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Perioperative telemonitoring of older adults with cancer: Can we connect them all?

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ABSTRACT

Objectives: Although the increasing cancer incidence in older patients is widely recognised, older patients remain underrepresented in clinical cancer trials and eHealth studies. The aim of this research is to identify technological and patient-related barriers to inclusion of this population in a clinical eHealth study.
Material and Methods: This is a retrospective analysis of a prospective cohort study with older patients (≥ 65 years) undergoing cancer-related surgery, who were identified for a perioperative telemonitoring study. Reasons for ineligibility and refusal had been prospectively registered. Characteristics and postoperative outcomes were compared between participants and non-participants.
Results: Between May 2018 and March 2020, 151 patients were assessed for eligibility, resulting in 65 participants and 86 non-participants. The main reason for ineligibility was lack of internet access at home ($n = 16$), while main reasons for refusal were perceived high mental burden ($n = 46$) and insufficient digital skills ($n = 12$). Compared with participants, non-participants were significantly older (mean age 75 vs. 73, $p = 0.01$); more often female (64% vs. 35%, $p = 0.00$), unmarried (42% vs. 8%, $p = 0.01$) living alone (38% vs. 19%, $p = 0.02$); had a higher ASA classification (43% vs. 19%, $p = 0.00$); often had polypharmacy (67% vs. 43%, $p = 0.00$); and were more often discharged to skilled nursing facilities (0% vs. 15%, $p = 0.00$).
Conclusion: Our results confirm the underrepresentation of older female patients with little support from a partner and higher comorbidity. We should be aware of technological and patient-related barriers to including older adults with cancer, in order to avoid further dividing patients with low and high digital health literacy.

1. Introduction

Older patients (over the age of 65) represent the majority of global cancer cases, with a predicted absolute number of 14 million worldwide by 2035 [1]. Surgery is a fundamental part of treatment in more than 80% of cancer cases, as well as for older patients [2]. Higher age alone does not necessarily increase the risk of adverse postoperative events, but the prevalence of age-associated comorbidities and frailty (age-related cumulative decline in multiple physiological systems) does increase this risk [3]. Frail older patients are three to four times more likely to develop postoperative complications compared with non-frail older patients [4,5]. Moreover, the occurrence of complications has a considerable impact on the quality of life and the survival of older patients [6]. Together with the fact that hospital admissions have been shortened due to changes in modern health care [7], this highlights the necessity of prevention and early detection of postoperative complications in this population.

New digital technologies (i.e., eHealth) are emerging rapidly in health care to promote patients' self-management and engagement and improve patient-centred cancer care [8]. The interest in remote care delivery by eHealth has increased even more during the current COVID-19 pandemic, as remote consultation decreases the risk of spreading the virus and could decrease the pressure on health care resources [9,10]. Additionally, eHealth is used to remotely monitor patients' postoperative recovery in surgical wards or at home after hospital discharge [11,12]. This so-called telemonitoring could contribute to timely detection of postoperative complications and therefore potentially decrease the impact of these complications in frail older patients with cancer [13].

Although the increasing incidence of cancer in older patients is widely recognised, these patients remain underrepresented in clinical cancer trials [14,15]. They are excluded from clinical cancer trials because of study

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restrictions, comorbidity, polypharmacy, or physicians' attitudes [16]. Older patients are also underrepresented in most perioperative eHealth intervention studies. This underrepresentation of older, and often frail, patients leads to a bias in research outcomes, non-generalisable results and inequality in healthcare provided [17]. This poses a real risk that eHealth interventions will remain geared towards a younger, more flexible population, and will result in the exclusion of the population likely to show the greatest benefit. Also, eHealth literacy is known to be lower among older adults with cancer compared with their younger counterparts [18]. The COVID-19 pandemic has further increased the need for new digital solutions in health care and clinical research [9,10]. It is thus of the utmost importance to identify barriers to participation in clinical eHealth trials among the older population. When these barriers are known, both clinical eHealth trials and eHealth applications may be adjusted so that they may benefit the entire oncological population, including frail older patients.

In a prospective cohort study with the aim of assessing feasibility of perioperative telemonitoring of older patients with cancer, we were able to include approximately half of the identified patients. To investigate possible technological and patient-related barriers to participation, we analysed reasons for ineligibility and refusal and differences in characteristics of non-participants and participants. To explore the impact of possible benefits a postoperative telemonitoring intervention could provide for our population, we additionally compared the postoperative outcomes between non-participants and participants.

2. Material and Methods

2.1. Study Design

This study is a retrospective analysis of a prospective cohort study with older patients undergoing cancer-related surgery, who were identified for a perioperative telemonitoring study (Netherlands trial registration number: NL 8253) [19]. The prospective telemonitoring study was conducted in a tertiary referral hospital in the north of the Netherlands and approved by the local medical ethical committee (registration number: 2017/286). In consultation with legal officers at our local medical ethical committee we obtained permission to collect additional routine data on care of all identified patients. The principal reason was to collect reasons why candidates did not participate, to identify potential modifiable factors to improve on this situation for future studies. Also, it was evaluated that obtaining additional consent was perceived too burdensome for patients and/or carers.

2.2. Setting and Patients

We had identified patients over the age of 65 with an indication for oncological resection of a solid malignant tumour. Patients had been approached at the hospital's outpatient clinic or by telephone in the period between May 2018 and March 2020, after they were identified for the study by a surgical nurse or surgeon from the treatment team. Patients were eligible if they had internet access at home. Exclusion criteria were severe auditory, visual and cognitive impairment that were expected to impair the ability to use digital technologies or hear/understand the explanation by telephone; being wheelchair- or bed-ridden; having contact dermatitis; insufficient understanding of Dutch; and emergency surgery.

Participants had been assessed at three moments in time: before surgery, before hospital discharge and at three months after surgery. Participants had used a mobile application connected to various electronic monitoring devices. Physical activity had been measured using an accelerometer-based wearable activity monitor (Fitbit Charge 2, Fitbit Inc., San Francisco, CA, USA) during the entire study period. For two weeks after hospital discharge, postoperative recovery had been monitored using the mobile application and additional devices to measure temperature, blood pressure, heart rate, pain, and the occurrence of other postoperative symptoms. Due to the observational character of the study, no intervention followed when a deviation had been detected in monitored data. Patients had only been contacted by telephone by the research physician if no data was transferred or if alarming parameters had been observed. Following the latter, the treating physician would have been contacted if there was a need for medical consultation.

We had implemented several strategies in our study design to minimise refusal, based on solutions presented in previous studies for approaching older patients [20]. First, we recognised the importance of adequate communication, especially with older patients. We preferred face-to-face contact to inform patients, offered clearly written study information and emphasized that the study case manager in charge was easily available by telephone for any questions during the study period. Second, we involved patients' family members in the recruitment process, as family members have a major influence on the decision to participate. The study information at the outpatient clinic was preferably provided with a family member present. The supporting role of the family member was emphasized before the start of the study, and if the patient preferred that communication about study participation or technological explanation was given to a family member, this family member was approached by telephone. Third, we decided to plan follow-up visits with patients at home or schedule appointments to coincide with planned hospital visits because additional hospital visits discourage patients from participating [20]. These strategies to minimise refusal were also meant to promote study completion. Family members were involved in technical actions. Technology support was provided by the case manager throughout the whole study period by telephone and if necessary, at home or coinciding with planned hospital visits [19].

2.3. Data Collection and Handling

Reasons for ineligibility and refusal had been prospectively registered in a database by the case manager directly after assessing eligibility or after approaching patients for the prospective telemonitoring study. Relevant demographics, preoperative indicators of frailty, surgical data and postoperative complications of participants were prospectively collected in face-to-face assessments and from hospital medical records. Routine care data about non-participants was retrospectively collected from hospital medical records to evaluate health outcomes. No additional non-consented patient data was collected outside routine care. Collected data on the somatic domain of frailty included preoperative physical status assessed by an anaesthesiologist (American Society of Anesthesiologists [21] [ASA classification]), comorbidity (Charlson Comorbidity Index [22]) and, polypharmacy (>4 different types of medication [23]). Nutritional status was assessed using body mass index (BMI). Marital status and housing data were collected to indicate social status. Data on the psychological domain was collected from the routine consultation with a nurse at admission and registered in the medical records; including i) concerns about hospital admission, ii) anxiety that influenced daily life and, iii) the use of any psychiatric medication. Functional status had been determined using the reported Katz Activities of Daily Living (ADL [24]) score.

Data on tumour location, recurrence of disease, primary malignancy, neoadjuvant therapy, and anaesthesia time was collected. Postoperative outcome measures found in the medical records of the individual treatment centre, were collected from its administration. Postoperative outcome measures included postoperative ICU (intensive care unit) admission, length of hospital stay, complications related to surgery in-hospital and within 30 days after discharge (Clavien–Dindo classification ≥2 [25]), unplanned hospital readmission to the individual treatment centre and outside the treatment centre within 30 days after discharge, referral to a nursing home or skilled nursing facility (SNF) post-discharge, and overall survival at three and twelve months.

2.4. Statistical Analysis

We compared characteristics and outcomes from non-participants and participants using an independent sample *t*-test for parametric continuous data, Mann-Whitney *U* test for non-parametric continuous data, and Pearson's chi-squared or Fisher's exact test for categorical data. A *p*-value <0.05 was considered statistically significant. Data on baseline characteristics was only used for analysis if it was available for more than 90% of both groups. We compared postoperative outcomes for all patients and per subgroup, classified by type of primary malignancy (gastro-intestinal, gynaecological, or other oncology). The participants and non-participants who underwent surgery were included in overall survival analyses using the Kaplan-Meier with log-rank testing. Data was analysed with IBM SPSS Statistics version 23 (IBM Corporation, Armonk, NY).

3. Results

Out of 151 patients who were assessed for eligibility, 65 patients consented to participate, and 86 patients did not participate (Fig. 1). Of the 86 non-participants, 21 patients were not eligible for participation and 65 patients did not want to participate. Technological barriers to participation were lack of internet access at home ($n = 16$) and the perceived inability to work with electronic devices and mobile applications (digital illiteracy, $n = 12$). The main patient-related barrier was a perceived high mental burden ($n = 46$). Baseline characteristics of participants and non-participants are presented in Table 1. Compared with participants, non-participants were significantly older and more often female (Table 1). In addition, non-participants had a significantly higher ASA classification, more polypharmacy and less social support based on data regarding marital status and housing circumstances. Non-participants were more often ADL-dependent compared with participants, although this difference was not statistically significant.

From the 65 patients who consented to participate, seven patients were excluded before surgery and 43 patients completed the study. Reasons for study drop-out were cancellation of surgery, logistic issues regarding baseline assessment, or the combination of a high burden of disease and treatment and performing measurements at home. Results of our feasibility study demonstrated that the compliance of performing vital sign measurements and completing electronic health questionnaires was lower than synchronising physical activity (Fitbit-)data, suggesting that these aspects were challenging for the patients [19].

Surgery was cancelled for four participants and six non-participants, resulting in analysis of postoperative outcomes of 61 participants and 80 non-participants (Fig. 1; Table 2). Compared with participants, non-participants had similar complication rates. Difference in readmission rates were not statistically significant (23% vs. 15%, $p = 0.27$). In sub-analysis, these differences in postoperative adverse event rates tended to be larger in the patients who underwent gastro-intestinal oncological surgery, although the difference remained not statistically significant. Non-participants were significantly more often discharged to an SNF compared with participants. The twelve patients who were discharged to an SNF were significantly older (mean age 79.0 versus 73.6 years old [$p = 0.01$]), had a higher ASA classification (ASA 3–4 58% versus 29% [$p = 0.05$]), used more medication (% polypharmacy 92% versus 50% [$p = 0.00$]) and were more often living alone or in a nursing home before surgery (50% versus 30%, 17% versus 0% [$p = 0.00$]). The survival analysis in Fig. 2 demonstrates no difference in survival between three and twelve months for non-participants compared with participants ($p = 0.37$).

4. Discussion

In this prospective cohort study, we investigated technological and patient-related barriers to participation of older patients with cancer-related surgery in a perioperative telemonitoring study. Main inclusion barriers were ineligibility due to lack of internet access at home, refusal due to digital illiteracy (the perceived inability to work with electronic devices and mobile applications), and a perceived high mental burden. Non-participants were older, were more often female, had a higher

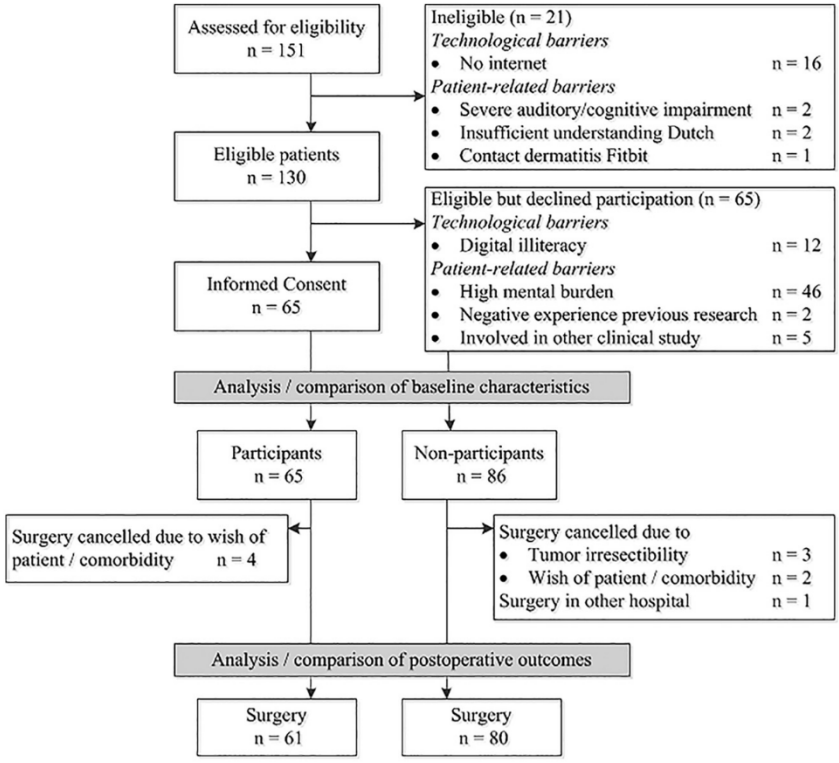


Fig. 1. Study flowchart.

Table 1
Patient and tumour characteristics.

Variables	Participants $N = 65$	Non-Participants $N = 86$	p-value
General patient characteristics			
Age, mean in years (SD)	72.8 (5.4)	75.1 (5.7)	0.01*
Gender, *n* (%)			
Male	42 (64.6)	31 (36.0)	
Female	23 (35.4)	55 (64.0)	0.00*
Nationality, *n* (%)			
Dutch	64 (98.5)	81 (94.2)	0.24
Domains of frailty			
Somatic - Comorbidity			
ASA-classification, *n* (%)			
ASA 1–2	53 (81.5)	49 (57.0)	
ASA 3–4	12 (18.5)	37 (43.0)	0.00*
Charlson Comorbidity Index, median (IQR)	4.0 (2.0–6.0)	3.0 (2.0–6.0)	0.88
Polypharmacy (≥ 4), *n* (%)	28 (43.1)	58 (67.4)	0.00*
Nutritional status			
BMI, mean (SD)	26.9 (4.2)	28.0 (6.0)	0.18
Social status			
Marital status, *n* (%)			
Married	53 (81.5)	50 (58.1)	
Widow(er)	9 (13.9)	24 (27.9)	
Divorced	1 (1.5)	5 (5.8)	
Single	2 (3.1)	7 (8.1)	0.01*
Housing, *n* (%)			
Independent, alone	12 (18.8)	33 (38.4)	
Independent, with others	52 (81.3)	51 (59.3)	
Nursing home	0	2 (2.3)	0.02*
Psychological status			
Concerns about hospital admission, *n* (%) [a]	17 (27.9)	27 (34.2)	0.47
Anxiety that influences daily life, *n* (%) [a]	4 (6.6)	4 (5.1)	0.73
Use of psychiatric medication? *n* (%)[b]	6 (9.8)	8 (10.3)	1.00
Functional status			
Impaired ADL [c] (Katz ≥1), *n* (%)	4 (6.2)	14 (16.7)	0.05
Participation in other research			
- Yes, *n* (%)	34 (52.3)	39 (45.3)	0.42
Tumour characteristics			
Tumour location, *n* (%)			
Intracavitary	54 (83.1)	64 (74.4)	
Superficial	11 (16.9)	22 (25.6)	0.20
Primary Malignancy			
Gastro-intestinal oncology [d]	48 (73.8)	53 (61.6)	
Gynaecological oncology [e]	7 (10.8)	19 (22.1)	
Other oncology [f]	10 (15.4)	14 (16.3)	0.17
Recurrent disease, yes, *n* (%)	18 (27.7)	35 (40.7)	0.12
Neoadjuvant therapy, yes, *n* (%)	24 (36.9)	36 (41.9)	0.54

SD: standard deviation; ASA: American Society of Anesthesiologists [19]; BMI: body mass index; ADL: activities of daily living; *Statistically significant, $p < 0.05$.
[a] Data missing for four participants and seven non-participants.
[b] Data missing for four participants and eight non-participants.
[c] Data missing for two non-participants.
[d] Mostly colorectal cancer ($n = 77$).
[e] Vulva carcinoma ($n = 20$) and ovarium carcinoma ($n = 6$).
[f] Mostly sarcoma ($n = 12$).

Table 2
Number of participants and non-participants with postoperative adverse outcomes, in total and per type of surgery.

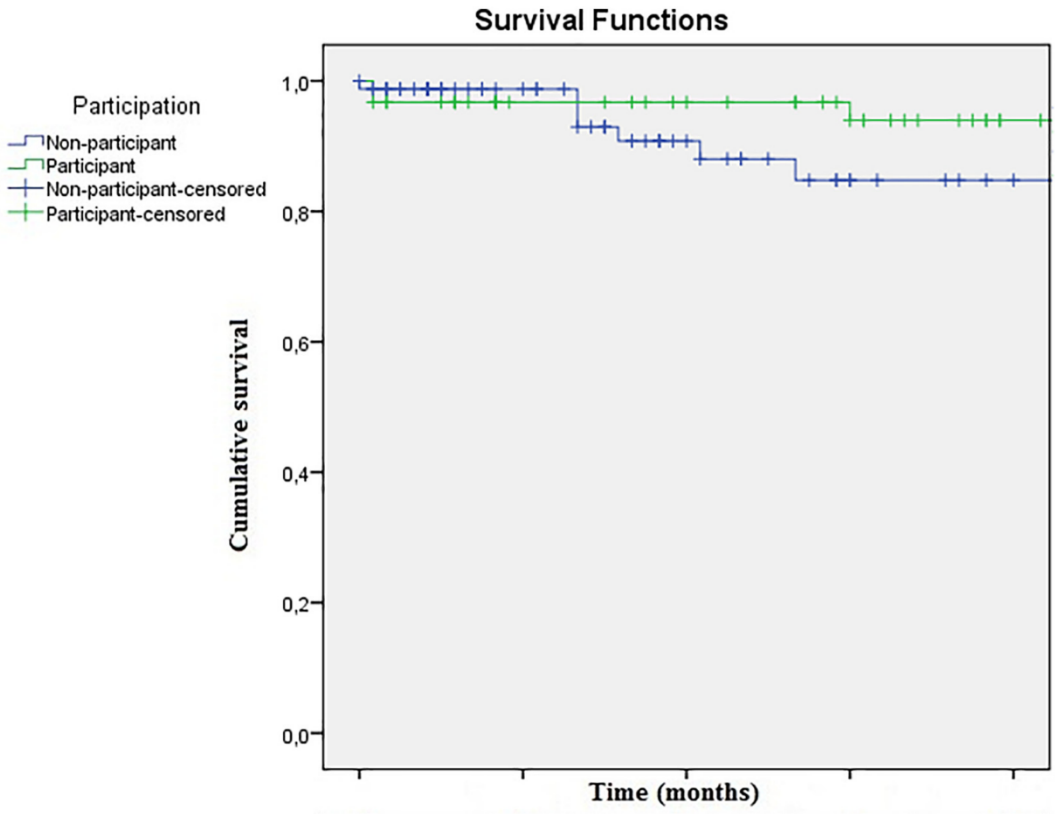
	Participants	Non-participants	p-value
Surgery performed	$N = 61$	$N = 80$	
As planned	60 (98.4)	77 (96.3)	
Irresectable tumour	1 (1.6)	3 (3.7)	0.63
Type of surgery, *n* (%)			
- Gastro-intestinal oncological surgery	44 (72.1)	48 (60.0)	
- Gynaecological oncological surgery	7 (11.5)	19 (23.8)	
- Other oncological surgery	10 (16.4)	13 (16.3)	0.17
In-hospital			
Postoperative ICU, *n* (%)	**13 (21.3)**	**24 (30.0)**	**0.33**
- Gastro-intestinal	12 (27.3)	21 (43.8)	0.13
- Gynaecological	0	2 (10.5)	1.00
- Other	1 (10.0)	1 (7.7)	1.00
Median length of hospital stays, days (IQR)	**8.0 (4.0–21.0)**	**10.0 (5.0–17.0)**	**0.92**
- Gastro-intestinal	13.0 (7.0–22.0)	15.0 (9.0–20.0)	0.30
- Gynaecological	2.0 (2.0–3.0)	2.0 (2.0–5.0)	0.50
- Other	4.0 (2.5–13.0)	6.0 (4.0–10.5)	0.24
In-hospital complications, [a] *n* (%)	**19 (31.1)**	**28 (35.0)**	**0.63**
- Gastro-intestinal	16 (36.4)	25 (52.1)	0.13
- Gynaecological	0	1 (5.3)	1.00
- Other	3 (30.0)	2 (15.4)	0.62
In-hospital mortality, *n* (%)	**2 (3.3)**	**1 (1.3)**	**0.58**
- Gastro-intestinal	1 (2.3)	1 (2.1)	1.00
- Gynaecological	0	0	–
- Other	1 (10.0)	0	0.44
After hospital discharge			
Referral **skilled nursing facility**, *n* (%)	**0**	**12 (15.2)**	**0.00***
- Gastro-intestinal	0	6 (12.8)	0.03*
- Gynaecological	0	4 (21.1)	0.55
- Other	0	2 (15.4)	0.50
Complications at home, [a,b] *n* (%)	**12 (20.3)**	**17 (21.5)**	**0.87**
- Gastro-intestinal	7 (16.3)	11 (23.4)	0.40
- Gynaecological	1 (14.3)	1 (5.3)	0.47
- Other	4 (44.4)	5 (38.5)	1.00
Unplanned readmissions, [b] *n* (%)	**9 (15.3)**	**18 (22.8)**	**0.27**
- Gastro-intestinal	5 (11.6)	13 (27.7)	0.06
- Gynaecological	0	1 (5.3)	1.00
- Other	4 (44.4)	4 (30.8)	0.66

ICU: intensive care unit; IQR: interquartile range; *Statistically significant, $p < 0.05$.
[a] Complications classified as Clavien–Dindo 2 or higher.
[b] Complications and unplanned readmissions within 30 days post-discharge.

ASA classification, used more medication, and were more often living alone compared with participants. About one fifth of participants and non-participants experienced a serious complication after hospital discharge. In addition, we observed significantly more SNF referrals for non-participants compared with participants. No statistical differences were observed in other postoperative outcomes between participants and non-participants.

In our study, 11% of all patients who were assessed for eligibility could not participate because they had no internet access at home. This corresponds with statistics provided by the Dutch Central Bureau of Statistics [26]. Although access to the internet in the Netherlands has improved considerably in the past decade, in 2019 6% of the Dutch population aged 65–75 and 23% of people aged over 75 still had no internet access at home [26]. Another 8% of all patients who were assessed for eligibility refused because they thought they possessed insufficient digital skills or felt uncomfortable with acquiring these skills for study purposes. Studies have confirmed that the main reason people refuse to learn new technologies is anxiety about using them [27]. In addition, ageing causes a decrease in self-efficacy, memory and speed of learning [27]. However, if the perceived advantages of new digital technologies are large and relevant enough and family or peer support is present, older adults are able to overcome their fears and start learning to use new technology [28,29].

One of the main reasons for refusal was a perceived high mental burden, which might be related to technological barriers as well. An inclusion rate of 50% (65/130) was achieved through several strategies in our study design such as face-to-face contact, involving family members in the recruitment process and, flexible home study visits [20]. The difference in characteristics of participants and non-participants in our study corresponds with previous studies [15,17,18,30]. Previous eHealth studies have also demonstrated that older, unmarried, less educated, and lower-income patients use health applications for self-management less frequently than their younger counterparts [30]. Unfortunately, we did not have sufficient data on education level and social-economic status



	0	3	6	9	12
Non-participants					
Patients at risk	79	50	30	19	14
Cum. Survival	0.988	0.932	0.888	0.856	0.790
Participants					
Patients at risk	59	45	40	30	19
Cum. Survival	0.967	0.967	0.967	0.940	0.940

Fig. 2. Survival analyses of non-participants and participants.

in our population. However, data on social status, housing, and referral to SNFs suggests that non-participants had less social support. Also, the two patients who were residing in a SNF both refused participation. We believe that improving social support would decrease both technological barriers and refusal rates due to a perceived high mental burden.

The acceptance and implementation of new digital technologies has been accelerated by the COVID-19 pandemic, as remote consultation and monitoring decrease the risk of spreading the virus [9]. These changes will lead to a more prominent and perhaps permanent role for telemedicine in future health care and underline the urgency of improving digital technology skills in specific populations such as older adults [9]. Because learning new digital skills takes time and energy [27], it is best to empower older adults to do so when they are relatively healthy and not when they have just been diagnosed with cancer or scheduled for surgery. Furthermore, it is essential that people who have insufficient social support can rely on professional or peer support provided by, for example, older adult advocacy groups or the government [31].

A limitation of this study is that we did not have information on the patients' socio-economic status, educational level, geriatric assessment, or impact of complications on functional recovery and quality of life. This is inherent to the retrospective analysis of a prospective cohort study. Approximately one fifth of all patients experienced a serious complication within 30 days after hospital discharge, and hospital readmission rates were 15% for participants and 23% for non-participants. Because we retrospectively collected data regarding non-participants from hospital medical records, complications and readmissions outside our hospital might have been missed; on the other hand, for participants, data on complications and readmissions were complemented with self-reported data at three months follow-up. In addition, participation in the telemonitoring study might have led to identification of more complications. Nonetheless, these results demonstrate a high incidence of postoperative complications post-discharge for all patients. More referrals to SNFs among non-participants also suggest that complications have a larger impact on this group. Additional parameters to measure the impact of complications, such as functional recovery, quality of life and long-term survival, are needed in future research. Subsequent telemonitoring studies with older adults should consider various logistical problems in usability and acceptability [19]. When considering the technological and mental barriers described in this study, studies could be even more inclusive. For example, WiFi hotspots could be provided at home for the patients without internet access at home. A technical 'buddy' could be assigned or technological support materials developed to decrease the fear of new technologies and enrol patients with digital illiteracy.

5. Conclusion

The main barriers to older adults' participation in a perioperative telemonitoring study were lack of internet access at home, digital illiteracy, and a perceived high mental burden. Non-participants were older and more often female, had a higher ASA classification and

more polypharmacy, and more often lived alone without a partner compared with participants. The complication rate was high in both participants and non-participants, with a seemingly greater impact of those complications in non-participants. This demonstrates the need for inclusion of underrepresented patients, who are at a high risk for severe postoperative complications and who experience a large impact of these complications. We should be aware of the barriers to participation of this population in order to avoid further dividing patients with low and high digital health literacy. Solutions to improve this situation are needed on a societal level and include improving internet accessibility, teaching digital skills and expanding social support for older people.

Author Contributions

Conceptualization: LTJ, MMHL, SF, GHdB, BLvL; Data curation: LTJ, MMHL, MHMO; Formal analysis : LTJ, MMHL, SF, GHdB, BLvL; Funding acquisition: MMHL; Formal analysis : LTJ, MMHL, SF, GHdB, BLvL; Funding acquisition: MMHL; Investigation: LTJ; Methodology: LTJ, MMHL, SF, GHdB, BLvL; Project administration: LTJ, MMHL; Resources: LTJ, MMHL; Software: LTJ; Supervision: MMHL, GHdB, BLvL; Validation: LTJ, MMHL; Visualization: LTJ; Writing - review & editing: MMHL, SF, MHMO, GHdB, BLvL.

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Declaration of Competing Interest

LTJ: no conflicts of interest to declare; MMH: no conflicts of interest to declare; SF: no conflicts of interest to declare; MHMO: no conflicts of interest to declare; GHdB: no conflicts of interest to declare; BLvL: no conflicts of interest to declare.

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