Completion rate and satisfaction with online Computer Assisted History Taking questionnaires in Orthopedics: A Multicenter Cohort Study

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Abstract

Background: Collecting the medical history during a first outpatient consultation plays a crucial role in making a diagnosis. However, it is a time-consuming process while time is scarce in today's healthcare environment. Computer Assisted History Taking (CAHT) systems allow patients to share their medical history electronically before their visit. Although multiple advantages of CAHT have been demonstrated, adoption in everyday medical practice remains low. This has been attributed to various barriers.

Objective: To implement a CAHT-questionnaire for orthopedic patients in preparation to their first outpatient consultation.

Methods: A multi-center retrospective cohort study was conducted in which all patients who were referred to the orthopedic department were invited to self-complete the CAHT-questionnaire. The primary outcome of the study is the completion rate to the questionnaire. Secondary outcomes included patient's and physician's satisfaction. These were assessed via surveys and semi-structured interviews.

Results: In total, 5,321 patients were invited and 4,932 (92.3%) fully completed the CAHT-questionnaire. Participants (n=224) rated the easiness to complete the questionnaire with an 8.0 (0-10 scale, SD 1.9) and an 8.0 (0-10 scale, SD 1.7) on satisfaction of the consult. Satisfaction with the outpatient consultation was higher in case the given answers were used by the orthopedic surgeon during this consultation (8.3 IQR 8.0-9.1 versus 8.0 IQR 7.0-8.5, p<.001). Physician's (n=15) scored the added value as 7.8 (0-10 scale, SD 1.7) and unanimously recognized increased efficiency, better patient engagement and medical record completeness. Implementing the patient's answers into the EHR was deemed necessary.

Conclusions: In this study, we have shown that previously recognized barriers to implementing and adapting CAHT can now be effectively overcome. We demonstrated that almost all patients completed the CAHT-questionnaire. This results in reported improvements in both the efficiency and personalization of outpatient consultations. Given the pressing need for personalized healthcare delivery in today's time-constrained medical environment, we recommend implementing CAHT-systems in routine medical practice.

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Author contributions: Casper Craamer, Thomas Timmers, Michiel Siebelt and Walter van der Weegen conceived the study and designed the trial. Walter van der Weegen and Taco Gosens supervised the data collection. Casper Craamer managed the data. Casper Craamer, Thomas Timmers and Walter van der Weegen provided statistical analysis. Casper Craamer drafted the manuscript. All authors contributed to its revision.

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Keywords: Computer-assisted history taking; History taking; Digital Medical Interview;

Orthopedics; Digital health.

Introduction

Background

The patient's medical history plays a crucial role in establishing an accurate diagnosis [1, 2, 3]. However, collecting the medical history during a first consultation is time consuming while time is scarce in today's healthcare environment. In addition, the first consultation can be a stressful event for a patient, resulting in anxiety and misinterpretation of the questions asked during a medical encounter [4]. Subsequently, this can potentially result in incomplete and invalid information, hindering a patient's ability to participate in shared decision-making [4].

Computer Assisted History Taking (CAHT) systems, also known as digital medical interview assistant systems, are software programs that allow patients to present their medical history electronically before an outpatient consultation. For instance, this can be done remotely via a web-based portal or smartphone application prior to the scheduled consultation [5]. CAHT was first introduced in the early 1970s as an additional channel to collect highly relevant, comprehensive, and accurate patient information [6]. Multiple advantages of CAHT have been demonstrated, including saving face-to-face consultation time spent on history taking, and empowering patients to be active in their own care [7]. Moreover, CAHT might enhance the comprehensiveness of patient history taking by employing standardized algorithms that expand questioning depth based on the participant's responses. This approach holds the potential to uncover psychosocial and psychiatric issues potentially associated with the presenting complaint [8].

Although these findings are promising, the adoption rate of CAHT within healthcare remains low. This is attributed to various barriers for both healthcare professionals (HCPs) and patients [6]. The accessibility of healthcare for all comes into question while digitalizing healthcare. Additionally, concerns arise regarding the interoperability of data that is fragmented across multiple compartments. The ability of patients to provide accurate answers is also brought into focus when they are consulted via an online survey rather than an in-person consultation [9].

Despite these barriers to integrate CAHT into everyday medical practice, the current pressure on the healthcare system demands for action. Since the projected growth of multiple patient populations by

far exceeds the number of available HCPs in the near future, time spent on each patient needs to be as efficient and effective as possible, without reducing (perceived) healthcare quality. Given the number of patients that nowadays have access to email, websites and smart devices, and the unprecedented advances in technologies in recent years, a more successful implementation of CAHT in clinical practice could be expected. However, no research has been published about achieving this goal.

Objectives

The aim of the study was to analyze completion rate and HCP satisfaction to an online orthopedic CAHT-questionnaire that allow patients to provide their medical condition before their first outpatient consultation.

Materials and Methods

Study design and setting

This multi-center retrospective cohort study was conducted at the orthopedic departments of the Anna Hospital (Geldrop, The Netherlands) and Elisabeth-Tweesteden Hospital (Tilburg, The Netherlands). No changes were made to the design after the study was commenced. We followed the STROBE guidelines for reporting data in a cohort study [10].

Informed consent and Ethical considerations

Approval was obtained from the medical ethics committees of both hospitals. The study was deemed exempt from the Medical Research Involving Human Subjects Act (WMO, N23.090). Patients were informed about data usage for research and publication purposes at the start of the CAHT questionnaire, with participation being voluntary.

Participant selection

All patients aged 18 and above who were referred to the orthopedic departments of the participating centers for their first in-hospital consultation, were invited to participate in the study. Patients needed to have an email address and sufficient command of the Dutch language. Patients with a cognitive disorder and patients specifically referred for pediatric orthopedics were excluded. Inclusion criteria were assessed by hospital staff when they contacted the patients to schedule their appointment.

All physicians and orthopedic residents (n=24) working in the participating hospitals and who have had scheduled initial consultations with patients during the study period, were invited to participate in the study as well [11].

CAHT- questionnaire

The questionnaire aimed to collect the patients' medical condition, in preparation for their first outpatient consultation. The questionnaire included several topics in the following order: affected joint, previous diagnoses or treatments, health status, personal care needs or preferences, and patient characteristics (Table 1). Some questions are generic, but most are joint-specific. Depending on the answers given by the patient on specific questions, standardized algorithms expand questioning depth using branching logic (e.g. in case of trauma, more information was requested about the trauma origin). The online questionnaire was offered to patients in the look and feel of the healthcare organization and some questions were supported with illustrations and instructions (Figure 1).

Table 1. Example of covered subjects and related questions for patients suffering from knee complaints. Questions are translated from Dutch (language used in the study) to English.

Topic	**Question**
History	- Have you ever received a **diagnosis,** by a physician or general practitioner, due to complaints in your knee, and/or your lower back? - Have you ever undergone **a surgical procedure** for your knee, and/or lower back?
Main complaint	- In **which knee** do you experience complaints?

	- **For how long** do you experience knee complaints? - On a scale of 0 to 10, how severe is you knee pain **at rest**?
Main complaint in relation to social activities	- Are you limited in playing sports or executing your hobby due to your knee complaints? - Are you limited in your job due to your knee complaints?
Personal care needs and preferences	- Your orthopedic surgeon would like to know what your main worry or question is regarding your complaints. This way the consultation can be about what's important to you. - If necessary, to what extent are you willing to undergo a surgical procedure to get rid of your knee complaints?
Effect of conservative therapies	- Have you tried **muscle strengthening physical training** for a period of 4 to 6 weeks?

Development of CAHT-questionnaire

An expert panel was created for the development of the CAHT questionnaire and its output.

The expert panel consisted of three experienced orthopedic surgeons and of both hospitals. First, input from the physicians at Anna Hospital was elicited, offering insights from the perspective of their professional focus area. Subsequently, the draft version was developed and internally reviewed before undergoing external assessment by three orthopedic surgeons of the Elisabeth Tweesteden Hospital. The answers to the CAHT-questionnaire were automatically presented as a coherent summary in a format designed by the expert panel (Figure 2). A weblink from the CAHT-platform with single sign-on was integrated with the two Electronic Health Records (EHR) used by the participating hospitals. All feedback on the questionnaire and its output was processed before the study commenced.

CAHT-platform

OnlinePROMS (Interactive Studios, ‘s-Hertogenbosch, The Netherlands) was used as the CAHT-platform. The platform meets European regulations for the privacy and security of patient reported health data. Invitations to answer the CAHT-questionnaire were automatically sent by email when a patient was added to the platform by hospital administration staff. The CAHT- questionnaire became accessible for the patient after entering a two-factor-authentication code. The platform allowed hospitals to send two reminders by either email or SMS if the patient did not complete the questionnaire. Participants of Anna Hospital were reminded at 1 and 2 days after initial invitation at 9:00 A.M. via SMS or email if the phone number was unknown. ETZ Hospital has chosen to send

automated reminders 5 and 10 days after initial invitation at 9:00 AM. (Figure 3).

Study outcomes

The percentage of patients that completed the CAHT-questionnaire was the primary outcome. Usage statistics were collected for secondary outcomes and included time needed to complete the CAHT-questionnaire and number of necessary reminders. Patient demographic data was collected from the CAHT-questionnaire (age, sex, Body Mass Index (BMI), and affected joint). In addition, in July 2022 all patients were invited to answer a questionnaire on the usage of the CAHT-questionnaire. After reaching a convenience sample (n=224), this invitation was deactivated. All physicians of the participating hospitals were asked to rate satisfaction with the information collected with the CAHT system as well as its accessibility and added value. An overview of the study outcomes is presented in Table 2. All data was collected for the duration of the study via OnlinePROMS platform.

Table 2. Overview of study outcomes

Outcome	**Description**
Completion percentage[a]	The percentage of patients that completed the CAHT[b] - questionnaire in preparation for their outpatient consultation.
Duration to complete[c]	Time (in minutes) needed to complete the CAHT-questionnaire.
1st reminders sent[c]	The number of 1st reminders automatically sent by the CAHT-platform in case the CAHT-questionnaire was not completed yet.
2nd reminders sent[c]	The number of 2nd reminders automatically sent by the CAHT-platform in case the CAHT-questionnaire was not completed yet.
Patient demographics[a]	Age, sex, body mass index, and affected joint.
Easiness of the CAHT-questionnaire[d]	Easiness of the CAHT-questionnaire on a 10-point Likert-scale
Patiënt satisfaction[d]	Satisfaction of the consultation on a 10-point Likert-scale
Usage by the physician[d]	The number of patients reporting that the CAHT-questionnaire summary was used by the physician during consultation.
Added value[d]	The added value of a CAHT-questionnaire supported medical history taking during consultation on a 10-point Likers-scale.
HCP[f] data accessibility[e]	Experienced easiness for data accessibility. Satisfaction is rated on a 10-point Likert-Scale

Added value for HCP[e]	The added value of a completed CAHT-questionnaire during outpatient consultation on a 10-point Likers-scale.

[a] Collected prior to consultation

[b] CAHT: Computer Assisted History Taking

[c] Derived from platform user-statistics

[d] Collected 1 day after consultation

[e] Collected at the end of the study

[f] HCP: Healthcare Professional.

Statistical methods

Categorical variables are presented as numbers and percentages. Normally distributed continuous variables are presented as means (with SD). Non-normally distributed variables are presented as median value (with IQR). To analyze satisfaction between groups, data were considered statistically significant at $p<.05$. In case of normal distribution and variances an independent t-test was used. For non-normal distributions, a non-parametric test was used. All data was analyzed using IBM SPSS Statistics for Macintosh, version 29.0 (IBM Corporation, New York, USA).

Results

Study Sample

Between April 2022 and July 2022, a total of 7,065 patients were scheduled to have a first consultation with an orthopedic surgeon in one of the two participating hospitals. Of these, 5,321 met the study's inclusion criteria (75.3%). In addition, 224 provided feedback on the usability of the CAHT-questionnaire after sending 414 (54.1%) invitations (Figure 4). Semi-structured interviews were performed with 15 orthopedic surgeons from the participating hospitals.

Completed CAHT-questionnaires

In total 5,321 patients were invited to complete the CAHT questionnaire. Out of these, 4,932 (92.3%) participants fully completed the questionnaire. Of the 2,620 participants invited by Anna Hospital, 2,516 (96%) completed the CAHT-questionnaire. Of the 2,701 invited by ETZ, 2,416 (89.4%) completed the CAHT-questionnaire (Table 3).

Table 3. Number [n] of invitations sent and completed Computer Assisted History Taking-questionnaires, divided by hospital.

	Invitations sent, n	Completed, n (%)
Anna Hospital	2,620 (49.3%)	2,516 (96%)
Elisabeth Tweesteden Hospital	2,701 (50.8%)	2,416 (89.4%)
Total	5,321 (100%)	4,932 (92.7%)

Usage statistics

Duration to complete the questionnaire for participants who started and completed the questionnaire on the same day displayed a median value of 16.2 (IQR 11.4-26.1) minutes. Anna Hospital needed 1,846 first and 707 second reminders to reach 2,516 (96%) completed questionnaires and ETZ 796 first and 323 second reminders to reach 2,416 (89.4%) completed questionnaires (Figure 5).

Patient characteristics

The mean participant age was 56.5 years (SD 16.8) and 2,208 participants were male (44.8%) with a mean BMI of 27.4 (SD 5.1). The three joints most often selected as affected were the knee (n=2,205, 44.7%), hip (n=962, 19.5%), and ankle/foot (n=908, 18.4%).

Table 4. Participant characteristics.

Characteristic	**Patients from Anna Hospital (n=2,516)**	**Patients from Elisabeth Tweesteden Hospital (n=2,416)**
Age (years), mean (SD) - 18 – 27, n (%) - 28 – 37, n (%) - 38 – 47, n (%) - 48 – 57, n (%) - 58 – 67, n (%) - 68 – 77, n (%) - 78 – 87, n (%) - 88 – 97, n (%)	55.4 (SD 16.9) - 239 (9.5%) - 206 (8.2%) - 254 (10.1%) - 548 (21.8%) - 592 (23.5%) - 511 (20.3%) - 156 (6.2%) - 10 (0.4%)	57.5 (SD 16.7) - 165 (6.8%) - 190 (7.9% - 272 (11.3%) - 468 (19.4%) - 552 (22.8%) - 529 (21.9%) - 220 (9.1%) - 20 (0.8%)
Sex (male), n (%)	1,157 (46%)	1,051 (43.5%)
Body Mass Index	27.2 (SD 16.8)	27.6 (SD 5.2)
Affected joint [a] - Knee, n (%) - Hip, n (%) - Ankle/foot, n (%)	 - 1,205 (47.9%) - 437 (17.4%) - 423 (16.8%)	 - 1,000 (41.4%) - 525 (21.7%) - 485 (20.1%)

- Shoulder, n (%)	- 409 (16.3%)	- 310 (12.8%)
- Elbow, n (%)	- 34 (1.4%)	- 48 (2%)
- Wrist/hand, n (%)	- 57 (2.3%)	- 116 (4.8%)
- Spine, n (%)	- 183 (7.3%)	- 349 (14.4%)

[a] *The CAHT-questionnaire allowed patients to select multiple affected joints.*

Patient satisfaction

Participants included to rate the CAHT-questionnaire usability (n=224) rated an 8.0 (SD 1.9) out of 10 on easiness to complete the questionnaire and an 8.0 (SD 1.7) out of 10 on satisfaction of the consult. Satisfaction with the outpatient consultation was higher in case the given answers were used by the orthopedic surgeon during this consultation (8.3 IQR 8.0-9.1 versus 8.0 IQR 7.0-8.5, p<.001). 145 (65%) participants report that the CAHT-questionnaire was used by the physician during the consultation and 157 (70.4%) participants had the feeling that their physician had a better understanding of their complaint due to the CAHT-questionnaire.

Physician satisfaction

Physicians (n=15) scored the added value of using the CAHT-questionnaires during their consultation as 7.8 (0-10 scale, SD 1.7). One physician reported not to use the answers at all during the consultation. Physician’s unanimously recognized benefits during outpatient consultations, such as increased efficiency, better patient engagement, and medical record completeness. This was more the case for CAHT use with hip or knee complaints, and less with foot and ankle complaints. Physicians highlighted the questionnaire's value in eliciting pertinent information, aiding diagnosis, and providing a framework for informed decision-making. Implementing the summary generated from patients' answers in the EHR was deemed necessary to achieve this.

Discussion

The present study demonstrates the feasibility of the implementation and clinical adaptation of CAHT for orthopedic patients scheduled for their first consultation in a hospital. The completion rate to answer a CAHT-questionnaire before the first consultation was very high (94%), and patients found the questionnaire easy to understand and to complete. Additionally, they were more satisfied with their outpatient consultation when the summary of the CAHT-questionnaire was taken into consideration by their physician. Physicians rated the CAHT-questionnaire to be a useful addition to standard outpatient consultations as insight in the personal care needs and preferences allowed them

to address the main concern of the patient directly.

To reach a high completion rate to the CAHT-questionnaire, we took implementation-barriers addressed in previous studies (accessibility, accuracy, and acceptability) into consideration [6]. For accessibility, linked with interoperability [12], we integrated a single sign-on weblink that displayed a comprehensive summary (and the entire questionnaire when needed) of the answers directly in the EHR. From a patient perspective, the CAHT-questionnaire was easily accessible from their email inbox with a two-factor-authentication code. For accuracy, there is conflicting evidence [9, 13]. We aimed to stimulate accurate answers by enriching some questions with illustrations or a short instruction and used easy/informal language where possible. For data acceptance [14], we created an expert panel to develop and design the CAHT-questionnaire and its output. This method is underlined by research, addressing an improvement in quality and acceptance of data [15].

Examining the impact resulting from implementation of CAHT in a multicenter study design represents a major strength of this study. By incorporating two hospitals (one non-academic teaching hospital and one general hospital), we were able to include a high number of patients, strengthening the generalizability and robustness of our findings. This is confirmed by the similarity of the data between hospitals in terms of demographics, completion rate and satisfaction.

This study is not without limitations. For this study, we implemented CAHT within orthopedic departments only, limiting generalizability towards other medical departments. The study population's characteristics age and gender distribution might however indicate usability within other departments as well. Another limitation is the absence of non-verbal communication that occurs in a face-to-face conversation. On the other hand, CAHT-completion allows for more time to think about the answers and fact check them, without the stress and time-pressure that is experienced during outpatient visits. The reported median time of 16 minutes for completion supports this.

Implications for clinical practice

Our study demonstrates that implementing CAHT in the daily routine of an orthopedic department is feasible and can lead to good clinical adaptations but does require the necessary steps to be taken. Requirements are that the patients have an email address, and hospital staff must be available to invite patients to the CAHT-platform. The latter would ideally be done through an automated connection with the EHR. Making the results of the questionnaire available in the EHR can be done

through a single sign-on weblink, offered by almost all EHR-suppliers.

Future research

Today's healthcare system is facing an immense burden. Time is limited while personalized healthcare needs to be maintained or even improved. Increased consultation duration is associated with better health outcomes, fewer prescriptions, and better recognition of long-term and psychosocial problems [16, 17], but this is simply impossible in most healthcare systems. Nevertheless, a physician that is supported by CAHT results, might optimize consultation time in a friendly manner while improving patient centered communication (i.e. signposting, summarization and repetition of the medical history). This may lead to more accurate diagnoses, enhanced shared decision-making, and increased patient satisfaction [18, 19]. Future research could aim to study the effect of optimized face-to-face consultation time with the support of CAHT and its effect satisfaction and cost-effectiveness.

Conclusion

Previously reported barriers to implementing and adapting CAHT in clinical practice can nowadays be resolved. In this study, we demonstrated that almost all patients completed the CAHT-questionnaire before their outpatient consultation. Both patients and HCPs reported a more efficient and personalized consultation when the answers to the questionnaire were used. Given the pressing need for personalized healthcare delivery in today's time-constrained medical environment, we recommend implementing CAHT-systems in routine medical practice.

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Conflicts of interest

Casper Craamer and Thomas Timmers work at the research and development department of

Interactive Studios. Interactive Studios is the company that developed the CAHT-platform used in this study. Interactive Studios offered the CAHT-platform used in this study free of charge. The other coauthors declare that the research was conducted in the absence of any other commercial or financial relationships that could be construed as a potential conflict of interest. Moreover, all authors have completed the ICMJE uniform disclosure form and declare the following: no support from any organization for the submitted work, no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

Abbreviations

CAHT: computer assisted history taking

EHR: electronic health record

HCP: healthcare professional

BMI: body mass index

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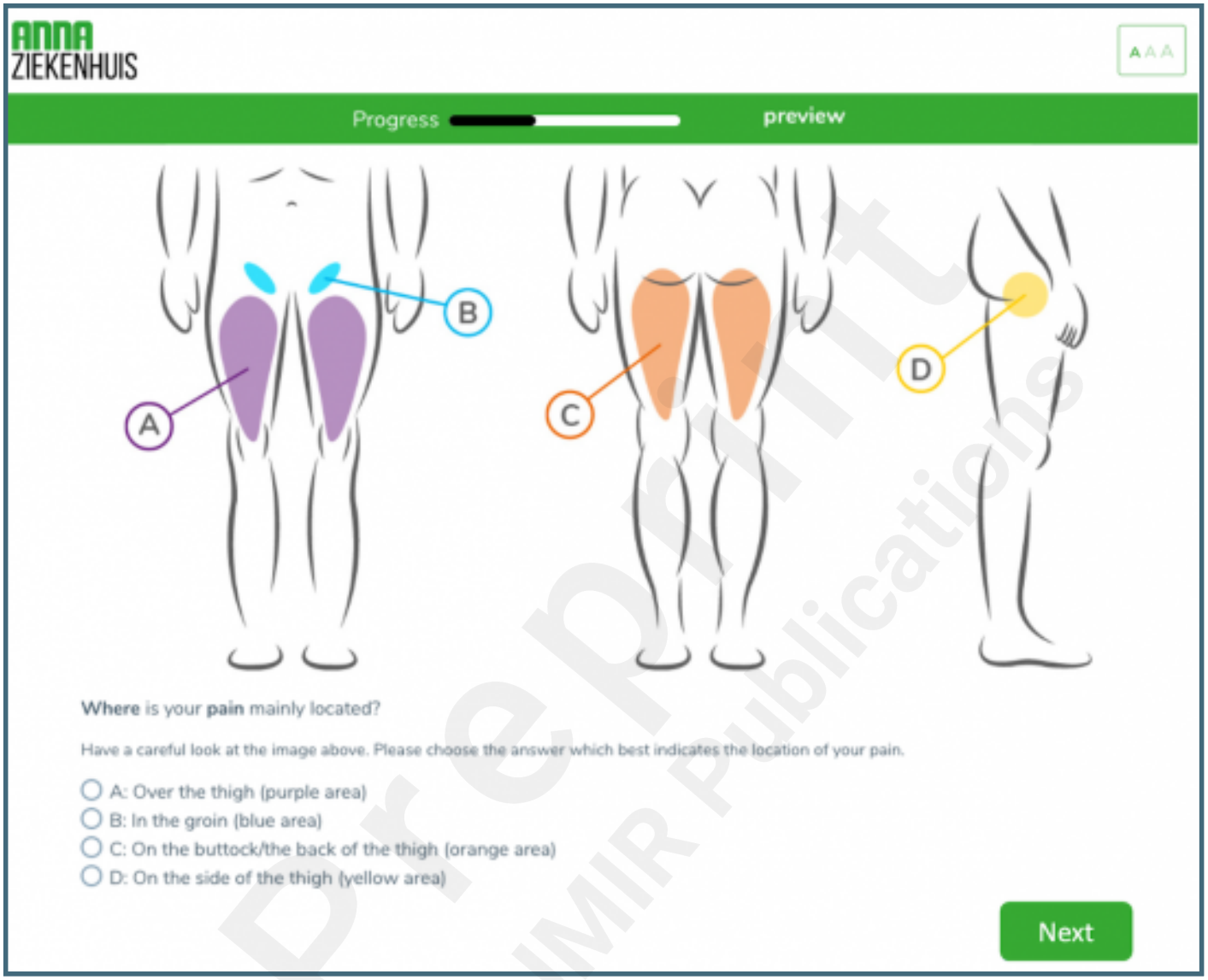
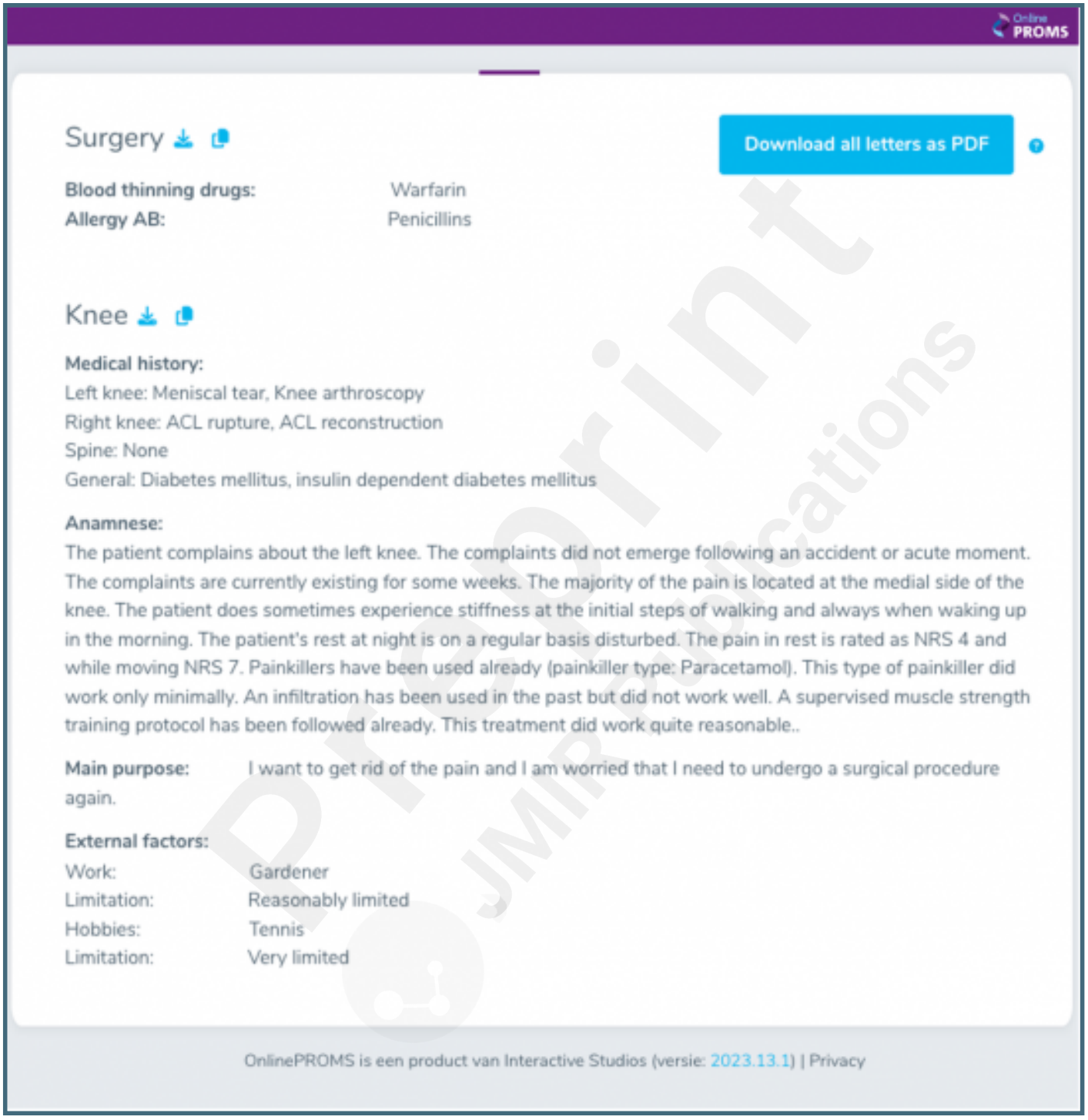
Supplementary Files

Figures

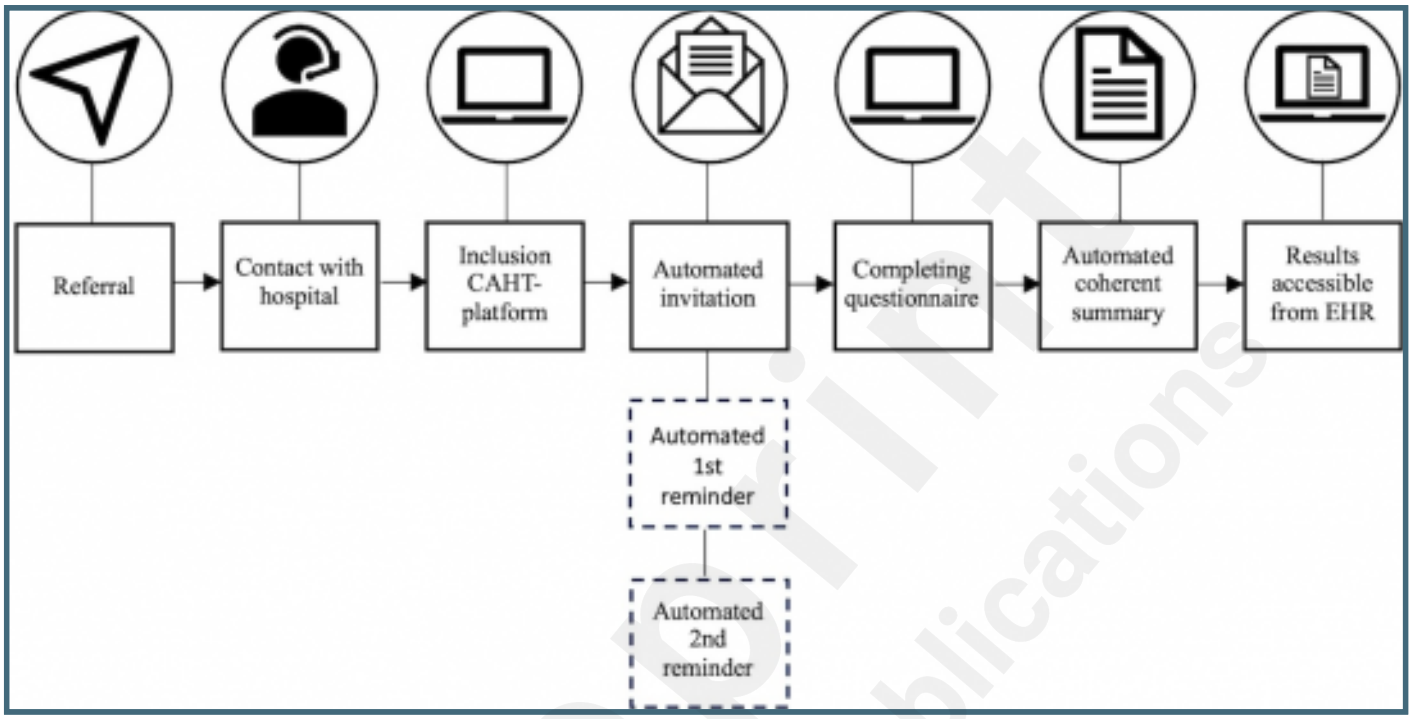
Example of the Computer Assisted History Taking-questionnaire for patients suffering from hip complaints. Patients can indicate the location of their hip pain using an illustration. Questions are translated from Dutch (language used in the study) to English.



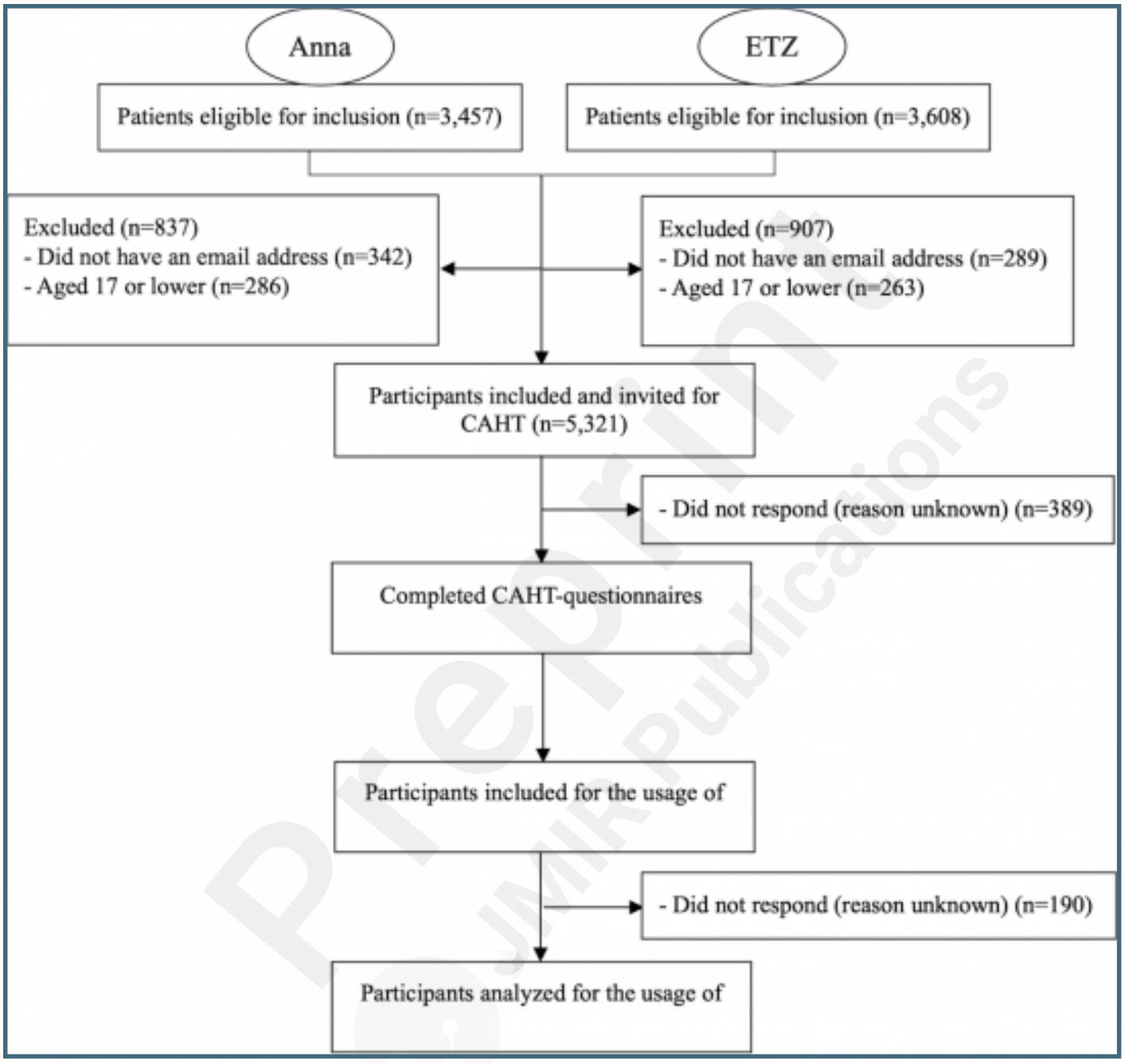
Example of the answers to the Computer Assisted History Taking [CAHT]-questionnaire, presented as a coherent summary of a patient indicating the knee as affected joint. The summary is translated from Dutch (language used in the study) to English.



Flowchart of Computer Assisted History Taking [CAHT]-platform. After a patient was referred to the hospital and got in contact with the hospital staff, patients were included and, subsequently, an automated invitation was sent. If the patient did not respond to the invitation, a 1st and 2nd reminder was sent based on the response schedule. If the patient completed the questionnaire, a coherent summary of the answers was generated automatically from the available data and, eventually, accessible from the Electronic Health Record [EHR].



Participant flow diagram. Anna: Anna Hospital; ETZ: Elisabeth Tweesteden Hospital; CAHT: Computer Assisted History Taking.



Flow diagram of number [n] of completed questionnaires and completion rate to automated sent invitations per hospital. Anna: Anna Hospital; ETZ: Elisabeth Tweesteden Hospital.