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Barriers and facilitators for implementation of automated home medication dispensers in home care from Dutch professionals' perspective: a qualitative study

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ABSTRACT

Introduction and aims: Present-day home care needs to be more efficiently organized in view of the aging of the population and the current nursing shortages. Ensuring safe medication use is part of the challenge. The number of required visits could be reduced if automated home medication dispensers (AHMD) are adequately implemented. However, the barriers and facilitators for implementation are unknown. This project explored determinants (barriers, facilitators, or both) for implementing AHMD in home care, from Dutch home care nurses' perspective.

Methods: Semi-structured interviews were conducted with 15 home care nurses. Determinants were identified through thematic content analysis. The first four transcripts were coded inductively. Then, a code tree was developed based on the Tailored Implementation for Chronic Diseases checklist, consisting of seven domains. Each code/determinant was then labelled as a barrier, facilitator, or both.

Results: The most relevant domains were innovation factors, individual health professional factors, and patient factors. The most frequently mentioned barrier was the required unplanned visits when patients did not withdraw medication within the scheduled time limit (alarm). According to our respondents, carefully assessing patients' eligibility (e.g., learnability) and properly instructing and guiding them will help prevent these alarms from occurring. Next to these determinants, motivating patients to start using an AHMD and professionals having sufficient knowledge and confidence were the most frequently mentioned facilitators.

Conclusion: This project provided an overview of 78 determinants from nurses' perspective for implementation of AHMD in home care. This can form the basis for developing strategies for implementing AHMD in home care. Further research is recommended to investigate the perceived determinants from the patients', relatives', and informal caregivers' perspectives, and to prioritize the determinants from all perspectives.

Keywords: frail elderly; home care services; implementation science; qualitative research; telemedicine

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What is known about the topic?

- Given the shortage of nursing staff, home care must be efficiently organized to continue providing care to the increasing number and proportion of older people in the population.

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- Using AHMD increases medication adherence, and patients accept the dispenser as reliable, easy to use, and helpful in coordinating personal medication management.
- With properly implemented AHMD, fewer home care visits are needed, which helps solve efficiency challenges.

What does this article add?

- The Tailored Implementation for Chronic Diseases checklist, supplemented by the implementation factors of Grol and Wensing, was a useful framework to gain a comprehensive overview of the determinants (which were labelled as barrier, facilitator, or both) for successful implementation of AHMD.
- A list of practical strategies for implementation was developed, which can be consulted to develop adequate tailored strategies for implementing AHMD in home care.
- Although the most frequently mentioned facilitators focus on the nurses' behavior (assessing eligibility, motivating patients, giving instructions, and having sufficient knowledge and confidence), the most frequently mentioned barrier was the patient's behavior (unplanned visits when patients do not withdraw the medication in time).

INTRODUCTION

Older people with chronic diseases require drug therapy to reduce symptoms. Therapy adherence is essential for successful medical treatment.[1,2] Non-adherence to drug therapy is significantly associated with all-cause hospitalization and mortality in older people.[3] Nevertheless, older people are susceptible to non-adherence due to drug-related factors, such as dosing regimen, side effects and polypharmacy, and patient-related factors, such as cognitive function, health literacy, multimorbidity, and functional decline.[3–6] Nonadherence is determined by interactions of medical, personal, and economic factors, the relationship with the physician, and cognitive status.[7,8]

Older people live longer in their own homes[9,10] and health care services are being shifted from hospital care toward home care.[11,12] Moreover, nursing shortages are increasing globally.[11,13] For these reasons, the Dutch government encourages the use of technologies that save time.[14–16]

Home care nurses support patients' medication adherence and prevent errors by providing reminders or handing out medication,[17] sometimes multiple times a day.[18] Automated home medication dispensers (AHMD) are available as e-health devices to support patients who are unintentionally non-adherent.[19,20] The device involved in this study is the Medido AHMD (Vitavanti Healthcare Solutions, Rijswijk, The Netherlands). The medication is provided by a pharmacy in a unit-dose system, consisting of sachets with the prescribed doses of medication for a specific patient at a specific time point.[21] Home care nurses place the sachets in the device every 1 or 2 weeks, instead of visiting the patient at every scheduled time point. At a scheduled time point, the AHMD provides an audio signal to remind the patient to take the medication. By pressing a button on the device, the device delivers the sachet(s) containing the prescribed medication for that time point. The device makes a small incision in the sachets so that patients can easily open them. If the button is not pressed within an adjustable scheduled time limit, home care is notified (alarmed). Many settings on the device, such as the sound volume and the length of the incision, are adjustable, for which the Medido helpdesk can be contacted by home care nurses.

A study found that the mean medication adherence rate significantly increased from 49% to 97% after 6 months of using AHMD.[19] Furthermore, patients found AHMD reliable, easy to use, and helpful.[22] In addition, fewer visits were required.[23] A reported disadvantage of AHMD is that the focus on empowerment and self-care is not suitable for all patients.[23] The persisting challenge for e-health is that traditional care remains essential for many patients: human hands are perceived as warm and compassionate; technology comes across as cold and impersonal.[23] Studies commissioned by the Dutch government[15,16] show that the use of AHMD saves home care nurses' travel time and caring time. Nevertheless, unplanned visits may be necessary due to alarms or technical malfunctioning of an AHMD (unknown frequency). According to these studies, approximately 5500 AHMD were in use in the Netherlands in 2021, out of a potential of 28 500.

To determine adequate strategies to implement an e-health innovation such as AHMD, barriers and facilitators in home care must be considered to tailor the implementation strategy to this particular context.[24] The most frequently mentioned barriers for implementing e-health in general are limited exposure/knowledge of e-health, lack of necessary devices, and problems with financing.[25] The most frequently mentioned facilitators are ease of use, improvement of communication, and motivation.[25] However, the barriers and facilitators for implementing AHMD specifically have not yet been investigated.

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AIM

The current study aimed to explore the barriers and facilitators for implementing AHMD in home care from the perspective of home care nurses in the Netherlands. Home care organizations can use this knowledge to develop tailored strategies for implementing AHMD.

METHODS

Design

A descriptive qualitative study was conducted, using semi-structured interviews. The Consolidated Criteria for Reporting Qualitative Research (COREQ)[26] checklist was followed to ensure transparent reporting (Appendix I, http://links.lww.com/IJEBH/A118).

Participants

District nurses (European Qualifications Framework [EQF-5/6]), nurses (EQF-4), and nurse assistants (EQF-2/3) working in home care were sampled purposively from one large home care organization in the south-west Netherlands. This organization employed approximately 800 home care nurses at the time of the study and had used the Medido dispenser since 2013.

In sampling, we ensured maximum variation in geographic areas of operation (by including various work cultures and team processes, and neighborhoods where the nurses work), educational level (EQF),[27] age, sex, years of work experience, and level of experience with AHMD.

The main inclusion criterion was working in a team that provides regular (non-specialized) home care. Seconded employees and professionals with insufficient mastery of the Dutch or English language were excluded.

Procedures

Managers of the home care organization nominated eligible nurses. We selected participants based on the maximum variation criteria by asking each manager, representing different geographic areas, to nominate two nurse assistants EQF-2, two nurse assistants EQF-3, two nurses EQF-4, and two district nurses EQF-5/6 (including information on age and years of work experience). From there, we selected two or three names per manager, with as much variation as possible in all factors. Potential candidates received a letter with information about the subject, the aim of the study, and the study procedures. After we received written informed consent, interviews were scheduled. Interviews took place in March and April 2021 and were conducted by CM. Due to COVID-19 restrictions, online videoconferencing software (Microsoft Teams, Microsoft, Redmond, Washington, USA) was used. The interviews were audio-recorded and video-recorded, transcribed verbatim, and pseudonymized. Sampling continued until no new patterns or themes emerged (thematic data saturation).[28] Then, two more interviews were conducted to ensure data saturation was reached.

Data collection

The seven domains of the Tailored Implementation for Chronic Diseases (TICD) checklist[29] were used to derive a comprehensive overview: (1) guideline factors; (2) individual health professional factors; (3) patient factors; (4) professional interactions; (5) incentives and resources; (6) capacity for organizational change; and (7) social, political and legal factors.[29] Because AHMD is an innovation rather than a guideline, the first domain was supplemented with the innovation factors of Grol and Wensing[30]: advantages in practice, feasibility, credibility, accessibility, and attractiveness. These domains were translated into an interview guide that fitted daily practice (Appendices II, http://links.lww.com/IJEBH/A119 and III, http://links.lww.com/IJEBH/A120). This was piloted in one interview, as described by Creswell and Poth.[31] No further changes were deemed necessary. This interview was included in the main analysis.

Data analysis

Thematic content analysis started after the first interview. New insights gained from consecutive analyses were included in the successive interviews, and constant comparison was applied until data saturation.[32,33]

The first four transcripts were initially open-coded inductively to ensure important themes were not lost through deductive analysis.[34] After that, a code tree was developed, based on the TICD checklist[29] and the inductive codes (Appendix IV, http://links.lww.com/IJEBH/A121). The code tree was constantly adapted during data analysis. When data were relevant to multiple codes, they were included in all relevant codes. Using the method of Dierckx de Casterle *et al.*,[35] we created overviews of the codes/determinants per interview labelled as barrier, facilitator,

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or both (conceptual interview scheme[35]). Determinants were labelled as "both" when on the one hand it was a facilitator, but on the other hand it was also a barrier. Finally, all determinants were combined into a comprehensive overview of barriers and facilitators. To determine which domains were dominant, we counted the determinants (derived from our code tree) per TICD domain. In addition, we developed a checklist of practical strategies to guide the implementation of AHMD in home care (Appendix V, http://links.lww.com/IJEBH/A132). Data were managed and analyzed in NVivo 12 (Lumivero, Denver, Colorado, USA).

Study rigor

Member checking during the interviews was performed by probing the respondents to ensure that their opinions were correctly understood. After analysis, written feedback was requested from the respondents on the conceptual interview schemes.[31] Through peer reviewing, the reliability of the coding was strengthened.[33] EI and an independent researcher coded two different, randomly chosen interviews, and discrepancies were discussed until consensus was reached. Member checks and peer reviews were performed to strengthen the credibility of our study. Memos about context, observations, and methodological choices were written after each interview, thereby creating an audit trail, useful to judge validity and to strengthen the study's dependability and confirmability[33] (Appendix VI, http://links.lww.com/IJEBH/A123).

Ethics

The Medical Ethics Research Committee of the Erasmus University Medical Center Rotterdam approved this study (MEC-2021-0071). Written informed consent was obtained prior to all interviews. Respondent confidentiality was ensured by pseudonymizing the transcripts, and only members of the research team had data access. The study conforms to the Declaration of Helsinki (as revised in Tokyo in 2004).

RESULTS

Respondents

Eighteen nurses were invited. Two declined participation for personal reasons, and one did not respond. Thus, 15 nurses participated. Non-participants were not present. Ages ranged from 23 to 65 years (median 34 years). Years of work experience varied from 2 to 48 years (median 10 years). All respondent characteristics are presented in Table 1.

The mean duration of the interviews was 50 minutes (range 39−72 minutes). Thematic data saturation was reached after 15 interviews. Thirteen respondents returned member checks. Four provided additional information, which was included in the analysis. The peer reviews did not reveal major discrepancies and new determinants did not come to the fore.

Seventy-eight determinants (barrier, facilitator, or both) were identified (Table 2 and Table 3). Sixty-four (82%) fell within the first three TICD domains[29]: innovation factors ($n = 16$), individual health professional factors ($n = 20$), patient factors ($n = 28$), professional interactions ($n = 6$), incentives and resources ($n = 2$), and capacity for organizational change ($n = 6$). Determinants in the social, political, and legal factors domain were not identified. Therefore, this domain is not further reported in this article. A comprehensive overview of the barriers and facilitators is presented in Table 4.

Table 1: Characteristics of the interviewed home care nurses

Characteristic	Participants ($n = 15$)
Sex (female), *n*	12
Age (years), median	34
Educational level (EQF[a]), *n*	
EQF-2	2
EQF-3	1
EQF-4	7
EQF-5/6 (district nurse)	5
Years of work experience[b], *n*	
2–9 years	6
10–29 years	6
30–48 years	3
Number of patients with AHMD, *n*	
1–5 patients	10
6–10 patients	4
>10 patients	1

AHMD, automated home medication dispenser; EQF, European Qualifications Framework.
[a]European Qualifications Framework[25] for education level.
[b]Years of work experience was measured as a continuous variable, and then classified into a categorical variable to ensure the anonymity of the respondents.

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Table 2: Domains of the Tailored Implementation for Chronic Diseases checklist and the numbers of determinants coded within the domain

TICD domain	Barriers, *n*	Facilitators, *n*	Both, *n*	Total, *n*
Innovation factors	3	6	7	16
Individual health professional factors	3	6	11	20
Patient factors	4	12	12	28
Professional interactions	1	–	5	6
Incentives and resources	–	–	2	2
Capacity for organizational change	1	4	1	6
Social, political, and legal factors	–	–	–	–
Total, *n*	13	28	37	78

TICD, Tailored Implementation for Chronic Diseases.

Table 3: Determinants for the implementation of automated home medication dispensers labelled as barrier, facilitator, or both, and the number of mentions

TICD domain	Determinant	Barrier	Facilitator	Mentioned by *x* of the 15 respondents, *n*	Number of times mentioned in total, *n*
Innovation factors	Disadvantages in practice				
	Alarms + unplanned visits	X		14	62
	Nurses having less control over the situation	X		2	5
	Less social contact	X		7	8
	Advantages in practice				
	Creative solutions to prevent and fix minor errors		X	4	10
	Quality of life		X	4	4
	Quality of treatment		X	9	17
	Sachets are cut open		X	4	4
	Self-sustainability		X	13	33
	Accessibility	X	X	10	14
	Home care is required	X	X	3	7
	Attractiveness	X	X	3	4
	Conditions	X	X	7	18
	Credibility		X	13	23
	Efficiency in home health care	X	X	12	27
	Feasibility	X	X	5	7
	Not portable (but early take-out possibility)	X	X	5	7
Individual health professional factors	Cognition (including attitudes)				
	Feeling competent and confident	X	X	11	30
	Feeling frustrated	X		4	9
	Intention and motivation	X	X	9	18
	Perspectives				
	Perspectives on AHMD	X	X	7	13

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Table 3: (*Continued*)

TICD domain	Determinant	Barrier	Facilitator	Mentioned by *x* of the 15 respondents, *n*	Number of times mentioned in total, *n*
	Perspectives on eHealth (in general)	X	X	12	23
	Knowledge and skills	X	X	7	12
	Awareness and familiarity	X	X	13	36
	Clarity	X		1	2
	Administration	X		6	7
	Make it simple for home care professionals	X	X	1	3
	Point of contact for asking questions		X	3	3
	Products and tools for home care professionals		X	11	32
	Sustainability	X	X	7	13
	Training		X	10	31
	AHMD dummy for practice		X	13	25
	Coaching on the job		X	7	20
	E-learning	X	X	10	25
	Learning from others' experiences		X	4	8
	Professional behavior	X	X	1	2
	(Impact of) past experiences	X	X	8	21
Patient factors	Anxiety or panic	X		8	10
	Concerns	X		10	11
	Family and informal caregivers	X	X	5	12
	Family's opinions and experiences	X	X	7	13
	Involving family	X	X	8	17
	Needs and wishes		X	2	2
	(Phasing out) guidance		X	11	31
	Evaluation		X	4	12
	Feeling confident	X	X	3	3
	Keep or make it simple (patient)		X	5	19
	Knowledge and instructions		X	12	28
	Products and tools (patient)		X	10	22
	YouTube videos		X	6	15
	Point of contact for questions		X	6	9
	Opinions and experiences	X	X	9	22
	Patient motivation	X	X	7	25
	Explaining advantages		X	12	19
	Relationship of trust		X	7	11
	Trying without obligations		X	9	17
	Selecting patients	X	X	12	24
	Being away from home	X	X	4	11
	Combination with other care	X	X	2	3
	Forgetting medication	X	X	8	13
	Knowing the patient, tailored decision		X	3	4
	Learnability	X	X	6	10
	Cognitive impairment	X		14	36

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Table 3: (*Continued*)

TICD domain	Determinant	Barrier	Facilitator	Mentioned by *x* of the 15 respondents, *n*	Number of times mentioned in total, *n*
	Non-adherent on purpose	X		4	12
	Patient selection tool	X	X	8	12
Professional interactions	Collaboration and support				
	External collaboration	X	X	8	16
	Internal collaboration	X	X	14	21
	Communication	X	X	4	4
	Involving whole team (signalling role)	X	X	8	18
	Helpdesk employees available by phone call to adjust settings	X	X	8	12
	Takes too much time to reach the helpdesk; some nurses wish to be able to adjust settings themselves, without needing the helpdesk	X		3	10
Incentives and resources	Financial (dis)incentives	X	X	12	29
	Quality and safety assurance	X	X	14	33
Capacity for organizational change	Leadership		X	1	1
	Direction from manager		X	3	4
	Superuser		X	3	5
	Priority of necessary changes	X		3	10
	Registration and deregistration	X	X	5	19
	Repeated attention		X	9	19

AHMD, automated home medication dispensers.

Innovation factors

Advantages of AHMD were identified as facilitators, such as increased self-sustainability, ease of use, not having to wait for home care, and taking medication exactly at the prescribed timepoint. Because of this, the respondents believed in the concept, which made credibility another facilitator.

Disadvantages of AHMD were described as barriers, such as patients having less social contact and professionals having less control. When patients did not withdraw their medication (unanswered alarm) or the system was malfunctioning, the home care organization was notified (alarmed). This was a safety net for patients (facilitator), but a barrier for nurses, who had to make an extra visit in the middle of their scheme. All respondents stated this as the most important barrier: the more they had to respond to alarms, the bigger the perceived barrier.

> Alarms take time, and it frustrates me. I get the call and must cycle all the way back to that patient, but I can't leave because I'm busy with another patient. (R11, EQF-2)

> If I hadn't experienced those alarms, I wouldn't know any disadvantages. It would be perfect (. . .) Occasional alarms, no problem. But this many? Nooo, big drawback. (R3, EQF-5/6)

Individual health professional factors

Lack of knowledge, awareness, and confidence are barriers. Some respondents stated that not all colleagues were familiar with AHMD, and awareness decreased when AHMD were not used regularly. In addition, AHMD might have come across as too technical and complex, leading to fear of dehumanizing care and being substituted by technology.

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Table 4: Comprehensive overview of the perceived barriers and facilitators

TICD domains	Sub-domains	Perceived barriers	Perceived facilitators
Innovation factors	(Dis)advantages in practice	Disadvantages • Alarms and required unplanned home care visits. - Frustration (both patient and home care professional), especially when it happens frequently. - Cause of alarm not always clear before visit. - Not always a home care professional available for unplanned visits. - Patients leaving the house without withdrawing medication in advance causes alarms. - The more patients use AHMD, the more alarms (and unplanned visits) will occur, the more disruption in workflow. - Family picking patients up spontaneously without alerting the home care organization causes alarms. • Having less control. - No guarantee that the patient in fact takes the medication, only that medication is withdrawn from the device. - Medication will not be double-checked before intake. - The device cannot be fixed in one place. • Patients having less social contact due to fewer home care visits.	Advantages • Some technical issues can be prevented with creative solutions. - Moving the pills to one side to prevent errors caused by the sensor. - Adjusting settings (length of sachets) to prevent wrong cuts and pills falling on the floor. • Not having to wait for home care: more freedom. • Increased quality of treatment: taking medication at exact time of prescription. • The device pre-opens the sachets (suitable for patients who cannot open packages). • Increased self-sustainability. • Home care organization is alerted when medication is not being withdrawn: safety net for patients. • The ability to adjust distribution time to the daily life of the patient.
	Accessibility	• Involvement of home care is required but not always desired. • Display not readable for all patients, sound not hearable for all patients, no light signals available in current AHMD model.	• Stable internet connection through SIM-card. • New AHMD model combines sound and light signals.
	Attractiveness	• Look of the device is technical (a square device with multiple buttons).	• Look of new model is an improvement: less technical looking (an analog clock with only one large button).
	Preconditions	• Some preconditions are beyond the influence of home care nurses (e.g., housing, server connections and supplying processes).	• The device will be a success if all preconditions are met (e.g., suitability of the patient, simple manual, external factors such as housing and server connections). "It is a great system when it is successful." • Home care nurses need to be able to trust that the device works properly.
	Credibility		• All respondents believe in the concept of AHMD: "It is a great invention."
	Efficiency in home care	• Efficiency will not be reached if extra visits remain needed (e.g., when a patient situation has changed since the start of AHMD use, and suitability has not been re-assessed). • In the case of many required unplanned visits due to alarms, home care nurses experience less efficiency in home care.	• Increased efficiency in home care because fewer home care visits are needed. • In the case of required unplanned visits due to alarms: the absolute number of home care visits still outweighs the number of visits that would be needed without the AHMD.
	Feasibility	• Digitalization is perceived as too complex for patients.	• The device is simple and easy to use.
	Not portable	• Patients leaving the house without withdrawing medication in advance causes alarms.	• The ability to withdraw medication in advance to take with them when patients leave the house.

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Table 4: (*Continued*)

TICD domains	Sub-domains	Perceived barriers	Perceived facilitators
Individual health professional factors	Cognition (including attitudes)	Perspectives on e-health • Fear of e-health taking over their job. • Risk of coming across as complex and technical. Feeling competent and confident • Not feeling confident might cause panic, which demotivates patients and home care nurses from using AHMD. Feeling frustrated • Having an insufficient level of patience: wanting to see results immediately after the start of AHMD. • Alarms frustrate both the patient and the home care professional, especially when it happens frequently.	Perspectives on e-health Intention and motivation • Home care nurses should feel the urgency to use AHMD. • YouTube videos of home care patients using AHMD stimulate motivation to use AHMD. • Feeling competent and confident stimulates the motivation to use AHMD.
	Knowledge and skills	Awareness and familiarity • Not all colleagues know about AHMD or how to use them. • When AHMD are not used regularly, awareness decreases. • Knowledge of seconded employees is insufficient. Training • Mandatory e-learning is already being used often, which causes resistance.	Awareness and familiarity • Promoting awareness and use of AHMD through internal publicity, discussion, making home care professionals curious about them. Training • Group meetings, teams mixed. • Using a dummy device to practice with. • Coaching each other on the job. • YouTube videos. • E-learning. - Mandatory to ensure participation. - Not mandatory, but as a reference when needed/desired. • Using tools: step-by-step instruction cards, detailed protocol. • Current administrative processes are clearly structured. • Making information available for seconded employees by instructions on article or through a link in the digital care plan. • Having a point of contact for questions.
	Professional behavior	• Making a number of team members responsible for the use of AHMD, but not involving all team members in the process. Impact of past experiences • Negative experiences demotivate home care nurses from using AHMD.	• Respecting the elderly while discussing AHMD with them. Impact of past experiences: • Positive experiences motivate home care nurses to use AHMD. • Sharing positive experiences with other home care nurses. • Starting off with a maximum chance of positive experience: selecting an obviously suitable patient (e.g., a patient with high levels of learnability and motivation).
Patient factors	Anxiety or panic	• Alarms and unplanned visits by home care nurses can distress the patient. • When alarms happen often, the patient will lose confidence and not want AHMD anymore. • Patients will feel panic if home care nurses are not confident.	
	Concerns	• Patients can be too fixated on the beeping device and withdraw their medication as quickly as possible, which increases the risk of falling. • Patients sometimes think in advance that they cannot do it, because they think it is too technical for them.	• Home care nurses can help patients with their concerns by having a conversation about these concerns and giving them proper instructions.

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Table 4: (*Continued*)

TICD domains	Sub-domains	Perceived barriers	Perceived facilitators
	Family and informal caregiver(s)	• Concerns of family may demotivate the patient from using AHMD. • Insufficient level of knowledge of family and informal caregivers may raise concerns in them. • Family picking patients up spontaneously without alerting the home care organization causes alarms.	• Involving family or informal caregiver(s) throughout the process before and during the use of AHMD. • Providing family with a sufficient level of knowledge by providing instructions (oral, video, or article).
	Selecting patients	• Suitability criteria are not always clear. • Not all home care nurses know about the existing patient selection tool. • Cognitive impairment might be a risk. - Insufficient ability to learn how to use AHMD (learnability). - Daily structure is provided with frequent home care visits, the frequency of which is less when AHMDs are used. • Patients being non-adherent on purpose. • Patients being familiar with medication abuse. • Patients rejecting support with medication intake. • Patients often being away from home. • Patients also having other care: no extra visit needed to hand out medication.	• Patients being able to learn how to use the AHMD (learnability). • Patients forgetting medication by accident, but wanting to be adherent. • Patients currently being reminded through phone call or alarm clock. • A patient selection tool is available. Using the selection tool helps to select theoretically eligible patients, but the final decision in selecting a patient is tailored. • Using incident reports about forgetting medication intake.
	Patient motivation	• Technology might come across as scary (e.g., difficult words, multiple institutions involved, thick manual). • View that home care nurses should not tell the elderly how to live their lives.	• Emphasizing the advantages and importance. • Explaining the possibility to try it without obligations; there is a way back if needed. • Explaining the need for efficiency in home care, endorsed by health insurance companies. • A relationship of trust between patient and home care professional. • Using YouTube videos for demonstration. • Information material (e.g., brochure). • Home care professionals being enthusiastic themselves.
	Needs and wishes		• Increasing patients' confidence by providing them with guidance, which phases out depending on whether the AHMD is being used successfully. • Simplified instructions, preferably delivered by the supplier. • Using tools: step-by-step instructions, YouTube videos. • Having a point of contact for questions. • Explaining the need for patience (e.g., it takes some time to get used to it, do not give up immediately). • Re-assessing suitability regularly.
	Opinions and experiences	• Seeing patients who are unhappy and disappointed with AHMD due to negative experiences.	• Having seen patients currently using AHMD and being happy and satisfied about it (positive experiences).
Professional interactions	Collaboration and support	Internal collaboration • COVID-19 restrictions. External collaboration • Adjusted medication sachets are required (collaboration with pharmacies). • Awareness: not all pharmacies and general practitioners know about AHMD.	Internal collaboration • Supporting each other in the case of alarms (unplanned visits). • The use of AHMD should be widely promoted among the home care nurses. • Not only involve home care nurses and patients, but also the department that receives the alarms from the device. External collaboration • Starting using AHMD at an earlier stage, before home care is involved, will prevent patients needing more support from home care later.

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Table 4: (*Continued*)

TICD domains	Sub-domains	Perceived barriers	Perceived facilitators
	Communication	• Patients or family do not always contact home care nurses when they leave the house, which may cause alarms when the AHMD distribution is not cancelled in time.	• Communicating a uniform message towards patients.
	Involving whole team (signalling role)		• Involving the whole team in the process of using AHMD (e.g., having a signalling and advising role).
	Medido Helpdesk	• Contacting the Medido Helpdesk takes time, which sometimes causes delay in planned care visits.	• The Medido Helpdesk is available 24/7, and staff are helpful and friendly. • Some home care nurses wish to be able to solve problems themselves, without having to call the helpdesk (e.g., adjusting settings or distribution times).
Incentives and resources	Financial (dis)incentives	• Costs of implementation. • Financial situation of the home care organization currently has priority over implementation of AHMD.	• No costs for patients because of full refund by health insurance companies. • Sufficient time must be made available at the expense of time that would normally yield money when spent on clients.
	Quality and safety assurance	• Patients pulling the sachets from the device before the device cuts them off causes safety and technical issues.	• Home care as a back-up. • Well-functioning device. • No more loose medication sachets lying around the house.
Capacity for organizational change	Leadership		• Appointing a group of key users to share positive experiences and answer questions (experience experts). • Managers giving direction on using AHMD more. Providing clarity • Where to ask which questions? • Administrative processes.
	Priority of necessary changes	• Financial situation of the home care organization currently has priority over implementation of AHMD. • Another e-health implementation is currently in progress. • COVID-19 restrictions. • History: previous implementations were started in the home care organization without proper consideration for sustainability.	
	Registration and deregistration	• No confirmations or status reports from the supplier. • Delivering and retrieving devices sometimes take too long (e.g., a few months).	• Current administrative processes are clearly structured.
	Repeated attention		• The organization should consistently raise and sustain awareness (e.g., evaluation, inquiry, repeated training).

AHMD, automated home medication dispenser; TICD, Tailored Implementation for Chronic Diseases.

This is a cultural change which not everyone has joined yet. Because we love to care for patients. When the patients become more and more independent, what will happen to my job? Is there still work for me? (R8, EQF-5/6)

Simplified instructions, group training, dummy devices to practice on, and e-learning were facilitators for knowledge gain. Opinions varied on whether e-learning should be mandatory. The respondents received only written instructions and a demonstration.

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Respondents suggested using YouTube videos and pocket cards with step-by-step instructions.

Past experiences of nurses could be both facilitators or barriers, depending on whether the experiences were positive or negative. Sharing positive experiences was a facilitator.

> I don't use AHMD because I've had bad experiences (. . .) But in another team, my colleagues have excellent experiences. So, I should get back at it (. . .) It helps if we hear more positive experiences. (R3, EQF-5/6)

Patient factors

Determining whether AHMD is suitable for a patient should be an individual process in consultation with the patient and relatives or informal caregiver(s). Most of the respondents mentioned that thorough assessment of patients' eligibility prevented unanswered alarms. Learnability (being able to learn how to use AHMD) was essential for eligibility.

> There are patients with dementia – well, let's say forgetful people – who can't learn new things well. AHMD would be such a new thing. (R10, EQF-4)

Using a selection tool provided by the supplier, with criteria such as learnability, was a facilitator. However, most respondents were unfamiliar with this tool, which was a barrier.

Respondents identified two groups of patients: first, those who want to be independent and appreciate the regained freedom; and second, those who deeply value the social contact with nurses and resist being visited less frequently. Although the first group is happy to start using AHMD, the second group needs more motivation.

The nurses employed several facilitating techniques to motivate patients, such as emphasizing the advantages and offering the option of trying AHMD without obligations.

> We explain they don't have to wait [for us] to take their medication (. . .) I also tell them that we don't drop them suddenly or don't look after them anymore (. . .) And the fact: "If you don't like it, we can return it." (R1, EQF-5/6)

After a patient confirms willingness to use AHMD, providing simplified instructions, step-by-step, was a facilitator.

> When it beeps, it's time for your medication. If it beeps louder, it means you didn't hear it the first time. Really a very concise description: when the device does this, you should do that. (R15, EQF-5/6)

Moreover, providing guidance during the initial period of use was a facilitator. Over time, the patient needed less guidance, and guidance could be phased out.

> We [nurses] don't throw them [patients] into the deep, like: "OK, here's the device, good luck." No. They must be guided during the first few weeks. (R6, EQF-4)

Professional interactions

Internal collaboration within home care teams was a facilitator, such as dividing unplanned visits or coaching on the job. Moreover, assessing eligibility should involve all colleagues.

> You shouldn't do it alone. We work with first contact persons [each patient gets assigned one nurse]. They visit the patient weekly. They should certainly play a role. They are my eyes and ears and know the patient the best. (R15, EQF-5/6)

In collaboration with other organizations (external collaboration), such as general practices and pharmacies, raising broad awareness and proactiveness to use AHMD was a facilitator.

> We often get requests from general practitioners to hand out medication multiple times a day (. . .) But AHMD would be better (. . .) General practitioners are quick in saying, "Oh, home care will do that." They should be made aware too. (R3, EQF-5/6)

Incentives and resources

AHMD being fully refunded by health insurance companies in the Netherlands was a facilitator. Furthermore, fewer visits are needed when AHMD is

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successful, reducing home care costs in general. If many unplanned visits were required, however, it was perceived as inefficient. Nonetheless, the objective number of unplanned visits might still outweigh the number of visits needed without AHMD.

> For example, a Parkinson's patient who needs medication six times a day. If we must go there, that is six times, seven days a week. Then, yes, it weighs up to introduce AHMD; it of course reduces the costs a lot. (R9, EQF-4)

With regard to quality and safety, both barriers and facilitators were identified. AHMD increased safety, especially with home care as a safety net. However, the respondents experienced having less control.

> If you only visit once a week and the patients do it themselves the rest of the time, you have no further notice whether they are really taking the medication. . . Errors could still occur. (R5, EQF-5/6)

Patients pulling their medication out before the device cuts the sachet was a safety barrier that caused malfunctions and medication errors. Patients should be instructed to wait for the device to cut the sachet.

> When the patient pulls, another sachet [for later use] might get pulled out too. Pulling also causes faults in the cutting of sachets. Loose tablets fall on the floor; medication gets lost and not taken. (R7, EQF-3)

Capacity for organizational change

Managers should pay repeated attention to AHMD, for example, by reminders or repeating training sessions.

> After a while, it [attention] becomes less and less, so that, yeah, you kind of forget it again. So they should pay attention to it more often (. . .) For example, once per year a reminder that it exists at all. (R5, EQF-5/6)

Simple and well-organized administrative processes of requesting (starting) and cancelling (stopping) AHMD was a facilitator. Miscommunication with the supplier and delivery delays were barriers.

> We constantly had to call them [the supplier], and it took 3 months to deliver the device (. . .) They said they were busy, and then that the communication had gone wrong. They kept giving different explanations. We almost felt like "whatever, we'll just keep visiting the patient." (R15, EQF-5/6)

DISCUSSION

This project provided a comprehensive overview of 78 determinants (barriers, facilitators, or both) for implementing AHMD. To our knowledge, this is the first study of its kind. Sixty-four determinants (82%) fell within three domains: (1) innovation factors such as (dis)advantages of AHMD; (2) individual health professional factors (such as knowledge and skills, confidence, motivation, and past experiences); and (3) patient factors (such as eligibility, motivating patients, instructions, and guidance).

Our respondents believed in the concept of AHMD, as it offers increased efficiency and patients' self-sustainability, among other benefits. Kleiven *et al.*[36] support our finding that patients become less dependent on and less vulnerable to delays in home care. Our respondents perceived the unplanned visits as an important barrier, which supports the claim of Ross *et al.*[37] that e-health systems (not specifically AHMD) can disrupt workflow. The respondents mentioned AHMD alarms as the main factor disrupting workflow, because these necessitate unplanned visits. Alarms can be largely prevented by critically assessing the patients' eligibility for AHMD, and adequately instructing and guiding the patients and their family and caregivers.

Our respondents stated that thoroughly assessing eligibility is essential to minimize unplanned visits, with learnability being the essential criterion. Guise and Wiig[38] confirm that older people may have difficulty coping with technology due to insufficient learnability. Even if technology is straightforward and familiar,[25,37,38] it may still not succeed.[38] Although previous studies did not specifically address AHMD and the home care setting, our study confirms some of the reported barriers and facilitators: an important barrier is limited experience/knowledge, while an important facilitator is ease of use and motivation.[25] Problems with financing[25] were not mentioned in our study, because AHMDs are fully refunded by health care insurance in the Netherlands.

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Reeder *et al.*[22] reported that older people found AHMD easy to use. The nurses in our study considered AHMD user-friendly, but the perspectives of patients should be verified in future research. Nevertheless, user-friendliness does not guarantee success. Thoroughly assessing eligibility remains essential.

We identified nurses' lack of knowledge, skills, awareness, and confidence as barriers, which is supported by prior research.[23,25,36] According to Nakrem *et al.*,[23] health care professionals' insecurity with new technology negatively affects relationships with patients, who develop the same insecurity. Some studies verify our findings that training,[37] written instructions, such as step-by-step pocket cards,[39] hands-on practice with a dummy device,[38] and (phased out) guidance[36] are facilitators to improve knowledge, skills, and confidence. In addition, our respondents considered the sharing of past experiences a facilitator to learn from each other and to gain confidence.

Our respondents distinguished two groups of patients. One group—patients wanting to be independent and appreciating fewer visits—was also described in other studies.[23,36] However, the other group—patients who resist using AHMD because they fear less social contact with nurses—was not. Emphasizing the advantages and importance of AHMD and being enthusiastic as a trusted professional can be helpful.

A strength of our study is the maximum variation sample in geographic areas, educational level, age, sex, experience with AHMD, and years of work experience. Further, the TICD checklist[29] guided the design of the interview guide and data analysis. We chose to use the TICD checklist as a roadmap because of its comprehensive overview of all relevant domains in implementation. We preferred this over behavioral theories and frameworks because we did not want to presume that behavioral factors were dominant, and the TICD checklist is broader in scope than just behavioral factors. Finally, taking an inductive and deductive approach, member checks and peer reviews were performed to strengthen trustworthiness. Only four member checks provided additional information. During peer reviews, there were no major discrepancies, and no new determinants arose. Thus, the code tree can be deemed comprehensive and complete.

Some limitations should be considered. First, respondents were sampled from one large organization. Sampling respondents from multiple organizations spread over one or more countries would increase transferability. Second, we did not reach maximum variation in sex. However, with 70% of health care professionals being women,[40] our sample seems representative. Third, we did not interview the patients themselves. Instead, we studied the nurses' perspective because they play an essential role in the process of working with AHMD, and work with the patients daily and know them well. To approach the patient's perspective as closely as possible, we asked the professionals to formulate how they thought the patients felt. We recommend exploring patients' views in future research. Lastly, the researcher being employed at the home care organization might have influenced the results. Five respondents, with whom no direct working relationship existed, were met before; respondents with whom a direct working relationship existed were excluded from recruitment. The researcher was continuously aware of her role by putting her knowledge aside and entering each interview with an open mind (bracketing) and constantly reflecting on her role (reflexivity).

Implications for further research

Based on how often determinants are mentioned by respondents, we could have estimated which determinants were the most important. However, this approach would not be trustworthy. Further research is recommended to rigorously determine the perceived importance of the determinants among patients and relatives, and apply trustworthy prioritization. Moreover, the perspectives of the patients and relatives themselves on the use of AMHD should be explored in further research.

CONCLUSION

In conclusion, we recommend considering the determinants (barriers, facilitators, or both) that this study revealed when developing tailored implementation strategies for implementing AHMD in home care. To this aim, we have developed a list of practical strategies (Appendix V, http://links.lww.com/IJEBH/A132).

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Author contribution (CRediT Author Statement): CM: Conceptualization, investigation, formal analysis, writing – original draft, visualization, project administration; JdMvG: Writing – review and editing; MvD:

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Writing – review and editing; EI: Conceptualization, formal analysis, validation, writing – review and editing, supervision.

ETHICS APPROVAL

The Medical Ethics Research Committee of the Erasmus University Medical Center Rotterdam approved this study (MEC-2021-0071).

CONSENT FOR PUBLICATION

All authors and respondents have consented to publication.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy reasons.

CONFLICTS OF INTEREST

The study was a Master's thesis for the Clinical Health Sciences program at Utrecht University. Respondents were informed about this in the information letter. CM is an employee of the same home care organization, which constituted a potential source of selection bias.

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