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Clinical Overview and Emergency-Department Whiteboards: A Survey of Expectations toward Electronic Whiteboards

Morten Hertzum^a, Jesper Simonsen^b

^a Computer Science, Roskilde University, Roskilde, Denmark, mhz@ruc.dk

^b Computer Science, Roskilde University, Roskilde, Denmark, simonsen@ruc.dk

Abstract

In Denmark emergency departments are newly established and still in a process of devising their procedures and technology support. Electronic whiteboards are a means of supporting clinicians in creating and maintaining the overview necessary to provide quality treatment of patients. The concrete meaning of the notion of overview is, however, fussy. To explore the notion of overview and how it might be affected by whiteboards, we conducted a survey at two emergency departments and, for reasons of comparison, a pediatric department. Our results indicate that respondents consider the information on their dry-erase whiteboards important to their overview and that they are positive toward the introduction of electronic whiteboards. At the emergency departments, the physicians' and nurses' overall perception of their overview correlates with different subcomponents of overview, suggesting differences in what constitutes an overview for these staff groups. Respondents' expectations toward the electronic whiteboards are to a considerable extent explained by whether they perceive that the electronic whiteboards will improve patient treatment. This finding applies across staff groups. Several significant differences between the emergency-department respondents and the pediatric respondents call for caution in transferring electronic whiteboards designed for emergency departments to other departments.

Keywords:

Clinical overview, emergency departments, electronic whiteboards, healthcare informatics.

Introduction

An important element of the clinical work at departments that treat acute patients consists of forming and maintaining an overview [1-3]. The emergency departments that have newly been established at Danish hospitals are a prominent example of such departments. At emergency departments, the support for clinical overview includes whiteboards with carefully selected, frequently updated, and highly visible information about patients [2, 4, 5]. The reorganization associated with the establishment of the Danish emergency departments is an oc-

casional for reconsidering what clinical overview means and how it may be supported. Another occasion is the possibility of replacing dry-erase whiteboards with electronic whiteboards that can directly access and modify information in electronic patient records.

In this paper, we report from a survey of Danish emergency-department clinicians' perception of overview, their experiences with dry-erase whiteboards, and their expectations toward the electronic whiteboards currently being introduced at their departments. The electronic whiteboards give one row of information for each patient, including information such as time of arrival, room, name, age, triage level, problem, responsible physician, responsible nurse, and next action. That is, the electronic whiteboards largely mimic dry-erase whiteboards in content and structure. While the electronic whiteboards are at present updated manually, they will gradually be extended with automatically updated fields of information, for example heart rate and other vital signs. The survey aims to inform the ongoing work to improve the electronic whiteboards. To achieve this aim we explore the notion of overview and how whiteboards may support overview.

Technological developments, cross-disciplinary patient trajectories, and documentation requirements lead to the recording of still more information about patients and a concomitant risk of information overload among clinicians. Thus, providing clinicians with the right information is obviously important to their overview. Previous work on clinical overview also shows that the layout of the information in consistent patterns contributes substantially to clinicians' overview by indicating, at a glance, which parts of a form contain much information and warrant further attention [3], by aligning information temporally, which often hints at causal relationships [6], and by presenting information in compact graphics [7]. In addition, we want to distinguish between aiming for an overview of a single patient and of the group of patients admitted at a department. This distinction is important because overview is relative to the task at hand, and the clinical tasks at the patient level differ from those at the department level. A department-level overview is, for example, also a matter of logistics and resources, in addition to the clinical patient data, which are primary to a patient-level overview. The focus in this paper is on department-level overview.

Survey Methodology

To investigate department-level overview we conducted a survey at two emergency departments and, for reasons of comparison, a pediatric department. The survey was approved by the management of the three departments and by the healthcare region's department for quality and development.

Respondents

The two emergency departments, ED1 and ED2, were established in April 2009 by uniting previously separate departments under one management and starting to establish procedures for ED1 and ED2. ED1 has about 30 beds divided onto a fast-track area, an acute area, and an acute-medical area. ED2 has about 15 beds divided onto a fast-track area and an acute area. The pediatric department is a longstanding department with about 22 beds. The staff at the three departments consists of physicians, nurses, auxiliary nurses, and secretaries.

Table 1 – Resulting response rates

Department	Staff members	Responses	Response rate
ED1	62	33	53%
ED2	69	28	41%
Pediatric	56	29	52%
Total	187	90	48%

The questionnaire was distributed to all staff at the three departments, a total of 187 people. We received 84 full and 18 partial responses, for an overall response rate of 55%. Responses were included in the analysis if half or more of the questionnaire had been completed. This led to discarding 12 partial responses. Table 1 gives the resulting response rates for the 90 responses included in the data analysis, distributed on the three departments.

Table 2 – Survey questions analysed in this paper

Id	Question
Q3	Overall, I have the overview I need in my work
Q4	I have an overview of the patients' condition
Q5	I have an overview of the relative priority of the patients
Q6	I have an overview of ongoing and planned patient treatments
Q7	I have an overview of who is presently responsible for which patients
Q8	I have an overview of the occupancy level in my area of the department
Q9	I have an overview of the patients who are on their way but have not yet arrived at the department
Q10	I have an overview of the patients in the waiting room
Q11	I have an overview of the occupancy level in the other areas of the department
Q12	The information on the dry-erase whiteboards is important to my overview
Q13	The information on the dry-erase whiteboards is available when and where I need it
Q14	The information on the dry-erase whiteboards is easy to understand
Q15	It is fast and simple to update the information on the dry-erase whiteboards
Q16	The dry-erase whiteboards are pivotal to important collaborative activities among the clinicians
Q18	Overall, it is a good idea to introduce the electronic whiteboards
Q19	It will likely take a long time to incorporate the electronic whiteboards in the daily work practices
Q20	The electronic whiteboards will, over time, lead to improvements in the treatment of the patients
Q21	The electronic whiteboards will become pivotal to important collaborative activities among the clinicians
Q22	The electronic whiteboards will be used by clinicians individually to an extent that reduces each clinician's overview
Q23	The electronic whiteboards will reduce the clinicians' shared understanding of their work situation
Q24	The electronic whiteboards will always be up to date
Q25	I like to start using new technology

Survey questionnaire

The questionnaire consisted of 39 questions, of which 36 were fixed-response questions and 3 were free-text questions. In this paper we analyse the 22 questions concerning the clinicians' perception of their overview, their experiences with the dry-erase whiteboards, and their expectations toward the electronic whiteboards, see Table 2. Responses to these questions were indicated on seven-point rating scales with the end points *Disagree* (1) and *Agree* (7). All questions had an additional response option of *Don't know*.

Procedure

The survey was administered when the departments started pilot using the electronic whiteboards that were to replace their dry-erase whiteboards. This happened in December 2009 at ED1, in January 2010 at ED2, and in March 2010 at the pediatric department. At each department the survey was administered a few days after they had started pilot using the electronic whiteboard.

Each staff member received an email with a link to the online questionnaire. The email also guaranteed that no individual respondent would be identifiable in the reportings from the survey and informed the staff that their department management approved of the survey. Staff members who did not respond within ten days received a reminder. A second reminder was sent to staff who did not respond within another ten days.

Data analysis

We used non-parametric Kruskal-Wallis tests to analyse selected questions for effects of department and staff group. And, we used linear regression to analyse which questions contributed to explaining the variation in the respondents' overall perception of their overview (Q3) and in their overall expectations toward electronic whiteboards (Q18). To determine the regression models we used a standard procedure of backward elimination [8]; that is, we initially included a set of questions in the analyses and then sequentially removed the question that contributed the least to explaining the variation in the responses to Q3 and Q18. This removal process continued as long as the significance of the *F*-test of the removed question exceeded 0.1. The resulting regression models include the questions that contribute appreciably to explaining the variation in the overall perception of overview and in the overall expectations toward electronic whiteboards, and they exclude the other questions. In all analyses *Don't know* responses were treated as missing values.

Q3

ED1 (*N* = 28)

ED2 (*N* = 32)

Pediatric (*N* = 29)

Q12

ED1 (*N* = 25)

ED2 (*N* = 33)

Pediatric (*N* = 26)

Q18

ED1 (*N* = 25)

ED2 (*N* = 31)

Pediatric (*N* = 21)

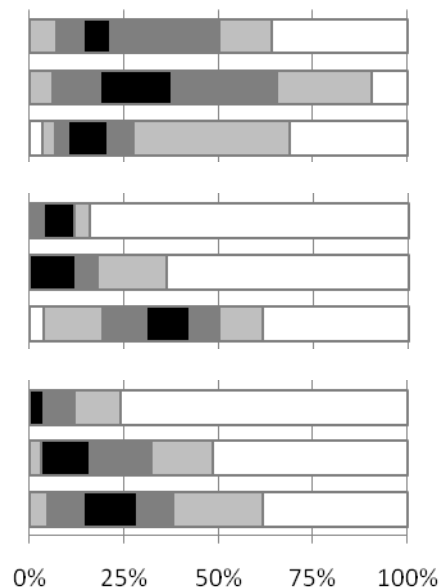


Figure 1 – Distribution of responses to Q3, Q12, and Q18. Legend: rating 1 (disagree) – leftmost white, through rating 4 (neutral) – black, to rating 7 (agree) – rightmost white

Results

Figure 1 shows the responses to three key questions in the survey. The median ratings for Q3 are 5, 5, and 6 for ED1, ED2, and Pediatric, respectively, and thus at the positive end of the scale. This indicates that the respondents find that they tend to have the overview they need in their work. A Kruskal-Wallis test shows a significant effect of department, $\chi^2(2, N=89) = 6.94, p < 0.05$, with Pediatric respondents reporting that they have less of an overview than ED2 respondents. The information on the dry-erase whiteboards is perceived to be important to respondents' overview, as indicated by median ratings of 7, 7, and 5 to Q12 for ED1, ED2, and Pediatric, respectively. A Kruskal-Wallis test shows a significant effect of department, $\chi^2(2, N=84) = 13.71, p < 0.001$, with Pediatric respondents considering the whiteboard information less important to their overview than ED1 and ED2 respondents. In spite of this positive assessment of the dry-erase whiteboards, the respondents consider the introduction of the electronic whiteboards a good idea, as indicated by median ratings of 7, 7, and 6 to Q18 for ED1, ED2, and Pediatric, respectively. A Kruskal-Wallis test shows a significant effect of department,

Table 3 – Regression models of the emergency-department clinicians' overall perception of their overview

Departments	Staff group	Resulting predictor variables	<i>R</i> ²	<i>N</i>	Significance test
ED1 and ED2	Physicians	Q5	82%	11	$F(1, 9) = 40.41, p < 0.001$
ED1 and ED2	Nurses	Q6, Q8, Q5, Q4	61%	35	$F(4, 30) = 11.55, p < 0.001$
ED1 and ED2	Auxiliary nurses	-	-	3	-
ED1 and ED2	Secretaries	Q10	29%	12	$F(1, 10) = 4.08, p = 0.07$

$\chi^2(2, N=77) = 7.84, p < 0.05$, with Pediatric respondents being less positive about the introduction of the electronic whiteboards than ED1 respondents.

Table 3 elaborates on the emergency-department respondents' perception of their overview by regressing Q4 to Q11 on Q3. The resulting regression models are significant for physicians and nurses. For physicians the variation in Q5 explains 82% of the variation in Q3, indicating that the prioritizing of the patients is central to the physicians' sense of having the overview they need. For nurses the combination of Q6, Q8, Q5, and Q4 (in order of decreasing explanatory power) explains 61% of the variation in Q3, indicating that the nurses feel they have the overview they need when they have an overview of the ongoing and planned patient treatments, the occupancy level in their area, the relative priority of the patients, and the patients' condition. For secretaries the regression model approaches significance and, thereby, suggests that having an overview of the patients in the waiting room (Q10) may be important to the secretaries' sense of having the overview they need. (For auxiliary nurses, there were too few respondents to perform the regression analysis.)

The high perceived value of the dry-erase whiteboards (Q12) is corroborated by Q13 through Q16. The clinicians at ED1 and ED2 experience that the information on the dry-erase whiteboards tends to be available when and where needed (Q13), to be easy to understand (Q14), to be fast and simple to update (Q15), and that the whiteboards tend to be pivotal to important collaborative activities among the clinicians (Q16) with median ratings of 5, 6, 6, and 6, respectively. Kruskal-Wallis tests show no effect of staff group for these questions (Q12: $\chi^2(3, N=58) = 7.59, p = 0.06$; Q13: $\chi^2(3, N=58) = 5.31, p = 0.2$; Q14: $\chi^2(3, N=59) = 4.06, p = 0.3$; Q15: $\chi^2(3, N=59) = 2.60, p = 0.5$; and Q16: $\chi^2(3, N=56) = 7.18, p = 0.07$).

Table 4 elaborates on the emergency-department respondents' expectations toward the electronic whiteboards by regressing Q19 to Q25 on Q18. The resulting regression models are significant for physicians, nurses, and secretaries. For physicians and nurses the variation in Q20 explains 76% and 72%, respectively, of the variation in Q18, indicating that their expectation as to whether the electronic whiteboards will lead to improvements in the treatment of the patients is central to their overall perception of whether it is a good idea to introduce the electronic whiteboards. For secretaries the combination of Q23 and Q20 explains 52% of the variation in Q18. Thus, the importance of improvements in the treatment of the patients is reiterated, but for the secretaries it is combined

with a concern that the electronic whiteboards may reduce the clinicians' shared understanding of their work situation.

For reasons of comparison we also regressed Q19 to Q25 on Q18 for the Pediatric department, $N = 24$. The resulting regression model is significant, $F(2, 21) = 14.70, p < 0.001$, and shows that the combination of Q20 and Q25 explains 58% of the variation in Q18. Again, the clinicians' assessment of the introduction of the electronic whiteboards is partly explained by their perception of whether these whiteboards will lead to improvements in the treatment of the patients. The other factor explaining part of the variation in the Pediatric clinicians' assessment of the introduction of the electronic whiteboards is whether they personally like to start using new technology.

Discussion

The surveyed emergency-department clinicians find that overall they tend to have the overview they need in their work, and they consider their dry-erase whiteboards important in forming and maintaining this overview. In spite of this positive state of affairs, the clinicians generally welcome the electronic whiteboards that are being introduced in place of the dry-erase whiteboards. Such a positive reception improves the chances that the clinicians will overcome any initial difficulties with the electronic whiteboards and will seek to adapt their work practices to assimilate the electronic whiteboards. The positive reception is, however, likely to be short-lived unless expectations are quickly confirmed by experience.

We see five implications of the survey results for the design of electronic emergency-department whiteboards. These implications should, however, be interpreted in light of the limited number of survey respondents. The five implications are:

First, there are large differences across staff groups in the issues that explain the variation in the clinicians' perception of whether they have the overview they need. For the physicians a single issue dominates, namely clarity about the relative priority of the patients; for the nurses this issue recurs but in combination with three other issues; and for the secretaries these four issues may be replaced by a fifth issue, namely having an overview of the patients in the waiting room. This strongly suggests that emergency-department whiteboards must simultaneously support disparate sets of need. While this may seem banal, it emphasizes the importance of involving all relevant staff groups in the design work, and it suggests that the value of a whiteboard may in part be to bring these

Table 4 – Regression models of the emergency-department clinicians' overall expectations toward the electronic whiteboards

Departments	Staff group	Resulting predictor variables	R ²	N	Significance test
ED1 and ED2	Physicians	Q20	76%	10	$F(1, 8) = 24.66, p < 0.01$
ED1 and ED2	Nurses	Q20	72%	32	$F(1, 30) = 77.41, p < 0.001$
ED1 and ED2	Auxiliary nurses	-	-	3	-
ED1 and ED2	Secretaries	Q23 (-), Q20	52%	11	$F(2, 8) = 6.46, p < 0.05$

groups' different views together in one coherent interface [2].

Second, it is notable that the variation in the staff groups' perception of having the overview they need is not, to an appreciable extent, explained by the variation in respondents' overview of who is responsible for which patients (Q7), of the patients who are on their way but have not yet arrived (Q9), and of the occupancy level in the other areas of the department (Q11). While these issues may still be important to single individuals among the clinicians, their negligible overall importance suggests that design features aiming to support these issues should only be included in the whiteboards if these design features do not conflict with other design features.

Third, across staff groups the dominant issue in explaining the variation in the emergency-department clinicians' overall expectations toward the electronic whiteboards is whether they perceive that the whiteboards will lead to improvements in the treatment of the patients. The only other issues that explain part of the variation in overall expectations are a concern that the whiteboards may reduce the clinicians shared understanding of their work situation and (for the Pediatric department) whether the clinicians personally like to start using new technology. Other studies have frequently found that people's early assessment of a system is also affected by their expectations about the effort required to adopt the system [9]. The absence of such findings in our survey may suggest that the clinicians perceive the electronic whiteboards as a simple system, the adoption of which does not present a learning barrier.

Fourth, while the emergency-department staff groups differ in their responses, we find no differences between the two emergency departments in their responses to key survey questions. This is the case in spite of differences in the organization of work at ED1 and ED2. Consequently, we may hope that with small differences in its setup the same electronic whiteboard can be used at multiple emergency departments. Conversely, we find several differences between emergency-department responses and pediatric-department responses. This suggests that more caution – and redesign – is required in transferring the electronic whiteboard from an emergency department to another type of department.

Finally, it is worth repeating that the clinicians at both emergency departments perceive the whiteboards as important to their overview and, thereby, to their competent performance of their work. This calls for care in the design of the electronic whiteboards and in the incorporation of these whiteboards into the daily work practices at the departments.

Conclusion

To perform competently emergency-department clinicians must be able to gain and maintain an overview. The dry-erase whiteboards the clinicians have hitherto depended on for information important to their department-level overview are now in the process of being replaced with electronic whiteboards. At the time when they started to use the electronic whiteboards, the surveyed clinicians displayed staff-group differences in their notion of overview, had positive expecta-

tions toward the whiteboards, appeared to base their overall expectations mainly on whether they expected the whiteboards to produce improvements for the patients, and displayed no differences across emergency departments in responses to key survey questions. In future work we will compare the clinicians' expectations with their experiences after extended use of the electronic whiteboards, and we will feed insights from the survey back into the design process to exploit the possibilities of electronic whiteboards and, where relevant, move beyond mimicking dry-erase whiteboards.

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References

- [1] Hertzum M, Simonsen J. Positive effects of electronic patient records on three clinical activities. *International Journal of Medical Informatics*, 2008, 77(12): 809-17.
- [2] Aronsky D, Jones I, Lanaghan K, Slovis CM. Supporting patient care in the emergency department with a computerized whiteboard system. *Journal of the American Medical Informatics Association*, 2008, 15(2): 184-94.
- [3] Nygren E, Wyatt JC, Wright P. Helping clinicians to find data and avoid delays. *Lancet*, 1998, 352(9138): 1462-6.
- [4] Bjørn P, Rødje K. Triage drift: A workplace study in a pediatric emergency department. *Computer Supported Cooperative Work*, 2008, 17(4): 395-419.
- [5] France DJ, Levin S, Hemphill R, Chen K, Rickard D, Markowski R, Jones I, Aronsky D. Emergency physicians' behaviors and workload in the presence of an electronic whiteboard. *International Journal of Medical Informatics*, 2005, 74(10): 827-37.
- [6] Plaisant C, Shneiderman B, Mushlin R. An information architecture to support the visualization of personal histories. *Information Processing & Management*, 1998, 34(5): 581-97.
- [7] Powsner SM, Tufte ER. Graphical summary of patient status. *Lancet*, 1994, 344(8919): 386-9.
- [8] Thompson ML. Selection of variables in multiple regression: Part I. A review and evaluation. *International Statistical Review*, 1978, 46(1): 1-19.
- [9] Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 2003, 27(3): 425-78.

Address for correspondence

Morten Hertzum, Computer Science, Roskilde University, 1 Universitetsvej, Bldg 43.2, DK-4000 Roskilde, Denmark, phone: +45 4674 3077, email: mhz@ruc.dk