

# Identify facilitators and challenges in computerized checklist implementation

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## Identify Facilitators and Challenges in Computerized Checklist Implementation

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### Abstract

*Safety checklists have been considered as a promising tool for improving patient safety for decades. Computerized checklists have better performance compared with paper-based checklists, though there are barriers to their adoption. Given previous literature, it is still unclear what assists implementations and their challenges. To address this issue, this paper summarizes the implementation of two successful computerized checklist implementations in two countries for two different clinical scenarios and analyzes their facilitators and challenges.*

### Keywords:

Patient Safety; Checklist; Decision Support Systems, Clinical

### Introduction

In recent years, several studies have proved that process-oriented and context-aware computerized checklists can improve adherence to safety checklists and consequently improve clinical outcomes [1]. Previous studies have addressed several technical barriers to the wide adoption of computerized checklists [2]; however, it is still unclear what the facilitators and challenges are in the implementation phase.

Due to the limited amount of implementation research, it is still not possible to summarize the facilitators and challenges out of literature. However, our research team has recently implemented computerized checklist systems in two countries for two different clinical scenarios [3]. It would be meaningful to summarize and communicate the facilitators and challenges gained from these two studies.

An intensive care unit (ICU) round computerized checklist and a supporting system were developed and implemented in a Dutch tertiary hospital in 2014. The computerized checklist was connected to the electronic medical record (EMR) system in the hospital. Each item is customized to specific patient conditions by executing clinical rules. Clinical rules help intensivists to double check items, highlight items that were critical for specific patients, and tailor items to become specific for the patient. A simulation-based study was carried out to validate the user acceptance and effectiveness. Compared to the paper-based checklist, the adherence to the checklist increased from 73.6% to 100% [3].

A computerized percutaneous coronary intervention (PCI) peri-operative checklist set was developed for a Chinese tier-three hospital from 2015 to 2017. The computerized checklist was also connected to the hospital EMR. Patient data were

extracted out of the EMR database. A semi-structured interview was carried out while implementing this checklist. Cardiologists reported this checklist helped them to complete the safety checklist faster, since the checklist helped them by showing relevant patient data and check items automatically.

In the remainder of this paper, we identify facilitators and challenges by analyzing our own experiences gained from these two cases.

### Methods

While developing the computerized checklists in these two studies, we followed a proof-by-demonstration approach [4]. With this approach, we divided the development into several iterations. In each iteration, we demonstrated the latest software to the clinical users, interviewed them while demonstrating, analyzed users' comments, and applied validated comments to the next version of the software that would be discussed in the next iteration. Change Management Principles [5] were applied while implementing the software. After several iterations, the software was stable and brought to daily use.

In the Dutch case, two engineers and one intensivist had worked on developing checklist items and related clinical rules for half a year based on the local protocols. Another large part of the clinical rules was derived from the Clinical Decision Support System (CDSS) knowledge base.

In the Chinese case, three engineers and two cardiologists had been working on the computerized checklist for two years. The related clinical rules were based on their existing paper-based checklist and narrative clinical guidelines.

Users' comments were collected and analyzed afterward. Those comments on what they liked about computerized checklists were categorized as facilitators. Those comments on what may hinder the acceptance were considered challenges. Additionally, engineers' own development experiences were summarized into these two categories.

### Results

#### Facilitators

##### *Use the Established Local Standard of Care*

Both hospitals already had a great amount of established local standard of care, includes existing guidelines, pathways, safety checklists, CDSSs, and other approaches that aimed to

improve quality of care. These standards were derived from published literature and adapted to their hospitals.

All providers who participated in this study suggested that this knowledge was already accepted and followed in the department level. Using this knowledge made checklist items more acceptable and reasonable to clinicians.

#### **Make Computerized Checklists Dynamic**

Providers claimed they refused to use paper-based checklists due to its static nature that did not fit in their dynamic and demanding daily workflow.

A computerized checklist that could be adapted to each specific patient made much more sense to clinicians. During the interviews, clinicians mentioned that they liked the dynamic properties as it saved time to complete the checklists and it could detect more patient-specific problems that were worth noticing.

#### **Adaptive to Clinicians' Requirements**

In both of the studies, during our implementations, clinicians also mentioned new potential clinical rules sparking their interest in computerized checklists. Especially in the Dutch case, a visualized knowledge acquisition tool was used to build clinical rules. An intensivist implemented and updated the clinical rules independently.

#### **Provided Users Additional Value**

The length of time to complete computerized checklists was a major concern for checklist users. Users claimed that the exercise of ticking boxes was time-consuming, even though it was necessary. Nevertheless, they eventually liked the idea of the computerized checklist after several iterations, because it provided additional value. While computerized checklists could help clinicians complete the checklists and worked as cognitive aids resulting in better acceptance and compliance, the additional value of the digital checklist was also their capability to extract and display relevant patient data, to analyze data automatically, and to provide evidence-based literature or local protocol.

#### **Reuse Existing Hospital Information Systems**

In our practice, we found that by reusing existing hospital information systems and their components as much as we could, we could save a great amount of time and make the computerized checklist easier to be accepted.

One example was the CDSS used in the Dutch hospital. The clinical rules in the system had been developed and tested for decades. Intensivists had all agreed on them and were familiar with these rules. Reusing these rules saved not only time for the development phase, but also made the checklist items more convinceable to the intensivists

#### **Challenges**

##### **Users' Perception and Medical Culture**

Checklists could help deliver more transparent healthcare, that people could know who did what at what time; however, some providers had their concerns. Some clinicians worried about patients and their family, who could lack medical knowledge and could misinterpret the records that they made. This could be used as evidence against them if something wrong were to happen. Therefore, these clinicians refused to use the checklists, or they ticked everything to avoid trouble.

#### **The Right Level of Variability**

Healthcare processes were highly variable. It was yet difficult for computerized checklists to cover every path of the healthcare process. In some situations, there were no checklists which could cover them or a checklist could no longer validate for those cases.

#### **Knowledge Acquisition**

The cost of knowledge acquisition was high. Knowledge engineers and clinical experts had difficulties in understanding each other. The knowledge provided by experts did not always reflect the specific problem in a specific department. It sometimes took several iterations to finalize a clinical rule.

#### **Conclusions**

Safety checklists have been considered a promising tool for improving patient safety for a decade. Computerized checklists can help implement safety checklists in a process-oriented and patient context-aware way so that they fit better in medical practices; however, due to the lack of experiences, it remains unclear what the facilitators and challenges are when implementing them in hospitals. To help accelerate the widespread adoption of computerized checklists, this paper summarizes facilitators and challenges of two successful computerized checklist implementations. Suggestions for future computerized checklist implementations and other possible research directions are considered for future research.

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#### **References**

- [1] H.S. Kramer, F.A. Drews, Checking the lists: A systematic review of electronic checklist use in health care, *J. Biomed. Inform.* **71** (2017) S6–S12.
- [2] S. Nan, X.-D. Lu, P. Van Gorp, H.H.M. Korsten, R. Vdovjak, U. Kaymak, H.-I Duan, Design and implementation of a platform for configuring clinical dynamic safety checklist applications, *Front Inf. Technol Electron Eng.* **19** (2018) 937–946.
- [3] A. de Bie Dekker, S. Nan, L. Vermeulen, *et al.*, Improving checklists: Making them dynamic and connected to the EHR, in: Proceedings of the 11th Annu. Int. Conf. Rapid Response Syst. Med. Emerg. Teams, (2015).
- [4] A.S. Vinzé, D.G. Gregg, U.R. Kulkarni, Understanding the philosophical underpinnings of software engineering research in information systems, *Inf. Syst. Front.* **3** (2001) 169–183.
- [5] R. Kandt, Organizational change management principles and practices, *Fourth Int. Conf. Prod. Focus.* (2002).

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