet-based tools in healthcare is exponentially growing, and there is an expectation that it will play an important role in service delivery as Digital Health strengthens. Although it is recognized that the digital transformation of health care will be disruptive, digital and ground breaking technologies, have the potential to enhance health by improving

medical diagnosis, data-based treatment decisions and self-management of care. (29) However, this transition is not a straightforward path, and many issues must be addressed before considering the digital world as a conquered frontier in healthcare.

A study done with patients undergoing hernioplasty or cholecystectomy showed that only 31% of patients with internet access spontaneously used online resources to obtain information about their procedure. (61) Another corroborative study demonstrated that the internet was infrequently used as a source of information for patients undergoing cholecystectomy. (62) However, these studies are over 10 years old and the advancement of the digital era has since been undeniable, expanding internet access to households anywhere in the world. A more recent study by Koenig *et al.* assessed patient use of internet-based resources for sports medicine and revealed that 54% of patients used the internet for find information about their condition, but most were either neutral or distrusted the available online information. (35) This study demonstrates an increase in numbers, but still fails to show adequate use of digital platforms for healthcare. Nonetheless, the extent to which online media has quickly spread to other parts of daily lives is an empirical demonstration that the future of healthcare is inevitably to become progressively more digital. A recent randomized trial using a web-based education platform for preoperative orthopedic patients suggested that this approach resulted in improved preparedness for surgery and rehabilitation, as well as encouraged patients to participate actively in their treatment with more knowledge. (54)

The issue of online misinformation is one that must be faced as Digital Health moves forward. Professionals need to understand how patients are using the internet and guide patients through the sources. (35) Contradictory information coming from an array of sources with no coordination may create uncertainty and even worsen anxiety. (23) Patients do not know how to identify reliable and evidence-based information on the internet due to the abundance of sources. (41) Additionally, word of mouth – including but not limited to relatives and friends – is still a major source of information for patients and may serve to disseminate more misleading suggestions. (62) A centralization of content by governments healthcare institutions and/or associations may be required in order to organize the content available. Digital health must be an integral part of health priorities and benefit people in a way that is ethical, safe, reliable, equitable and sustainable. (29)

Another aspect that must be considered is the population's acceptability and accessibility to digital medias and internet. This was identified as one of the main obstacles identified in our study. Although internet is widely diffused around the world, we still see varied degrees of connectivity for healthcare use, especially in LMICs. (31) Many health workers and patients experience logistical challenges when using digital health technologies due to poor network connectivity. (7) This factor may also culminate in patient dissatisfaction, because it creates an impression of delays in receiving health services, causing a result opposite from the intended purpose of the tool. (7) Additionally, while it seems optimal to use online resources, this may exclude those with limited digital skills and those who refrain from using online media altogether. (35) The solution identified in this study to decrease the need for high-quality connectivity has been previously described in the context of digital health interventions and presented itself as an adequate solution in this scenario. (31) Nevertheless, it does not apply to all cases where patients choose or are not able to access internet-based resources. Therefore, understanding the feasibility of applying digital health tools in an LMIC can provide vital information to improve the intervention and its sustainability.

Feasibility studies are designed to identify problems that might occur with interventions and aim to guide further studies about testing for their acceptability, estimating rates of recruitment of subjects and calculating sample sizes. (43,63,64) Acceptability of technology has been defined in four primary ways: satisfaction with the technology, usage or adoption of the technology, efficient or effective use of the technology, and intention or willingness to use the technology. (34) This study opted to assess feasibility through concepts of acceptability, mainly adoption of the technology and willingness to use it. This methodological choice to narrow the concept of feasibility allowed the study to produce both quantitative and qualitative data, which culminated in broader evidentiary information concerning feasibility. Although some limitations may have resulted from this choice, its effect was a more consistent definition of the feasibility of this tool.

This study considered the literature evidence surrounding the use of digital interventions in patient education as sufficient to warrant its support. However, obstacles to it effective use have been well-describe and had to be taken into consideration during the development of this research. The platform utilized in this study attempts to address these issues by taking several precautionary measures:

Environment. The in-hospital use of the tool in place of domestic use was an important aspect, as the patient had in-person support and reinforcement for preoperative education from the professionals.

Connectivity. The use of a platform with technical specifications that allowed low connectivity demand to access the multimedia animations was crucial to eliminate the problem of limited internet connection.

Device. The acquisition of one electronic device maintained under the possession of the surgical department for exclusive use was also valuable and did not add relevant cost to the study.

Standardization. The centralization of the creation process and development of the content facilitated the standardization of the content offered in a way that avoided a high volume of sources and the resulting misinformation.

Platform. The creation of the platform with a linguistically and culturally appropriate approach was very important for patients to identify with the tool, thereby enhancing engagement.

The use of spoken animations as guides was also an important choice proposed by this study to improve the multimedia platforms used previously in the literature and address issues aforementioned about the use of digital tool in health. This may have been a relevant contributor to higher acceptability rates and should be considered separately in this intervention. An online experiment showed that spoken animations were the best way to communicate complex health information to people with low literacy, (36) and evidence that best teaching practices revolve around multiple cognitive and sensorial stimuli is extensive. The use of audiovisual tools to enhance learning is a significant and widespread instrument that can feasibly be applied in healthcare. It facilitates overall comprehension, which grants it a place in any health education program, even if there is no distinguished literature evidence of improvement in a specific health outcome indicator.

Following the development of the online platform with adequate education content to address problematic aspects foreseen in the literature about the use of digital interventions in healthcare, this research created a feasibility study for the application of this tool in a low resource setting. The results of the feasibility analysis from this study identified an acceptability rate of 76.5% for the tool applied. This rate does constitute a strong indication

of the feasibility of this intervention, as it was defined by this methodology to be an acceptability rate above 50%. A review on adherence rates to medications identified a completion rate of 43% – 78% for clinical trials. (65) Therefore, this educational intervention has an acceptability rate comparable to those found in traditional clinical trials, which serves to ratify the feasibility of this tool. Furthermore, this same study identified evidence that adherence rates to medication of 80% can be considered adequate. (65) Thus, the rate of acceptability to this educational tool is comparable to traditional pharmaceutical prescription, which is a highly disseminated and popularized medical intervention. An acceptable inference is that this digital tool – if implemented as a medical prescription – could present acceptability rates akin to those seen for any other traditional medical recommendation. Since it then becomes reasonable to expect patients to accept the use of this tool, this comparison serves to confirm its feasibility and helps to support its implementation in low resource contexts.

It is noteworthy, however, that despite the fact that this study observed a high acceptability rate of this tool in the hospital setting, no home access was identified. This may indicate either a problem in the application of the tool or a general lack of interest in post-operative postoperative phases. The implementation phase of the study took place in a single moment and there were no reminders for patients that the videos were available in the postoperative stages. Therefore, patients did not have a follow-up phase that offered an assessment window of the feasibility of this tool's postoperative home access potential.

This research identified some differences in the demographic characteristics of the patients between the two surgeries, but which drew parallels to what is expected as an epidemiological pattern for both diseases. The observed difference in gender ratios and age correspond to the expectation that cholecystitis is more frequent in women and in higher age groups when compared to appendicitis. However, this research found relevant differences in the participants' demographic characteristics that may have had an effect in their acceptability. It is important to note that no statistical significance was identified with this demographic data most likely due to the sample size and study power. Nonetheless, some admissible hypothesis may be scrutinized and could serve to explain findings from the data herein presented. Indeed, a randomized trial assessing the use of a multimedia tool in the consent process for elective surgical patients identified that race, education and age were

independent predictors of patient comprehension. (66) Some possible explanations for them call for further examination.

This study showed that patients with higher educational levels tended to have a lower acceptability of the educational intervention, whereas patient with the lowest levels as a whole completed the study. The totality of participants in this research with an educational level lower than a high school degree completed this study, while participants with a high school degree had an acceptability rate of 80% and that rate was only 54.5% for those with secondary level education. A possible rationale for this finding is that those with lower educational levels feel they have more to benefit from preoperative guides. In contrast, those with higher educational levels may assume possession of more knowledge, more autonomy to reach additional information and less overall interest. Studies have shown that patients with lower educational levels may gain most when multimedia tools are used for preoperative education. (48–51) Contrarily, a study on the consent process for sinus surgeries identified education level as an important factor in preoperative patients' wishes to know in greater detail all possible risks associated with the surgery. (67) Regardless of which direction the results pointed to, there seems to be a consensus in most studies that the patients' educational levels, and the resulting health literacy levels are crucial aspects to consider when implementing an educational intervention for patients.

Age and gender were also identified as varying factors in the groups of acceptability in this study. A small age difference of approximately nine years between patients who completed the intervention and those who did not was identified, which may indicate that younger people accept educational tools with superior ease. Indeed, studies have demonstrated that younger patients may have greater information needs. (46,67) Likewise, women had an acceptability rate of 85% and were more likely to complete the entirety of this tool, while men had 64.3% acceptability rates. One randomized study identified that age was an independent predictor of better comprehension with the use of a multimedia consent approach, while gender was not predictive of improved understanding. It is plausible indeed that the generational gap may impact the acceptability of a multimedia tool as an educational method for patients. This effect may be diluted as time passes, and the digital era dominates the way of life for all age groups. Contrarily, no studies were identified showing a gender effect on

the acceptability of a tool, which may point to a random finding in this study that could be curtailed had there been a greater sample size.

A total of 12 comments were received from participants, representing 46% those who completed the study. It is noteworthy that, with the exception of two comments – one of which was made by the first participant enrolled in the study – all other comments were positive. Most reviews described a tool that provided accessible and engaging information which resulted in improved satisfaction. Positive comments from viewers represent direct indications of the acceptability of the tool, although they do not provide quantitative data. As qualitative evidentiary datasets, these comments provide a clear picture of patients' impressions after watching the guides and matches quantitative data findings regarding the acceptability of this tool.

Although it is common that the implementation of new protocols in healthcare is initially met with a certain degree of skepticism, the introduction of the tool in this study was received with high rates of acceptability by the professionals and the department administration. There was great interest by the part of the staff to implement this tool and create sustainable programs for long-term use of technologies in the emergency department. No issues were mentioned by the professionals involved in the study and there were no obstacles to introduce this tool into the local protocols and daily routines.

Considering the analysis from the data collected in this study and the review of evidences in the literature, it is possible to conclude that it is feasible to conduct digital health interventions in LMICs. The WHO proposes three components for a digital health implementation: health content, digital health intervention and digital applications. (7) This approach attempts to direct the attention of those intent on developing such tools to important elements to achieve effective implementation. The WHO's mechanisms through which it has supported efforts in digital has been summarized in four categories: data collection, data standards, partnerships and local policy-making. (40) However, no precise global mechanisms are established to support the development of patient education programs in digital health, as these roles attempt to address a broader aspect of digital solutions in health (electronic health records, telemedicine, etc.).

This study produced a literature review that demonstrated a need for the advancement of innovative digital interventions for patient education in low resource settings. Through this research results analysis, some clear methodological elements in the development of a new platform to address this issue in LMICs were observed. As a result, this study constructed a protocol proposal to provide future educational interventions with a straightforward framework to achieve feasibility and sustainability with more specific actions to be adopted. An 8-step procedure is outlined as a protocol for the development of feasible online patient education interventions in LMICs:

1. Establishment of the content demanded based on health needs
2. Definition of the target population (age, gender and socioeconomic status)
3. Development of content with partnerships, considering a Patient Education Triad:
    I. Evidence-based medical information
    II. Didactically engaging multimedia product
    III. Locally appropriate content (linguistically and culturally)
4. Creation of a user-friendly online platform
5. Implementation of intervention tool
6. Generation of assessment tools for results analysis
7. Collection of feedback and suggestions
8. Elaboration of long-term sustainability project to maintain usage of platform

This 8-Steps Protocol approach proposed by this study may contribute with a focused compass to be followed for successful employment of digital resources to educate patients. Following a steps-based approach to establish an innovative educational tool for patients in low-resource scenarios may result in higher acceptability rates and, therefore, successful long-term interventions. Appendix 8 includes a graphic representation of these steps.

The implementation of a free, web-based, multimedia platform to deliver patient education has great sustainability prospects since it depends on very little local resources to be maintained. As the demand and desire for new educational tools grows, the development of innovative digital health technologies may be done in a centralized fashion, which may incur in an initial expenditure, but results in a globally available tool with low maintenance cost. The maintenance of a digital platform and can be done in a centralized way – i.e. in a national level, for example – which requires less long-term economic expenditure. Thus, a unification

of digital platforms potentially lowers costs, since all institutions in any given country may access it and may even share global sustainability efforts. This model can guarantee long-term economic sustainability for local institutions.

The WHO suggests that digital health interventions should be developed while considering some fundamental aspects: accessibility, scalability, replicability and interoperability with data security, privacy and confidentiality in mind. (29) Additionally, the generation and constant analysis of evaluation tools must be emphasized as digital health interventions grow to global levels. (68) These elements should be pillars of prospective educational programs, and efforts to addressed them were backbones of the digital platform created as a result of this research. However, in the world today, policy environments, business models and funding schemes for digital health have incited the generation of many projects without considering their scalability, replicability or monitoring and evaluation methods. (40)

Although international institutions have indeed diverted efforts to coordinate digital health interventions, proper evaluation on the impact of digital health on patient care and outcomes has been difficult. (69) There seems to be a lack of robust empirical evidence supporting the value of digital health interventions in terms of cost-effectiveness and performance. (30) Some positive financial consequences to healthcare systems may be observed from a successful implementation of this tool, such as the reduction of healthcare costs with analgesia and a decrease in hospital visits. Additionally, patients may see a reduction of the burden of travel to healthcare institutions and easier, more positive return to work activities. (7) Lastly, adequate preoperative informational sessions have been shown to be more effective when they last longer. (66) By offering digital tools for patient education, it may be possible to reduce the time spent by healthcare professionals during preoperative sessions, thereby reducing workload and increasing work efficiency. (48) However, future studies should explore this matter to determine strong evidences that may support these possibilities.

This study presented limitations that should be explored here. The main limitation of the study design was its limited sample size, which restricted its power. This choice was established during the methodology phase as a study design decision, since the objective of this study was to assess the feasibility of introducing a specific tool in a unique scenario. With this design, the research was able to determine the acceptability of this tool, identifying

particularities to the context and drawing conclusions about the entire creation and implementation process. However, as a consequence to the design, the study was not able to demonstrate statistical significance with inferences tests to corroborate the possibility that certain demographic factors influenced the acceptability rate. This lack of significance due to the small sample size does not exclude the clear discrepancies identified between the groups of acceptability, but it hinders any conclusion in as to predictors of feasibility.

Furthermore, this study was not designed as a randomized, controlled trial; that in itself may have produced research biases, which was reduced by the fact that all patients who underwent those surgeries during the intervention period were willing to be enrolled in the study. Other limitations of this study were restrictive budget for the implementation of the project, as no institution funded this research. Additionally, there was a lack of human resources or infrastructure dedicated exclusively to this study, which limited its capabilities to expand interventions, and may have affected the patients' home access of the platform, for instance.

An unexpected setback observed in the results of this research was the absence of any home access from the patients. This study did not offer the patients with follow-ups or reminders of for postoperative access availability. Additionally, there may have been a lack of clarity about the home access from the part of the professionals administering the intervention. The patients did not receive explicit information about home access at the moment of the intervention, except for the information displayed on the platform itself. These factors may have contributed to the absence of visualizations at home by the patients. Nonetheless, another understanding that may arise from this finding is the possibility that this might reflect an overall indifference for health education after the preoperative anxiety is dissipated. Contrary to this theory is the observation that there were absolutely no home views, and it is unlikely that there was zero interest for the videos at home. A lack of adequate information about that availability is more reasonable to assume.

CONCLUSION

This study aimed to assess the application of a tool to overcome the existing gap in the communication between healthcare professionals and patients by creating multimedia

animations as preoperative patient guides. With these multimedia guides, patients can better understand their medical condition, participate in the decision-making process together with the medical professionals and expand their knowledge base about what to expect from their surgical procedure. This study demonstrated the feasibility to introduce an innovative tool for patient education in low resource contexts.

Presently, new web-based platforms can readily be available universally and offer the possibility to standardize content and eliminate misinformation, while providing locally appropriate content through global collaborations. LMICs may benefit the most with online multimedia interventions for healthcare due to its higher rates of inadequate patient education and lower availability of resources. Potential improvement of surgical outcomes should be studied in future research projects to establish the clinical benefits of such interventions.

This study is a product of the perception of neglected challenges in the surgical field and of the intention to create innovative and sustainable solutions applicable universally. The aim has been to improve healthcare in LMICs by recognizing the possibility of introducing these multimedia guides in low resource contexts, while generating a path to disseminate this tool in a global level. This research addresses the issue of inadequate preoperative patient education in LMICs, where patients lack basic knowledge of their conditions and the medical decisions being made for them.

The implementation of this proposed tool is feasible and may present patients with easier access to appropriate and engaging information for their comprehension in order to allow better surgical preparation and recovery. This tool can be offered online and free of access, allowing it to be sustainable for a more extended period while creating the foundations for a modern patient education culture. By offering technologies to educate patients, populations from anywhere in the world can be empowered to improve health individually and collectively.

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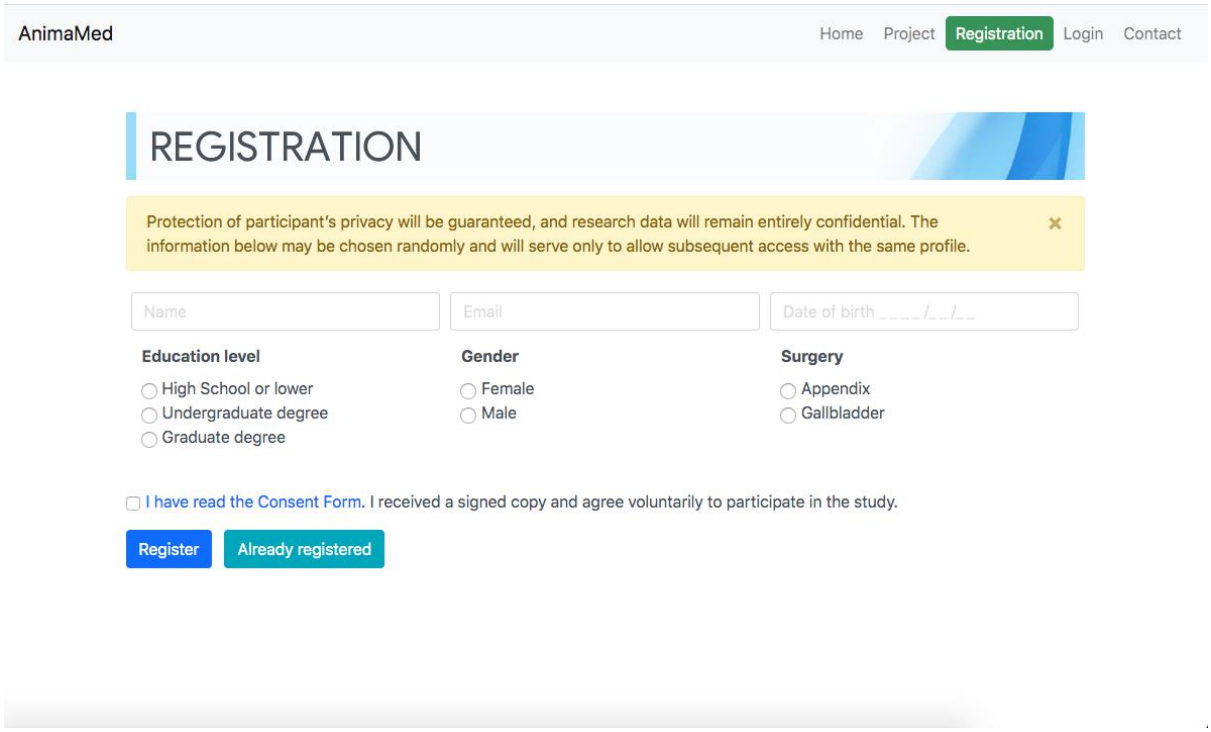
APPENDIX

Appendix 1: Images of the online platform



Appendix 2: Suggested introduction to patients

1) DIALOGUE

Hi, my name is _____. At our hospital, we are currently doing a study about preoperative online animation guides. If you choose to participate, this study will not affect your treatment in any way, and you can do it on your own cell phone. If you agree to participate, I will give you a small orientation and you can start the process. After this, you can also contact me again at any time.

2) PRINTED ORIENTATION

HELLO! WELCOME TO YOUR SURGERY ORIENTATION!!

THIS IS A STUDY INTENDED TO START A PREOPERATIVE ORIENTATION PROTOCOL FOR PATIENTS. PLEASE ACCESS THIS WEBSITE TO BEGIN YOUR ORIENTATION:

_____

BEGIN WITH YOUR REGISTRATION. YOUR PERSONALIZED ANIMATION GUIDE WILL THEN APPEAR AND YOU CAN START TO WATCH IT. THE ORIENTATION IS DIVIDED INTO 4 PARTS. PLEASE VIEW ALL OF THE PARTS AND ANSWER A FEW QUESTIONS AFTERWARDS. THE TOTAL PREDICTED TIME FOR THIS STUDY IS 10 MINUTES TO WATCH ALL OF THE ANIMATED ORIENTATIONS AND 5 MINUTES TO ANSWER THE QUESTIONS.

AFTER THE PROCEDURE, AT ANY TIME DURING YOUR STAY AT THE HOSPITAL OR AT HOME, YOU CAN VIEW THE ANIMATIONS AGAIN. YOU CAN LOGIN AT ANY MOMENT TO REVIEW ANIMATIONS USING THE USERNAME YOU CHOSE.

ALL OF THE INFORMATION YOU PROVIDE IS CONFIDENTIAL AND WILL NOT BE USED OUTSIDE THIS STUDY.

IF YOU HAVE ANY DOUBTS, COMPLAINTS OR SUGGESTIONS, PLEASE FEEL FREE TO CONTACT THE MAIN RESEARCHER BY EMAIL:
schnitman.gabriel@gmail.com.

Appendix 3: Flow chart of application protocol

1) INTRODUCTION

Initial view of the website shows the title of the study and the following description:

"This study aims to assess the application of animation guides for preoperative patients. The purpose is to improve communication tools for patients by creating multimedia guides that intend to focus on educating patients on preoperative information, offering an overview of the treatment, surgical procedure and expected postoperative details."

2) REGISTRATION

Participants follow to a registration page that displays the following:

LOGIN: ____(create a username)____ EMAIL:

_____

GENDER: ( ) male ( ) female DATE OF BIRTH:

_____(DD/MM/YY)_____

EDUCATIONAL LEVEL: ( ) Primary ( ) Secondary ( ) Undergraduate ( ) Graduate

MY SURGERY WILL BE FOR: ( ) Appendix ( ) Gallbladder

3) CONSENT

Below the registration, participants find the consent form and must read and agree in order to have access to the next page, shown as follows:

( ) I have read the PARTICIPANT CONSENT FORM and agree to the terms.

4) ANIMATION

After registration, participants have full access to the animations, as shown below:

( ) WATCH VIDEO

5) QUESTIONNAIRE

After the animation has been fully visualized, participants are asked the following:

ANSWER 5 QUESTIONS (shown in Appendix 5)

LEAVE COMMENTS: _____

Appendix 4: Patient consent form

Researcher: Gabriel Schnitman
MSc Experimental Surgery, McGill University
Telephone: +1 (438) 522-6625
Email: schnitman.gabriel@gmail.com

Supervisor: Dan Deckelbaum
Department of Experimental Surgery, McGill University
Telephone: +1 (514) 934-1934 ext: 45933
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Project Title: Feasibility of the application of multimedia animations as preoperative guides for urgent abdominal surgeries in public hospitals in Brazil.

Purpose of the Study: This is an invitation to participate in a research study that aims to assess the application of animation guides for patients. The purpose is to improve communication tools for patients by creating multimedia guides. Utilizing updated medical literature, these animations intend to focus on educating patients on preoperative information, offering an overview of the treatment, surgical procedure and expected postoperative details.

Study Procedures: You will be contacted by a member of the surgical team and be advised to begin the preoperative guide. You will then register for login, give basic information, and follow instructions to watch the animation. The video will be universally available without user-fees, accessed via the web. After the video, you will be advised to answer a questionnaire to assess the application of this tool.

Voluntary Participation: Your participation in this study is voluntary, and you may refuse to participate, may decline to answer any question, and may withdraw from the study at any time, for any reason. If you choose not to participate or to withdraw, that option will not result in any loss of benefit to which you are otherwise entitled, and all available information you had offered will be erased.

Potential Risks: There are no anticipated risks to you by entering in this research.

Potential Benefits: Participating in the study might not benefit you, but we hope to learn how to create animation guides that allow patients to better understand their medical condition and participate in the decision-making process by facilitating comprehension with better information distribution and availability.

Confidentiality: No personal identifying information will be collected, and you will remain completely anonymous. None of the information you provide will be linked to your hospital history. The username used to access the platform is randomly chosen by you. Stating your gender, age of education level will not be linked to your personal data. The answers to the survey will not be linked to your hospital file. All data will be collected in a password-protected digital database. Patient information will remain confidential and access to the database will be reserved for the main researcher.

Questions: In case of any questions or comments related to the study, please contact the main researcher as above listed.

If you have any ethical concerns or complaints about your participation in this study and you want to speak with someone not on the research team, please contact the McGill Ethics Manager at + 1 514-398-6831 or lynda.mcneil@mcgill.ca.

A copy of this consent form is available for you. Please save or print a copy of this document to keep for your own reference.

Please click "Accept" below if you have read the above information and consent to participate in this study. Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities.

Fist Version, March 16, 2019

Appendix 5: Post-animation questionnaire

1. DID YOU UNDERSTAND THE INFORMATION ABOUT YOUR PROCEDURE?

   ( ) YES ( ) NO

2. DID YOU WATCH THE ANIMATIONS?

   ( ) YES ( ) NO

3. IF NO, WHAT WAS THE REASON?

   ( ) SCREEN SIZE
   ( ) DIFFICULT INTERNET ACCESS
   ( ) LACK. OF TIME
   ( ) LACK OF INTEREST
   ( ) LENGTH OF VIDEO
   ( ) OTHER: _____

4. DID YOU LIKE THE ANIMATIONS?

   ( ) YES ( ) NO

5. IF NO, WHAT WAS THE REASON?

   ( ) IT MADE ME SCARED OR NERVOUS
   ( ) THE ANIMATIONS WERE BORING
   ( ) THE ANIMATIONS WERE TOO DIFFICULT TO UNDERSTAND
   ( ) I WAS ANXIOUS WITH THE PROCEDURE
   ( ) THE ANIMATIONS WERE TOO LONG
   ( ) OTHER: _____

LEAVE YOUR COMMENTS HERE: _____

Appendix 6: Animation manuscript

Joint script for both surgery animations

Dark gray highlight = exclusive for cholecystectomy

Light gray highlight = exclusive for appendicectomy

INTRODUCTION

Hello there! Our hospital team recently diagnosed you with a problem in your gall bladder. Our hospital team recently diagnosed you with a problem in your appendix. We are here to help your through this situation by providing you with some practical information to help you along your surgical procedure. It's completely normal to feel nervous right now, to have doubts and many questions. But together we'll explore how to prepare, what to expect and the best way to be involved in your recovery after your surgery.

All information presented here is recommended by a critical review of the medical literature and supported by your team of surgeons. Surgery guides like these have been shown to reduce fear, fatigue and pain while speeding up the recovery process. Planning for your procedure and going in as healthy as you can, will have a positive influence on your recovery.

PREOPERATIVE

Your surgery will start soon enough, with no rush. Until then, there are somethings that you have to do:

1. To have the operation you must have spent at least 8 hours without eating any food and 4-6 hours without drinking water. If your doctor hasn't allowed you to eat, you should follow that order until further notice. Sometimes if your surgery is only going to happen another day, the doctor can give you food, but remember to only eat when he tells you that you can.
2. Until your surgery, you are allowed to walk freely if you want and are able to without causing more pain.
3. You can take a shower or bathe your full body with soap but avoid washing your hair. Doing this will lower your risk of surgical site infection. Also ask for someone to help you remove your nail polish from your hands and feet.
4. Don't shave the area where you will be operated on. If needed, this will be done for you by the nurse or in the operating room.

5. Give all your jewelry and accessories to a family member. When it's close to your surgery, you will be asked to remove your clothes and put the hospital gown.
6. You are probably already receiving antibiotics and some medications to improve your pain and nausea. If you are still feeling anything, let the nurse know so she can help you feel better.

You can relax now and wait for them to call you to surgery. Let's continue with this guide to talk about your procedure.

INTRAOPERATIVE

To make you feel better, the best solution for your situation is to have surgery. When there is a problem with the gallbladder, the procedure to solve that is called cholecystectomy, which is just a technical word to say: removal of the gallbladder. When there is a problem with the appendix, the procedure to solve that is called appendicectomy, which is just a technical word to say: removal of the appendix. Don't worry because your body will not miss it!

This surgery is always done with general anesthesia. This surgery is usually done with general anesthesia. This way, you will be sleeping the whole time and feel no pain or remember anything after the anesthesiologist gives you all of the medications.

Most of the time, this procedure will be done using a video camera that goes inside your belly through a small cut in your belly button. The surgeon will also make 2 or 3 additional small cuts under your ribs in order to do the surgery. Sometimes it is necessary to do the surgery with a bigger cut under your ribs on the right side. The surgeon will also make 2 or 3 additional small cuts on the lower part of your belly. Sometimes it is necessary to do the surgery with a bigger cut in the middle of your belly or on the lower part of it. This is all done to ensure the safest and best quality treatment for you.

If the surgeon finds that there is an important infection in the area, it may be necessary to put in a drain. That means you will wake up with a piece of plastic coming out from one of the cuts. But don't worry because this is not bad for you and does not hurt! Th surgeon will remove it as soon as possible.

This surgery usually takes 1-3 hours but remember that the preparation also takes some time, so tell your relatives to stay calm because the surgeon will talk to them as soon as it's over.

Do you have any questions about the surgery?? You can still ask your doctors there. If not, then you are ready to hear about how it will be after surgery.

POSTOPERATIVE

When you wake up after surgery, you may feel cold, weak, tired, nauseated and experience pain in your belly or in your shoulder. If you are having pain or nausea, tell your nurse, who will help you get more comfortable and give you medication.

Your throat may feel sore from the tube used to help you breathe during surgery. Feeling stiff or achy is also normal at this time. These feelings will go away when you start to move around more.

After you are fully awake, if your surgeon has allowed it, you can drink something and when it's mealtime the hospital will also bring you food. But don't wait for all that to sit up or get out of bed. The sooner you move, the better your recovery. Just remember to ask for help the first time out of bed, since you may feel a little dizzy. This will pass after your body readjusts.

You will have bandages where the cuts are. Don't remove them before 24 hours. If they happen to fall out or get wet, exchange them for a similar bandage. After 2 days, you can leave the cuts without any protection. If they are not yet dry, you can use bandages to protect your clothes. You can then wash them normally in the bath. Just remember to leave them dry after the shower. If you see small tape strips over the cuts, you can just wait for them to fall off after a few showers. If you see stitches or clips, leave them there until a healthcare professional removes them after about 10 days. If you don't see any stitches there, then great! You don't have to worry about anything.

If you feel numb or sensitive around the area of the cuts, that's normal. You may also see some bruising on the skin and some swelling as well. This will all disappear with time.

If you have a drain, the nurse will empty it while you're at the hospital. Take that time to learn how you can do it at home. You don't have to be scared about it, just be careful not to pull it too hard.

AT HOME

After you leave the hospital, you will still have to take some time off to recover from the surgery. You will go back to feeling well after a few days, but it usually takes about a week for you to start feeling normal again. Take the time to catch up on some personal hobbies and rest!

It's normal to have some pain during the first weeks following surgery. You should have pain and nausea medications prescribed for home. You can take them for as long as the doctor prescribed. If you not feeling anything without them, you can stop taking them. Sometimes you may also need to take antibiotics at home. These have to follow strict schedule, so don't forget about them. You can also go back to taking your usual medications before the surgery, unless your doctor specifically told you not to.

If you have a drain, make sure you or a relative knows how to empty it and care for it at home. It is important to write down how much fluid is coming out of the drain each day and bring it to your follow up appointment.

Sometimes the cuts can get infected. If they appear red, painful or start to leak fluid, please contact a healthcare professional. You should also seek professional help if you feel severe pain in the belly or chest, fever (38.5^{o}C or above), shortness of breath or constant vomiting.

There are no special restrictions to your diet, but a balanced, varied diet is always a good way to go. If you were on a special diet before your surgery, such as for diabetes or high blood pressure, start back on it.

Sometimes it's normal to have constipation after surgery. To avoid that, remember to drink lots of fluid and eat fiber rich foods like fruits and vegetables.

It's best to avoid pressing or stretching your belly. That means you should not lift anything heavy for at least 2-3 weeks after surgery. For example, you should not carry babies or heavy boxes around.

You can drive when you feel comfortable sitting and alert enough to pay attention to the road.

You can also resume sexual activity normally as you feel gradually better.

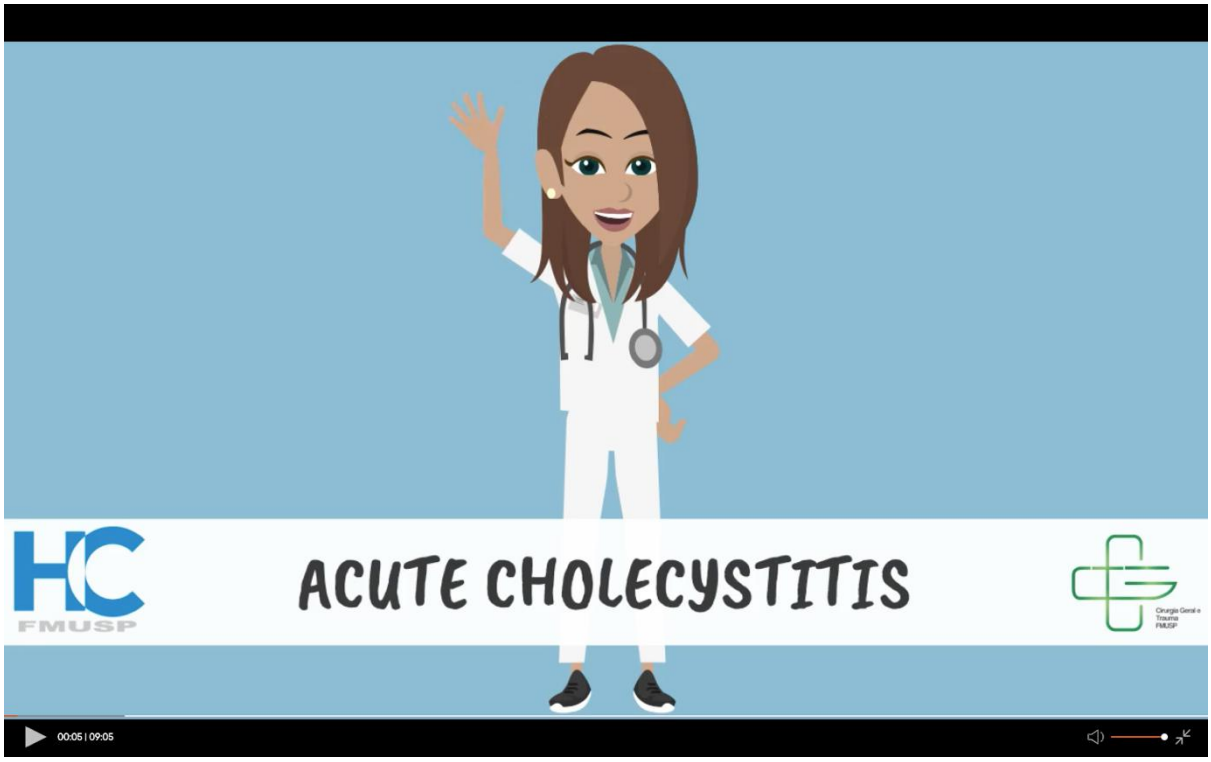
You can try to increase your activities everyday according the progress you feel. You can go for walks, go out with friends and celebrate with family.

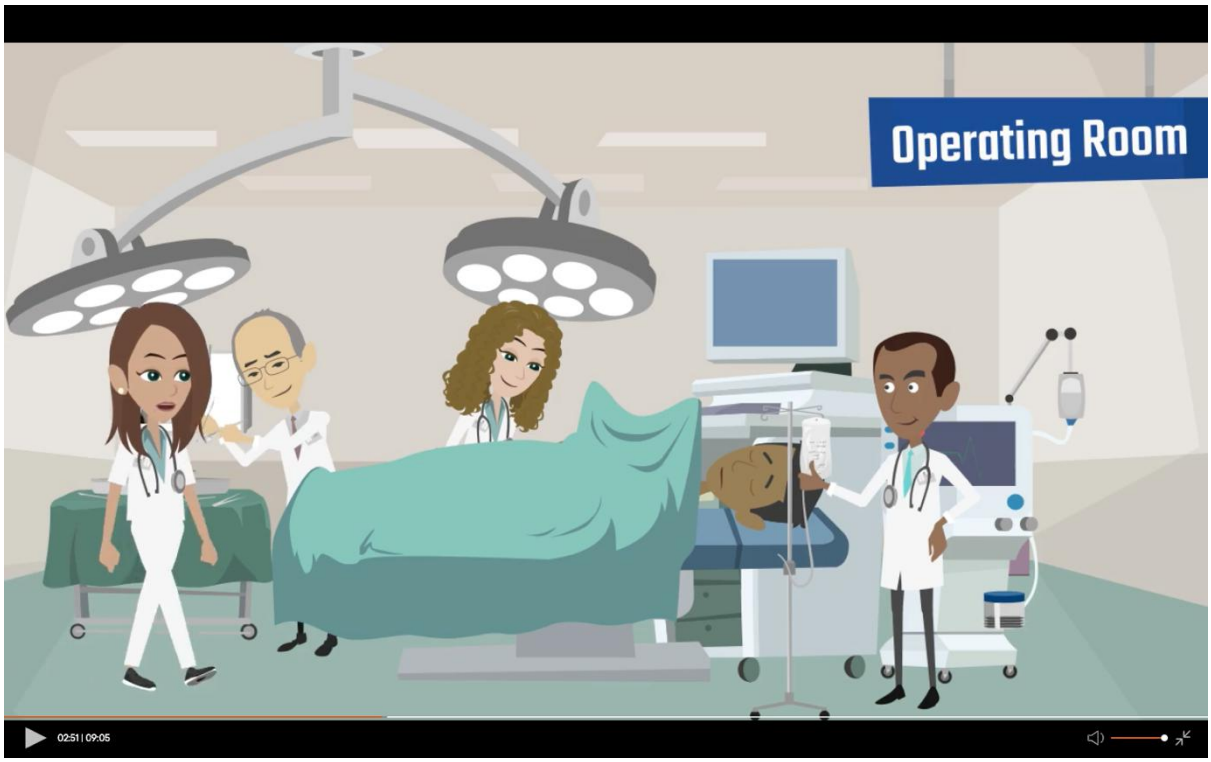
CONCLUSION

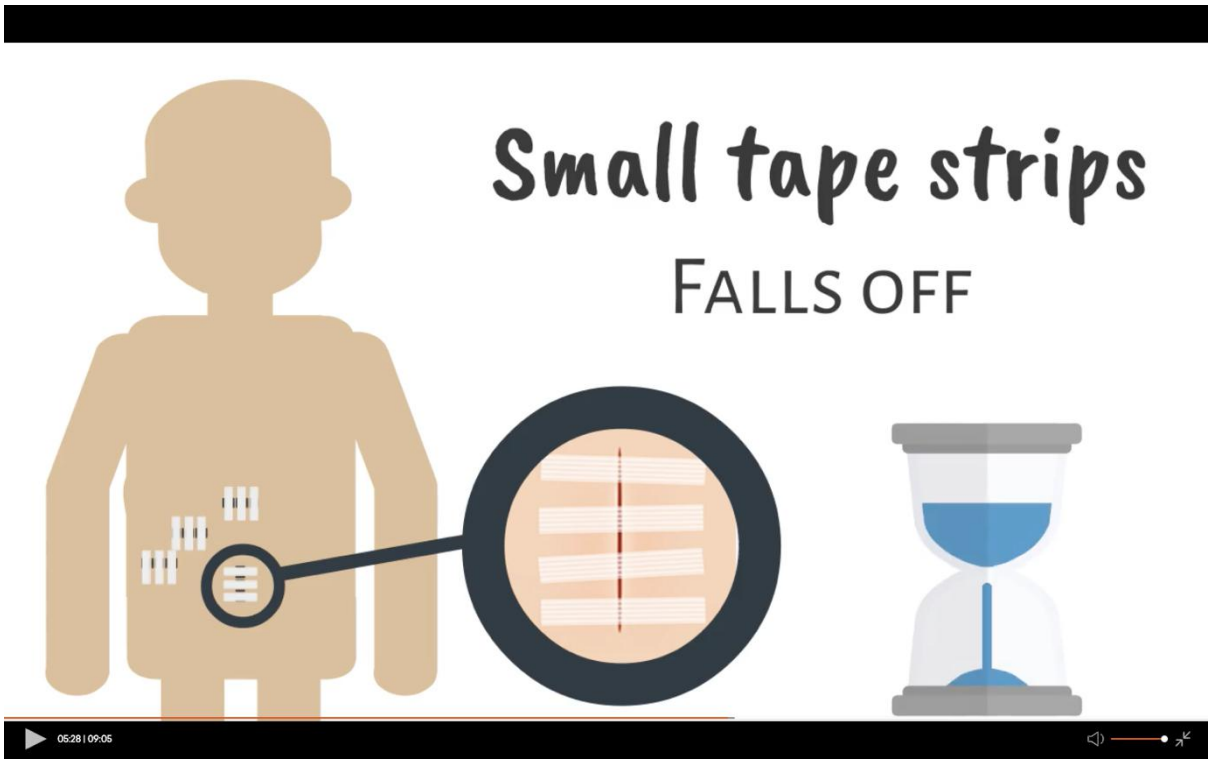
Remember to schedule a follow up appointment. Each day, you should feel some improvement but do ask your healthcare provider if you are worried about something.

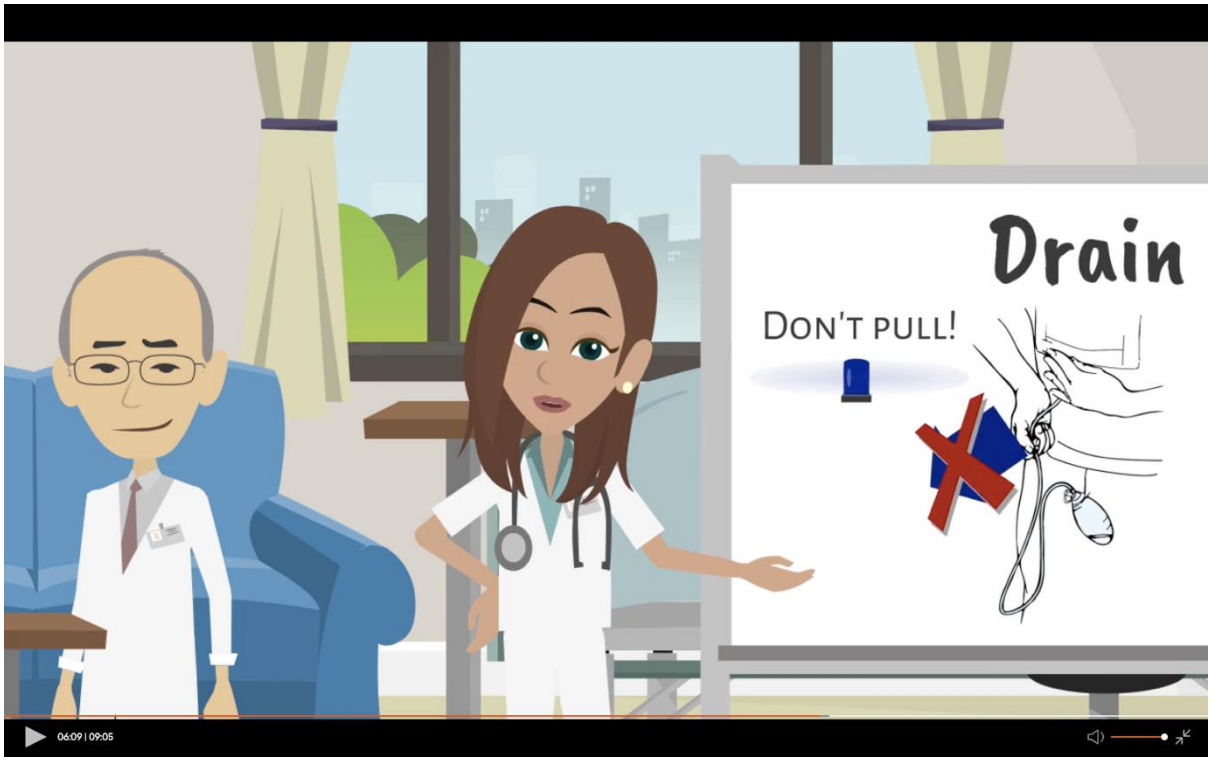
It is our hope that this video makes you feel more confident about what's ahead. We wish you the best on your journey.

Appendix 7: Still images of animations

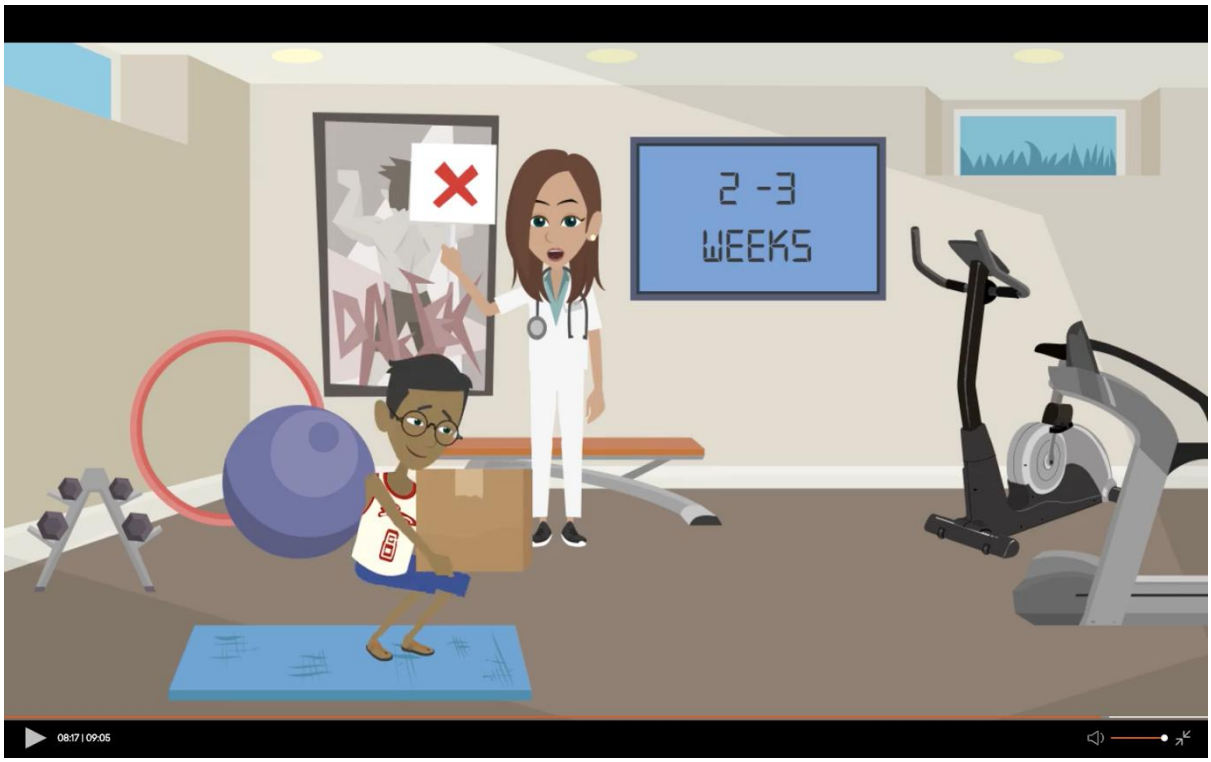



Operating Room
02:51 | 09:05


Small tape strips
FALLS OFF
05:28 | 09:05


Drain
DON'T PULL!
06:09 | 09:05


08:04 | 09:05


2 -3
WEEKS
08:17 | 09:05


HC
FMUSP
Cirurgia Geral e
Trauma
FMUSP
CENTRE FOR
GLOBAL SURGERY
09:03 | 09:05

Appendix 8: 8-Steps Protocol

8-STEPS PROTOCOL

Development of feasible patient education intervention in LMICs

1. Establish content based on health needs
2. Define target population, considering age, gender and socioeconomic status
3. Develop product with partnerships, considering a Patient Education Triad:
   I. Evidence-based medical information
   II. Didactically engaging multimedia product
   III. Locally appropriate content (linguistically and culturally)
4. Create a user-friendly online platform
5. Implement the intervention plan
6. Generate assessment mechanisms for results analysis
7. Collect feedback and suggestions
8. Elaborate of long-term sustainability project to maintain usage of platform