Usability and feasibility of a web-based communication tool for postoperative follow-up and pain assessment at home after primary knee arthroplasty.

Torbjørn Rian, Kari Sand, Eirik Skogvoll, Pål Klepstad, Tina Strømdal Wik

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Torbjørn Rian[1] MD; Kari Sand[2] PhD; Eirik Skogvoll[3] MD, PhD; Pål Klepstad[3] MD, PhD; Tina Strømdal Wik[4, 5] MD, PhD

[1]Department of Anaesthesiology and Intensive Care Medicine, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway Department of Neuromedicine and Movement Science, Norwegian University of Science and Technology NTNU, Trondheim, Norway Trondheim NO
[2]Department of Health Research, SINTEF Digital, Trondheim, Norway Trondheim NO
[3]Department of Circulation and Medical Imaging, Faculty of Medicine and Health Sciences Norwegian University of Science and Technology NTNU Trondheim NO
[4]Department of Orthopedic Surgery, St. Olavs Hospital University Hospital of Trondheim Trondheim NO
[5]Department of Neuromedicine and Movement Science Norwegian University of Science and Technology NTNU Trondheim NO

Corresponding Author:
Torbjørn Rian MD
Department of Anaesthesiology and Intensive Care Medicine, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway
Department of Neuromedicine and Movement Science, Norwegian University of Science and Technology NTNU, Trondheim, Norway
Prinsesse Kristinas gt. 3
St. Olavs Hospital
Trondheim
NO

Abstract

Background: We report the use of an electronic tool, Eir (Eir Solutions AS, Norway), for symptom registration at home after knee arthroplasty. This electronic tool was used in a randomized controlled trial comparing three different analgesic regimens with respect to postoperative pain and side effects.

Objective: The aim of the present sub-study was to investigate this electronic tool for symptom registrations at home with respect to usability, i.e. how easy it was to use, and with respect to feasibility, i.e. how well the tool served its purpose.

Methods: To assess the tool's usability, all participants were invited to fill out the ten-item System Usability Scale (SUS) after using the tool for eight days. To assess feasibility, data regarding the participants' ability to use the tool with or without assistance or reminders were collected qualitatively on daily basis during the study period.

Results: A total of 134 patients completed the RCT. Data were collected from all 134 patients concerning feasibility of the web-based tool. The SUS form was completed by 119 of the 134 patients. 70% of the patients managed to use the tool at home without any technical support. All their technical challenges were related to the login procedure or internet access. The mean SUS-score was 89.6, median 92.5, range 22.5-100.

Conclusions: This study showed a high feasibility and a high usability of the Eir web tool. The received reports gave the necessary information needed for both research data and clinical follow up. Clinical Trial: ClinicalTrials.gov NCT02604446

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Introduction

Background

Length of hospital stay (LOS) after hip and knee arthroplasty is reduced in modern fast track surgery [1]. Therefore, symptoms and complications previously observed and treated in the hospital will now occur at home. These include risks for respiratory depression caused by opioid analgesics and infectious complications. Tools for active communication with the patients after early discharge from the hospital will be important to avoid or address these problems.
Benefits of communication via Internet using tablets and smartphones for postoperative follow-up after surgery are reported in previous research [2-5]. Several advantages of using electronic tools for patient-recorded outcomes have been identified, such as fast and direct communication between patient and health personnel, easier storage of data, easier access to data for both patients and health personnel, access to real time patient data for health care personnel, and easier connection of different sources of data [6]. Electronic tools should be user-friendly and understandable for the patients, and they should be able to obtain the information needed for clinical follow up. Evaluations of electronic tools related to specific patient populations must highlight these features, and should be done before implementing a tool in routine use.

Objectives

We report the use of an electronic tool, Eir (Eir Solutions AS, Norway), for symptom registration at home after knee arthroplasty. This electronic tool was used in a randomized trial [7] comparing three different analgesic regimens with respect to postoperative pain and side effects. An electronic tool for symptom registration was initiated to closely monitor the patient's course at home over the succeeding postoperative week. The aim of the present sub-study was to investigate this electronic tool for symptom registrations at home with respect to usability, i.e. how easy it was to use, and with respect to feasibility, i.e. how well the tool served its purpose.

Methods

Study design

In a randomized double-blinded placebo-controlled study comparing three different postoperative analgesic regimen [8] we used a web-based tool, Eir, for registration of patient-reported outcomes and medication [9, 10] to evaluate the effect of the pain management and to assess side effects. The patients registered pain levels, medication use and side effects the first eight days after surgery. Two of the postoperative regimens included the use of opioids; oxycodone 10 mg twice daily or tapentadol 50 mg twice daily. All three groups had access to immediate release oxycodone 5 mg as rescue medication for pain. Other sedative medications were not given as a part of the study interventions. Assessment of the tool's usability and feasibility was an integrated part of the trial. To assess the tool's usability, all participants were invited to fill out the ten-item System Usability Scale (SUS) after using the tool for eight days. To assess feasibility, data regarding the participants' ability to use the tool with or without assistance or reminders were collected qualitatively on daily basis during the study period.

Patients and setting

The study was a single center, prospective, randomized, double blinded trial carried out in a university hospital setting from November 26, 2015, to November 7, 2018. Patients scheduled for surgery with total knee arthroplasty (TKA) between 18 and 80 years of age were considered for inclusion in the study. Exclusion criteria were cognitive impairment, inability to read or speak Norwegian, lack of cell-phone or wireless Wi-Fi connection at home, or use of drugs or medical conditions that conflicted with one or more of the study drugs or any of the multimodal basal pain medications given in the study. One hundred and thirty-four patients completed the trial [8].

The web-based application

Eir is an electronic symptom assessment tool developed by the European Palliative Care Research Centre at the Norwegian University of Science and Technology and St. Olavs hospital, Trondheim University Hospital for use in cancer care. A separate patient-module was designed for patient-reported postoperative symptom assessment and medication registration after fast track knee arthroplasty. It consisted of measurement of pain and side effects, and detailed registration on use of analgesic drugs (table 1).
Table 1 Questions on tablet.

Question	Alternatives

Have you taken your study drug as planned the last 24 hours?	Yes/No
If no, why not?	Forgot it/No pain/Too much side effects/Other
Have you taken the scheduled analgesics (4 doses of Paracetamol[a] and two doses of Vimovo[b]) the last 24 hours?	Yes/No
If no, why not?	Forgot it/No pain/Too much side effects/Other
How many tablets of Oxynorm[c] have you used the last 24 hours?	Number of 5mg tablets
You will now receive some questions regarding pain. Pain is rated on a 0 to 10 scale where 0 is no pain and 10 is the worst imaginable pain.	
How much pain do you have now when you move?	NRS 0-10
How much pain do you have now when you are at rest?	NRS 0-10
How much pain have you had on average the last 24 hours when you move?	NRS 0-10
How much pain have you had on average the last 24 hours at rest?	NRS 0-10
How high was your highest pain score the last 24 hours?	NRS 0-10
How much nausea have you had the last 24 hours? (0 is no nausea and 10 is the worst imaginable nausea)	NRS 0-10
How much dizziness have you felt the last 24 hours? 0 is no dizziness and 10 is the worst imaginable dizziness)	NRS 0-10
Have you passed stool the last 24 hours?	Yes/No
Do you feel constipated? (0 is no constipation and 10 is the worst imaginable constipation)	NRS 0-10
Are you tired or sleepy? (0 is no sedation and 10 is the worst imaginable sedation)	NRS 0-10
Have you had slept badly last night? (0 is the best imaginable sleep and 10 is the worst imaginable sleep)	NRS 0-10
How much headache have you had on average the last 24 hours? (0 is no headache and 10 is the worst imaginable headache)	NRS 0-10

[a]Acetaminophen 1 g [b]Naproxen 500 mg + esomeprazole 20 mg [c]Oxycodone immediate-release 5 mg

Procedures

Patient-reported data concerning effect and side effects of the pain treatment were registered daily for 8 days by use of Eir on a tablet and transferred wirelessly to the Eir database. The patients used Eir either on their personal tablet or on a tablet supplied by the study (Apple iPad mini 2 16GB). The patients were introduced to the application and the tablet after surgery when awake and after mobilization. All patients were supervised for two electronic self-reports while hospitalized, to check that the system was working, and that the patient was able to comply with the procedure. To be able to use Eir on tablets at home, the patient had to log on to a wireless Wi-Fi-connection, use the correct password to log in and answer 15 questions regarding use of study drug and other analgesics, pain intensity and side effects of analgesics (Table 1). Pain intensity and side effects were all measured on an 11-point numeric rating scale (NRS) from 0 to 10 (figure 1).

All patients were instructed to self-report on the tablet each day before noon. A reminder was sent by the main author as a SMS if no registrations were received within the agreed time. The patient received a second reminder as a phone call if there were no registration after the SMS-reminder. The patient`s closest relative was contacted if none of these communication methods succeeded. All patients received a paper version of the tablet questions for back-up in case of technical failure.

Data collection instruments

For each patient, the completeness of data, the use of reminders, potential user problems, solution to problems, and phone calls were registered for feasibility assessment. Usability was measured by use of the 10-item System Usability Scale (SUS), which is designed to measure the subjective usability of websites and software [11, 12]. SUS gives a 0-100 score, where higher score means better usability. A paper-version of the SUS questionnaire was given to the participants on the day of discharge from the hospital, and the participants were instructed to complete the form eight days after surgery. All patients received a reminder about the SUS form as an SMS and returned the questionnaire by mail.

Two weeks after the operation, all patients were interviewed by telephone as a follow up, and a global satisfaction score on the pain treatment was registered. The patients were given the opportunity to comment on any part of the treatment and follow-up after the operation.

The participants were grouped into five levels of technical skills, tech groups, based on their need of assistance (table 2). The patient's skill levels were compared to the registered data on side effects, drug consumption, age, and gender to assess if such factors could explain the difference in feasibility.

Table 2 Classification of the tech groups.

Tech group	Level of technical skills
1	No assistance needed
2	1-2 reminders, no technical support needed
3	Technical support provided one time
4	Technical support provided several times
5	Not able to use the application at all, all data collected by paper forms

Statistical methods

Descriptive statistics were reported as mean with standard deviation or median with 25 and 75 percentiles, as appropriate, according to the distribution of variables. The distribution of feasibility categories was reported as multinomial probabilities with exact 95 % confidence intervals. Correlation between feasibility and SUS, and between feasibility and other clinical characteristics (age, gender, type, and amount of drug received, etc.) was calculated using Kendall’s non-parametric correlation coefficient, and plotted as appropriately. Correlation between feasibility and use of personal tablet as opposed to those who borrowed a tablet from the hospital was calculated using Mann-Whitney U test.

Ethics

The study was approved by the Regional committee for Medical and Health Research Ethics (2015/209/Rek-Midt) and the Norwegian Medicines Agency (15/01581-13) and registered at clinicaltrials.gov (NCT02604446) on November 13, 2015. The study was conducted in compliance with the Declaration of Helsinki and Good Clinical Practice. Written informed consent was obtained from all participants before inclusion.

Results

Patients

A total of 134 patients, sixty-one men and seventy-three women between the age of 32 and 78 years, completed the RCT. Data were collected from all 134 patients concerning feasibility of the web-based tool. The SUS form was completed by 119 of the 134 patients.

Evaluation outcomes

The mean SUS-score was 89.6, median 92.5, range 22.5-100. This score correspond to an A+ in a scoring system given by Sauro [13].

Most the patients, 94 of 134, managed to use Eir without any technical support (Table 3). 68 patients managed to provide patient-reported data for the defined period of 8 days without any assistance (tech group 1). Twenty-six patients received 1-2 reminders but did not need any technical support (tech group 2). Twenty-four patients received simple technical support once, typically on their first attempt to answer after hospital discharge (tech group 3). Ten patients received technical support several times (tech group 4), and 6 patients did not use the application system at home at all (tech group 5). For this tech group, all data after hospitalization was collected from the paper version.

In tech group 5, one patient was transferred to ward home for blood transfusion and never managed to connect to the internet, one patient could not find the password for his home network, and one patient was sent home without a tablet. These three patients did not complete the SUS form. The last three patients in tech group 5 did not use the tablet at home and gave a SUS score based on their use of the application while hospitalized, their scores being 50, 62.5 and 85 respectively.

Forty-nine of the 134 patients (37%) used their own tablet with the application installed, while 85 borrowed a study tablet in the registration period at home.

Patient demographics, study drug, level of self-reported side effects, and mean SUS score for each tech group related to their technical skill level is displayed in table 3.

Table 3. Patient demographics, study drug, level of self-reported side effects, and mean SUS score for each tech group.

Tech group N=number of patients	1 N=68	2 N=26	3 N=24	4 N=10	5 N=6
	No assistance needed	1-2 simple reminders	Technical support once	Support on multiple occasions	Unable to use
Proportion (95% CI)	0.51 (0.39, 0.62)	0.19 (0.12, 0.30)	0.18 (0.10, 0.27)	0.07 (0.03, 0.15)	0.05 (0.01, 0.11)
Sex M/F (% male)	29/39 (43%)	10/16 (38%)	12/12 (50%)	6/4 (60%)	4/2(67%)
Age[a]	61 (SD 9.82)	58 (SD 9.76)	64 (SD 9.92)	62 (SD 7.69)	71 (SD 5.37)
LOS days[a]	2.1 (SD 0.66)	2.5 (SD 0.76)	2.1 (SD 0.58)	2.3 (SD 0.95)	2.5 (SD 0.84)
Study drug in original trial (number of patients) Oxycodone depot Tapentadol depot Placebo	 23 24 21	 12 8 6	 6 10 8	 3 3 4	 2 0 4
SUS form completed	61/68	25/26	21/24	9/10	3/6
SUS-score[a]	91.8	92.9	85.2	84.4	65.8
Pain (at rest)[b]	2.17	2.35	2.09	3.26	1.21
Constipation[b]	0.66	0.47	0.42	0.59	0.93
Dizziness[b]	0.95	1.13	0.88	2.29	0.57
Headache[b]	0.42	0.76	0.59	0.90	0.14
Nausea[b]	0.88	1.08	0.99	1.79	0.76
Sedation[b]	2.03	2.21	2.16	3.26	1.21
Sleep quality[b]	2.97	3.4	3.49	4.53	1.98
Amount of rescue drug (oxycodone 5 mg tbl) Mean value pr 24/h	1.59	2.3	1.79	3.2	1.02
Used personal tablet	30	9	7	2	1
Used borrowed tablet	38	17	17	8	5
Fraction borrowed (of total)	56%	65%	71%	80%	83%

[a]*mean values*

[b]*mean values measured on a 0-10 scale, 0 best 10 worst (NRS)*

Figure 2 shows the relationship between tech group and SUS. We observed a significant negative correlation between technical performance (feasibility) and the patient´s evaluation of the electronic tool´s usability (SUS-score) (correlation

coefficient -0.178, *P*=.016). The six patients that were not able to or interested in using the tablet for self-registration (tech group 5), had a significant higher age than the rest of the patients (*P*=.004). We found a correlation between feasibility and use of personal tablet (*P*=.038) as opposed to those who borrowed a tablet from the hospital. We observed no gender differences related to technical skills (*P*=.16). There were no significant associations between the patients' technical skills and the use of study drug (placebo versus the opioid groups, tapentadol and oxycodone).
The total amount of reports possible was 1072 both at hospital and home. At home the maximal total number of reports was 642, of which 631 was delivered. Four-hundred -and-fifty out of 631 reports (71.3%) were received from the tablets without technical support.

Discussion

Principal results

This study showed a high feasibility and a high usability of the Eir web tool. A large majority (70%) of the patients managed to use the tool at home without any technical support. All their technical challenges were related to the login procedure or internet access. The received reports gave the necessary information needed for both research data and clinical follow up.
Almost 90% of the patients completed the SUS form to evaluate the usability of the electronic tool. Missing reports were evenly distributed between all technical skill groups. We found a clear correlation between the SUS-score and feasibility of the tool, i.e. the level of technical support given. In the tech groups with higher need of technical support, there were also a higher fraction of patients not having their own tablet, and those not able to give report were older. This implies that the differences in feasibility and usability score between the tech groups are more related to technical experience and skills, rather than effects of the original study intervention or factors explained by the tool itself. The total score for usability were high, and more than 80 in group 1 to 4.

Comparison with prior work

The electronic tool evaluated in this study has previously been tested among patient groups with cancer treated in hospital [9, 10]. This is the first time the tool is evaluated for unassisted symptom registration at home. There are a few studies on electronic symptoms assessment at home after surgery [2-5], indicating that electronic postoperative follow-up at home might be an emerging field. Previous studies for electronic follow-up have obtained different information. Chevalier et al evaluated 29 patients with home assessment after ambulatory surgery and measured pain, nausea, vomiting, comfort, oxygen saturation, heart rate and blood pressure[2]. Pombo et al used an electronic tool for pain registration, which generated treatment recommendations for the patients after ambulatory surgery [3]. Hajewski et al [4] used automated mobile messaging to gather detailed data on pain development and opioid utilization after periacetabular osteotomy. Lyman et al [5] used a smartphone application to measure step counts and patient recorded outcome measures, including pain scores, in patients after TKA and total hip arthroplasty surgery. These four studies had patients with a mean age of 47, 48, 22 and 61 years respectively, while mean age in our study was 61.5 years. The need for technical support was 38% in the study by Chevalier et al and 30% for Pombo et al. The need for technical support is not stated in the studies by Hajewski and Lyman, but they report missing or incomplete data for 16% respectively 30%. Even though the technological tools and patient populations differ between these four studies the need for assistance in the present study were about the same, as 30% of the patients needed technical support.

Use in research

The original trial [8] used this tool to obtain data for pain research. The pain data from the Eir database provides a detailed diary with daily pain scores with an exact time stamp, and is a promising tool for pain research in the early post-operative period after early admission to home. Electronic assessment at home provides unbiased data from the patients, and may be more reliable as the patients are not influenced by the investigators. As for other surgery the length of stay in hospital after arthroplasty is reduced the recent years, and in our study mean LOS was 2.1 days. This advocates a closer evaluation of symptoms at home

Limitations

There is no consensus in previous studies evaluating electronic tools how to measure feasibility. The need for technical assistance has been defined differently between studies. Our intention was to describe the variation, and we found that a division into five tech groups was informative as it elaborates the variation within the tech group with regard to need for support. This symptom assessment system requires a well-developed technological infrastructure, which is present in Norway and many developed countries, but not in all countries. It also demands a population which is familiar with use

of technology. The study population is not necessarily representative for all patients operated with TKA since patients with cognitive impairment, age above eighty years and inability to read or speak Norwegian were excluded from this study. For a home electronic registration of symptoms to be of use for patients it must also be connected to an organization which monitors the patients' responses and if needed intervenes.

Conclusions

In this study, we evaluated an electronic symptom assessment tool that most patients used without technical support. The tool's usability was scored as high, and it seems as the differences in feasibility and usability scores were more related to technical experience and skill, rather than the tool itself or the clinical intervention in this study. An electronic tool that is easy to use for patients and do not require technical support can provide adequate follow-up for patients in the early postoperative period at home.

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Conflicts of Interest

None declared.

Abbreviations

LOS: length of stay
NRS: numeric rating scale
RCT: randomized controlled trial
SUS: system usability scale
TKA: total knee arthroplasty

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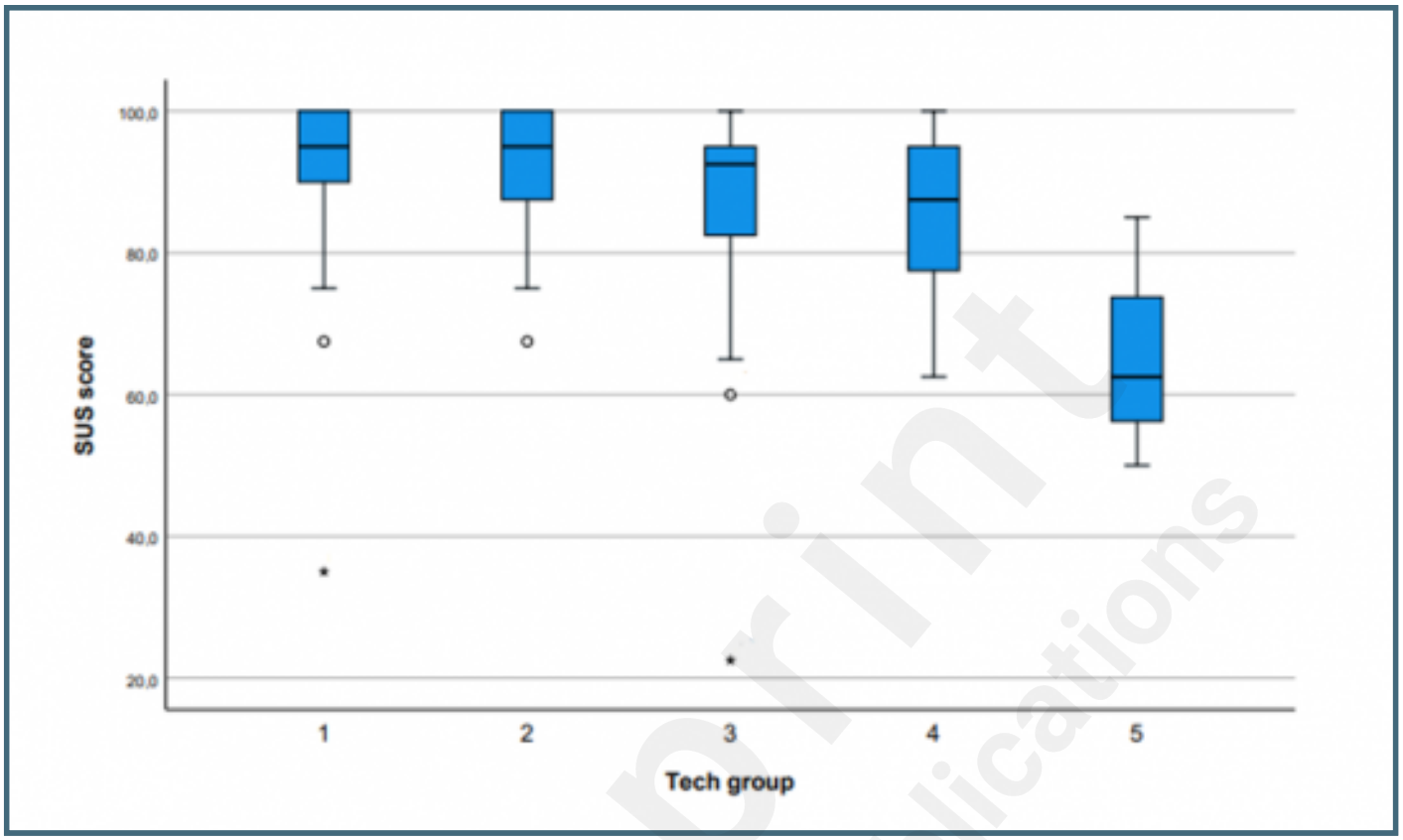
Supplementary Files

Figures

Picture of the application in use with English text (Norwegian text was used in the study).

The relationship between tech group and SUS score.



Multimedia Appendixes

Consort EHealth form.
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