

# Usability and Utility of Head Mounted Displays in Care according to Caregivers

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**Abstract.** Nowadays, professional caregivers need to provide care in less and less time, while quality requirements are increasing. Therefore, access to information and guidance need to be improved. One solution to support caregivers is the Care Lenses which support caregivers during everyday care with Augmented Reality (AR). AR may provide additional information, guidance and remote support. While technology is not always the best solution for such a difficult and manifold problem, extensive evaluations are needed in order to investigate the potential of AR in everyday care context. In this Paper we summarize perceptions of 25 caregivers, who were participating in our study, using Care Lenses in a simulated everyday care situation. It shows AR is able to support caregiver during their work and what kind of problems might occur during the introduction into professional care.

## Introduction

Care Lenses is a smart concept using augmented reality (AR) technology to support caregivers in their daily work. It is meant to ease the time and quality pressure in the care system by providing smart support such as access to information on the patient, workflow guidance and remote helper access during the provision of care. With the help of AR Head Mounted Displays (HMD), it is possible to provide people with additional information while they are able to interact with the real world freely (e.g., using their hands for work tasks instead of operating computing devices). Augmented Reality (AR) supplements the real world with digital

information (Azuma, 1997). Typical use cases include expert-novice scenarios (e.g., Datcu, Lukosch, & Lukosch, 2016; Fakourfar, Ta, Tang, Bateman, & Tang, 2016) or workflow support for workers (e.g., Blattgerste, Strenge, Renner, Pfeiffer, & Essig, 2017).

The potential of AR support for caregivers has been recognized. Among relevant work in this area, AR has been investigated for remote support of caregivers (Mather et al., 2017), care procedure training (Azimi et al., 2018; Kobayashi, Zhang, Collins, Karim, & Merck, 2018) as well as image capture and documentation (Aldaz et al., 2015).

Despite this work, little is known about the application of AR support for care in practice. To close this gap, we conducted a study with our Care Lenses, a multi-functional AR support tool for care. In particular, we were interested in the applicability in care practice and the acceptance of the Care Lenses. We present results of interviews conducted with caregivers and insights stemming from this.

## The Study

### Care Lenses

Care Lenses provide caregivers with planned care guidance for care specific tasks such as pain management, wound management or endotracheal suction and provides data from patients, making health infrastructure accessible. In addition, caregivers can call remote experts via video calls and synchronize data from tasks done in digital documentation systems directly. Care Lenses are supposed to ease care practice, increase care quality and to unburden caregivers from effortful and time-consuming tasks like documentation or ordering material.



Figure I: Left: A caregiver while treating a patient in the study. Right: The AR Head Mounted Display used in the study (Epson Moverio BT 300).

### Care Lenses Features Tested

In the study we used support for ordering everyday care material and a typical care workflow. The first supports ordering with Care Lenses' context recognition, which

enables users, among other things, to order some recognized material by selecting one of a couple of preset amounts. This makes ordering material, which we were reported as lengthy and complicated, a ten second process directly feasible. The second feature provides support for pain management workflows at the patient. It consists of seven steps leading the user through the workflow during the treatment and providing helpful information about what to do, ensuring a high standard of care. The workflow holds short questions (for example “Can the patient answer to questions?”) in order to adapt the workflow according to the needs of patients. It also allows caregivers to enter patients’ assessments of their pain level, matches it with the maximum and minimum levels prescribed and provides advice how to proceed according to those levels. Finally, the Care Lenses document the pain level in the documentation backend. Both were chosen as they had been identified to be tasks that either were error-prone (pain management) or time-consuming and often forgotten (ordering material) in the design phase of the Care Lenses as they had been identified in our field work and from statements by care staff we interviewed. In our study we used a fully operational prototype, controllable via touchpad or head gestures (Prilla, Janßen, & Kunzendorff, 2019) and displaying static data instead of using a documentation backend. As HMD we used an Epson Moverio BT 300 (see Figure I), which is a lightweight model of and looks close to real glasses.

Table I: Research questions of our study and examples for questions in the interview.

<b>Research Question</b>	<b>Examples for Questions in Interview</b>
How is support for workflows in AR able to facilitate and relieve everyday care?	“Can you imagine using Care Lenses in everyday care? Justify please!”
	“What kind of benefits of Care Lenses do you notice for the executed task?”
	“What kind of limitations of Care Lenses do you notice for the executed task?”
How does AR influence the interaction of caregivers with patients?	“What do you think about how Care Lenses will change the interaction with patients?”

## Methodology

The study was performed in simulated care situations: They took place in real patient rooms, and we used one of the researchers to act as a patient (see Figure I). For reasons of ethical approval collected for the project, we did not use Care Lenses prototypes with real patients. In the study, the care givers were asked to use the Care Lenses for the conduction of the two tasks described above. After that, they were interviewed. Besides questions about perceived usability and utility of Care Lenses in everyday care we were interested in general impressions of caregivers

about the Care Lenses and their opinion about how Care Lenses could be used during the interaction with patients (see Table I). We audio-recorded the interview and transcribed them later for analysis.

## Participants

The study was done at four different locations (care providers) and with 25 caregivers in total (see Table II). The participants were aged from younger than 25 to older than 50. 19 of them were female and 6 male. Their experience in care was on average 12.6 years (SD=8.6), and all of them had experience in pain management or were at least educated in it during their apprenticeship. In what follows, we will refer to participants as caregiver 1 to 25 (C1-25, see Table II).

Table II: Overview of caregivers participating in the study.

Care Provider	Participants	Indices
Elderly care ward	6	C1-C6
Intensive care shared apartments	6	C7-C12
Care laboratory, participants from different care providers	5	C13-C17
Intensive care stationary unit, participants from different providers	8	C18-C25

## Data analysis

For data analysis, we transcribed and paraphrased the recorded interviews and sorted the paraphrases into categories mainly derived from the questions of the structured interview (see Table I). Within those categories we sorted positive and negative aspects of the feedback (e.g., what they liked and did not like regarding interaction with patients). In the following analysis, we used mainly inductive clustering. We clustered paraphrases according to their content within the negative and positive aspects of our categories in order to find underlying arguments for or against Care Lenses in practice. As an example, one resulting cluster contains all positive arguments about using Care Lenses in the near of patients and another holds negative arguments about using them during the whole day. From these, we created 32 clusters that represent topics mentioned in the interview through a second clustering. For example, clusters about working with Care Lenses at the patient and potential reactions of patients to it were summarized in the topic “Care Lenses at the patient”.

Below, we report on general topics dealing with the applicability and utility of Care Lenses in care. These include everyday use at the patient, familiarization and learning curve, ensuring quality in care, and communication.

# Results

## Use of Care Lenses in everyday care

In general, the caregivers were positive about the Care Lenses. One even told us: “Continue! I would wish that the Care Lenses will arrive in practice!” (C2).

The Caregivers appreciated different aspects of Care Lenses and none stated that they did not see benefits in using it. Availability of data from health infrastructure in situ was an aspect often mentioned: “For assessment I think it is great that I can directly access it (Author comment: Health infrastructure) at the patient. Without the need to write anything (Author comment: Documentation of assessment). So, I can talk to the patient and concentrate on him completely.” (C16).

The caregivers also stated they appreciated getting information from Care Lenses they would otherwise miss or need to lookup: “The information I get from it!” (C10 on the pros of Care Lenses in everyday care). Regarding helpful information to be displayed on Care Lenses, caregivers mentioned “vital parameters” (C3), “weight” (C23) and “diet” (C2). Furthermore, they asked for “information about care plans” (C10) and “reminders about specific care tasks” (C23).

Another aspect mentioned is the ease provided to otherwise effortful tasks. They particularly liked to order or document directly, which helped to avoid to forget documentation: “Very good! ...When you notice something must be reordered, you have it on the spot, can order and done!... Usually you will definitely forget it faster than with such glasses!” (C2 on benefits of workflow support). Others mentioned advantages for coordination: “With four people in service you always have to talk about what they have to do and when... With glasses this is done in a few seconds.” (C19 on benefits of Care Lenses)

Despite the positive feedback, caregivers also mentioned some problems. Some were concerned that (other) caregivers could rely on the Care Lenses too much without using their own experience or knowledge: “Perhaps someone relies too much on the device without rechecking.” (C17). Another issue mentioned was whether Care Lenses could be misused e.g. to enable unexperienced caregivers to do tasks they were not trained in – which is not the purpose of Care Lenses. In contrast, some caregivers even thought the Care Lenses could provide a chance to support less able colleagues (compared to letting them work without support): “But it is better to have bad staff with Care Lenses than bad staff without... or to work too much under the Care Lenses without to bring in own experience.” (C10).

A few caregivers were unsure how the Care Lenses would fit in everyday care practice because they “learned to treat patients differently” (C13) or they already have a routine in everyday care and therefore do not need Care Lenses. “Perhaps I am stuck in my everyday routine and I just know what I have to do ... Actually I do not need the Care Lenses, but I did not have it before. Perhaps I cannot imagine being without it if I worked with it a little bit more.” (C25)

## Perceived influence on interactions with patients

The caregivers discussed and were able to differentiate between which support provided by Care Lenses should be used at the patient and which not. A few caregivers stated they would avoid to wear Care Lenses in front of patients. For example, they suggested to use ordering support only outside the patient's room and to document care tasks while going from one patient room to another: "At the bed of the patient I would not like to use it (because Care Lenses distract from patient (interpreted from prior comments in this interview)). For documentation afterwards, it was fast and practical, or for ordering care materials it is useful." (C9). In contrast, many others stated they wanted to use Care Lenses in front of the patient because of the offered support like automatic documentation (C4, C5, C10, C16, C18).

Regarding the interaction with patients, some caregivers concern: "Care Lenses are not patient friendly" (C9). This was often explained by the distraction from the patient Care Lenses could possibly provide. Some mentioned they had the impression to talk less to the patient than usual. One caregiver mentioned that he did not "talk to the face of the patient" (C25) and another reported on missing eye contact to the patient (C23). Another caregiver stated he felt unpleasant if he does "look into the Care Lenses without focusing on the patient because in care patients expect caregivers to talk with them" (C19). In the same vein, a caregiver assumed colleagues could be more focused on Care Lenses and talk even less with patients if those patients are less talkative by themselves (C10). In contrast, some caregivers denied any influences of the Care Lenses on their interaction with patients, stating for example to "still talk with the patient as usual" (C22).

## Keeping patients in focus

Care Lenses were also perceived as distraction by caregivers, with some mentioning difficulties to keep the patient in focus. They mentioned that "the focus goes away from the patient" (C20) while wearing Care Lenses and that the use of it requires concentration because caregivers "have to read the text" (C20) on it. Some Caregivers expressed their fear to "miss something important at the patient" (C9) while using Care Lenses or that a patient could notice their distraction and "could get the feeling he would not be taken seriously as a human" (C12). Some mentioned the impression they were not completely focused on the patient like they usually are ("I believe I was just to less there for Miss Smith<sup>1</sup>" (C21)). It needs to be mentioned that besides these few statements, most of the caregivers did not mention these fears. Many stated they would most likely get used to the Care Lenses over time (see below).

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<sup>1</sup> Name changed by the authors.

## Estimated reactions of patients and experience with Care Lenses

Some caregivers mentioned the Care Lenses make them “look ridiculous (Author comment: for the patient)” (C20) or they “feel strange while wearing it” (C15). Some of them just stated they are not used “to wear glasses” (C12) or simply “to work with Care Lenses in front of patients” (C23). Others said they would feel uneasy during the patient contact. They also estimated patients would think caregivers would be “out of their mind” (C23) or “do not take them seriously” (C12) if they use Care Lenses in front of them without looking to them.

Some caregivers feared patients would not be able to understand Care Lenses and their purpose because they show information only to their wearer. One caregiver added that “patients suffering from dementia could be even more irritated by Care Lenses than they usually are, which is a big problem for them” (C1). Nevertheless, caregivers stated also that the current generation of patients is not used to technology in general. Some caregivers concluded that “later generations of patient will possibly not have this problem” (C23).

On the other side, most caregivers did not assume negative reactions of patients and some were even speaking of positive reactions. A lot of caregivers thought that patients would “accept the Care Lenses if they get a proper explanation” (C3) or that “many (Author comment: patients) will tolerate the Care Lenses and will find it great” (C6). Some even assumed that patients could be interested in Care Lenses by themselves: “The mentally healthy (patients), depending on how technophilic they are, (...) can be enthusiastic about the Care Lenses” (C12).

## Familiarization and Learning Curve

Many caregivers recognized that some of the difficulties they had with the Care Lenses could stem from the fact that they were just not used to it and needed some more practice: “Had to be occupied with the Care Lenses, because I did not know it before” (C4). For example, one caregiver mentioned that wearing HMDs in general “is matter of habit” (C12). Other caregivers mentioned that distraction from patient could also be reduced if the Care Lenses become a known tool: “You have to get used to it (Care Lenses) first, (...) it is quite big, I think it is heavy, it is unfamiliar.” (C18). According to caregivers the focus on patients could be a question of getting used to the Care Lenses: “If you cope with the Care Lenses nicely at some time, the patient definitely is paramount. (...) Initially you focus more on the Care Lenses, but you get used to it.” (C22).

Another aspect caregivers estimated to get accustomed to is the handling of the Care Lenses in order to work faster than in the study and to get along with the Care Lenses while treating a patient: “As soon as I get used to it (Author comment: Care Lenses) I think I will become faster (Author comment: in using Care Lenses) and come along at the patient quite well” (C16).

## Discussion and Conclusion

Our study shows that our concept of using AR for the support of caregivers has good potential to provide value and to become accepted. We did not find reasons that would prevent users from using Care Lenses in everyday care while treating patients, and no other reasons to exclude usage. Nonetheless, we found considerable concerns about using Care Lenses. Many of them arise from the study situation and brief confrontation with Care Lenses. The concept was new and unknown to the caregivers, and in many of their statements it became clear that this affected their perception of using Care Lenses. Caregivers also told us their impression could change if they had more time to get used to the concept. Moreover, some caregivers said they focused too much on the Care Lenses and had difficulties to focus on the patient or talk to them during care. As above, caregivers stated that they just need time to get used to and deal with Care Lenses in order to diminish this problem. We will explore this in long-term exposure studies and onboarding or tutorial strategies for the initial usage of Care Lenses.

Another issue that could have caused concerns is the HMD used in the study, which is a commercially available product and should be wearable by the general public. However, in practice it often did not fit perfectly or was too big and slipped. Current and future development will most certainly solve this with less weight and displays that can show information easier to read and less obtrusive.

Beyond the concerns mentioned above, most caregivers did not have additional concerns. We assume they understood Care Lenses as a tool supporting them, while others rather understood them as something new, they needed to explore first causing them to focus on the HMD.

One interesting aspect is that caregivers told us they might be embarrassed by wearing the Care Lenses in front of patients. These caregivers also had concerns about their own appearance with Care Lenses on, which reinforces their concerns about using them with patients. Therefore, they told us they would avoid using Care lenses near the patient. In practice, it may be the case that this feeling changes quickly when they recognize that patients accept or even welcome the support provided by the Care Lenses as assumed by other caregivers. Less obtrusive technology with more natural and inconspicuous controls can also help caregivers to overcome this. Moreover, it will also be easier for patient to get used to caregiver wearing it and even helps avoiding confusion of patients who are suffering from dementia.

While our insights suggest that Care Lenses can be accepted and helpful in care practice, this needs to be scrutinized in practice. It is not sure that Care Lenses work in real care practice where people are stressed, attending multiple patients, and where the potential for technical issues is much higher. The simulated care task was free of this and possibly ease to accept Care Lenses this way. Our future work will be devoted to investigate this any further.

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