COGNITIEF

Design for non-clinical skills in healthcare:

Design implications for digital role-based support in intensive care nursing[1]

Medical staff should not only possess excellent clinical skills, but also be proficient in non-clinical, or non-technical, skills. These skills play an important role in, for example, teamwork, task management and coping. Our research investigates how product design can help support medical staff in their day-to-day non-clinical tasks. In the study presented here we focus on the work of intensive care nurses (ICU nurses). Workload and burn out rates are relatively high among this group. We investigated the functions future digital systems might offer to support them in their roles as practitioner, scholar and human. An interactive prototype was used to collect insights from ICU nurses. The results are design implications for digital role-based support for non-clinical tasks of ICU nurses.

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The prototype used in this study is developed starting from a design-oriented framework for supporting ICU nursing (Melles, 2011). In this framework, the cognitive activities of interpretation, anticipation and reflection are connected to the three roles an ICU nurse fulfils (also illustrated in figure 1): (1) the role of the practitioner, referring to the strategies nurses undertake to implement and execute the nursing process. Examples of such activities are autonomously planning all work-related actions and reporting on the status of the patient; (2) the role of the scholar, referring to the strategies nurses undertake to obtain and maintain their own required knowledge and skills. Examples include training, but also putting thought processes into words when tutoring trainee nurses; (3) the role of the human, referring to the strategies nurses undertake to cope with stress and the emotional consequences of working with seriously ill or dying patients. Examples are sharing experiences with colleagues and the use of humour. We want to explore the extent to which the concept of roles can serve as a blueprint for product development in daily nursing support. Note that the prototype is meant to trig-

1 This article is based on Melles, M., Freudenthal, A., Bouwman, C.A.H.M., Snijders, C.J., de Ridder, H. (2010). Coping with different roles in intensive care nursing: design implications for digital support. *Quality and Safety in Healthcare*, 19 (Suppl 3), i36-i41.

ger reactions from ICU nurses about the suitability of the functions offered. It is not an end product but a 'vehicle for exploration', intended to encourage future users to participate in the design process (following e.g. Holmquist, 2005).

The functionality of the prototype is based on previous studies that investigated the opportunities for enhancing patient safety by means of technology (Melles, 2011). The following findings from these studies shaped our prototype: (1) supplying nurses with enhanced insights into their working environment contributes to the quality of their work; (2) the information that nurses use is provided by the different actors in their working environment, namely the patient, equipment, nursing team, physician team, relatives of the patient, and other medical staff; and (3) although nurses continually interpret a current situation and anticipate future events, there is little reflection upon past events, even though reflection is important for building skills. These findings were translated into different potential functions to support the work of ICU nurses.

Methods

Participants

Seventeen ICU nurses from six different Dutch hospitals took part in this study. Six participants were male and eleven were female. Their experience ranged from none (having just started as an ICU nurse) to 25 years.

Materials

The prototype used during the interviews is a software simulation and has three mutually excluding modes: the practitioner mode, the scholar mode and the human mode. Each mode includes several functions. For this study four functions were used; two from the practitioner mode ('web of actors' and 'timeline and notes'), one from the scholar mode ('assessment of the condition of the patient') and one from the human mode ('perception of the shift'). The functions offered are envisioned to be embedded in a patient data management system, meaning that the system would be linked to a bed (i.e., a patient) and personalized to the nurse who is currently responsible for the patient in that bed. All data are envisioned to be stored in a networked database, so a nurse can retrieve information from previous shifts and plans made by others.

Function 1: Practitioner mode - Web of actors (figure 1)
The web of actors is a visualisation of the working environment of the ICU nurse. Icons represent all actors that are related to the patient and therefore influence the work of an ICU nurse. The nurse is represented with a flower-like shape. When the mouse moves over a petal, the application switches to the corresponding role (i.e., mode) and stays there. Each mode has a different colour.

Function 2: Practitioner mode - Timeline and notes (figure 2)
Another function in the practitioner mode is a timeline. On this timeline important tasks and events in the (near) future as well as from the past are arranged, such as meetings in the future but also stressful events that happened in the past (e.g., a cardiac arrest). By clicking on an envelope displayed on the timeline for each event, the nurse can view more information about that particular event. The timeline shows one 8-hour shift and can be scrolled back and forth.

Function 3: Scholar mode - Assessment of the condition of the patient (figure 3)
The function that is part of the scholar mode needs to be prepared during the actual shift. Every two hours, the nurse has to indicate his or her assessment of the condition of the patient. This is done by clicking on the star displayed on the timeline under the current time. When clicking on this star, the nurse can colour it making a choice between routine, vigilance, and emergency (based on Groen, 1995). At a later moment in time (in the scholar role), this 'snapshot' of the

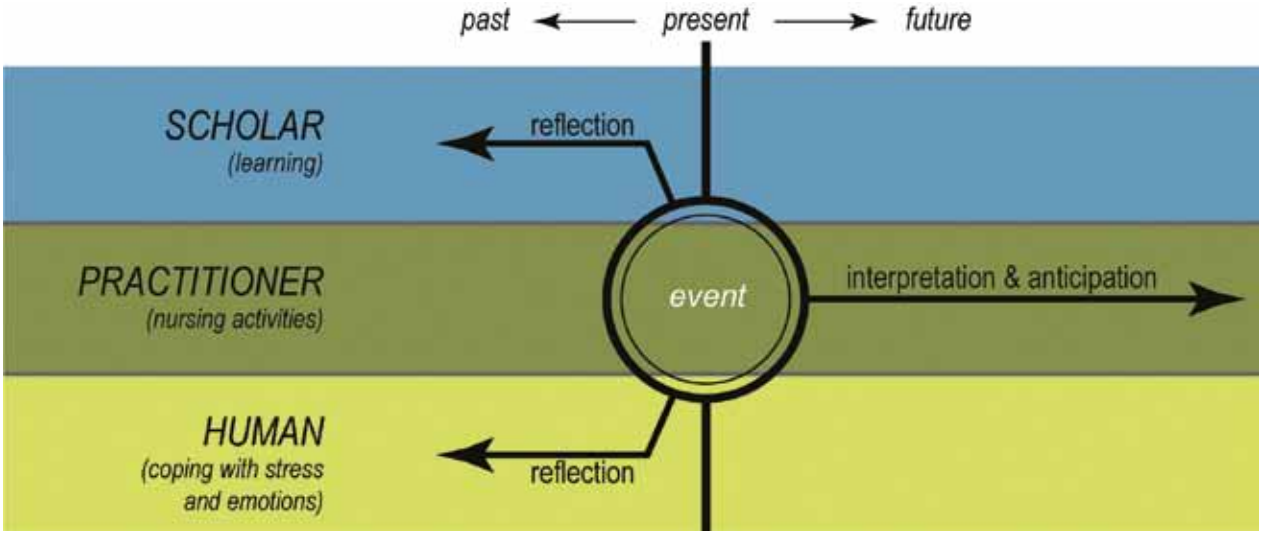

Figure 1. Schematic representation of the different roles an ICU nurse fulfils (Melles, 2011)

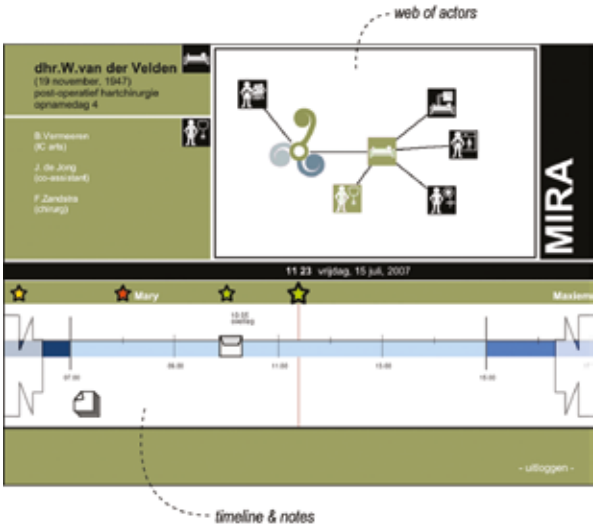

Figure 2. Screenshot of the prototype in practitioner mode (in Dutch), illustrating the functions 'web of actors' (upper part) and 'timeline and notes' (lower part). The web of actors (physicians, equipment, patient relatives, etc.) and the timeline visualize the actual work environment of the nurse. The timeline shows one 8-hour shift and can be scrolled backward (left) or forward in time to see past or future shifts

Figure 3. Screenshot of the prototype (in practitioner mode) preparing the scholar mode (translated from Dutch), illustrating the function 'assessment of the condition of the patient'. The nurse assesses a patient's current condition by choosing a star (upper part) indicating a case requiring routine, vigilant or emergency care (based on Groen, 1995). At a later moment in time, this snapshot of the situation can be compared with the objective data measured at the same moment, thereby creating a learning experience

situation can be compared with the data measured at that same moment. In this way, a learning situation is created, comparing the subjectively experienced situation with objective data from the same situation.

Function 4: Human mode - Perception of the shift (figure 4)

The function chosen to explore the possibilities of supporting the human role is a personal diary. After each shift the nurse can fill in whether he or she felt pleasantly calm, unpleasantly calm, pleasantly stressed or unpleasantly stressed by choosing an emotion icon (based on studies by Desmet, 2002). In the personal diary this emotion icon is displayed for each shift. Also displayed are the coloured stars indicating the nurse's assessment of the condition of the patient in her role as scholar (see function 3), and whether it was a day, evening or night shift. This provides a rough indication of the context of a shift, giving the nurse the means by which to relate her emotional well-being to the actual circumstances during a shift.

Procedure

The interview began with an explanation of the goal of the study (i.e., eliciting responses and ideas for future nursing informatics applications). The interviewer demonstrated the functions. Participants were then asked whether they considered the demonstrated function to be useful or not and why. When the function was considered to be useful they were asked how and when they would use it. They were encouraged to think about other situations in which they could use the particular function or about elaborations of the function. Using this procedure, a form of participative design was adopted during the interview. The interview took place at the ICU department where the participant worked. Due to tight ICU work schedules each interview lasted about 15 minutes max.

Analysis

Transcripts of all interviews were made. Each function was assessed in terms of whether or not the participant considered it to be useful. Situations in which the participant indicated that the function could be useful if some changes were made to the current implementation were marked as

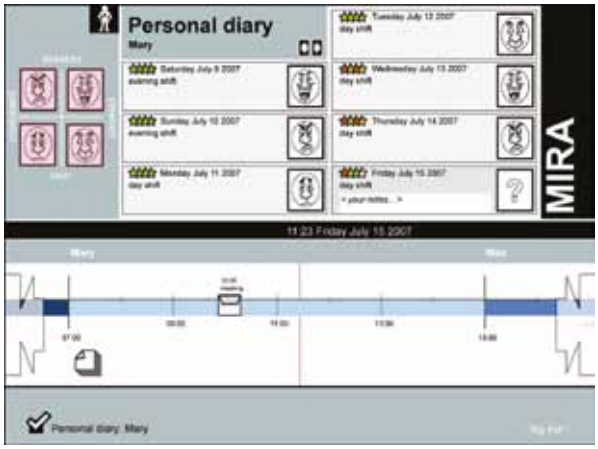

Figure 4. Screenshot of the prototype in human mode (translated from Dutch), illustrating the function 'perception of the shift'. The nurse can indicate how (s)he perceives the shift by choosing a face (upper part left) corresponding with her (his) mood: pleasantly calm, pleasantly stressed, unpleasantly calm or unpleasantly stressed (based on Desmet, 2002)

Table 1. Number of participants who assessed the different prototype functions in general as useful, not useful, or 'having potential'. The denominator indicates the number of participants who responded to the specific functions

Prototype mode and function	Useful	Potential	Not useful
Practitioner:			
Web of actors	13/16 (81%)	1/16 (6%)	2/16 (13%)
Timeline and notes	15/15 (100%)	0/15 (0%)	0/15 (0%)
Scholar:			
Assessment of the patient	9/17 (53%)	4/17 (23.5%)	4/17 (23.5%)
Human			
Perception of the shift	8/16 (50%)	4/16 (25%)	4/16 (25%)

'potential'. Remarks about how, why, or when the function would - or would not - be used were divided into three groups, each with a specific relevance to product design: (1) the perceived added value of the function; (2) suggestions for elaboration of the function; (3) negative remarks about the function. All remarks were then grouped by topic. A total of 23 topics emerged. resulting in 23 design implications. For a more detailed description of the procedure and analysis, see Melles e.a., 2010).

Results

Usefulness of the functions

Table 1 shows the participants' assessments of the four different functions. The two practitioner-related functions were considered to be useful by most of the participants. Both functions mainly triggered reactions about how they would be used (perceived added value, see table 2). The functions related to the scholar and human roles elicited more doubt and discussion. One-quarter of the participants indicated that both functions have potential, but they questioned the current implementation. Another quarter assessed both functions as not useful. They indicated that they found it threatening to share a personal assessment with a computer because management can have access to this information and use it when evaluating staff. Even though the interviewer suggested that certain information would be confidential, some participants were not confident that it would not be used by their managers.

Usefulness of prototyping

Table 2 shows the number of design-relevant remarks (i.e., added value, suggestions for other use and perceived negative impact) per function. A total of 116 remarks were made by the 17 participants, which means an average of nearly 7 design relevant remarks per participant. Based on these results we conclude that the prototype does trigger discussion and encourages nurses to participate in the process with the designer.

Design implications

Table 3 lists the 23 design implications that emerged from the assessment of the four functions. Although the implications are based on remarks made with reference to the prototype, we expect that the findings are generic and also applicable to other applications. In the following a selection of design implications will be discussed per function. The codes between brackets in the text refer to the numbering of the design implications in table 3.

Practitioner mode - Web of actors

As a main added value of the web of actors function the participants mentioned that it provides a convenient arrangement of information generated by their working situation, something which most current patient data management systems lack. The actors were considered to reflect an ICU working domain appropriately by all participants. The participants foresee using this survey for two reasons: (1) as checklist (A2); and (2) as a way to retrieve

Table 2. Number and percentages of design-relevant remarks made per function

Prototype mode and function	Remarks about…			Total
	Perceived added value	Suggestions for other uses	Perceived negative impact	
Practitioner:				
Web of actors	17 (15%)	5 (4%)	3 (3%)	25 (22%)
Timeline and notes	28 (24%)	6 (5%)	1 (1%)	35 (30%)
Scholar:				
Assessment of the patient	10 (9%)	9 (8%)	10 (8%)	29 (25%)
Human				
Perception of the shift	8 (7%)	12 (10%)	7 (6%)	27 (23%)
Total	63 (54%)	32 (27%)	21 (18%)	116 (100%)

extra information about the different actors in the working environment (A5), for example maintenance information for the equipment used. An interesting suggestion for another use of the function is to view the patient's condition from the perspective of another discipline (such as the physician) by clicking on an actor icon (B7). This may provide a valuable learning experience.

Practitioner mode – Timeline and notes
The main added value of the timeline as noted by the participants is its reminder function, providing support to anticipate tasks (A1). An interesting comment about the timeline is that it shows the context within which tasks have to be performed (A9). Current task lists often show only the tasks that have to be done, sometimes even only the task that has to be performed at that very moment. Making the context of a task explicit in some way, clarifies why a certain task has to be performed. This contextuality can contribute to patient safety, for example, by allowing the nurse to check whether a medication is appropriate.

Scholar mode - Assessment of the condition of the patient
All participants considered the categorisation of patients into cases requiring routine, vigilant and emergency care to be appropriate. Two participants described recording personal assessments of the patient's condition as a way of making the intuition of nurses explicit (A8). This function can be used, for example, to back up the nurse's opinion about a patient when communicating with physicians (B1), or be included in patient assessment tools (B2), as suggested by five participants. Three participants find it threatening to share a personal assessment with a computer because management can have access to this information (C2) and use it when evaluating staff.

Human mode - Perception of the shift
The categorisation used in the human mode to assess a shift (pleasantly calm, pleasantly stressed, unpleasantly calm, unpleasantly stressed) was recognised and considered to be appropriate by all participants. The main added value of this function is that it acknowledges the emotional load of ICU nursing (A6). A suggestion for another potential use of this function is to couple the (personal) perception of the shift to the (personal) assessment of the condition of the patient (B2). In this way it can provide a more accurate picture of the patient than current patient assessment tools do. Routine cases can be very labour intensive because they need a lot of psycho-social attention, which is not measured with the current tools.

Conclusions
This study demonstrates the potential for implementing the roles of practitioner, scholar and human in daily digital support systems for ICU nurses. The requirements for support in all three roles should be considered for each task.
This study also demonstrates that using a prototype is a useful strategy for encouraging medical practitioners to participate in the early phase of the product development process. Discussing functions through an interactive prototype provides the product developer with insights about perceptions of added value and the negative impact of ideas in a relative short time. It also triggers suggestions from the participants about other uses, hence generating a participative design approach between product developer and medical practitioner. In addition, medical practitioners are given an idea of the extent of technological possibilities. They are encouraged to critically consider their own work situation and what they might expect from future systems supporting their work. This is particularly important with the current regulations concerning early user involvement in the product development process and post marketing surveillance.

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Samenvatting
Binnen ziekenhuisorganisaties neemt de bewustwording toe dat ook niet-klinische vaardigheden, zoals samenwerken, het organiseren van je werkzaamheden en omgaan met stress, een belangrijke bijdrage leveren aan de kwaliteit van patiëntenzorg. Er zijn echter nog weinig producten die medisch personeel ondersteunen in deze taken. Het doel van deze studie is om te onderzoeken hoe digitale informatiesystemen deze ondersteuning kunnen bieden. Intensive care-verpleegkundigen zijn geïnterviewd aan de hand van een interactief prototype waarin mogelijke functies zijn geïmplementeerd. Uitgangspunt van het ontwerp is dat een verpleegkundige verschillende rollen aanneemt tijdens het werk en dat deze rollen verschillende niet-klinische vaardigheden vragen. Deze studie resulteert in een set ontwerprichtlijnen voor het ondersteunen van medische professionals in hun dagelijkse niet-klinische taken. Daarnaast illustreert deze studie hoe een prototype ingezet kan worden om een participatieve ontwerpaanpak te faciliteren en zo meer inzicht te krijgen in de werkwijzen van de doelgroep.

Table 3. The 23 design implications that emerged from grouping the remarks made by ICU nurses during the prototype study. For each implication the number of participants who made remarks regarding that implication is shown, divided into the four functions. An empty cell means that no remarks were made

Design relevance		Design implication		Practitioner		Scholar	Human
				Web of actors	Timeline	Assessment of patient	Perception of shift
A	Perceived added value of the function	1	The function provides insight into future tasks, hence providing support for anticipating tasks		13		
		2	The function serves as a checklist for fully comprehending the work situation	11	2		
		3	The function makes the personal work process explicit, yielding a personal learning experience		2	6	4
		4	The function provides the possibility of reflecting on a chain of events, yielding a learning experience		7	2	
		5	The function provides additional, easy to retrieve information about each actor in the working environment	6			
		6	The function acknowledges the emotional load of nursing				4
		7	The function provides the possibility of personalizing the timeline using notes		3		
		8	The function makes the nurses' intuition concrete, formalizing intuitive patient assessments			2	
		9	The function provides insight into the context of tasks and to why certain tasks are needed, thereby improving safety		1		
B	Suggestions for other uses of the function	1	Use this function during formal team evaluations to discuss (emotion-related) issues			2	6
		2	Include this function in patient assessment tools for management purposes, in particular to assess the degree of care			5	1
		3	Include this function in the shift handover	1	2	1	
		4	Include alterations of the medical policy in this function; differentiate between alterations and recurring tasks		4		
		5	Include this function in management tasks: how employees experience their work				3
		6	Use this function to visualize the care plan in context	2			
		7	Use this function as a training tool: Assess the patient from the perspective of another discipline and learn from this different opinion	2			
		8	Include this function in the personal digital portfolio for reflection				2
		9	Use this function to encourage nurses to develop views on medical policy			1	
C	Perceived negative impact of the function	1	The information provided by the function is unnecessary, because nurses know the information provided from memory or other sources	2		4	1
		2	The requested information can be (mis-)used by managers			3	3
		3	The use of technology is inappropriate			2	2
		4	Using the function is too cumbersome	1	1		
		5	The function has no added value, hence no incentive to use it			1	1