

# Adjusting AR-Workflows of Care Tasks:

Experiences from an Initial Study

Marc Janßen<sup>†</sup>

Human Centered Information System  
Clausthal University of Technology  
Germany  
marc.janssen@tu-clausthal.de

Michael Prilla

Human Centered Information Systems  
Clausthal University of Technology  
Germany  
michael.prilla@tu-clausthal.de

## ABSTRACT

Professional caregivers need to adhere to standards when treating their patients in order to ensure a certain level of quality and hygiene. Whenever standards are refined or changed, caregivers must keep pace with them. However, these standards are interpreted differently by care providers and also offer degrees of freedom which enable caregivers to adapt them in certain situations and according to their own experience and practice.

Workflows are a useful tool to define, share and execute standards correctly. In this paper we investigate the possibility to adjust workflows with our Care Lenses, an Augmented Reality based tool, which can be used by caregivers during the execution of care tasks and which supports them with guidance regarding standards. We show how care practice influences the development of technical support for workflows and what kind of advantages the possibility of adjustments grants to workflows and the integration into practice.

## KEYWORDS

HMD, AR, caregivers

### ACM Reference format:

Marc Janßen, Michael Prilla. 2018. Adjusting AR-Workflows of Care Tasks: Experiences from an Initial Study. In *Mensch und Computer 2019 – Workshopband*, Bonn: Gesellschaft für Informatik e.V., 7 pages. <https://doi.org/10.18420/muc2019-ws-623>

## 1 Introduction: AR-Workflows support everyday care tasks

Working in care is a stressful job, in which caregivers need to accomplish many tasks with different patients under high time and quality pressure. The demographic change in western and

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

MuC'19 Workshops, Hamburg, Germany

© Proceedings of the Mensch und Computer 2019 Workshop on Virtual and Augmented Reality in Everyday Context (VARECo) Copyright held by the owner/author(s).

<https://doi.org/10.18420/muc2019-ws-623>

other societies cause a worsening of this situation, in which there are less (young) caregivers available for (mostly older) patients to be cared for. Therefore, technology support for care is an important field for research and business, which aims at facilitating the work of caregivers while keeping care quality and satisfaction of all stakeholders (patients, relatives and caregivers) at a high level.

The work presented aims at supporting caregivers with information and guidance in workflows that they need to perform. It is part of the project called Care Lenses (German: “Pflegebrille”), in which we develop Augmented Reality (AR) support for caregivers [6,8]. As part of this project, we offer guidance through typical care workflows such as pain and wound management or endotracheal suction (see below) to caregivers in order to strengthen the compliance to standards, to refresh their knowledge about the workflow or to train it (e.g. when starting their job after being educated to become a caregiver).

Care work needs to adhere to standards in order to ensure high care quality and liability. In addition, the ability to settle the cost of care to insurances needs compliance to these standards and proper documentation of such compliance. This is where the workflows on Care Lenses provide benefits. Literature and our prior field work [10] points to the fact that in care practice, performed workflows deviate from standards. This is due to the experiences and practices of individual caregivers, which they have developed over time, and due to differences in caregiver education. For example, while wearing protective gloves is a standard in most current care education, some caregivers do not use them for certain tasks. While this seems like a quality threat, there are techniques used by these caregivers, with which hygiene and compliance to standards can be ensured without gloves. Therefore, *instead of providing one fixed standard workflow* on Care Lenses, it seems to make sense to *enable caregivers or care providers to adapt workflows* to their rules and practices. Based on this, creating workflow support for care work needs to face the questions *whether and how to adjust workflows to the needs of caregivers* as well as *what is the value added of adapting workflows*.

Our work is built on and adds to the body of literature in HCI that deals with the difference of perspectives on IT support (or, in general, socio-technical systems design) between tasks and practice [7]. In particular, the adaptation of workflows in care work is closely related to the discussion on prescriptiveness of

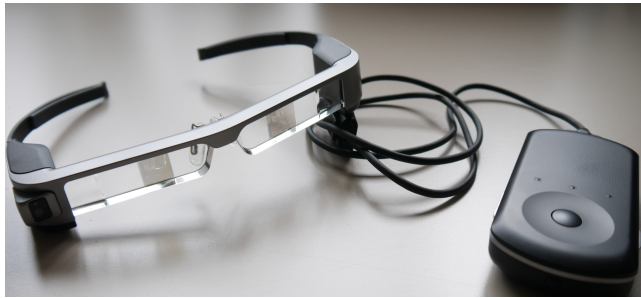
workflow representations [2,4] and Lucy Suchman's differentiation of plans vs. situated actions [11]. In short, the questions mentioned above look at how practice and planned workflows overlap or conflict in care, and whether adaptations of workflows are helpful in this context.

In the work presented here, we tackled the questions mentioned above in an initial study, in which we implemented and evaluated a feature in the Care Lenses that allows caregivers to make personal adjustments to workflows. In particular, we provided them with the opportunity to make adjustments to one part of a workflow they had used before to investigate whether and how this is beneficial, and whether and how adjustments of workflows in care work can or should be made.

## 2 Care Lenses

### 2.1 Concept

Care Lenses is a concept that uses head mounted devices (HMD) for Augmented Reality (AR) to support care work in order to enhance care quality. AR was used to enable caregivers to use their hands for treatment and other care tasks while using digital information to support this work.



**Figure 1: The Epson Moverio BT-300 HMD used for the Care Lenses (right: the handheld touch controller). Own image.**

The support provided by Care Lenses is based on (ethnographic) field work and co-design with caregivers [9]. From this, together with caregivers and experts, we derived a large set of support options to be provided by AR HMDs in care, which includes support for care workflows (e.g., procedures for pain and wound management), features to ease otherwise effortful and often forgotten tasks such as documentation and ordering of assistive equipment and many others (see [10] for details on these features). The current Care Lenses prototypes are implemented on an Epson Moverio BT-300 device (see Figure 1). In order to interact with the information displayed on the glasses, it provides a handheld touch device physically attached to them.

The Care Lenses offer step-by-step instructions for care tasks (workflow support) that can be accessed and controlled by caregivers while providing care. The workflows available on Care Lenses were specifically designed to be used on AR devices, including the control of the workflow without using the hands but only by using head gestures [8]. For the *provision* of support, the Care Lenses provide information for a task, step-by-step

instructions for care tasks, access to organizational features and documentation of care tasks. The *documentation* of tasks includes the completion of tasks and manually entering values into or automatically recognized by the Care Lenses.



**Figure 2: A caregiver wearing Care Lenses while conducting the workflow for endotracheal suctioning in our studies (left). On the right, the instructions displayed on the Care Lenses are shown. Own images.**

### 2.2 Workflow for endotracheal suction

In the study presented here, we looked at the workflow for endotracheal suction available from Care Lenses. The creation of the workflow was based entirely on actual literature [1,3,5] and was therefore influenced more by care standards than by care practice. The workflow consists of 26 activities which are defined in short textual descriptions and/or videos and pictures showing what the caregiver needs to do during a certain activity (see Figure 2). In the workflow the preparation of the process, the execution of the care task itself and the post-suctioning process is supported in order to ensure and train compliance with hygienical regulations, which is a problem in care practice according to caregivers and managers.

Index	Activities in Group
A	Disinfect hands, put on personal security equipment, disinfect work surfaces (3 activities)
B	Check catheter; prepare care material in place (2 activities)
C	Check position of tracheal cannula
D	Technical inspection of suction machine
E	Set pulse oximetry

**Table 1: Sequence of activity groups of preparing endotracheal suction (initial sequence of the workflow for endotracheal suction provided by Care Lenses).**

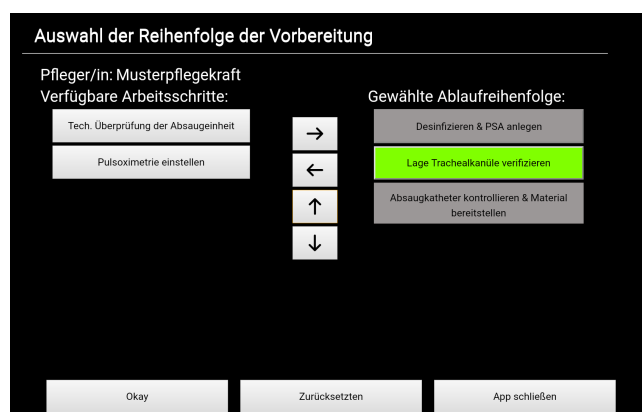
In this paper we focus on the preparation of the care task endotracheal suction and its adaptation, which is done in five steps (see Table 1).

In what follows, we refer to the workflow sequence by ordered indices. For example, the original workflow sequence as shown in Table 1 is referred to <ABCDE>.

## 2.3 Adjustment of workflow

Due to the reasons discussed above, we implemented a feature to offer caregivers the opportunity to change the order of the activities for preparation of endotracheal suction (see Table 1). In order to keep the workflow correct in comparison with the expert definition of endotracheal suction, we restricted the possibilities for adjustments. We grouped some activities, which need to be done in a certain order and without any activities between. For example, in activity group <A> the activities “disinfect hands”, “put on personal security equipment” and “disinfect work surfaces” are fixed in a certain order without any other activities between which is needed to comply with hygienical regulations (hands need to be disinfected first before any protective equipment should be touched). On the other side the activity groups <A> and <B> need to be done in a certain order (disinfection should go first), but not necessarily without activities between. Therefore, we restricted the adjustments and disabled the movements of these activity groups in the workflow.

For adjusting the workflow, we implemented a simple tablet app (see Figure 1). In the app the user marks a certain activity which needs to be moved with a simple click/touch and then can be moved to the bottom of the actual order of workflow activities (Button “→”) and moved within the actual order (Buttons “↑” and “↓”). While it is also possible to remove an activity from the actual order (Button “←”), it is not allowed to apply an order of activities to the Care Lenses as long as it does not contain all activities. This ensures that compliance to standards. In order to implement the rule that activity group <A> comes before <B> these activity groups are already placed in the final order and can not be replaced (represented through the dark gray color, see Figure 3).



**Figure 3: User interface of the app for adjusting our workflow. Gray activities cannot be moved, the other activities can be placed in a desired order and the green activity is marked as the one to manipulate. Own image.**

## 3 The study

### 3.1 Methodology

In our study, we tested the workflow for endotracheal suction in simulated care situations. Because we abstained from involving real patients with real tracheostomy tubes due to an ethical approval collected for the project, we used a dummy with artificial airways and lungs (see Figure 2).

The larger part of the study, which is not reported here, was to perform the workflow described above for three times. Each run was guided by the same workflow but different representations of the content. In the second part of our study we asked the participants to change the preparation part of the workflow with our adjustment tool (see Figure 3) and to bring the individual activity groups of the workflow into a familiar sequence. The adjustment tool did not offer a preset order and we did not help to remember that the preset order in the first part of the study was <ABCDE>. Through a confirmation button in the adjustment tool on the tablet and a simple transfer from tablet via a WLAN connection, the adjustments were applied to the Care Lenses. After that, we asked the caregivers to perform the preparation again with the adapted support.

We recorded the interactions with the adjustment menu and the execution of the preparation steps. After conducting the adapted workflow, we conducted and recorded a brief, structured interview (see questions below) with each participant. The interview was aimed at investigating how the possibilities of the adjustments influence the acceptance of caregivers for workflows on Care Lenses, for what the adjustment can be utilized and what kind of advantages or disadvantages comes with it. Questions included the following:

- “What did you like/dislike about the possibility of adapting the workflow and why?”
- “What kind of advantages and disadvantages do you see in adjusting the workflow and why?”
- “When would you like to use the adjustment of the workflow?”
- “Which dependencies do you see that require customizing the workflow?”

Care Provider	#Participants	Indices
University Hospital	2x5 (on two different days)	C1-C5, C9-C13
Care laboratory, caregivers from different care provides	3	C6-C8
Home care provider	5	C14-C18
Home care provider	2	C19, C20
Intensive care shared apartments	5	C21-C25

**Table 2: Participants of the study. We tested at five different locations from different care providers on six different days.**

### 3.2 Participants

25 caregivers from six different care providers participated in our study at five different locations. Only one of them was inexperienced in endotracheal suctioning and only three other participants stated that their last performed suction was longer ago. Except for the inexperienced participant, all participants worked with the process of endotracheal suctioning several times per day in the past. They had an average professional experience of 17.6 years (SD = 11.6) and were aged from younger than 25 to older than 60 years. 17 were female and 8 male. In the following we refer to the participants as caregiver 1 to 25 (C1–C25, see Table 2).

### 3.3 Data analysis

To illustrate the dimension of changes made by the caregivers, we used a simple distance metrics for the adjusted workflow, adding 1 to the distance score for each position change of an element. For example, if the workflow was adjusted from  $\langle ABCDE \rangle$  to  $\langle ACDEB \rangle$  the score is 6, as C, D and E were moved by one position and B was moved by three positions. We are aware that this is a very simple metric, but it fulfills the purpose of illustrating the differences caused by the adjustments.

The recorded interviews were transcribed and paraphrased. We singled out paraphrases about the adjustment of workflows and discarded everything else. The remaining paraphrases were clustered along the questions of the structured interview. For example, some clusters derived from the interview were about advantages and disadvantages of adjustment of workflows, when to adjust workflows and what caregivers liked or disliked about the adjustments. While clustering, we inductively found some other themes discussed by several caregivers and clustered them additionally. This way we found several caregivers talking about their feelings about the workflow before and after the adjustments, pros and cons about caregivers with similar and different workflows and effects of the restrictions of workflow adjustments. In the following we provide some insights into the most interesting and most discussed aspects of our study.

#	Workflow orders after adjustment
5	$\langle ABECD \rangle$
3	$\langle ABEDC \rangle, \langle ABDEC \rangle$
2	$\langle ABDCE \rangle, \langle ACBED \rangle, \langle AEDBC \rangle$
1	$\langle ACBDE \rangle, \langle ACEBD \rangle, \langle ADBEC \rangle, \langle DACBE \rangle, \langle DEABC \rangle, \langle DECAB \rangle, \langle ECDAB \rangle, \langle EDABC \rangle$

**Table 3: Workflow orders resulting from caregivers' adjustments**

## 4 Results

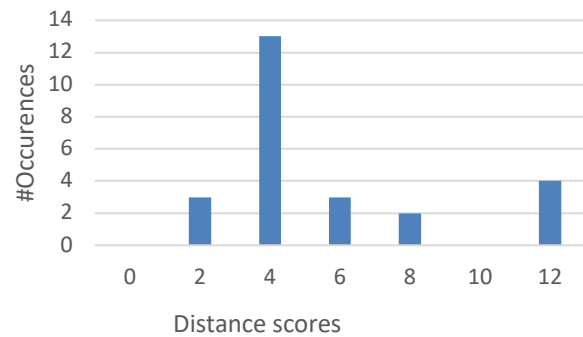
### 4.1 Changes in workflow order

The adjustments of our workflow for endotracheal suction from caregivers resulted in 14 workflows with different orders of activities (see Table 3). The adjusted workflow used most has  $\langle ABECD \rangle$  as order for activities and was created five times. Other

activity orders were created two or three times. Except from those, we found eight adjusted workflows which were only created once (see Table 3). The fact that only one workflow sequence was used by five caregivers and that eight workflows were unique to their creator shows how diverse the caregivers are working in practice, although endotracheal suction is (supposed to be) a standardized process.

No caregiver left the workflow in the original order, which is understandable, as they were asked to adjust it. Three workflows were created in a completely different activity order, meaning that none of the elements remained at their original position.

The amount of changes and the distance of the adjusted workflows differ greatly. Using the distance metric as described above, the average distance created by workflow adjustments is 5.6 (SD = 3.21). Among the adjusted workflows, we found distance scores from 2 (e.g.  $\langle ACBDE \rangle$ ) to 12 (e.g.  $\langle DECAB \rangle$ ). As shown in Figure 4, most changes were moderate with the score of 4 occurring for more than half of the adaptations. Activity group A of the workflow was often left as the first activity group in the sequence, B and C tended to be pushed to the end, and D and E were put in the middle of the sequence.



**Figure 4: Distance scores by the amount of their occurrence.**

Activity group A was used 20 times as the first part of the workflow, which makes sense, as disinfecting hands is seen as a prerequisite for care tasks. Taking the organization of the caregiver into account, we see that only caregivers from the university hospital created workflows without A as first activity. In the interviews, these caregivers stated that they would always check the machines first. Activity group B was at least used by 50% of caregivers (13) as the second part of the workflow. Another interesting finding is that C (checking the cannula) was never used as first part, but eleven times as the last part and seven times as the fourth part. On top of that, C was only used two times as the third part like in our predefined order. Activity groups C, D and E were chosen only less than six times as first or second part of the workflows.

This shows that there is a diversity of preferences among the caregivers, and that while the workflow mostly fit for many of them, others needed larger changes to use it like they preferred.



## 4.2 Reasons for changes

Activity groups A and B being chosen as the first two steps in workflows can be explained by its importance in care. Disinfecting and using personal protection (A) are taught in nursing school as elementary aspects of any nursing tasks, and need to be done before starting other activities. In addition, in our adjustment menu, these activity groups were colored gray and this probably suggested that A has to be the first activity group (while it really meant that A needs to be done before B). This was also mentioned by some caregivers in the interviews.

The changes made for other activity groups by the caregivers had different reasons. As stated above, caregivers from the university hospital mentioned they usually check the technical equipment first, because if something is not working properly, they mostly have to “start the whole preparation process from the beginning” (C2). The caregivers from home care mentioned less strict regulations for hygiene and all their patients having their own technical equipment (instead of shared suction machines like in the hospital), which influenced their (non) adjustments of the initial steps, because they do not have to restart their preparation like caregivers from the hospital. As also mentioned above, disinfecting the hands from the activity group A is mentioned by caregivers quite often as the very first thing to do before working at the patient, which explains why A was often chosen first and C later as C represents an activity at the patient.

## 4.3 How caregiver value the possibility for adjustments

19 of the 25 caregivers had nothing to answer when asked about things they did not like about adjusting the workflow. One of them even answered: “There was nothing! It (author: the adjustment) is made to adapt it to my needs!” (C7). This shows the need and potential benefit of adjusting workflows in care.

Caregivers stated they liked to be able to adjust the workflow, because “the performing human is taken into account” and the workflow is not a “standardized process, which ignores the performing caregivers” (C8). The possibility to individualize the workflow was liked most for complying with the “own working rhythm” (C25, C2) and not disturbing it. The individual preferences are manifold. Some caregivers wanted to start with “switching on devices in order to boot earlier” (C21) or to do some things first in order to “keep staying at the patient” (C8).

Caregivers also valued the combination of freedom and security offered by the adjustment: Five caregivers told us that they could “do nothing wrong” (C5) by adjusting the workflow. They told us they “cannot forget anything” (C19, C21) while creating the workflow, because all activities had to be chosen in order to finish and apply the workflow to the Care Lenses. This resonates in the value they perceived in adjusting the workflow to an own order without mistakes because of the “fixed and unchangeable points” (C10). On the other side some few caregivers noticed that activity group C should not be done before disinfecting the hands and told us that adjusting the workflow could result in an incorrect workflow with “hygienic mistakes” (C2). This shows that they actively engaged with the adjustment

and that our policy of allowing changes could have been even stricter.

Further aspects liked by caregivers are that they “personally” (C11) can adjust the workflow “anytime” (C23). With this they are able to react on different things like changes “of the binding standard” (C7) or “from the practice instructor” (C24). Working with adjusted workflows appeared to some caregivers as more “fluent” (C21) and “faster” (C18) than the execution before the adjustment. Caregivers also liked to work with the workflow adjustment in order to just “try to work in a different way” (C15) and find a possibility to “do a better job” (C14). To work with the menu to adjust the workflow was also mentioned as something that “reminds how to do it right” (C22) and to “help to internalize the workflow” (C14).

## 4.4 The pro and con of different workflows for caregivers

Most of the caregivers stated they liked the possibility to adapt the workflow and made it their own. However, some caregivers mentioned negative aspects of caregivers using different workflows, as this could “confuse new staff” (C6), who may experience the same process done in different ways by several caregivers. Another aspect can be found in “attentive patients, who notice caregivers working differently (authors: than others)” (C17). This could lead to patients who start to wish to be cared for by certain caregivers. A few caregivers even stated they wished for a “unique” (C17) execution of care tasks to avoid these problems.

Although these are arguments against individual workflows, caregivers also stated positive aspects of adjustments of workflows, which counter the disadvantages of individual workflows. For example, caregivers said that it could be possible and beneficial to “adjust workflows for all caregivers” (C17), meaning that there could be a general change of the workflow that fits the way the workflow is executed in a certain organization, department or ward. “At different stations suction is performed differently. The (authors: specific ward) does it differently than the (author: other ward)” (C4).

Advantages gained from workflow adjustments for several caregivers are developing workflows, which are “fitting to the colleagues” (C8), increase the “quality of work” (C8) and “decrease the care material wear” (C14). The advantage gained from different workflows according to caregivers is mostly the “own work rhythm” of individual caregivers which need to be considered.

The need for adjustments on the other side was often explained with own experiences and habits. For example, one caregiver stated “Sometimes the brain can’t handle the standard! Here, the adjustment helps to internalize it!” (C14). In addition, some caregivers mentioned they perceived the expert standard to be open enough to be interpreted with degrees of freedom.

Individual workflows are also helpful for caregivers in various situations. One caregiver stated that our predefined workflow would not fit to her practice in home care, because she often did “not have enough space to (author: do the workflow) in this order” (C6) of activities. Other caregivers also stated that “the situation

is not always the same" (C15), because of the patients and some patients "just want(s) to have some tasks done in a certain order" (C25). Additionally, some patients need to have workflows done differently because of different diseases which requires additional steps in the workflow like working with a "Cough Assist (authors: an auxiliary tool to aid the patient in coughing during the suctioning process)" (C6).

#### 4.5 Experience and fixed workflow: Unsettlement

Like already mentioned above, caregivers stated to have different experiences and practices, which need to be taken into account in the conduction of the workflow. For example, the routine of experienced caregivers made it hard for some caregivers to get used to the Care Lenses and the workflow. "If I learned it differently (author: than shown in the workflow provided by the Care Lenses), I would become insecure. The Care Lenses grant security, but also unsettles because it brings me out of my working day." (C25) After they worked with the adjusted workflow, caregivers stated to feel better about the workflow this way. They did not have to "completely rethink and rework their own process" (C5). Some spoke about the workflow being "more pleasing" (C5, C11, C13) and also said they "feel safer" (C22) with the adjusted workflow ("you do like you are used to") (C22). Caregivers also stated they "overcome their difficulties" with the workflow on the Care Lenses through the adjustment (C18, C10).

#### 4.6 Who should adjust workflows?

While the caregivers of our study were nearly all experienced in conducting the suctioning workflow, some came to the conclusion that people without proper experience with the care task or the workflow should not adjust the workflow. "If newcomers adjust the workflow, by chance, the workflow may be crap" (C12) and they could "make hygienic mistakes" (C13). Some thought that adjusting the workflow may provide a better overview over the workflow for inexperienced caregivers and help them to internalize it, but except from that, there were no positive arguments regarding adaptation for newcomers in the interview. Instead, some caregivers stated that only experienced caregivers can have a routine to adapt the workflow and that therefore adjustment "is only important for experienced caregivers" (C13). For inexperienced caregivers it is better to "have something firm to follow" (C5).

Another aspect of different persons adjusting workflows is that caregivers suggest different roles for adjusting different things. For example, one caregiver said: "Adjustments should be combined with roles; care service management should be able to adjust workflows down to the last detail and caregivers only (author: the order of) sequences or certain aspects."

## 5 Discussion

### 5.1 Adjusting what and for whom

Many statements show that caregivers feel a need to adapt care workflows to their practices and preferences, while they also emphasize the need to keep in mind boundaries set by professional care regulations and quality standards. In a job done under time, economic and quality pressures every day, a combination of both can provide a relief to caregivers and allow them to do their job better by adapting it to their practices. However, this also comes with certain needs, including the question what can and should be adjusted, and who should make the adjustments.

The way to do adjustments and their value need to be discussed on different levels and from different perspectives. For example, on one hand, caregivers can adjust the workflow in order to personalize it for themselves. On the other hand, workflows could be edited generally for all caregivers working for the same care provider or on the same ward. The latter could be done in order to adapt workflows to the procedure in a company, to apply new expert standards or as a reaction on problems with an existing workflow (e.g., too much waste of care material).

Additionally, ward and department managers could adjust workflows for several caregivers. According to caregivers, this is necessary while care tasks are handled similar for patients on a certain ward and differently on another ward.

The most frequently mentioned reason for personalizing workflows (that is, adaptation by individual caregivers) was to adjust the order of the preparation to own preferences and practices. Another aspect that could be changed by the caregivers for themselves could be alternatives for certain activities. To add the possibility to choose between different alternatives for certain activities can perhaps improve the acceptance of workflows on the Care Lenses even further while such workflows correspond even more to the practice of the caregivers. For example, more experienced caregivers are working with methods that suit them well and their acceptance towards the Care Lenses will probably suffer, if they need to change their practice in order to use it.

An important aspect for personalization can be found in the restrictions for workflow adaptations. While adjusting workflows in detail can be helpful for practitioners, it is also necessary to be able to define how and to what extent these workflows can be adjusted. Underpinning this, the restrictions of the adjustments were valued by caregivers as helpful tools which remind them of certain aspects of the process and ensures the correctness of workflows, thus granting safety. Another reason for restrictions could be in the experience and knowledge of caregivers, allowing more experienced caregivers to make some adjustments and not allowing new caregivers to adjust workflows on their own. In general, these and other adjustments of workflows could be extended by explanations for easier adaptation and the creation of learning effects.

Overall, we can see that the adaptation of care workflows by caregivers can be beneficial if we control certain boundaries and compliance to standards. To ensure this, certain areas and sequences can be unlocked for changes (while others are not), and

there is a need for roles and rights management to take the qualification of caregivers to adapt a workflow into account.

## 5.2 Standards vs. practice in workflow adjustment

As we assumed, the interviews show that workflow adaptation in care needs to take into account a trade-off between benefits such as personalization and fit to patients against compliance to standards. This is similar to adaptations in other applications areas. However, care and its specific needs provide a special application area, as patients are involved, who could notice differences in the way they are treated, and as changes in the workflow may have consequences on care quality and the health of patients. Due to these reasons, caregivers appreciated restrictions of adjustments of our workflow because their adjustments are still corresponding to the standard.

The statements of the caregivers show that adapting the workflow provided a relief for many of them and allowed them to work the way they thought was right (instead of working in a way that is against their thinking). A particular argument for the adaptation of workflows shown on the Care Lenses was that according to the caregivers, their working practice is different from our workflow, because they are using different care material, were educated in a different way or are used to work differently. For example, there were different opinions on how and when to use sterile gloves. To solve these and other problems, further means for adaptation could offer alternative activities to caregivers that they could choose from in their personal workflow variant. In this way, caregivers could choose between activities with the usage of sterile gloves and without them appropriate to their training and experience.

Despite the possibility for adaptation, there is a tension between the relief and quality it creates and the downsides of adapted workflows such as quality assurance and difference in work conduction noticeable by colleagues and patients. Even if caregivers believe there is a better way to conduct certain procedures, this may not be a better way in terms of care quality. In addition, in some care institutions a workflow adaptation may be seen as incorrect, while others would tolerate it (see the example of activity group C in section 4.3). Finding a balance between these two poles will be a major challenge in future work.

The tension between personal benefits and compliance to standards shows the difficulty of designing a workflow for AR support of care tasks that is purely based on the expert standard. Caregivers stated that the expert standard is not that strict, but that it does not allow personal handling of certain aspects of the process like the preparation. In our study we showed that working with adjustable workflows can be a suitable way to bring the expert standard into care practice with a high acceptance rate, but we also found that there is still work to do to find a good balance between adaptation and compliance.

## 6 Conclusion

In our study we showed that the possibility to adjust workflows has a positive effect on the acceptance of our Care Lenses and that it is helpful for the integration of Care Lenses and expert standards into care practice. It has potential to help caregivers to optimize and reflect their own care practice. On the other side, to keep the own practice and even to be technically supported by the Care Lenses has its downsides, as it is possible that caregivers could keep bad habits or suboptimal practice and feel safe with it. Nevertheless, without the possibility to adjust workflows, the attitude towards the Care Lenses and their acceptance among caregivers may decrease, as their practice and experience are not considered in the workflows. Additionally, care providers need to adjust workflows, too, in order to adapt them to their processes and needs. The differences between care practice and expert standards shows the need of adjustments of workflows in care that needs to be further explored from both sides: Care practice and standards (theory).

In the workshop, we would like to discuss how our insights into the adaptation of care workflows resemble experiences of others, and how the specific elements of Care Lenses (i.e. AR based workflow support in care, patients involved) need specific measures and methods for adaptation.

## ACKNOWLEDGMENTS

We would like to thank Timo Kunzendorff for the technical implementation and all other partners for their work in the Care Lenses project.

## REFERENCES

1. -. 2013. Prävention der nosokomialen beatmungssassoziierten Pneumonie: Empfehlung der Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 56, 11: 1578–1590. <https://doi.org/10.1007/s00103-013-1846-7>
2. LJ Bannon. 1995. The politics of design: representing work. *Communications of the ACM* 38, 9: 66–68.
3. Paul Diesener, Andrea Erdélyi, Gertraud Escher, Silvia Ferreira, and Martin Groß. 2017. *Fachpflege außerklinische Intensivpflege*. Elsevier, München.
4. G. Fischer. 2005. Beyond Binary Choices: Understanding and Exploiting Trade-Offs to enhance Creativity. In *Computational and Cognitive Models of Creative Design VI*.
5. Jens Jakisch and Renate Rettkowski. 2017. SOP Endotracheales Absaugen – unter Beteiligung der Hygiene. *Krankenhaushygiene up2date* 12, 01: 9–13. <https://doi.org/10.1055/s-0043-102858>
6. Marc Janßen and Michael Prilla. 2018. Integration of Augmented Reality into Professional Care Processes. In *Mensch und Computer 2018 - Workshopband*.
7. Kari Kuutti and Liam J. Bannon. 2014. The turn to practice in HCI: towards a research agenda. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3543–3552.
8. Michael Prilla, Marc Janßen, and Timo Kunzendorff. 2019. How to interact with AR Head Mounted Devices in care work? A study comparing handheld touch (hands-on) and gesture (hands-free) interaction. In *European Conference on Information Systems (ECIS 2019)*.
9. Michael Prilla, Heinrich Recken, and Marc Janssen. 2019. Die Pflegebrille: Möglichkeiten und Barrieren der Nutzung von Augmented-Reality-Technologie in der ambulanten Intensivpflege. In *Digitale Transformatin von Dienstleistungen im Gesundheitswesen*. Springer.
10. Heinrich Recken, Michael Prilla, and Asarnusch Rashid. 2018. Augmented Reality Datenbrillen in der ambulanten Intensivpflege. In *Zukunft der Pflege Tagungsband der 1. Clusterkonferenz 2018*, 180–184.
11. L.A. Suchman. 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press.