User experience with Atellica® VTLi Patient-side Immunoassay Analyser for point-of-care high-sensitivity troponin testing: A mixed-methods study

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ABSTRACT

Introduction

Ischaemic heart disease is the leading cause of death worldwide in 2021. In primary care, patients frequently present with chest pain but reliable tools for ruling out an acute coronary artery syndrome are lacking. A point-of-care (POC) device could relieve the emergency department (ED) from possible unnecessary referrals. In a randomized controlled trial called the "Point-of-Care high-sensitivity troponin testing in the Emergency Room to assess Myocardial Infarction for Timely discharge (CERMIT)" trial, POC high-sensitivity cardiac troponin I (hs-cTnI) testing was compared with the usual central laboratory testing method in the ED. This study is a substudy of the CERMIT-trial and aims to assess the user-experience with the Atellica® VTLi analyser used as the POC device in this trial.

Methods

As a mixed-methods early-phase implementation study, both a quantitative and a qualitative evaluation of the user experience with this POC device were performed. Six study members filled out the user experience questionnaires and participated in think-aloud interviews. The questionnaire consisted of 39 statements, divided into four different topics: the docking station, the analyser itself, the reagent cartridge and the general process. Study members scored each statement on a 5-point Likert-scale. The traditional concurrent think-aloud method, as first introduced by Ericsson and Simon in 1993, was chosen as the qualitative method. The transcriptions of the interviews were divided into segments coinciding with a single thought process. Each of these segments was then coded following a top-down custom coding scheme. A secondary code was given to each segment coinciding with the four different topics of the questionnaire.

Results

Quantitative analysis showed that the analyser itself received a high median score on the 5-point Likert-scale. Three questions about the docking station received a median score lower than four and two questions scored 5/5. Regarding the reagent cartridge, five questions received a score lower than four and no questions had a perfect score. Three questions about the general process received a score lower than four and no questions had a perfect score. Qualitative analysis showed that a cognitive error was experienced by two students during the interview regarding the waiting time between inserting the cartridge and the start of the analysis. Multiple study members found closing the cartridge lid and adequately filling the cartridge with the correct amount of blood, difficult. Two study members got confused because it was not clear they were already logged in. Another two study members described the keyboard as not user-friendly.

Discussion

Overall, both the quantitative and qualitative analysis agree that the Atellica® VTLi Patient-side Immunoassay Analyser and its corresponding hs-cTnI reagent cartridges score well on usability and are ready to be trialled in a clinical context. However, results show that there are still improvements to be made to enhance the workflow with the device. The biggest improvements could be made by adjusting the reagent cartridge, by changing the lay-out of the keyboard and by tweaking the login process. The next steps are to investigate the usability experience of actual nurses and physicians in a clinical context like the ED and then to assess the usability in primary care.

LIST OF ABBREVIATIONS

ACS: acute coronary syndrome

CERMIT: "Point-of-Care high-sensitivity troponin testing in the Emergency Room to assess Myocardial Infarction for Timely discharge" trial

CRP: C-reactive protein

EC Research: Ethics Committee Research

ED: emergency department

hs-cTn1: high-sensitivity cardiac troponin I

MACE: major adverse cardiac events

NSTE-ACS: non-ST-elevation acute coronary syndromes

POC: point-of-care

RCT: randomized controlled trial

STEMI: ST-elevation myocardial infarction

SUS : System Usability Scale

TAP: transcription protocol

INTRODUCTION

Ischaemic heart disease is the leading cause of death worldwide, accounting for 9.1 million deaths in 2021 (1). It is the leading cause of death in high-income countries, and ranks second or third in middle- and low-income countries respectively (1). In Belgium, 26.064 deaths were attributed to cardiovascular disease in 2023, making it the second leading cause of death after cancer (2). Immediate and early (i.e. undergoing angiography within 24h) invasive treatment strategies for acute coronary syndromes (ACS), for both ST-elevation myocardial infarction (STEMI) and non-ST-elevation acute coronary syndromes (NSTE-ACS) respectively, lead to better outcomes (3). Early and adequate diagnosis of ACS therefore remains a key priority in clinical research and practice.

Patients frequently present with chest pain in primary care. Data from the Intego general practice morbidity registration network, indicate an average yearly incidence of 88 patients per practice population presenting with chest pain in 2024 (4). Only 5% of patients presenting with chest pain at the GP's office, have an actual cardiac cause (5). Reliable tools for ruling out an ACS are lacking in primary care (6). The current primary care guidelines therefore advise a fast referral to the emergency department (ED) for further diagnostic workup (6). A diagnostic tool that could reliably rule out an ACS in the primary care, could relieve the ED from possible unnecessary referrals. Point-of-care (POC) high-sensitivity cardiac troponin I (hs-cTnI) testing may offer a valuable diagnostic tool in primary care to reduce unnecessary referrals to the ED. Other POC devices for CRP and D-dimers have already found their way to the general practitioner's office (7).

In a randomized controlled trial (RCT) called the "Point-of-Care high-sensitivity troponin testing in the Emergency Room to assess Myocardial Infarction for Timely discharge (CERMIT)" trial, POC hs-cTnI was compared with the usual central laboratory testing method in the ED (8). The primary and secondary outcome of this trial were the ED length of stay and the amount of 30-day major adverse cardiac events (MACE) respectively.

As part of this CERMIT trial, this substudy investigated the user experience with the Atellica® VTLi Patient-side Immunoassay Analyser and its corresponding hs-cTnI reagent cartridges (Siemens Healthineers, Erlangen, Germany).

This early-phase implementation study is a clinical trial support study that aims to evaluate the user experience of study staff with the Atellica® VTLi POC device and to identify usability barriers and facilitators in a clinical emergency department setting. This was done by not only emphasizing its strong points but also by highlighting any possible weaknesses or limitations, either within the measuring system itself or in how it is used by emergency staff in a clinical context. The next step will be to use these results to improve the user experience of the POC device in the primary care.

METHODS

Study design and population

In a single-centre RCT called the "Point-of-Care high-sensitivity troponin testing in the Emergency Room to assess Myocardial Infarction for Timely discharge (CERMIT)" trial, POC hs-cTnI was compared to the usual central laboratory testing method in the UZ Leuven ED (8). The primary and secondary outcome of this trial were the ED length of stay and the amount of 30-day major adverse cardiac events respectively. Exploratory outcomes were patient satisfaction and user experience. As part of the CERMIT trial, this mixed-methods substudy assessed the user experience with the POC device, namely the Atellica® VTLi Patient-side Immunoassay Analyser and its corresponding hs-cTnI reagent cartridges (Siemens Healthineers, Erlangen, Germany). As a mixed-methods study, both a quantitative and a qualitative evaluation of the user experience with this POC device were performed.

After a professional explanation of the POC device by the manufacturer, all six members of the study staff, with diverse backgrounds in both academic and clinical fields, working at the UZ Leuven ED as part of the CERMIT trial staff from September 2025 until March 2026, were asked to fill out a 5-point Likert scale user experience questionnaire as part of the quantitative analysis. With these same members, think-aloud interviews were conducted as part of the qualitative analysis. None of the study staff had any previous experience with POC devices.

Ethical approval for this substudy as part of the CERMIT trial was obtained from The Ethics Committee Research (EC Research) UZ/KU Leuven on 12/02/2025.

Device characteristics

A meeting held on 23/04/2024 with two Siemens representatives (Ann Lagaisse and Elke Deck) provided a first hands-on experience with the device and insight into potential difficulties while using the device. During this meeting, the technical specifications and the general operation of the device were reviewed and taught. This allowed the user experience questionnaire to be made more accurately. The device is portable, weighing 780g and can be used bedside or docked in the docking station. It has a 4,3-inch colour LCD-touchscreen and an integrated barcode scanner at the back of the device for easy user and patient identification. A cartridge loading area on the front of the device receives the reagent cartridges that are stored between 2-8°C following manufacturer guidelines.

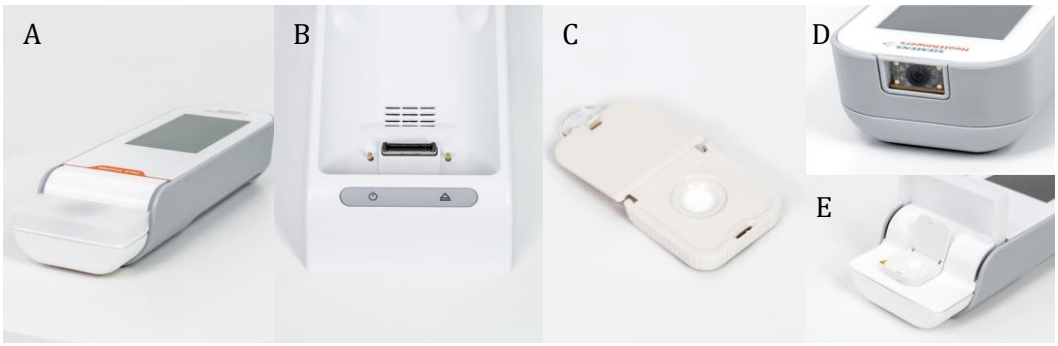


Figure 1 - Atellica® VTLi Patient-side Immunoassay Analyser (Siemens Healthineers, Erlangen, Germany). A. The Analyser. B. The docking station. C. The reagent cartridge. D. The barcode scanner. E. The cartridge loading area (9).

A Smearsafe™ Blood Dispenser device (Typenex Medical, Chicago, IL, USA) was used to apply whole blood samples onto the reagent cartridge. As per the instruction of the representatives, the cannula of the Smearsafe™ device was first inserted into the septum of the lithium heparin tube, the tube was then inverted onto the well of the reagent cartridge and then "milked" to apply between two or three drops of blood onto this well, corresponding to the required blood sample of 30-100 µL. After a mean duration of eight minutes for the analysis of the sample, the results were then wirelessly transmitted to the hospital's laboratory information system ready to be interpreted by the provider.

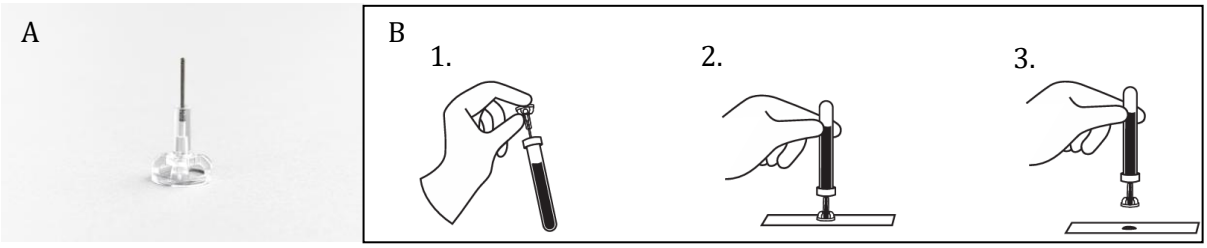


Figure 2 - Smearsafe™ Blood Dispenser device (Typenex Medical, Chicago, IL, USA). A. Blood dispenser. B. Three steps to obtain a drop of blood from a venous blood sample (10).

Quantitative evaluation of the user experience: questionnaire

After the meeting with the Siemens representatives and using their input, a 5-point Likert scale (1-5) user experience questionnaire was created, modelled after the form that was recently used in a study that compared user-friendliness of four different C-reactive protein point-of-care devices (11). The questionnaire consisted of 39 statements relating to four different topics: the docking station, the analyser itself, the reagent cartridge and the general process (Appendix 1). After each statement, room was provided to write an additional remark. Data was then manually extracted and entered into Excel. The data was analysed using the concepts of central tendency and variability as described by Boone and Boone 2012, where the median was used to provide an overview of possible usability problems (12). The optional remarks were then used to help explain possible lower scores.

Qualitative evaluation of the user experience: think-aloud interviews

The think-aloud method is a qualitative research method in which participants speak aloud any words in their mind while completing a task (13). The traditional concurrent think-aloud method, as first introduced by Ericsson and Simon in 1993, focused on continuously verbalizing the thought process while performing a task with only a minimal intervention by the interviewer, was chosen over more interactive versions of the method (14). This minimal intervention was to ensure that the participant's natural thought process and overall task performance was not influenced and the quantity and quality of the usability problems discovered was maximized (15, 16).

Before each interview, the participants were given simple but precise instructions based on the guidelines by Ericsson and Simon (14). The evaluator explained that the purpose of the interview was to gain insight in their thoughts and user experience while using the device and not to score their performance using the device. They were asked to verbalize their thoughts continually without filtering or explaining them, even if their thoughts were not complete sentences. The evaluator did not intervene unless the participant became silent for a duration longer than fifteen seconds. The evaluator would then tell the participant to keep thinking aloud

(14, 17). A pilot think-aloud interview was performed by the author and his daily study supervisor. A practice run was held before the actual interview to allow for a possible correction of the participants think-aloud performance and to ensure each participant fully understood the think-aloud assignment (17). The participants were asked to verbalize their thoughts while tying a knot in their shoelaces before starting the actual think-aloud interview with the POC device.

All think-aloud interviews were first transcribed in Dutch by a locally run AI-assisted transcription tool called Audacity/OpenVINO. All transcriptions were manually checked, supplemented and then translated into English by the author. A naturalized transcription approach was used where every hesitation, every “uh”, “ah” or pause of one second or longer was included in the transcription protocol (TAP) (18). This was done to best evaluate the usability of the product and to capture each student’s cognitive load. The transcriptions were then divided into segments by the author coinciding with a single thought process. Each of these segments was then coded by the author following a top-down custom coding scheme based on the framework provided by Kushniruk and Patel (Appendix 2.2) (16, 19). To better compare the results of both the quantitative and the qualitative analysis, a secondary code related to the four topics of the questionnaire was given to each segment (i.e. the docking station, the analyser itself, the reagent cartridge and the general process). The frequency of each code was then analysed to find possible usability problems, using the secondary code to link them to the questionnaire. The original Dutch transcription protocols and their English translations can be found in the appendix.

RESULTS

Quantitative analysis: questionnaire

Six questionnaires were filled out by members of the CERMIT study staff at the UZ Leuven ED. The results were summarized and subdivided by topic into 4 different tables: docking station, analyser, reagent cartridge and general process. For each question, the median of the given answers on the 5-point Likert scale from the six students was calculated, as shown in Table 1.

Docking station

Three questions have a median score lower than four and two questions scored 5/5. The indicator lights are not always clearly visible, as remarked by one student: *"The intensity of the lights should be higher".* There are no remarks as to why it is not always easy to understand when the device is plugged in. The charging speed of the docking station scored 3/5, three different students remarked that they never experienced a low battery: *"I have never had an empty battery to know how fast it charges".* Docking the analyser in the docking station and reading the screen when it is docked, received a high score of 5/5.

Analyser

All questions had a remarkable high score of four or more out of five. Nevertheless, two students remarked that typing letters using the touchscreen is sometimes difficult: *"Inserting letters is more difficult (like an old cellphone)"* and *"It is much faster"* (to use the barcode scanner compared to typing).

Reagent cartridge

Five questions received a score lower than four and no questions had a perfect score. Inserting the Smearsafe™ device into the specimen tube scored 3,5/5, as explained by one student: *"You need to apply some pressure before the needle enters the tube".* Three questions about filling the cartridge with blood and evaluating whether it is the correct amount, received a score of 3,5 or lower (Question 5, 6 and 7). Three students independently gave the following remarks: "*Depending on how fast the blood can be milked out the heparin tube*", "*Sometimes it is hard to see how much blood has been transferred onto the cartridge, while doing it",* "*You can see it, but it is not easy*". Lastly, closing the cartridge lid received a median score of 3,5/5. One student remarked: "*You need to apply some pressure and make sure it clicks*".

General process

Three questions received a score lower than four and no questions had a perfect score. Preferring to use the analyser when docked scored the lowest score, with 2/5. Two students remarked the following: "*When it is docked, it is closer to the wall and harder to read",* "*It is easier to use the analyser when it is not docked in the docking station*". Whether it is clear how to respond to an error code, received a score of 3,5/5. One student remarked: "*In the case of invalid error code, nothing is specified as to why it is invalid".* The acceptability of the cartridge failure rate received a score of 3,5/5. One student remarked: "*I only used the analyser for one month, the duration that I participated in the study*".

Table 1 – Results of the questionnaires showing the median score of each question based on the scores given by the six study staff members.

Docking station (DS)	Median
1. Docking the analyser is easy.	5
2. Indicator lights are clearly visible.	3,5
3. Easy to understand when DS is not properly docked.	4
4. Easy to understand when DS is plugged in.	3,5
5. Screen is readable when docked in the DS.	5
6. DS charges the analyser quickly.	3
7. Easy to upload results to the hospital information system.	4
Analyser	
1. Starting the analyser is easy.	5
2. Self-test duration time is acceptable.	4
3. Instructions on analyser are clear.	5
4. Reading the results is easy.	5
5. The touchscreen is responsive.	4
6. Screen is easy to read under different lighting conditions.	4
7. Barcode scanning of user-ID is easy.	4,5
8. Barcode scanning of patient-ID is easy.	4,5
9. Barcode login preferred over manual login.	5
10. Easy to clean analyser.	4
11. Opening the cartridge loading area is easy.	4,5
Reagent cartridge	
1. Opening packaging is easy.	4
2. Unloading cartridge from packaging is easy.	4
3. Inserting cartridge into loading area is easy.	4
4. Inserting Smearsafe device into specimen tube is easy.	3,5
5. Filling cartridge with correct amount of blood is easy.	3,5
6. Seeing if cartridge is overfilled with blood is easy.	3,5
7. Seeing if cartridge is underfilled with blood is easy.	3
8. Closing the cartridge lid is easy.	3,5
9. Applying blood sample onto the cartridge is easy.	4
General process	
1. The manual is sufficient to operate the device.	4
2. Symbols are clear & unambiguous.	4
3. Logging in is easy.	4
4. Number of preliminary steps is acceptable.	4
5. Cartridge stocking is easy.	4
6. Using the analyser when docked is preferred.	2
7. Duration of test analysis is acceptable.	4,5
8. Easy to interpret error code.	4
9. Correctly responding to error code is clear.	3,5
10. Cartridge failure rate is acceptable.	3,5
11. Easy to remember to log out.	4,5
12. Performing a patient test is easy.	4

Qualitative analysis: think-aloud interviews

Six think-aloud interviews were performed at the UZ Leuven ED on 18/09/2025 and 03/03/2026 by the same study members who filled out the questionnaires. The results of the transcription process are shown in Table 2. Only three of the four used topics are represented, because all study members performed the think-aloud interview with the analyser outside of the docking station.

Analyser

A cognitive error was experienced by two study members regarding the waiting time between inserting the cartridge and the start of the analysis. Confusion occurred because the waiting time was too long. Four study members gave a positive evaluation regarding the readability of the results on the screen. Three study members gave a positive evaluation because the analyser clearly indicated when the cartridge was inserted correctly.

Reagent cartridge

Two study members expressed a negative emotion because closing the cartridge lid was difficult. Four study members expressed a negative emotion or evaluation when trying to see if the cartridge was adequately filled with blood. In contrast, two study members gave a positive evaluation regarding the insertion of the cartridge into the analyser.

General process

Two study members experienced a cognitive error resulting in confusion because it was not clear that they were already logged in. Two other study members experienced a cognitive and physical error because using the keyboard was described as not user-friendly (difficult to write capitalized letters and to remove wrong input).

Table 2 – Most important coded segments organised by topic. Each staff ID-number (1-6) represents a study staff member who experienced the coded segment.

	Coded segments	Staff ID
Analyser	Positive emotion - the analyser indicates clearly how to proceed	2
	Physical error - the screen seems to automatically dim too soon after receiving the result (making it harder to read)	3
	Cognitive error - User finds the waiting time between inserting the cartridge and the start of the analysis too long, and this causes confusion	5, 6
	Positive evaluation - the result is clearly indicated on the screen	1, 2, 3, 4
	Positive evaluation - the analyser clearly indicated if the cartridge is inserted correctly and is validated	2, 3, 5
Reagent cartridge	Negative emotion - user finds it difficult to close the cartridge	1, 6
	Negative emotion/Evaluation - user finds it difficult to see when the cartridge is adequately filled with blood	2, 4, 5, 6
	Negative emotion - user finds it difficult to insert Smearsafe device into septum of the heparin tube	5
	Positive evaluation - inserting the cartridge into the analyser goes smoothly	2, 6
	Positive evaluation - User finds it clear to see when the cartridge is full	3
General process	Physical error - barcode scanner does not immediately scan	1
	Cognitive error + negative emotion - user doesn't know how to proceed after failed attempts to scan patient ID	1
	Physical error - button on touchscreen does not immediately respond	1
	Cognitive error - it is not immediately clear to the user that they are already logged-in	2, 3
	Cognitive + physical error - Logging-in while using the keyboard is not user-friendly (difficult to write capitalized letters and to remove wrong input)	4, 5
	Cognitive error - it is not clear how to go from manual user-log in to homepage to scan patient-ID	5
	Cognitive error - user accidentally aborts test while trying to go back to the homepage	5
	Positive evaluation - Scanning of the barcode of the user ID goes smoothly	6

Mixed-methods comparison of quantitative and qualitative results

Analyser
The following statement: "Reading the results on the analyser is easy" received a high median score on the Likert-scale of 5/5. The results of the think-aloud interviews mostly agree. During the interview, four study staff members exclaimed positive evaluations about the readability of the results on the analyser. In contrast, one study member reported that the screen sometimes dims too quickly after reading the result, making it harder to read again. This remark was not reflected in the perfect median score of the quantitative analysis.

"The touchscreen is responsive" received a high average median score of 4/5 on the Likert-scale. In contrast, one study member experienced a physical error where the button of the touchscreen did not immediately respond to their input.

"Barcode scanning is easy" received a score of 4,5/5 on the Likert-scale. One study member exclaimed a positive evaluation about the ease of scanning the barcode while another member experienced a physical error because the scanner did not immediately scan the barcode.

Reagent cartridge
Both the qualitative and quantitative analysis indicate that filling the cartridge with an adequate amount of blood and seeing whether it is over- or underfilled, is difficult. They also agree that closing the cartridge lid can be difficult. Both results show that inserting the Smearsafe™ device into the septum of the heparin tube does not always go smoothly.

General process
"Logging in is easy" received a high median score of 4/5 on the Likert-scale. However, two study members experienced a cognitive error during the think-aloud interview because it was not immediately clear to the user that they were already logged in. One member found it difficult to go from manual user-login back to the homepage to scan the patient-ID.

"Duration of test analysis is acceptable" received a high score of 4,5/5 on the Likert-scale. Two study members experienced a cognitive error while waiting for the start of the analysis after inserting the cartridge into the analyser because the waiting time was longer than they anticipated and it was not adequately shown on the screen.

Table 3 – Joint display of the quantitative and qualitative results and their concordance.

Quantitative analysis (median Likert-scale score)	Qualitative analysis: coded think-aloud segment (frequency of segment)	Comparison
Instructions on analyser are clear. (5)	Positive emotion - the analyser indicates clearly how to proceed (1)	Agree
Reading the results is easy. (5)	Positive evaluation - the result is clearly indicated on the screen (4)	Agree
	Physical error - the screen seems to automatically dim to soon after receiving the result (making it harder to read) (1)	Disagree
The touchscreen is responsive. (4)	Physical error - button on touchscreen does not immediately respond (1)	Disagree
Barcode scanning of user-ID is easy. (4,5)	Physical error - barcode scanner does not immediately scan (1)	Disagree
	Positive evaluation - Scanning of the barcode of the user ID goes smoothly (1)	Agree
Barcode login preferred over manual login. (5)	Cognitive + physical error – Logging in while using the keyboard is not user-friendly (difficult to write capitalized letters and to remove wrong input) (2)	Agree
Inserting cartridge into loading area is easy. (4)	Positive evaluation - inserting the cartridge into the analyser goes smoothly (2)	Agree
	Positive evaluation - the analyser clearly indicated if the cartridge is inserted correctly and is validated (3)	Agree
Inserting Smearsafe device into specimen tube is easy. (3,5)	Negative emotion - user finds it difficult to insert Smearsafe device into septum of the heparin tube (1)	Agree
Filling cartridge with correct amount of blood is easy. (3,5)	Negative emotion/Evaluation - user finds it difficult to see when the cartridge is adequately filled with blood (4)	Agree
Seeing if cartridge is overfilled with blood is easy. (3,5)		Agree
Seeing if cartridge is underfilled with blood is easy. (3)		Agree
Closing the cartridge lid is easy. (3,5)	Negative emotion - user finds it difficult to close the cartridge (2)	Agree
Logging in is easy. (4)	Cognitive error - it is not immediately clear to the user that they are already logged-in (2)	Disagree
	Cognitive error - it is not clear how to go from manual user-log in to homepage to scan patient-ID (1)	Disagree
Duration of test analysis is acceptable. (4,5)	Cognitive error - User finds the waiting time between inserting the cartridge and the start of the analysis too long, and this causes confusion (2)	Disagree

DISCUSSION

Key findings

During the think-aloud interviews, all six study members were able to complete a full analysis with the Atellica® VTLi Patient-side Immunoassay Analyser without any major problems. Overall, this was also reflected in high median scores on the Likert-scale of the questionnaires on all four topics. However, results show there are also some key areas where the device could be improved upon.

Strong points

Instructions on the analyser are clear and easy to understand, as shown by a score of 5/5 on the Likert-scale. The think-aloud interview also confirms this good evaluation. The readability of the screen also received the maximum score and four study members expressed a positive evaluation about the readability during the think-aloud interview.

The responsiveness of the touchscreen received a good score of 4/5 on the Likert scale. In contrast, one study member reported that the button on the touchscreen did not immediately respond to their input. On average, the results show the touchscreen is adequate to perform the task. The remarks made by the study members and the physical error could likely be explained because study members are used to more modern and responsive touchscreens on their smartphones.

Both analyses agree that logging in with the barcode scanner goes smoothly and is preferred over manual login. One study member experienced a hiccup where the barcode scanner did not immediately scan. This seems to be a one-off incident because another study member expressed the exact opposite and the average Likert-scale score was 4,5/5.

Inserting the cartridge into the cartridge loading area goes smoothly, as shown by a good score of 4/5 on the Likert-scale and a good evaluation by multiple study members during their think-aloud interview.

Areas for improvement

The readability of the screen was good. However, one study member indicated that the screen dimmed too soon after receiving the results. Increasing the duration by only a few seconds before dimming the screen could easily resolve this issue without majorly reducing battery life.

Both analyses agree that logging in with the barcode scanner goes smoothly. The manual login is more difficult as remarked by one study member, who explained that the keyboard is like using an old cellphone (where multiple button presses are needed to type one letter). During the interview, two study members found it difficult to write capitalized letters and to remove wrong input. Adjusting the keyboard for manual login to be more like a keyboard from a modern smartphone could be a huge improvement.

An interesting contradiction between both analyses is found in the process of logging in. While the user-experience questionnaire had a good average median score of 4/5 on the Likert-scale, two study members did not see that they were already logged in into the device which caused confusion. Another study member did not know how to go from manual user-login back to the homepage to scan the patient-ID. The study members gave a high score, but the process could

still be improved by more clearly indicating or confirming that the user is logged in. This way, identification mistakes can be avoided.

After the mixed-methods comparison, the most obvious improvement could be made with the reagent cartridge. Both analyses show that closing the cartridge lid and adequately filling the cartridge with the correct amount of blood is difficult. Both analyses also indicate that inserting the Smearsafe™ device into the specimen tube proved to be difficult, as shown by a lower Likert-scale score of 3,5/5 and one study member who explicitly expressed a negative emotion while trying to insert the Smearsafe™ device into the specimen tube. These difficulties could lead to improperly filled cartridges and wrong analyses or errors because of it.

The overall duration of the waiting time is acceptable, as shown by a high Likert-scale score of 4,5/5. However, two study members indicated that after inserting the cartridge into the analyser, the waiting time before the start of analysis was longer than they anticipated which caused confusion. Displaying more clearly that the device is about to start the analysis could improve the workflow.

Implications for clinical practice
Based on this mixed-methods analysis, the Atellica® VTLi Patient-side Immunoassay Analyser POC device is ready to be trialled in a clinical context with nurses and physicians in the ED. Some improvements as discussed above, can be made to improve workflow with the device. Based on this user-experience results, no major problems are expected while using it in the ED. Further research needs to be performed to assess the usability in primary care.

Strengths and limitations

The questionnaires and think-aloud interviews were performed in a limited time-period of seven months. Even though every single possible study member candidate filled out the questionnaire and was interviewed, the limited time frame resulted in a limited number of six staff members recruited for the study. A higher number of study members could have possibly resulted in the discovery of more usability problems. Because of the limited number of staff members, this study is not meant for generalisation but is to be seen as a study to detect possible problems in an early phase.

As a substudy of the CERMIT-trial at UZ Leuven ED, this study involved study staff with diverse backgrounds in both academic and clinical fields. However, only personnel involved in the clinical trial were included, and no frontline clinical staff such as nurses or physicians, who represent the primary end users of point-of-care testing devices, were assessed. While the results of this study are useful, it needs to be seen as an early-phase implementation study. The actual usability experience of nurses and physicians in a clinical context needs to be investigated further.

The interviews were segmented and coded by only one author. This could lead to coder bias because inter-rater reliability could not be examined. The same author developed a custom, but not scientifically validated user-experience questionnaire, modelled after the form that was recently used in a study that compared user-friendliness of four different CRP point-of-care devices. The unvalidated questionnaire could lead to response bias and interpretation bias. It is recommended that a future study uses a validated questionnaire, such as the System Usability Scale (SUS), together with a custom questionnaire to minimize the risk of bias.

CONCLUSION

This mixed-methods study shows that the Atellica® VTLi Patient-side Immunoassay Analyser and its corresponding hs-cTnI reagent cartridges score well on usability and are ready to be trialled in a clinical context with nurses and physicians in the ED. No major problems were identified, but some adaptations can still be made to improve workflow with the device. This is important for possible future research that tests its usability in primary care.

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