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Name:	Smart system for the management of Heart Failure in older adults
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D4.2 Pilot Evaluation Report

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Partners involved (leader in bold): **REM,** VPS, FhP, VIGS, SN, CHSJ, FMUP, SmH, SGE
Authors: Peter van Vooren (REM)

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[1] L = Legal agreement, O = Other, P = Plan, PR = Prototype, R = Report, U = User scenario

[2] PU = Public, PP = Restricted to other programme participants (including the Commission Services), RE = Restricted to a group specified by the consortium (including the Commission Services), CO = Confidential, only for members of the consortium (including the Commission Services)

Partner list

Nr.	Partner name	Short name	Org. type	Country
1	Fraunhofer AICOS *(coordinator)*	FhP	R&D	Portugal
2	Centro Hospitalar São João	CHSJ	End-U	Portugal
3	Verhaert New Products & Services NV	VPS	SME	Belgium
4	Remedus	REM	SME	Belgium
5	Seniornett Norge	SN	End-U	Norway
6	LifeonKey	LoK	SME	Israel
7	VigiSense S.A.	VIGS	SME	Switzerland
8a	KempenLIFE	KLF	End-U	The Netherlands
8b	Stichting Gezondheidscentra Eindhoven	SGE	End-U	The Netherlands
9	Stichting Smart Homes	SmH	R&D	The Netherlands
10	Faculdade de Medicina Universidade do Porto	FMUP	R&D	Portugal

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2.1	15.11.2018	REM	Final Review	Peter van Vooren

		Approved by REM

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Glossary

SBC: SmartBEAT Companion

VSS: Vital Signs System

MIU: Medical Inference Unit

CGP: Caregivers Portal

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1. Background of SmartBEAT Pilot Test

1.1. Objectives of the Pilot Test

The objectives of the pilot test are to evaluate usability and user satisfaction of the vital signs system (VSS) in combination with the SmartBEAT Companion (SBC) app to be used by senior CHF patients, and the Caregivers Portal (CGP). In addition to an intuitive and self-explanatory interface, the system should also fit in with existing infrastructure and current care processes in order to avoid mistakes and time loss.

The outcomes of the pilot will report usability issues, other remarks, and suggest changes for the SmartBEAT solution. The prototype will be refined accordingly, in order to end up with a high-quality solution before introducing the SmartBEAT technology for the field trial in the daily lives of real users.

It should be noted that the informal caregiver is seen as a passive user and will not be evaluated. It is asked to the patient to bring a family member voluntarily so it can give him support during the first days of use and/or when required. Since the app targets usability and satisfaction of HF patients, then it was considered not relevant to the main objectives.

1.2.Description of the SmartBEAT components under evaluation

The SmartBEAT pilot will evaluate the CGP portal (Remecare + eHealthStudio) and the SBC app + sensor kit. The devices to be used are depicted in **Error! Reference source not found.**. The Remecare will be evaluated in Belgium and the Netherlands, and the eHealthStudio will be evaluated in Portugal and Norway.

Table 1 SmartBEAT Sensor kit

Device	Name	Observations
Weight Scale	Yunmai Mini M1501	
Blood Pressure Monitor	Urion U80E	
Bracelet	Mio Fuse	
Oximeter	Jumper JPD-500F	
Smartphone	Wiko Pulp Samsung A3	SmartBEAT app installed

1.3. Elements of the SmartBEAT Pilot Test

1.3.1. Pre-User Testing

The Pre-User Testing is comprised of the Technical Evaluation Test and the Heuristic Evaluation.

- **Technical Evaluation**

In the pre-user testing phase, people in the different pilot countries will act as patients using the SmartBEAT solution. These people will perform all daily tasks patients would do, in order to check for its proper functioning. This test will challenge the SmartBEAT system, including faulty usage, varying context factors, reliability and remote services.

Three elements from WP3 of the SmartBEAT system were tested during 1 week. Each element belonged to different partners (VPS, REM and FhP) and it was required not to be directly involved in the development and integration of the system.

- **Heuristic Evaluation**

The heuristic evaluation helps identifying usability problems in the user interface. The simplicity of heuristic evaluations is beneficial at the early stages of design. It requires a low number of experts, and can be accomplished in a matter of days.

Besides evaluating the SmartBEAT interfaces on general usability heuristics, the expert reviewers will also verify accessibility of the SmartBEAT Companion app for older adults with minor or major age-related limitations.

1.3.2. Pilot Test Group Session for Patients

In the pilot test session, senior CHF patients are asked to perform a number of pre-defined tasks using a think-aloud protocol, in order to find out what constitutes an obstacle to effective and efficient interaction with the SmartBEAT Companion app and the vital signs system, and to identify usability problems. After individually using the SmartBEAT technology, patients are asked to fill out a questionnaire to report about their experiences. The pilot test session is concluded with a group discussion, examining topics as overall perceived usefulness, usability, acceptance and suggestions for optimization.

1.3.3. Pilot Test Two-week Patient Home Testing

For two weeks, patients will use the SmartBEAT Companion app and vital signs system at home, doing the morning ritual daily. Goal is to evaluate (technical) performance of the system, and to check the impact of human (senior) behaviour on system reliability. After these two weeks, each patient is requested to fill out a short questionnaire to evaluate user experience and effort of the daily process.

1.3.4. Pilot Test Health Care Professionals

The pilot tests with care professionals are dedicated to the evaluation of the SmartBEAT caregivers portal. First, a demo is organized to show the portal and its functionalities. Second, professionals are asked to evaluate the current version of the system; they are requested to perform a number of pre-defined tasks, check whether the menu is logical and complete, and report about their findings in quantitative and qualitative ways. Besides self-administered questionnaires and open feedback forms, experimenters do observations and ask questions in a semi-structured way.

2. SmartBEAT Pre-User Testing

2.1. Technical Evaluation

The system worked well, but it was detected major Bluetooth connectivity issues, particularly with the bracelet and weight scale. As a result, the development team – particularly for the SBC – made several changes to guarantee a better performance and connectivity between the sensors.

The Portal was not evaluated at this phase.

2.2. Heuristic Evaluation

SBC:

- **Overall results:**
  - At first sight, the SmartBEAT Companion app UI looks attractive, intuitive and consistent. When digging a little deeper, there are many small issues and inconsistencies that together can improve user experience quite a lot (without too much effort).
  - There are many connection problems to link the Bluetooth devices. Sometimes they seem to work, sometimes they don't. In addition, the smartphone HR measurement seems completely unreliable.

- **Home page**
  - Current home page only displays the morning ritual measurement functionality which is only a small part of the SBC, and you get the immediate instruction to start measuring.
  - When all measurements are taken, the SBC says "goodbye".
  - No motivation to check agenda, see history, read messages, etc.
  - To direct users directly to the MEASURE part, every day the app could be opened automatically, showing the measure screen as a trigger to start the morning ritual.
    - After measuring, user should be presented with an overview of the day (e.g. 1 new messages, check progress, appointment today,…)

- When starting the app manually, however, the app should display all functionalities. The home page should be the menu.

- **Menu** looks nice. The structure and different menu items, however, are not completely clear.
  - Measure, not including pedometer and continuous HR.
  - Parameters (weight, blood pressure,…) vs. device (pedometer)
  - History presents measurements of the morning ritual and the continuous measurements. Move history after all measurements.

- **Navigation** seems to be lacking some logic. Especially the meaning of the Android Back button, the SBC Back button and the SBC Cancel button.
  - BACK = BACK. Both buttons should have an identical effect in all cases.
  - Clear distinction between BACK and CANCEL
  - BACK (1 step back in process)
  - CANCEL (quit current process)

- **Fonts** are easy to read. Font size, however, is repeatedly too small, and in some cases background and text colour lead to low contract.

- **Instructions** in the interface are simple and clear. On the other hand, the use of exclamation marks does not give a friendly impression.
  - Pick one to begin!
  - DEVICE NOT FOUND. Please make sure that the device is on!
  - **Good morning, José Luis. Let's start today's measurements. Please remember to measure all parameters presented below.**
  - Instructions should be more clear and precise.
    - Which finger to put in oximeter, which direction?
    - Put cuff on which arm?
    - Explicitly mention "weight scale" instead of device.

- **Icons and images:**
  - In the measurement sections, patients are presented with images of the devices. In this way, they do not have to remember which device to use for which parameter. They can just see.
  - Sometimes, however, an image is missing, or not always used correctly.
  - Questionable whether the "faces scale" has added value.

- **Consistency measurements: To make the SBC app UI user-friendly, consistency is really important. Each measurement process should look similar, and each service should be** used in the same way. In this way, people learn how to use the system much more rapidly.
    - Images can help to understand the 4 process steps:
        - PREPARATION image or even picture of the device without user
        - START image of user with device
        - MEASURING consistent loader
        - RESULTS icon from menu bar + measurement data
    - Other inconsistencies:
        - Button labels (NEXT, START, CANCEL, BACK)
        - Button location
        - Grey-out buttons
        - Feedback (loaders, message,…)

CGP Portal – REM

- **Overall conclusions:**
    - At first sight, the Remedus Caregivers Portal (CGP) for SmartBEAT looks professional and well consistent. When digging a little deeper, however, it becomes clear that the systems covers many functionalities and that the structure is quite complex.
    - This complexity might be required by care professionals, and they can have education to learn how to use the system. This portal, however, seems to go beyond the scope of a portal for patients and informal caregivers.
    - It is very difficult to build one portal to be used by different user groups, as all of them have different requirements related to their needs and skills. The structure definitely needs to be reconsidered very carefully, and users need to be supported very well to handle this.
    - Limited number of errors/bugs.

- **Home page:**
    - Professional environment.
    - Not the home page a patient would like/expect to see when logging in into a patient portal.
    - Separate log-in and separate home page for different user groups?

- **Interface:**
    - The current interface makes use of a fixed colour scheme. This gives the interface a consistent look and feel at first sight.
    - However, inconsistencies in…

        - buttons
        - filters/selection
        - drop-down menus
        - checkboxes

- **Different levels of menus:**
    - Horizontal vs. Vertical
    - Text-based vs. Icon-based
    - 4 levels + pop-ups
    - Different items are presented in both levels of the menu.
        - Registratons in both
        - Alarms in both
    - Confusion buttons/highlights

- **Order of presentation:** Users can be supported in using the platform by presenting them different kinds of content in the most suitable order. People are used to read from the top-left to the bottom right. In that sense, it is important to present content accordingly:
    - Top and left (menu bars)
    - Content part
        - Upper left (instruction)
        - Central (content)
        - Bottom right (decision, action, button)
    - Lay-out of forms:
        - One linear form (top-bottom) with expandable sections.
        - Logic order, and clear subsections/categories

CGP Portal – LOK

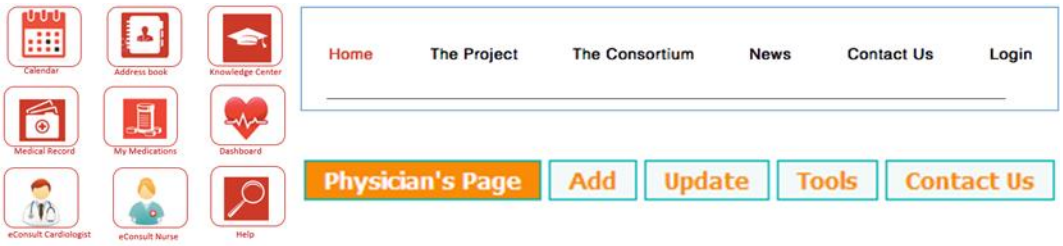
- **Overall conclusions:**
    - The LifeOnKey Caregivers Portal (CGP) is in a premature stage, and much work is still needed to realize it. In addition, a lot of attention needs to be paid at interface design to make it easy to use. Consistency and usability are key issues!
    - Also this CGP is planned to be used by patients and informal caregivers. It is very difficult to build one portal to be used by different user groups.
    - No error or bug reporting, as the heuristic evaluation is based on mock-ups.

- **Look and feel:** The current interface is a mix of two major design themes – being the SmartBEAT website interface (red) and LifeOnKey colour scheme (blue-orange) – and some additional designs.

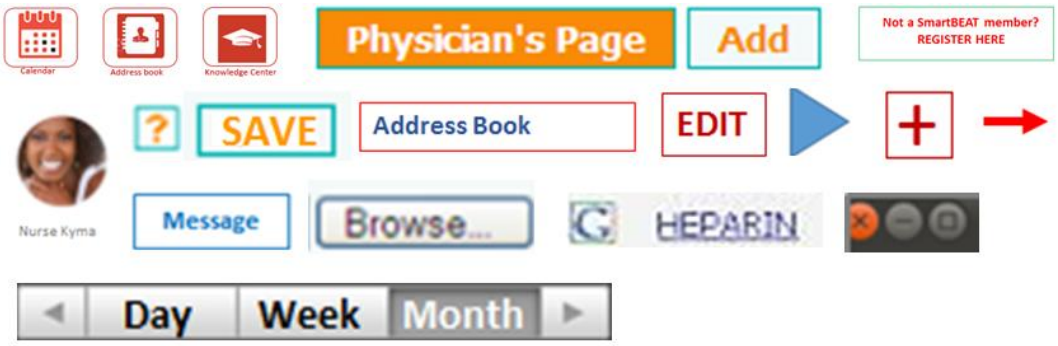
- So far, the mock-ups mainly focus on functionality, but many steps need to be taken to realize an interface consistent in terms of design and interaction.
- Apart from colour schemes… there is a variety in icon-based and text-based designs.

- **Log-in:** The log-in starts from the SmartBEAT project website.
  - No importance for users to know that SmartBEAT is an AAL project, which partners are involved, etc.
  - Mismatch in design SmartBEAT vs. LifeOnKey
  - 3 different user groups, and only two log-in possibilities
  - Different content, different look and feel
  - Two (or three) log-in boxes might confuse the user. They do not read all text but start typing when they see "username".
  - Different URL's for different types of users, presenting only one box
  - Have a log-in screen with 3 buttons (patient, informal caregiver and care professional)

- **Consistency menus:**



- **Consistency buttons:**



- **Menu structure and navigation:**
  - Icon-based menu: matrix of 9 – vertical, 4 + homepage (inconsistent)
  - Text-based sub menu horizontal
  - In order to prevent people from getting lost, they should be supported by providing them with feedback about their virtual location in the menu structure.

- No text-based breadcrumb, but there are some hints to visualize where the user is. (highlight current menu item).

- This can be improved by also changing the colour of the active icon and/or by applying a tab page design.

3. Pilot Test Group Sessions for Patients

3.1. Norway

The session took place in Oslo 7th June 2017. Three patients (elderly men with hypertension) participated. All the three have a positive attitude towards technology in general and have IT knowledge well above average. They are also experienced users of smartphones.

A set of equipment (Weight scale, blood pressure monitor, oximeter, the bracelet / MioFuse and the SBC) were distributed to each participant for individual testing including carrying out of the morning ritual. The session took about 4 hours, including a ½ hour brake. It is probably possible to do it in 2 hours if full testing of the equipment, including Bluetooth pairing, etc has been done prior to the session. It is also important to place the three sets of equipment (SBC and sensors) apart from each other – preferably in different rooms, and make sure that they are not mixed during the session.

The connection to the LifeOnKey part of the system was not up and running during the test. Consequently, features taken care of by this part (medication, messages, appointments, alarms, etc) was not tried out.

3.1.1. Usability Testing (NO)

Since the equipment had not been through a full technical testing prior to the session, even for these persons with IT experience, quite some time were spent with trial and error to have the four sensors play together with the SBC. The first version of the Quick User Guide was used, but did not give enough help especially regarding the MioFuse.

The Wiko Pulp is a general smartphone with lots of other possibilities having nothing to do with the SmartBEAT app. This created some confusion until they got familiar with the device. For persons with less experience it may become a serious drawback.

However, after the first period with trial and error mainly caused by unfamiliarity with the equipment – and some technical problems linked to connection between sensors and the SBC – the trial went satisfactory.

3.1.2. Individual Questionnaire (NO)

- **Usability**
  The overall feedback on usability is somewhat above average (score 3). No specific part came out significantly more positive than others. However, there is a slight positive tendency for "effectively/efficiently completing tasks and scenarios" (Q3, Q4 and Q5). The most negative results are on messages to help fixing problems and how to recover easily and quickly when you have made a mistake (Q8 and Q9).
- **Perceived Control**
  In short, the participants felt they had pretty good control (score 2-3). None felt like giving up at some time during the test (score 6 on Q27), and they did not feel discouraged during the test (average core 5,3 on Q25)
- **User Experience**
  The message is that the user experience was not very good – however, above average (score 3).

3.1.3. Group Discussion (NO)

- **Usefulness**
  Using the SBC with sensors for the morning ritual – following the instructions given on the screen - was found pretty self-explanatory. The *Daily measurement screen* and the way to use it for the various measurements was found very easy to understand – even without the user guide. The same applies for the various parts of the main menu. They had no problem understanding the measurement history and how to read it.
  However, the usefulness of the MioFuse is doubted. It is clear doubts about patient's willingness / ability / memory to every evening switch off – connect for charging – keep close to SBC to allow transfer of data. And again, in the morning remove from charging – remount on arm and switch on. It is also a bit complex to control the switching on and off and the wrist ban is too tight for some arms.
  For the session, the first version of the SBC Quick User Guide was used. Feedback on that was given, and a new version was generated taking these comments into account.
- **User acceptance**
  Unfortunately, the user acceptance was significantly influenced by a feeling of instability/unpredictability. The app sometimes - apparently without reason - locked itself. It was necessary to log out and log in again or sometimes switch off and on the phone to continue. Also, frustration caused by connection problems with the weight scale and with the usage of the MioFuse counted. In such cases neither the app itself, nor the User Guide was of much help.

  If these problems are removed it is good reason to believe that user acceptance would have been given a high score. But removing these problems is crucial!

- **Comments and suggestions**

Below are some more detailed comments and suggestions as a result of the group discussion:

  - All that can be done to ensure that when switching on the Wiko the SBC app symbol appears on the start screen – preferably with an app symbol greater than the others - and red background colour must be avoided**.**
  - The "upper right corner menu" on the SBC can be avoided by moving *Settings* and *Log out* to a "hidden" part meant for a person with the Administrator role (the patient / main user may also have this role if she / he is capable). *Cancel measurement* can be moved to the main menu. (Or is *Cancel measurement* really necessary since taking a new measurement will automatically override the previous one?)
  - It was also discussed whether when opening the app, the first page coming up should be the main menu. But a hybrid solution is perhaps better: When opening the app in the morning for the morning ritual the *daily measurement screen* should appear. In all other situations, it should be the main menu.
  - The weight scale.
    Some problems with the Bluetooth connection occurred; may be caused by keeping devices too close to each other. They seemed to disappear. Waiting up to a minute for the connection to the SBC feels frustrating.
  - Blood pressure monitor.
    A detailed instruction on how to mount the cuff is needed. A rough drawing is not enough and the user guide following the equipment is not easy to read. Perhaps a separate detailed description could be produced (it will probably be too detailed for the Quick User Guide).
  - The participants expressed willingness to share data with others (Formal and informal carers) – but only when approved by themselves.
  - It is seen as positive that services like messages and appointments are included.

3.1.4. Summary for Norway

Stability problems with the SBC app and some technical problems that remained also after an initial trial and error phase caused a relatively negative response among the participants. However, from the observer position it is a clear feeling that the participants liked the system as it is specified and had a clear interest in not only trying it out for a couple of weeks but even could imagine themselves as one of the future users – **if and only if the system lives up to its ambitions.** Important findings:

- A system with these specifications will definitely be of interest also for persons with only light heart problems like hypertension.
- Willingness to spend some minutes every morning to do measurements – without frustrating instability and waiting time – declared.
- SBC instability problems must be removed and messages giving easy-to-understand assistance when things go wrong must be implemented.

- The MioFuse creates too much frustration – difficult and uncomfortable to use – must be replaced.

3.2. Belgium

The session took place at Remedus office, Boomsesteenweg 44 2630 Aartselaar on 7 February 2018 at 15h00. It had a duration of 2 hours. The participating group of patients was composed of 2 females and 1 male, accompanied by his informal caregiver (spouse). The selected patients are comfortable with smartphones and have a positive attitude towards health apps.

A set of devices (smartphone with SBC app, weight scale, blood pressure monitor, oximeter and bracelet Mio Fuse) was distributed to each participant for individual testing including a manual about the devices and the morning rituals. All devices were paired and tested before the session. One smartphone did not receive pop-up reminders, this was reported to Fraunhofer and solved during the following week.

The feature of medication intakes was tested during the Belgian pilot phase.

3.2.1. Usability Testing (BE)

All patients understood the main screen with the daily routine easily. The patients managed to navigate through the app and the menu rather easily. Overall the colour of the SBC app and the icons were well liked. Also the font of the text was considered ok.

One patient wondered why the medication intake screen was so low on the menu and why it was not visible with the daily routine measurements. The window of the medication intake was for some patients already closed and was considered too small. This feedback has already been given to Fraunhofer.

The patients found the screen about history easily, it was not clear to the patients why heart rate and steps were not visible with the other parameters. One patient asked why the graph showed only 1 day (and not an evolution). The information from the graph was considered rather basic.

Since the devices were paired before the pilot test, taking the daily measurements went smoothly. The information about the steps they had to take was sufficient. Only pairing the MioFuse bracelet was difficult without help (the manual about the MioFuse bracelet was too short and not clear enough for all three patients).

3.2.2. Individual Questionnaire (BE)

See Appendix 3 of D4.1 – discussion of results of 30 questions (details in Appendix TBD)

- Usability Q1-Q19

All patients found the SBC app easy to use and the manual was considered helpful enough. Even without the manual, patients were able to perform their daily measurements. A lot of good reactions about the colour and font of the SBC app. Also the icons were appreciated. One patients found the app too sensitive when using it.

Not all patients had errors during the pilot session. But those who had errors were not able to solve them with the given feedback.

The usability of the devices was considered ok, but activating the MioFuse bracelet was not so easy and most patients did need extra help to activate the MioFuse bracelet and connect it to the SBC app. The manual was not sufficient to help the patients. The fact that the MioFuse bracelet had to be close to the SBC app was object to some discussion as it was perceived as inconvenient.

Overall, all patients were fairly satisfied with the SBC app and devices.

- Perceived Control Q20-27

All patients felt in control and did not want to give up. It seemed easy for the patients to work with the app and they did not have a lot of extra questions.

- User Experience Q28-Q30

All patients were enthusiastic about the pilot and were eager to start their testing phase.

3.2.3. Group Discussion (BE)

Result of group discussion

- Usefulness & user acceptance

All patients were interested in the technology but had never used a health app before. The usefulness for the HCP is perceived as very high. All patients are interested to know their own measurements/ parameters. The patients are overall willing to share their data with their HCP or with external partners (if anonymous).

3.2.4. Summary for Belgium

All patients were open to technology and already experienced in the use of apps and smartphones. Therefore, there was a great openness towards the pilot and the patients were eager to test the system.

The information about their measurements was considered interesting. The patients agreed that including their HCP in the ambulant monitoring of their disease was a positive addition to their health care.

Overall the session went smoothly and the tasks were easily performed by the patients. No major problems were encountered. It was good the devices were paired before the session, which gave the patients a comfortable feeling about the devices. Only the MioFuse bracelet was under some discussion due the its discomfort.

3.3. The Netherlands

The group session took place in Eindhoven on the 20th of April 2018. Three patients (two elderly women, one elderly man) participated. The patients were invited for the pilot test by their General Practitioner or nurse practitioner. The women have a positive attitude towards technology in general and are experienced users of smartphones. The man is less experienced and not a user of a smartphone.

A set of equipment (weight scale, blood pressure monitor, oximeter, the bracelet / MioFuse and the smartphone with SBC-app) were distributed to each participant for individual testing including carrying out of the morning ritual. The session took about 2 hours. Testing of the equipment, including Bluetooth pairing, etc. was done prior to the session. In the session it was important to place the sets of equipment (SBC and sensors) apart from each other, preferably in different rooms, and make sure that they are not mixed during the session.

During the test session we were not able to connect the weight scale in one case, and the blood pressure monitor in another case with the SBC on the WiKo phone.

3.3.1. Usability Testing (NL)

The equipment was tested prior to the session with a different smartphone (Apple iPhone). It was not tested with the SBC but directly from that smartphone to the App (in the App-store) off the Yunmai weight scale and the Wireless BP monitor App of the blood pressure monitor. However, there were troubles during usability testing to connect the devices to the SBC on the Wiko smartphone. For the patients it is confusing when a device does not connect, or when it takes a long time to connect.

The Quick User Guide was used. The patients went very easy through the Quick User Guide. The SBC did not need further explanation; the patients hardly used the Quick User Guide. Even the patient not used working with a smartphone went easy through the usability tests.

All patients found the SBC easy to use. The patients reviewed the look and feel of the app as very functional: the design (colours, symbols, words used) is clear and inviting to start doing measurement.

Information on the bracelet was missing in the Quick User Guide. Some devices switch off automatically, and some do not. One patient had troubles finding 'history'. And another patient mentioned a different order is used in the SBC for measurements as in 'history'.

The usability tests went satisfactory, despite some technical problems to connect the sensors and the SBC.

3.3.2. Individual Questionnaire (NL)

- **Usability**
  The overall feedback on usability is for the women very positive; average scores for both women between 2 and 1, with the exception of questions that have a link with the technical problems in connecting the sensors (Q3 and Q9). No error messages were

shown (Q9). The male participant was less positive (average score of 3, negative scores on Q9, Q12, Q18 and Q19).

- **Perceived Control**
  The female participants felt they had good control (all scores 1-2). Even though the participants had some technical problems they did not feel discouraged (Q25, score 6-7) and did not want to give up (Q27, score 6-7). The male participant perceived less control (score 4-5), but felt good about his performances (score 3).
- **User Experience**
  The user experience was on average 2,1. The participants scored all questions with scores 1 or 2, expect of the male participant on using the system again (score 4) and one participant thinking other patients would like this system (score 3).

3.3.3. Group Discussion (NL)

Result of group discussion

- **Usefulness**
  The participants find the use of the SBC and the devices easy. The app will guide them through the morning ritual. They are confident to do the measurements at home. All three participants are self-conscious about their health and take their responsibility; they already measured weight or blood pressure and showed data to their GP or nurse.
  The participants are not positive about the usefulness of the MioFuse; for one participant the bracelet is too small and a second participant does not like to wear the bracelet as it is too showy to her. The participants think it is a disadvantage the bracelet can not store data, causing to keep the smartphone always nearby.
- **User acceptance**
  Participants are positive of using the SmartBEAT system to monitor at home. Unfortunately, the user acceptance was significantly influenced by a feeling of instability/unpredictability, due to the connection problems. No error messages were shown, to resolve the problems.
- **Comments and suggestions**

Below are some more detailed comments as a result of the group discussion:

  - Participants are willing to use technology, if technology gives them meaningful feedback. They are positive towards using the SmartBEAT solution.
  - Participants are interested in the measurements, and believe sharing data with their GP or nurse is valuable.
  - Two patients hesitate about the use of do all measurements every day.
  - Patients would like to view their data in the portal, additionally to the SBC.
  - Also, they would like the possibility to share data with informal caregivers. They would like to be in the lead in sharing data. One patient had some hesitation in sharing data (referring to the Facebook incidents).

- Patients at SGE use a portal to make appointments, view the results of a blood test etc. They prefer to use this existing portal instead of adding these functions to the SmartBEAT technology.

3.3.4. Summary for the Netherlands

The patients were enthusiastic to participate in the pilot and willing to work with the SmartBEAT system. They think that a system like SmartBEAT can help patients to get more control over their wellbeing.

They had no resistance using technology. However, the test session showed that the participant without a smartphone and less experience with devices was also less positive about the system and its use. All three participants did not use the bracelet.

3.4. Portugal

The session took place in the Heart Failure Outpatient Clinic in Centro Hospitalar São João, on 8 August 2017 at 17h30. It had a duration of approximately 2h – as estimated in the Pilot Design Plan (D4.1).

The participating group was composed of 2 males, one of them accompanied by his informal caregiver (his spouse), and 1 female. They were selected based on their previous knowledge with technology, especially smartphones – all three already owned smartphones (2 had iPhone and 1 had Android). Therefore, this selection should be seen as a group of seniors with technology literacy above average.

The tested system was exclusively the SBC + VSS kit – the connection with LoK's CGP was not concluded in time for the pilot phase with the patients. As a result, features such as medication, feedback messages and appointments were not used in this setting.

It should be noted that the SBC and the manual suffered some alterations since the Norwegian pilot. This modifications were a result of the valuable feedback provided throughout the whole process on that site.

3.4.1. Usability Testing (PT)

Patient 1:

a. Main screen

It was easy to understand the main screen with the daily routine. Each item was easily recognized and immediately knew what he had to do in each one. He had a little bit of trouble identifying the option menu icon (top left corner). With repetition, the action was performed smoothly.

b. History

The graphs in the history section were straight forward. He easily recognized the labels and axis of the graphs. The history of the heart rate and steps were also clear.

c. Execution of Tasks

There were some inconsistencies found in the App, particularly in the instruction for each measures. There were some instructions where the instruction "Next" was included and others where it didn't. As a result, the patient felt stuck and had trouble identifying the next step.

The sensors were easy to use. The bracelet was easy to start but didn't connect to the SBC, also it didn't fit the wrist of the user – it required a larger size. As a result, the patient was instructed only to use the remaining sensors.

During the measurement of blood pressure, the patient considered it was higher than usual, so he repeated it voluntarily. When looking at the history, both results were presented, and he questioned how he could select only the last one (the best and the one he knew it was his baseline). This incident suggested that very close in time measurements should be selected, probably the last one.

The manual was provided, but the routine was performed without much guidance. The screens were clear to him and he easily identified which step to take next.

Patient 2:

a. Main screen

The main menu was clearly understood and it was easy to identify what to do in each item. The options menu was also clear to understand.

b. History

There was some confusion of what the average of steps meant: if the average was of the total measurements available or only the ones seen on the screen. Other than that it was clear how to visualize the history of the measurements.

c. Execution of Tasks

Performing the required tasks was easy, although there is a tendency to turn on the sensors before tapping on the measurement item. It required some guidance to follow the "Next" step sometimes, as it was not clearly mentioned.

The "bt" intermittent symbol that appears in the blood pressure monitor screen can be a little confusing in the beginning. Also there is no clear instructions on how to put the bracelet correctly (the image is, however, correctly done).

The patient had a minor difficulty finding the button of the oximeter.

The manual was clear and simple to understand.

Patient 3:

a. Main screen

It was clear and easy to understand the main screen as well as the top-left corner menu. The top-left corner menu was particularly hard to find and get acquainted with, in the first attempts.

b. History

The graphics are a bit confusing overall, although he is able to identify easily where to observe the history of each parameter. The patient doesn't understand why steps and heart rate are not together with the remaining parameters.

c. Execution of Tasks

The patient is able to execute the daily routine easily as well as wear the bracelet. He notices that to avoid entering the workout mode accidently that he should put the finger gently and slide it gently towards the button. The graphics are again considered quite confusing.

The manual was clear and easy to follow.

3.4.2. Individual Questionnaire (PT)

The questionnaire had questions which were considered abstract and not clear. According to the participants, to answer some of the questions it would require a more extensive use of the system. It also included situations which did not occur – for example: error messages. In addition, the questions would repeat itself and it was considered too long.

- **Usability Q1-Q19**

All patients found that the system was easy to use and it had a pleasant interface. The information provided by the system was also clear and easy to understand. In addition,

There was one participant who was neutral about liking the interface of the system and that it provided all the functions and capabilities needed. Also it was neutral about the overall satisfaction with the system and its effectiveness in helping complete tasks and scenarios. These replies were probably due to an observation made by the participant regarding the level of knowledge of the system to reply to some of the questions. The short-time session was not enough to know the system and its capabilities, and therefore some of the questions were considered poorly formulated.

- **Perceived Control Q20-27**

All felt that they were in control and were able to apply their own approach. They also have a good perception on how the system works. There was no discouragement felt and in no situation they felt like giving up.

- **User Experience Q28-Q30**

All participants would use the system again. They also enjoyed to discover the system functionalities. 2 out of 3 thought other CHF patients would like the system, although 1 was neutral about it.

3.4.3. Group Discussion (PT)

The discussion was not only between the patients but also the doctors (examiners). The latter would frequently engage actively in the discussion, focusing on certain aspects shared by the patients.

- **Usefulness**

None of the three patients had used a telemonitoring system before. Still, they were all open to technological innovation in healthcare and were very motivated in using the system. 1 patient was particularly curious over the cost of a system like this.

The examiners explained the final prototype and how the network of care (nurses, cardiologist) would interact with the system and the patient. The patients found the full concept of SmartBEAT very useful and interesting.

The patients were interested in looking at the measured data, as it is a good and simple way to keep track on the trends of each parameter. All feel that the informal caregiver should have an active role in the care process too. 1 patient was accompanied by one (the spouse), who was the one that was more in control of the management process than the patient itself. In this case, the informal caregiver would like to be able to look at the data and see if any parameter is outside of the normal range.

- **User acceptance**

All three patients were very open to share its health data within the monitoring system network (the nurse or any technical person who would have access to the data). Yet, it was explained that the data would be anonymized and only a restricted group of people would be able to match the monitored data with their identification. They assured that the access to their data was not seen as being controlled; instead, it provides a feeling of being part of a network connected to their health professionals.

When asked about the current features of SmartBEAT, one mentioned that integrating HF comorbidities would be very useful, particularly diabetes (the patient was diabetic). One doctor added that integrating data from implantable cardioverter defibrillators (ICD) would be also of added-value to the system.

For all participants, technology is considered easy to use. This, however, is related to the fact that all three were already quite acquainted with smartphones and computers.

3.4.4. Summary for Portugal

Since all three seniors were quite knowledgeable in technology, there was no resistance observed towards the system. However, one senior had trouble understanding the graphics despite knowing what they represented. He was particularly confused with the fact that the steps and heart rate continuous were separated from other measurements. To another participant, the bracelet was too small and, as a result, it was disconsidered from his kit of sensors. There was also some inconsistencies in the app, particularly when using the word "Next" in the instructions. In addition, the blood pressure item did not provide clear instructions on how to wear the cuff.

The role of the informal caregiver was considered of high importance, as they are a fundamental part of the adherence to therapy component. It is common for the informal caregiver to know more about the health status of the patient than himself, especially when it is the spouse.

All patients liked to use the system and they acknowledge its usefulness in the management of their disease. Nevertheless, it was suggested that the SmartBEAT system would benefit with the integration of other HF comorbidities (ex. diabetes) and ICD data.

Knowing their data was being monitoring continuously did not make them feel under surveillance, instead they perceive themselves as part of a network of care in which a doctor and a nurse are on the other side guaranteeing that everything is well.

Overall, the session went smoothly. All seniors were highly motivated in participating in this phase and no major problems were encountered. The session was well prepared beforehand, but its success was also due to the valuable feedback gathered during the pilot in Norway.

4. Pilot Test Two-week Patient Home Testing

4.1. Norway

4.1.1. Prototype Use (NO)

At-home – in-house testing was performed from 8th to 28th June by two of the patients and from 17th to 28th June by the third one. All of them completed the daily morning ritual throughout the period, despite continued instability problems. However, usage of the MioFuse was more or less given up due to severe problems caused by both the measurements themselves and the transfer of data to the SBC.

4.1.2. Individual Questionnaire (NO)

Below, it is a short summary of feedback given by the three patients. It shows clearly that the instability / technical problems are the reason for most of the negative feedback. Except for the bracelet which is declared useless. For details see chapter 8.

- **SmartBEAT Companion**
  High score (2) from two patients, low from one. They all refer to instability and low battery capacity.
- **Weight scale**
  Average score 3+. Difficulties with the SBC connection and too long waiting time when it works.
- **Blood pressure cuff**
  Very positive feedback – Score between 1 and 2. Also here some problems caused by the smartphone.
- **Activity and Heart Rate Monitor**
  Completely ruled out when it comes to usability – score 6-7. ("Very difficult to understand", "Does it work at all?", "Sometimes it tracks, sometimes not", Very low battery capacity, the strap is too short and it cause some skin problems). But the type of measurements is regarded as valuable.
- **Oximeter**
  Easy to use and valuable. High score.
- **Daily Morning Ritual**
  They all used between 5 and 15 minutes and did take the measurements each day. Learning from doing and thus reducing time for the measurements seems to be very individual. Two of them are absolutely willing to do the morning ritual continuously for a month. The third is more reluctant (maybe).
- **Bracelet**
  See "Activity and Heartbeat Monitor". In addition: It is sensitive to spurious unintended pressures. It was taken off during the night, in the shower and "when painting".
- **Medication Reminders and Intake Registration**

Not applicable for Norway

4.1.3. Summary for Norway

As for the session 7th June, feedback from the in-house testing is strongly influenced by technical problems that continued even with a new version of the SBC app. Experience using the bracelet in fact strengthened the opinion that it is too difficult and very uncomfortable to use. However, even under those circumstances the testing was completed; the daily morning ritual was carried out every day, and willingness to do this continuously over a longer period was clearly expressed. Also, they feel that a stable system with such features will be of real added value for themselves and their carers.

4.2. Belgium

4.2.1. Prototype Use (BE)

At home – in house – testing was performed from 7 February 2018 until 22 February 2018 by all three patients. All of them (tried) to complete the daily morning ritual throughout this period, despite continued pairing and instability problems. For one patient, we did not manage to pair the blood pressure monitor again by telephone assistance.

During the 2 week home testing, an update of the SBC app was released so all patients could receive the reminders about medication intakes and daily measurements.

4.2.2. Individual Questionnaire (BE)

- SmartBEAT Companion Q1-3

The patients believe the SBC app has greater value for their caregivers than for themselves. The usability of the system is coloured due to the negative experience with the Bluetooth of the devices.

- Weight scale Q4-6

Medium score. Long waiting period before the weight scale connects to the SBC app.

- Blood pressure cuff Q7-9

Medium score. The device was easy to use. One patient stopped measuring his/her blood pressure due to pairing problems that could not be fixed over the phone.

- Activity and Heartbeat Monitor Q10-12

Bad score. The activity tracker was considered useless, the steps did not reflect reality. Heartbeat monitor was ok but the MioFuse bracelet was not considered user-friendly (not nice to wear, repairing to SBC app every morning, charging every night, problems with 'full memory', etc.)

- Oximeter Q13-15

Easy to use. Was not considered very reliable. First measurement was often too low to be reflecting reality.

- Daily Morning Ritual Q16-21

All patients tried to take their measurements every day, it takes between 5 and 30 minutes. Patients say it sometimes takes too long due to pairing problems. Patients find it useful to know their parameters in the morning, they were more motivated to continue their health care process.

- Bracelet Q22-23

See Activity and Heartbeat Monitor. The bracelet was not a success and was considered burdensome. Very sensitive and easy to enter the 'workout mode', which gave all kind of problems. The activity tracker did not work appropriately. The HR monitor does seem very accurate.

All patients removed the bracelet for showering.

- Medication Reminders and Intake Registration Q24-Q25

The feature of medication reminders were considered very useful. The window for registering was however considered too narrow (only 30 min). So patients could not always register their medication intake even though they did take their medication. The patient did not understand why the medication intakes did not appear on the daily routine scheme.

4.2.3. Summary for Belgium

Overall the pilot 2-week follow-up went smoothly with minor issues. During the 2 weeks, all patients needed help over the phone to repair their devices.

The use of the MioFuse bracelet was not good enough documented in the manual and the bracelet was not considered easy to use.

The patients remained positive even when pairing problems occurred and collaborated to re-pair the devices over the phone.

4.3. The Netherlands

4.3.1. Prototype Use (NL)

Testing at home was performed by the patients from 20th April to 7th May. All of them completed the daily morning ritual throughout the period, despite continued technical problems. During the time of measuring at home a logbook was kept mainly to mark the technical problems.

4.3.2. Individual Questionnaire (NL)

Below, it is a short summary of feedback given by the three patients. It shows clearly that the instability / technical problems are the reason for most of the negative feedback.

- **SmartBEAT Companion**
  They believe the system has added value for patients and care professionals (score 2-3). Twee patients find it simple to use (score 1-2), lower score from one (score 4).
- **Weight scale**
  Low scores (4-6) from two patients, and high score (2) from one patient. Difficulties with the SBC connection and too long waiting time when it works. Weight scale does not connect to SBC on the WiKo whereas connecting to an iPhone was no problem.
- **Blood pressure cuff**
  One patient was not able to use the device, as it did not connect (same problem as weight scale). One patient is negative (score 7), and the other patient is not convinced it is usefull to measure every day.
- **Activity and Heart Rate Monitor**
  Not used in pilot test.
- **Oximeter**
  Easy to use; high score on simple to use (1-2, average 1,3). And also rated as adding value (score 2-3).
- **Daily Morning Ritual**
  Two patients used between 5 and 15 minutes, and one less than 5 minutes to finish the daily morning ritual. They all did take the measurements each day. Two of them are absolutely willing to do the morning ritual continuously for a month. The third is more reluctant (maybe).
- **Bracelet**
  Not used in pilot test.
- **Medication Reminders and Intake Registration**
  The reminders and intake registration were most of the time not available. In the individual questionnaire there were no questions about medication reminders. One patient gave feedback on the medication reminders. She missed information on the reminders, and did not know in the pilot if and when to except the reminders.

4.3.3. Summary for the Netherlands

The pilot was influenced by problems connecting the devices (especially weight scale and BP monitor) to the SBC App on the WiKo smartphone. It was striking that patients each had a different device that was difficult to connect. We visited patient during the pilot at home in order to resolve the technical problems. Despite these issues, patients continued to carry out their measurements every day.

The participants did not use the bracelet. They were furthermore no major comments on the devices, apart from the Bluetooth / connection of the devices to the SBC app.

Also, it was not possible for caregivers (nor to the patient participating) to view any measurement on the Remedus portal. One exception were the results on the questionnaires, and the medication registration. The data were shown of one patient, and occasionally of two patients were the data on the questionnaires shown.

4.4. Portugal

4.4.1. Prototype Use (PT)

It was not observed any major difficulties from the patients. All performed the measurements correctly and on time, as it was instructed. Since the NO pilot, the SBC has gone through several improvements which contributed for a good acceptance of the full system as well as a more robust connection between devices. In addition, the use of 3G instead of Wi-Fi surprisingly fastens the connection between devices – particularly the weight scale by two-fold.

A senior-friendly launcher was installed on top of the SBC to guarantee a better adjustment with the technology. This launcher, developed by FhP, was designed taking into consideration seniors' needs and limitations, especially those with low to no technology experience.

With all three patients, there was episodes where the measuring devices could not connect. Consequently, 2 patients did not perform the measurements on one day as the technical support was only provided the following day. On all malfunctioning occurrences, a reboot of the device sufficed to resolve the issue.

One patient, in particular, performed several blood pressure measurements successively. When enquired about this pattern, the information given was that the values were considered too high so he felt the need to repeat it. He also mentioned that it would be nice to be able to see the average of the blood pressure of the full week.

Finally, one patient wisely mentions that the reason behind the selection of parameters and its frequencies (ex: why daily and not occasionally or weekly?) should be better explained to the patients. In addition, the VAS was considered unclear, since there was no indication of what which face represented in terms of health/symptoms.

4.4.2. Individual Questionnaire (PT)

The individual questionnaire was given to the patients at the pilot session with the instruction to be filled at home after the 2-week use. Despite the open questions available of the questionnaire, the examiners believe that it should have been organized a brief group or individual discussion. These would have provided valuable details which were not mentioned in the text. On the other hand, the troubleshooting phone calls were quite helpful to determine unnoticed difficulties and suggestions.

- **SmartBEAT Companion Q1-3**

Two patients consider it easy to use and 1 considers that despite finding it easy to use, it will be hard for less tech-literate seniors to handle the device. 1 also adds that the device has efficacy issues but does not elaborate further.

1 patient complains about the low battery life of the smartphone, mentioning that everyday needs to charge with only a morning use.

- **Weight scale Q4-6**

All 3 patients found the weight scale very easy to use and valuable. 1 had trouble connecting the weight scale to the SBC, however this was a situation related to the Bluetooth stack as a result of the uninterrupted connection between bracelet and smartphone throughout the day – it gets corrupted and only a system restart can solve the issue. Another considered the weight scale the perfect size – not too small, not too big – and very portable.

- **Blood pressure cuff Q7-9**

All patients considered the device easy to use and valuable. One patient, however, remarked that the instructions on how to wear the cuff were not precise and clear (ex: on which arm to wear the cuff?).

- **Activity and Heartbeat Monitor Q10-12**

Two patients considered the device easy to use and 1 was neutral. From the 2 who considered it easy to use, 1 mentions low efficacy of the device. To 1 of the patients, the bracelet had ergonomic issues (did not fit) so a bigger model was given. One patient also mentioned that the transmission of data and the execution of the "daily activity + HR" were not clear, since it was very easy to set the "workout" mode without noticing and extremely hard to go back. It was also observed poor battery life – only 5 to 6 hours of continuous use. On the other hand, this patient considers these activity and HR monitor very accurate.

- **Oximeter Q13-15**

Very easy to use and valuable by all 3 patients.

- **Daily Morning Ritual Q16-21**

Two out of 3 patients take 5 to 15 minutes, and after using the system for 2 weeks take much less time. One indicates taking less than 5 minutes and after using the system for 2 weeks take exactly the same time.

All 3 patients performed all measurements every day, with a few exceptions: (1) 2 did not measured for one day because of connectivity issues with the devices (Bluetooth) – technical support was necessary; (2) 1 performed all with the exception of the bracelet for half of the 2-week follow-up because of fitting issues (see *Activity and Heartbeat Monitor* for more details).

The 3 patients are willing to measure all parameters daily. And 2 out 3 are willing to perform the daily ritual for 1 month. The remaining patient did not reply to the question.

- **Bracelet Q22-23**

Two out of 3 patients felt good wearing the bracelet, although it felt quite tight – more sizes should be available. The remaining patient felt a little bit uncomfortable because of the material.

All patients would remove the bracelet either for shower, swimming, or any activity/task which involved water. These revealed that the patients were not informed about its waterproof features.

- **Medication Reminders and Intake Registration Q24-Q25**

Not applicable.

4.4.3. Summary for Portugal

Overall, the pilot 2-week follow-up went smoothly with minor issues, all related directly or indirectly to the bracelet – a continuous transmission of data through Bluetooth causes the service to malfunction. These, however, was an expected result since it had already been remarked by the NO pilot and technical evaluation. Also, the size of the wristband was also a concern.

The use of 3G instead of Wi-Fi and the improvements to the SBC might as well have contributed on a good feedback from the patients, since there were no major complains about the remaining sensors or the App.

In summary, there were some aspects that are worth retaining: (1) the instructions for the use of each device should be clearer – especially the blood pressure cuff; (2) the VAS needs to be properly defined (perhaps in the quick user guide?), so patients can classify more accurately their health status; (3) the future bracelet should have more sizes available, a simpler working mode, better battery life and a more transparent transmission of data; (4) the smartphone was considered poor in battery life; and (5) the SBC was found to be perhaps too complicated for a senior with no technology experience.

5. Pilot Test HealthCare Professionals

5.1. Norway

Not applicable.

5.2. Belgium

5.2.1. Usability testing HCP (BE)

The users were already acquainted with the technology, so it was not required a cognitive walkthrough. The feedback retrieved was exclusively from the questionnaires after asking to execute some tasks.

5.2.2. Individual questionnaire HCP (BE)

- **Usability Q1-Q19**

Overall, the users were neutral about the usability of the system. On the positive side, they considered it was a system easy to learn, easy to understand, and enjoyed the interface. On the negative side, they considered that it could be more efficient and provide more functionalities. They were particular critical of the dedicated time to use the system.

- **Perceived Control Q20-27**

Overall, the users were neutral on the perceived control of the system. Although they felt like not giving up or discouraged, there was a perception of not being able to execute the tasks they wanted. Two out of 3 felt not in control.

- **User Experience Q28-Q30**

Overall, there are some reservations on the user experience. There is one user that is very willing to use the system again, where the other two are neutral. Also, all 3 are generally neutral when suggested the usefulness of this system to their colleagues.

5.2.3. Individual feedback collection HCP (BE)

Q1: two out of three HCP's experienced the menu as logical and could easily find all needed information. One of the HCP's commented that the menu could be more intuitive.

Q2: all HCP's were ok with the way the menu is structured. One HCP suggested to take another look at the order of the thresholds of vital parameters.

Q3: The HCP's all comment about the many steps they have to take to view the right patient information. Using filters to get the right view is perceived as extra time lost. As last point, the velocity of the program could be improved. One HCP suggested it could be helpful to see the different actions other HCP's have conducted in the patient's dashboard.

Q4: It's clear to the HCP's what information can be changed or personalised and how to do this.

Q5: All HCP's see the potential of the program. Two out of three comment about the extra workload to register in two systems, integration with already existing hospital software is seen as a must. One HCP does have questions because of the reliability of the data (data was often missing or wrong. For ex. Oximeter for CO2).

Q6: HCP's see following points of added value: consultation is more efficient, black box between consultations becomes smaller, possibility to coach patients about adherence, better evaluation of the patient during home stay, easier communication between HCP – nurse – patient, more global picture of the patient.

Q7: The HCP's would like following functionalities added or changed: better view of continuous data, view of patients medical history (maybe on a timeline), easier way to change thresholds of vital parameters in order to reduce the amount of 'false' alarms, better usability of the medication scheme.

Q8: Positive aspects according to the HCP's: the concept of the to do list or worksheet to keep the focus on the actions to be done, faster and more accurate interventions due to deviations, better contact with the patients, patient dashboard is clear and easy to read, clear overview to be used in consultations, feeling of safety when patient is at home, patients seem to be more actively involved with their therapy.

Q9: Following aspects could be improved: inertia of the platform, easier overview of different actions taken by different care givers, to many false alarms due to inadequate algorithms or bad measurements of the patients, overall usability of the system is a little too complex or nog intuitive enough.

Q10: The HCP's think the platform has its pro's but the extra time and work is a big barrier. One HCP suggests a view of all patient data together would be nice (instead of a dashboard per patient).

5.3. The Netherlands

5.3.1. Usability testing HCP (NL)

In the Netherlands there were technical problems during the pilot test, and in such a way that feedback from healthcare professionals could not be generated from the pilot test. The healthcare professionals have not been able to use the portal. The measurements of their patients did not end up in the portal, which made use of the portal by the practice nurses not meaningful.

During the pilot test, the investigator of SGE in the SmartBEAT study looked at the portal daily to see if data were visible. Only the medication intake and questionnaire were visible on a number of days. A logbook has been kept of the operation of the SmartBEAT system.

5.3.2. Individual questionnaire HCP (NL)

The individual questionnaire was not filled in by the healthcare professionals for the same reasons.

5.3.3. Individual feedback collection HCP (NL)

To get feedback from the healthcare professionals we used three dashboards from patients from the Belgian pilot. The healthcare professionals assessed the print screens of the dashboards as clear and informative. However, more than a global assessment was not possible: they do not have the actual user experience to provide feedback.

5.3.4. Group Discussion HCP (NL)

Since there were no individual questionnaires, SGE decided to have a group discussion with the healthcare professionals.

GPs and practice nurses consider telemonitoring of patients as relevant; they see possibilities for telemonitoring in disease management programs in the primary care. They have experienced during the pilot testing that patients also appreciate the use of a system like SmartBEAT and deal more consciously with their health condition.

The healthcare professionals indicate that it is difficult to work with different portals. Next to the information system of general practitioners, they use a system for disease management and eHealth portals.

5.4. Portugal

5.4.1. Usability testing HCP (PT)

For both the cardiologists and the nurse, the portal was considered very complex. There were many functionalities that were not relevant for the care protocol for this patients.

The login page requires too much typing, particularly selecting the country. If the user does not logout before closing the window, it is unable to login again.

The nurse portal does not display alerts, only the cardiologists' page does.

5.4.2. Individual questionnaire HCP (PT)

See Appendix 7 of D4.1 – discussion of results of 30 questions (details in Appendix TBD)

- Usability Q1-Q19

All health care professionals are neutral about the usability of the system. They were also neutral about the appearance of the interface. Also, the nurse considered that there were functionalities still missing.

- Perceived Control Q20-27

Both the cardiologists and the nurse felt in control and were able to successfully execute evert task requested.

- User Experience Q28-Q30

All would be willing to use the system again, but are uncertain if their colleagues would be interested in using this platform as it is at the moment.

5.4.3. Individual feedback collection HCP (PT)

Health professional see the potential of platforms such as these, however they feel that there is a lot to be done.

General

- Look and appearance could look more modern and attractive (ex: the crop-like look of the "dashboard" and "medical record", and the color palette does not match between each other)
- Nurse portal is different than doctor (does not provide same functionalities, and design is different)
- Diagnosis, medications, and other medical details do not get recorded
- The Login page requires too much typing, including selecting country
- If the user does not logout, and closes the window, it cannot login again (cookies)

Dashboard

- The scaling should be fixed for each parameter, i.e. not adjustable according to the range of available values
- The plot windows should be bigger (perhaps 2 per row), the order should also be altered: Column 1 (Weight, BP, Physical Activity, HR); Column 2 (Dyspnoea/VAS, SpO2, Questions (Orthopnoea, Edema, Syncope), Medication)

My History

- It was considered too confusing.

Add/Update

- "Add Medical Data": considered too exhaustive to fill (lab results, vital signs and other medical information). The users suggest to possibly remove it.
- "Update Medical Details": there are parameters that do not apply to heart disease monitoring. Details such as smoking, alcohol should be updated on an appointment. In this section, it should be included the patient's NYHA Class, Ventricular Ejection Fraction, baseline values (HR, BR, devices used including brand, date of implementation and context). In this section
- "Add Caregiver" and "View Caregiver" should be merged
- "Add Visit Documentation" rename to "New Appointment". This should not be accessible to the patient.
    - Location, Name of Carer, Professional should be filled automatically
    - "Complaints", "Physical Examination", "Diagnosis", "Medications", "Allergies", "Procedures", "Immunizations", "Further Tests", "Personal Note" all should be changed. There is preference over writing in open field rather than selecting under combo-boxes.
    - "Medication" should allow different doses on the same day (it is uncommon, but it does occur).
    - Suggestion: (Tab 1) "Plan" - open field text to describe what was done to the patient, (Tab 2) "Summary" - summary of the patient medical file (see "Medical Detail"), (Tab 3) Plan from previous visit.
- "Add Medical History"
    - Once data is upload, it does not redirect to Medical Record (but Dashboard)
    - Doctors would rather prefer it to be open field also (similar to "Visits")

Medical Record

- List of diagnosis should be listed in a hierarchical structure associated with the medications, i.e. it should be possible to identify which diagnosis each medication targets.
- The "G" icon does not work as intended

6. Overall Conclusion of the SmartBEAT Pilot Tests

With HF patients, the results were different between countries. Although the cultural factor has a high impact, it should be noted that the conditions in each site were not the same. There was a continuous improvement from Norway to Portugal and Portugal to Belgium and the Netherlands. Therefore, the first evaluation in Norway encountered several problems, particularly with the connectivity with the sensors: the bracelet and weight scale. As a result, the users were very displeased with the system although acknowledging its usefulness if working properly. Portugal, in contrast, was very successful with their evaluation. Most of this success was due to improvements to sensors' connectivity. The negative aspects were minor connectivity problems and the bracelet was considered uncomfortable. In Belgium, the sensors connected smoothly but the bracelet was also considered problematic. In the Netherlands, the users detected problems with BP monitor and the weight scale, and the bracelet was not used due to connectivity problems.

The differences between Portugal and then the Netherlands and Belgium, it is believed to be associated with the configuration of sensors that is required before the introductory sessions with the patients. This configuration is challenging, and elements not involved in the development of the SBC components encountered difficulties that reflected in the sessions and then home-use.

With HCP, it was evaluated two different portals that were in two different development stages. Remecare (BE and NL) and eHealthStudio (PT) – Norway did not have health professionals. Remecare is a more developed portal, with pleasing UI and many functionalities implemented. The users (NL and BE) felt that system was clear and intuitive. However, NL users only had access to screenshots of the portal due to malfunctioning of the server that is responsible to host the parameters' data of the patients. On the BE side, the users felt that it was time consuming to execute tasks in the portal, felt that were not in control and several functionalities still missing. In Portugal, the portal was still under-development and many functionalities were still not implemented. Either way, users acknowledged the benefits of such portals – particularly to visualize a more broad view of the patient's health status. However, similar to BE, the PT users consider that the system still needs to be better adjusted to their needs and the care process.

In conclusion, for HF patients, it is noticed that the set of sensors needs to be changed – particularly the bracelet and, possibly, the weight scale. The Bluetooth connectivity also needs to improve due to generalized complaints. For HCP, it is observed that the use of these portals is considered too time consuming and several functionalities are lacking and need to be better adjusted to their needs. Notwithstanding, they acknowledge the benefits of these health portal for monitoring patients.

7. Appendix (Data Analysis)

Refer to excel file *SmartBEAT_Pilot_Test_Results.xlsx*.