ORIGINAL ARTICLE

What are the objective key elements for successful deployment of telemedicine in hospitals: A holistic approach after 2 years of using a connected tracking solution

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ABSTRACT

Objective: The number of telemedicine solutions is growing, and studies are focusing on feasibility assessments. It is time to consider the fundamentals of deploying telemedicine solutions and provide recommendations for effective implementation.
Methods: A qualitative data collection through observation and interview was conducted at our tertiary academic hospital after 2 years of experience with a telemedicine solution. The data underwent semantic analysis, and hypotheses were compared with a literature review to provide recommendations for implementation. Between February 2021 and October 2022, patients' opinions were gathered through feedback questionnaires using the institutional mHealth application, a key component of the deployed telemedicine solution. Satisfaction results guided conclusions and reevaluations.
Results: During April 2021, 14 interviews were conducted with 7 medical department chairs, 2 head nurses and 5 administrative leaders. Between February 2021 and October 2022, a total of 760 surgical patients used the mobile application CHUV@home and 478 (62.9%) answered the feedback questionnaire. During this period, 1,226 surgical patients were included, and 760 used the mobile application, generating 1,693 alerts with an average resolution time of 130 minutes per alert. Feedback questionnaires were answered by 478 (62.9%) patients, with global satisfaction. Patients and healthcare workers opinions were aligned to foster a design of telemedicine experience. Results were presented in the form of a risk matrix. Five major risks and their mitigation recommendations were highlighted.
Conclusions: With the growing number of telemedicine solutions, many studies focus on feasibility assessment. The present study suggests that a holistic approach, engaging healthcare workers and patients, is essential for developing a meaningful and sustainable telemedicine strategy at a broader systemic level.

Key Words: Telemedicine, mHealth, Implementation of telemedicine solutions, Holistic approach

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1. INTRODUCTION

After more than 2 decades of telemedicine, and the emergence of the first medical app in 2010,[1] the supply of connected health-related solutions has increased dramatically. Recently, out of 165,000 "medical" apps available, only 2% had the function of connecting consumers to healthcare providers.[2] Digital tools are increasingly recognized as a solution to prevent and detect complications after hospital discharge, thus contributing to the reduction of hospital stays and potentially avoidable readmissions.[3] However, telemedicine faces major challenges related to various aspects, including care organization, patient management approaches, task distribution between physicians and caregivers, interactions between stakeholders, knowledge, and the professional identity of each.[4]

So far, most published studies on telemedicine have focused on feasibility, with a limited number of patients.[5–7] These evolving practices have had several impacts, such as a temporo-spatial redefinition of the care relationship, the emergence of patient accountability, and the identification of new legal responsibilities. Considered a new actor in healthcare provider-patient relationship, telemedicine must be effectively understood and mastered by all stakeholders, including healthcare professionals, hospital administrators, and patients.

Growing reliance on telemedicine, along with its associated challenges and transformations in care delivery, aligns with a broader trend of increasing patient engagement and empowerment. This shift is reshaping traditional care models and emphasizing the need for effective interaction and digital integration.[8] Thus, seamless patient communication and engagement are key drivers of success.[9] Tools like mHealth applications[10] play a significant role by opening new channels of communication.[11] However, even though today's patients are digital natives, and connected follow-up strategies appear feasible,[12] additional factors are needed to ensure an efficient and effective strategy at the institutional level. Large-scale and long-term implementation requires the integration of fragmented knowledge to develop recommendations for sustainable telemedicine solutions. Nowadays, the literature primarily focuses on the technical aspects of mHealth solutions with short-term goals.[13] In this context, the present study aimed to identify key factors for successful and sustainable implementation of telemedicine in hospitals using stakeholder questionnaires, a literature review, and over two years of experience with telemedicine through an mHealth application. While theoretical frameworks exist to support change, such as Kotter's 8-step model, this work focuses on the practical and essential elements that can be applied in implementing such frameworks.[14]

2. METHODS

2.1 Telemedicine solution

The connected mobile tracking solution CHUV@home was deployed between February 2021 and August 2022 at our tertiary academic medical center. Adult patients after elective surgery who agreed, were eligible to use a connected tracking mHealth application. A further requirement was the possession of a smartphone, and patients who did not understand and read French were excluded. Surgical specialties included visceral surgery, orthopedic and traumatology, plastic and reconstructive surgery, urology, and thoracic surgery. Each surgical specialty created its own structured protocols, which allowed for an active search of specific post-surgical complications. Questionnaires were available on the patient's smartphone starting the day following hospital discharge for a duration of 7 or 14 days, depending on the protocol. All items were closed questions with predefined answers and recommendations. A built-in app messaging option was available for free text questions. Finally, at the end of the monitored period, the patient was notified about a satisfaction questionnaire available on their profile in the mHealth application.

In parallel with the deployment of the connected tracking mHealth application, a newly created center for telemedicine (CTM) ensured 24/7 availability. In the case of an adverse event, alerts were automatically generated by the patient's responses to the questionnaire. Alerts were recorded by the CTM, which followed a predefined algorithm based on the respective protocol. The resolution could involve reassuring the patient, arranging home help or organizing a visit to a specialized clinic or the emergency room. The communication channels used by the CTM were the mHealth application's internal messaging or direct phone call contact.

2.2 Ethnographic survey

An ethnographic survey is a social science method that studies people in their environment. It combines quantitative survey techniques, such as questionnaires and structured interviews, with ethnographic methods like participant observation. Both approaches were used in this study.

Research hypotheses were generated through an inductive qualitative survey conducted in April 2021 at our tertiary academic medical center. The questionnaire was designed along three lines: needs and expectations of the CHUV@home app, needs and expectations of the CTM, and identified risks. The outcomes were compared with the literature to provide recommendations for successful implementation of a strategy for a connected tracking solution. One interview was conducted with a nurse home care manager, and others were conducted with hospital caregivers and administrators.

Collected information went through semantic analysis using the QDA Miner Light software. The latter is a free qualitative data analysis (QDA) tool designed for coding, analyzing, and retrieving text data, commonly used for analyzing interview transcripts, open-ended survey responses, and other textual data. The risk matrix was obtained by exporting coded data from QDA Miner Lite to Excel® for Microsoft 365 MSO (Version 2408). Risks were categorized based on likelihood and impact, incorporating social insights common to all clinical services included in the study, with numerical values assigned to generate a visual representation of risk levels. The product was finally presented using a validated risk map,[15] with qualitative scales for both probability, ranging from 1 (rare) to 5 (almost certain) and impact, ranging from 1 (insignificant) to 5 (extreme).

2.3 Patient's feedback

Patients' opinions were gathered through feedback questionnaire from patients who used the institution's connected mHealth application CHUV@home. Patient satisfaction acted as a feedback loop, reinforcing conclusions or prompting reevaluation, based on insights from the ethnographic survey and literature review. Finally, recommendations were issued for successful and sustainable implementation.

3. Results

3.1 The ethnographic survey

During April 2021, 14 interviews were conducted. All the healthcare workers contacted agreed to the interview. Among them were seven medical department chairs, two chief nurses (including a home care manager), and five senior administrative leaders. The departments involved included visceral surgery, thoracic surgery, pediatrics, obstetrics, gynecology, medical oncology, and internal medicine. The administrative professionals included the hospital's chief executive officer, finance director, medical director, head of medical coding, medical controlling and health care record management, and the coordinator of architectural projects.

The interviews led to a risk matrix (see Figure 1). Three identified areas of risk were in the critical zone: The targeted patient population, the caregivers involved, and the perimeter of deployment. These risks were associated with patient safety, operational disruption, and jeopardizing the patient-care worker relationship. The mitigation strategy included preventive measures, continuous monitoring, and immediate action.

The center of telemedicine, as well as the mHealth application were in the moderate risk zone. These risks were associated with operational inefficiencies, minor financial loss, and temporary disruption. The mitigation strategy associated included regular monitoring and timely intervention to prevent escalation. No low-risk area was identified.

Probability	Impact				
	Insignificant	Minor	Moderate	Major	Extreme
Almost certain					Targeted population of patients
Likely				Caregivers	Perimeter
Possible		Center of telemedicine	mHealth App		
Unlikely					
Rare					

Figure 1. Risk Matrix

Red zone: Critical risk. High likelihood and severe impact, needing strong preventive measures and continuous monitoring; Yellow zone: Moderate risk. Moderate likelihood and/or impact, needing proactive controls and regular monitoring; Green zone: Low risk. Low likelihood and minimal impact, needing basic precaution and periodically control

3.2 Patients' experience

Between February 2021 and October 2022, 1,226 patients accepted the telemedicine strategy. Among them, 466 were included in the telemedicine solution but were awaiting surgery, meaning their follow-up using the mHealth application had not started during the study period. The remaining 760 patients underwent surgery and completed their daily questionnaires, resulting in a total of 7,980 days of follow-up. Fewer than 10 patients were included per month during the first 4 months of implementing telemedicine strategy, ending with more than 100 patients included per month during the last 4 months (see Figure 2). Throughout the entire period, 1,693 alerts were generated by patients responding to questionnaires, which required a response from the Center for telemedicine (CTM) (see Figure 3).

During the same period, 6,281 automated care recommendations were transmitted to patients. Recommendations included responses to alerts and preventive care advice, not linked to an alert but predefined in the care protocol. These addressed guidance or measures for patients to adopt in anticipation of potential concerns.

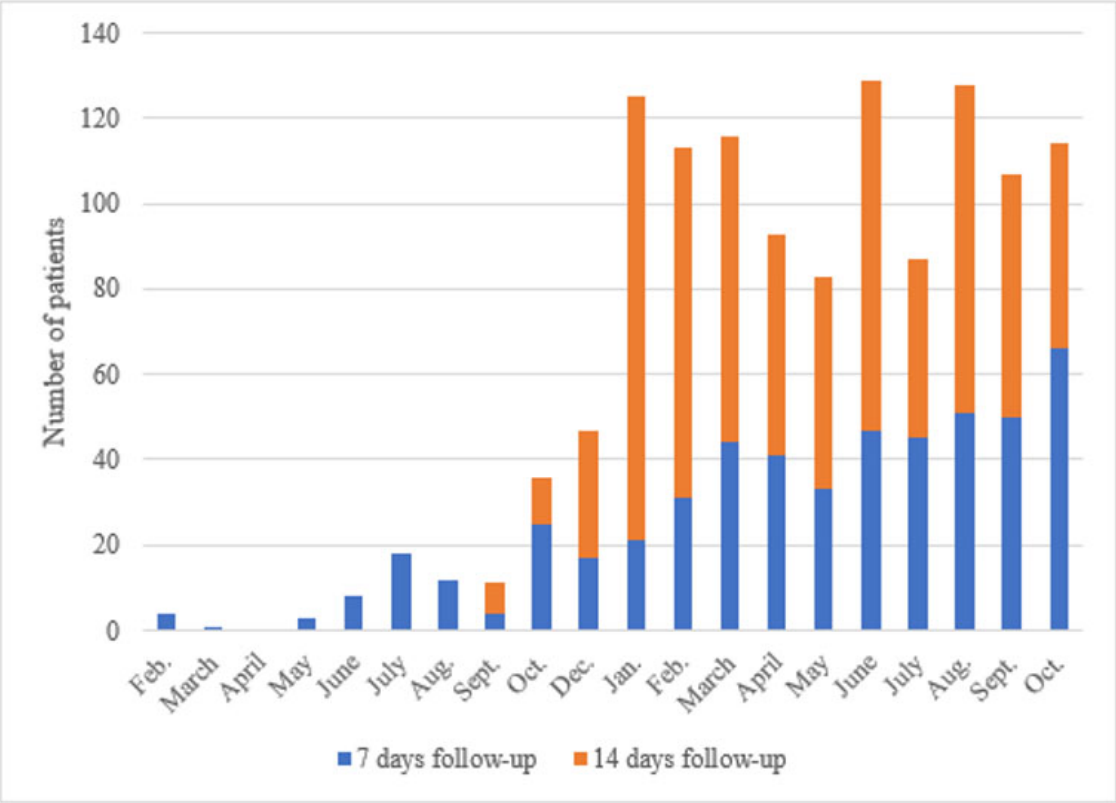

Figure 2. Patients follow up inclusions per month

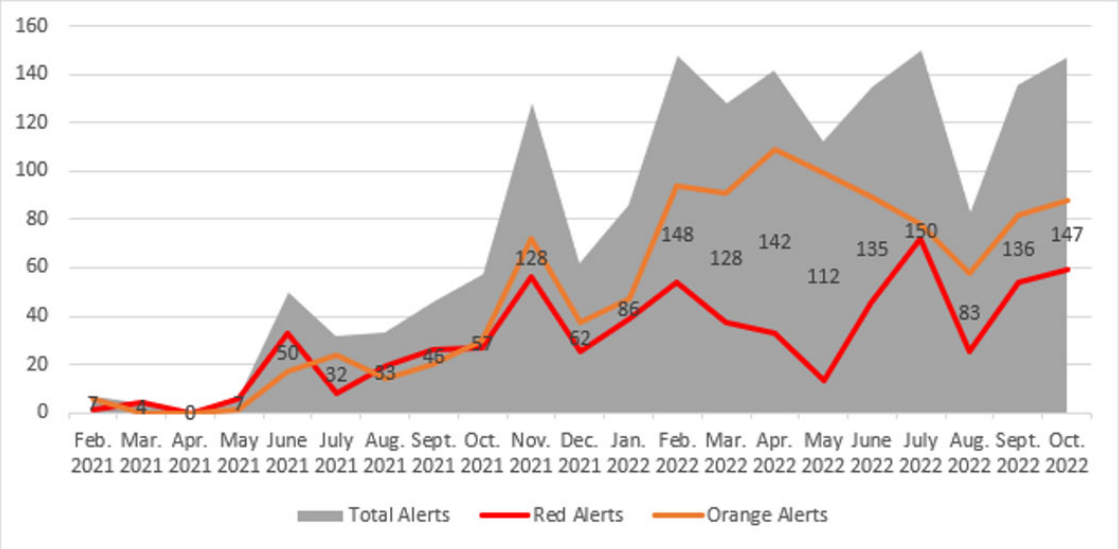

Figure 3. Alert rate by type

Red alerts are urgent and require a consultation of the alert by the center of telemedicine within 10 minutes of its creation by the patient who answered the questionnaire. Orange alerts are less urgent and require a consultation within 30 minutes of its creation

Among the 760 responding patients, 478 (62.9%) answered the satisfaction questionnaire. As shown in Figure 4, patients who used the telemedicine solution were highly satisfied (45%) or satisfied (37.2%), while 17.6% reported quite satisfied (14.0%) or low satisfaction (3.6%). Only one patient was not satisfied due to a technical problem.

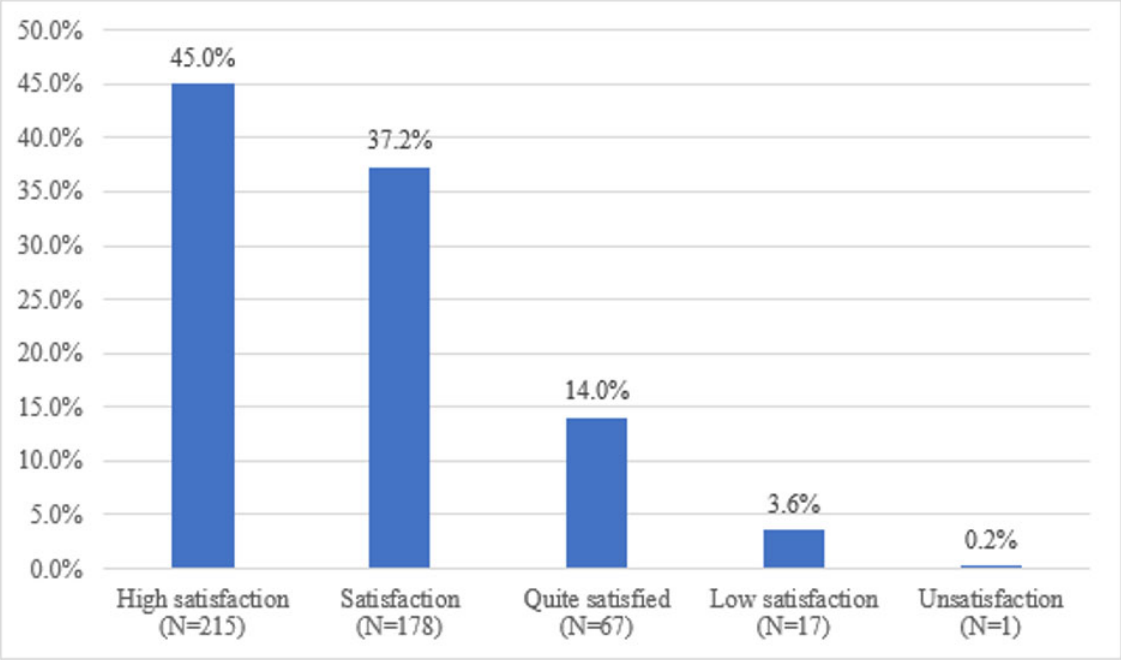

Figure 4. Patient satisfaction rate

4. DISCUSSION

Like many others, the Lausanne University Hospital's experience began with a feasibility-focused implementation of telemedicine, primarily addressing technical aspects.[12] While the mHealth application was deemed feasible, scaling beyond 50 patients and across multiple specialties required a strategic vision and solid implementation concepts based on a more in-depth analysis. Lessons from this pilot led us to choose a different solution, better integrated with our clinical and administrative processes, and capable of enabling rapid scale-up at the institutional level. This new approach allowed us to successfully deploy remote monitoring for more than 1,200 surgical patients during the first 21 months of its use. The present work provides valuable insights and a risk matrix to mitigate challenges for the large-scale and long-term implementation of a telemedicine solution, using one of the largest cohorts reported in telemedicine research to our knowledge, particularly concerning active telemonitoring participation.

While studies still mainly focus attention on technical-level issues like usability, system-level problems are less explored.[15] After more than two years of practicing telemedicine, and with the technical issues resolved, the shift in focus enabled us to delve into broader questions and explore the strategic directions for continued improvement. Also, while theoretical frameworks like Kottler's 8-step model exists to guide managers, this study highlights essential elements for applying such a framework.[14, 16–18]

The findings of the present study suggest that success and sustainability of such a solution must be based on the mitigation of five identified major risks (see Figure 1). As a result, the five recommendations are to define and comply with the chosen patients' population, define and state the usefulness in collaboration with the specific medical and nursing staff, set up a legal framework in advance, invest in the right information technology (IT) solution, and finally, obtain the support of the institution for efficient and effective change management. Rigorous application of these recommendations may enable positive experience for all stakeholders, and they are discussed hereafter.

4.1 Patients' population

Defining the targeted population prior to implementation allows for the identification of their specific needs based on clinical requirements. A patient-centered approach is therefore mandatory to achieve high compliance and positive experience for all parties.[19–21] In addition, alternative strategies must be defined for excluded patients, as they are often the most vulnerable, in order to avoid digital exclusion and over-reliance on automation and digital services.[22]

Initially working with willing care workers and clinical services, and selecting patients who would benefit the most based on the frequency and severity of potential adverse events, led to high satisfaction and response rate. In fact, response rates to satisfaction questionnaires in this study were 200% higher than usual online surveys and over 400% higher than usual in-app surveys.[23]

4.2 Caregivers

The overall strategy must make sense to the medical and nursing staff involved. Some added value can be obvious, like time savings, enhanced coordination, and improved safety. However, added value can also be hidden and must therefore be made explicit, like better patient outcomes or financial savings. To ensure caregiver support for the chosenmHealth application, clear goals and managerial support are essential. This includes managers engaging with mHealth application, understanding how it works, along with training for staff.

The CTM nurses played a role of care coordinators for the various specialties. To fulfill this nursing activity, the nurses need to be trained in a tailored knowledge-based model. For this reason, both telemedicine solutions and medical skills need to be acquired. According to the SECI (socialization, externalization, combination, internalization) model, a newly emerging knowledge must go through defined steps of "knowledge transformation."[24] Based on this model, the four learning processes are designed as follows: pre-use, creating an expectation (belief) about the technology; first use, where the expectation is compared to actual use; early use, creating an early experience and its use over time; and finally, routine use, corresponding to the cycle of adoption and learning. This process takes time and should therefore be started during the implementation and initial ramp-up period.[25]

4.3 Perimeter

Digital technologies offer a great flexibility in terms of timing and location, meaning that patients do not need to be at a precise time or location. Place and time have therefore become less important than before. However, studies have shown that appropriate balance between remote versus in person interactions must be carefully studied.[26,27] Therefore, selecting the appropriate departments and clinical specialties, such as those wellorganized and caring for low and medium-risk patients, can help maximize positive impact of telemedicine.[27]

Furthermore, all stakeholders in the mHealth ecosystem, including patients, health care professionals, providers, health care organizations, payers, and mHealth application vendors, must collaborate to overcome existing barriers.[1] The use of Information and Communication Technology (ICT) as well as telecare and assistive devices could improve the situation of family caregivers, in terms of organization and also in terms of costs for the society.[28] This broad impact is only possible if telemedicine deployment is carefully planned and takes place on a large scale. For this, senior management has to be not only involved, but also convinced about the usefulness and benefits of the deployed solution.

4.4 The information technology solution

The large number of available mHealth applications was a driving force in the development of the Mobile App Rating Scale (MARS), a tool for assessing health apps.[29] Choosing apps and e-tools tailored to the institutional needs is important. The necessary time to evaluate the available solutions should not be underestimated.[30] A successful technology must be oriented towards user acceptance. Thus, the Technology Acceptance Model (TAM) assesses individuals' behavioral intention to use a system: 1) perceived usefulness and 2) perceived ease of use.[31] People use a technology only if they perceive its usefulness and if the technology is user-friendly.[32] An acceptance model extension of the TAM is the "Unified Theory of Acceptance and Use of Technology" (UTAUT).[33] UTAUT explores two direct determinants of actual use: 1) the intention to use and 2) the facilitating conditions (material and/or human conditions that facilitate the use of the product). In addition to the direct determinants, UTAUT also examines moderating variables: previous experience with the system, whether use is voluntary or not, gender and age. A user will most often adopt a "lazy user behavior" to satisfy her /his information needs by choosing the solution that requires the least amount of effort.[34] These elements are part of the requirements to choose a specific solution and design the inclusion process.

The use of a mHealth application can be seen as empowerment of patients.[35] However, Mohlman and Basch[36] described that those who could benefit most from smartphones do not develop expertise in their use. Elderly patients for example, an important target population could have great benefits from a close follow-up using new technologies. Levine et al.[37] perceived however a discrepancy between reality and enthusiasm for technology as support for elderly. The chosen solution must therefore target this population with user-friendly strategy.[38]

4.5 Center of telemedicine

The introduction of a new mHealth application, in addition to existing tools, should not increase complexity without providing additional benefits. Indeed, existing solutions may be maintained to avoid creating care gaps for patients. In our experience, the development of a new center of telemedicine (CTM) was an essential investment made in parallel with existing resources, ensuring 24/7 availability.[12] This helped prevent overloading the existing staff. In fact, since January 2022, a mean rate of 126 (83-150) alerts has been generated each month, corresponding to 4 alerts per day. Red alerts were processed within 10 minutes of their creation by the patient while orange alerts, less urgent, were processed within 30 minutes, in line with the objective set. Persistent

pain after taking the prescribed painkillers and fever are two examples of red alerts. Absence of bowel movements or nausea is an example of orange alerts. While red alerts took on average 120 minutes to be solved, with the resolution being considered a therapeutic attitude communicated to the patient, orange alerts were solved on average in 140 minutes. This time includes the study of the patient's medical file, the coordination of care and the communication of the attitude to the patient.

This remote patient management, which involves interactions between medical staff, nursing staff, and patients, requires predefined clear legal framework with well-defined responsibilities. This also applies to the technology used.[39] These interactions, guided by pre-established protocols, therefore impose a strict framework that leaves little room for autonomy. The lack of autonomy and variety in the CTM's activities due to the obligation to follow protocols in a rigorous manner has a negative impact on the motivation of healthcare professionals. Increasing their involvement in the development of telemedicine solution reduces the negative impact of this lack of autonomy. It also helps to reduce the turnover of caregivers in the CTM and therefore optimizes training costs and increases patient satisfaction.[40] The CTM nurse activity is a new role with an expected high skill level.[41] The quality of the clinical assessment performed by the nurses will determine the quality of patient's management.[42,43]

Maintaining a good relationship and continuity of care between the hospital and the patient is a key element for the success of remote solutions.[44–46] Precisely following the pre-established medical decision-making protocols is an important task for CTM health care professionals.[47,48] In the situations not covered by protocols, specific communication between CTM and specialists must be established, clearly defining and framing the new responsibilities of the CTM and the physicians in charge.

Overall, the benefits for stakeholders are clear. First, patients are empowered in their own care and discharge are secured through improved communication and delivery of continuous information. Second, health care professionals maintain direct patient contact and communication in a context of increasingly short or ambulatory stays. This improves the coordination of care in necessary cases. Finally, hospital management offer their institution competitive advantages, increases the range of available services to the patient, with possible self-financing.[20] All these benefits are the result of a well-prepared implementation strategy. The points described in the risk matrix (see Figure 1) and the five proposed recommendations may contribute to the success of a telemedicine solution available immediately after hospital discharge.

5. Limitations

The actual performance of the connected mHealth application may be regarded as adequate, and a wide deployment may be recommended. However, alternative follow-up solutions must be available for excluded patients.[12,49] This is especially important, because there is a risk of widening inequities for patients without internet access or cell phones.[27] Moreover, even if the population of the present study is one of the largest ever published, generalization of these results is not possible everywhere.

Finally, to the best of our knowledge, the present study is the first to assess the social and organizational implications of remote solutions. The continuously increasing healthcare costs may be partially controlled by new approaches such as value-based healthcare (VBHC),[50] cost-effectiveness analysis (CEA),[51] and health technology assessment (HTA).[52] To promote future telemedicine development, the use of VBHC, CEA and HTA concepts will be necessary in future studies, as well as ethical assessment.[53]

6. Conclusions

This work shows that a holistic approach is necessary, involving healthcare workers as well as patients, to implement a sustainable telemedicine strategy. The matrix of risk proposed in this study is a true aid in preparing the ground for implementing a telemedicine strategy in the healthcare field. In order to be successful in setting up telehealth, the healthcare organization must define the target patients, set up a legal framework in advance, define the usefulness for the services in collaboration with the medical and nursing staff involved and have the support of the institution's management for an efficient and effective change management. Finally, our work contributes to establishing the first gold standard in telemonitoring reaction time.

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Authors contributions

VA, FA and EF contributed to the literature review and study design. VA and FA, collected the data. VA, FA, and EF analysed and interpreted the data. VA, FA, EF and ND wrote the manuscript. All authors performed critical revision and editing, and read and approved the final manuscript.

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CONFLICTS OF INTEREST DISCLOSURE
The authors declare they have no conflicts of interest.

INFORMED CONSENT
Informed consent is not applicable to this study. Indeed, this work has been granted an exemption from requiring ethics approval by our local Ethic Committee (CER-VD-Req-2022-01297).

ETHICAL STATEMENT
(a) The protocol of this work has been granted an exemption from requiring ethics approval by our local Ethics Committee (CER-VD-Req-2022-01297); (b) All methods were carried out in accordance with relevant guidelines and regulations (CER-VD-Req-2022-01297); (c) Informed consent is not applicable to this study. Indeed, this work has been granted an exemption from requiring ethics approval by our local Ethics Committee (CER-VD-Req-2022-01297).

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The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

DATA SHARING STATEMENT
No additional data are available.

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