



# Information Management in Hospital Unit Daily Operations

## A Descriptive Study With Nurses and Physicians

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Operations management of a hospital unit is a shared activity involving nursing and medical professionals, characterized by suddenly changing situations, constant interruptions, and ad hoc decision-making. Previous studies have explored the informational needs affecting decision-making, but only limited information has been collected regarding factors affecting information management related to the daily operations of hospital units. The aim of this study was to describe the experiences of nursing and medical professionals of information management in the daily operations of hospital units. This qualitative study consists of interviews following the critical incidence technique. Twenty-six nurses and eight physicians working in operational leadership roles in hospital units were interviewed, and the data were subjected to thematic analysis. The data analysis showed that strengths of current systems were organizational operational procedures, general instruments supporting information management, and a digital operations dashboard, whereas opportunities for improvement included the information architecture, quality of information, and technology use. The study findings highlight that despite several decades of efforts to provide solutions to support information management in hospital daily operations, further measures need to be taken in developing and implementing information systems with user-centered strategies and systematic approaches to better support healthcare professionals.

**KEY WORDS:** Hospital, Information management, Nurses, Operations management, Physicians

Operations management of a hospital unit is a shared multidisciplinary and interconnected activity involving nursing and medical professionals. The physicians' decision-making typically focuses on patients' medical care, whereas the nurses' managerial activities expand to include

coordination of staffing and material resources to meet the care needs of individual patients.<sup>1,2</sup> Although the role descriptions and terms regarding operations management differ between settings, the activity itself is characterized by suddenly changing situations, constant interruptions, and ad hoc decision-making in the hospital setting.<sup>3,4</sup>

Information management covers the collection, storage, curation, dissemination, archiving, and destruction of any sources of data or information. It is a central component of an intelligent organization, such as health services.<sup>5</sup> Information management in health services occurs in three levels: strategic, tactical, and operational, which are all connected to each other and affected by one another.<sup>6</sup> There is ample research showing how leadership style and leaders' decisions regarding resource allocation are associated with both nurse and staff outcomes.<sup>7-10</sup> However, knowledge regarding the role of information management in daily operations of hospitals is yet far less explored.

The existing scarce research covers operational leaders' decision-making, information needs, and information sources in different acute care settings.<sup>3,4,11-13</sup> This research shows that the decision-making and information needs in operations management of hospital units mainly regard patients, staffing, and material resources.<sup>3,12,13</sup> Although some information items are shared by almost all operational leaders, most of the information needs differ between professional groups, time of day, and unit.<sup>13</sup> In addition, information necessary in operations management is scattered, and several different systems are needed during each shift.<sup>14</sup> Issues regarding functionality and user-friendliness may be explained by the low involvement of end users in information technology development processes as less than half of nurses have been involved in the development of information systems and they mainly participate in the process at the end of the development process.<sup>15</sup>

Information systems in healthcare may be divided into clinical information systems and administrative systems.<sup>16</sup> Digitalization has been suggested to improve information management in healthcare,<sup>17</sup> yet both nursing and medical professionals in charge of operations management have expressed dissatisfaction with current clinical information systems as well as a need to improve information management.<sup>1,2</sup> Successful and smooth daily operations in hospital units require sufficient information management solutions to support the decision-

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making in a cost-effective way.<sup>2</sup> Ample solutions have been developed for healthcare professionals, but they often lack user-centeredness and face issues regarding functionality.<sup>18</sup> Moreover, little research shows the impact of information management or information systems on the daily operations of hospital units.

The digitalization of Finnish healthcare is highly advanced, with all healthcare documentation and administration being conducted electronically. All participating units in this study were using a variety of digital information systems, including bedside clinical systems as well as administrative systems. In addition to this, four of the five units participating in this study had a novel digital operations dashboard developed to support and complement operations management in the hospital. The system, Columna Clinical Logistics (Systematic, Aarhus, Denmark) (CCL), is a workflow and communication instrument for professionals presenting information on large displays regarding staff, patients, care processes and material resources, as well as having a user interface on personal computers.<sup>11</sup> The length of using the CCL in the participating units varied between 0 and 4 years.

To this day, only limited information has been collected regarding factors affecting information management related to the daily operations of hospital units. The aim of this study was to describe the experiences of nursing and medical professionals of information management in the daily operations of hospital units. The study questions were as follows:

1. What enables and hinders information management in the daily operations of hospital units?
2. What benefits and challenges do nursing and medical professionals experience with information technology solutions developed to support daily operations of hospital units?

## METHODS

### Research Design

The study design was qualitative and descriptive. Interview data were collected to interpret participants' experiences, and a thematic content analysis was undertaken for analysis.<sup>19</sup> The COREQ (Consolidated Criteria for Reporting Qualitative Research) checklist for qualitative studies guided the reporting of the research.<sup>20</sup>

### Setting and Participants

Data were collected in three emergency units, one emergency inpatient unit, and one cardiac inpatient unit from three hospital districts in Finland. The data collection ended in December 2020. Participants included nursing and medical professionals working in operational leadership roles, and they were reached using a purposive sampling strategy. The study participants were required to have experience in

operations management of hospital units or of team leadership during their work shifts.

### Data Collection

The data were collected as semistructured telephone interviews in Finnish and Swedish. The interviews were voice recorded and conducted one-to-one with the participant, with the length of the recordings ranging between 4 and 39 minutes with an average length of 15 minutes 30 seconds. The participants were asked to describe situations, in which the information management in regard to daily operations had succeeded, as well as situations where it had failed, following the critical incident technique.<sup>21</sup> Additionally, the professionals familiar with CCL were asked to describe what was good with the system and how it could be improved. This was done to determine the impact the system has on daily operations of hospital units and explore its impact on the experiences of information management described by the participants. The critical incident technique offers adaptable principles guiding data collection that aim to identify incidents having positive or negative impact on information management in daily operations. The required number of incidents needed has been achieved when data collection does not result in new findings, and in simple activities, this saturation point can be reached with 50 to 100 stories.<sup>21</sup>

### Data Analysis

Data were analyzed with thematic content analysis.<sup>19</sup> Beginning with an *initialization* phase, meaning units were gathered from the interviews to an Excel-sheet (Microsoft Inc., Redmond, WA, USA), followed by an iterative *construction* phase with classifying, comparing, and labeling the meanings. In the *recognition* phase, the conducted themes were described and engaged with prior knowledge, ending with the development of storyline in the *finalization* phase of the analysis. Additionally, descriptive statistics (mean, standard deviation) were used to determine the demographic characteristics of the participants. The initial analysis was conducted by the two authors.

### Ethical Considerations

The study participants were informed both verbally and with a letter of the purpose of the study and that responding to the questions was regarded as an informed consent to participate. They were asked to contact their supervisor if they were willing to take part, and the researchers received the contact information via the supervisors. The subject of the study was not regarded as sensitive. No prior relationship was established with the study participants, and the participants were informed of the employment and occupation of the interviewees. The participants did not receive any compensation for their contribution. Ethical review was done by the university's Ethics Committee for Human Sciences (Health Care Division)

at the University of Turku. Administrative approvals were obtained from all three hospital districts for collecting the data.

## RESULTS

### Participant Characteristics

A total of 34 professionals working in operations management including nurses (n = 26) and physicians (n = 8) were interviewed. The participants' age ranged from 28 to 61 (M = 43.15, SD = 10.10) with work experience from 2 to 40 years (M = 17.91, SD = 11.14). Twenty-six of the participants were women, and eight were men. Twenty-one worked in the emergency unit, eight worked in the emergency inpatient ward, and five worked in the cardiac inpatient ward as nurse managers, assistant nurse managers, shift leaders, team leaders, residents, consultants, and medical directors. Respondents reported working mainly in three shifts (56%, n = 19), followed by day shifts (21%, n = 7).

### Factors of Information Management in Daily Operations of Hospital Units

The interviews resulted in 117 different stories on information management related to the daily operations in hospital units and 100 stories related to the digital information system

(CCL). The data analysis resulted in six themes and 20 sub-themes that were divided between two main themes: (1) strengths of current systems and (2) opportunities for improvement, as illustrated in Figure 1.

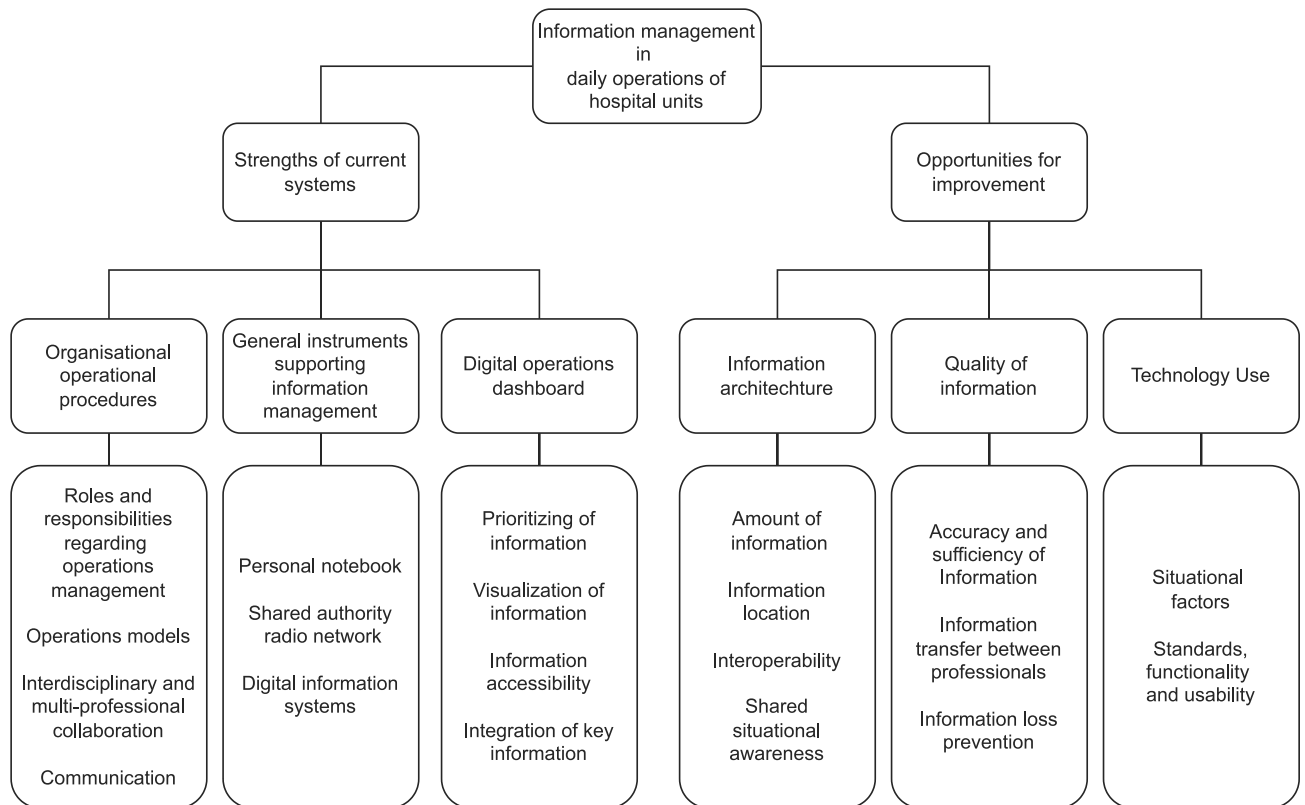
### Strengths of Current Systems

Strengths of current systems were (1) organizational operational procedures, (2) general instruments supporting information management, and (3) the digital operations dashboard CCL that was implemented into four participating units. Table 1 presents examples related to the subthemes. Nurses and physicians described predominantly similar stories related to strengths of current systems. Additionally, apart from stories related to the digital operations dashboard, there was no great variation in stories between the units where the CCL had been implemented and the units that did not have the system.

### Organizational Operational Procedures

#### Roles and Responsibilities in Operations Management

Participants described the shift managers' actions as a crucial part of successful information management. The shift manager was easy to reach, and rounds around the ward were



**FIGURE 1.** Factors associated with information management in daily operations of hospital units, reported by nursing and medical professionals.

**Table 1.** Strengths of the Current Systems as Reported by the Participants

Strengths of the Current Systems	Professionals	CCL <sup>a</sup>	Example Quotes
<b>Organizational operational procedures</b>			
Roles and responsibilities regarding operations management	Nurses, physicians	No	“When they’re at work you can always reach them, there is no issue there.” “... They call me on the phone that is in my pocket and I go to the field to check the situation and I’ll summon additional staff.”
Operations models	Nurses, physicians	No	“When the paramedics give us a prior notice of more seriously ill patients, it initiates a process at our end, where we, for example, check in the patient as an incoming patient and we start thinking about how we should proceed with the treatment process.”
Interdisciplinary and multiprofessional collaboration	Nurses, physicians	No	“It is better for the patient and for us that we have the time to admit them [...] that we have the time to prepare.”
Communication	Nurses, physicians	No	“Between colleagues, of course, just that you work in a module and that, if you communicate well and, like, you know what your colleagues are working on.”
<b>General instruments supporting information management</b>			
Personal notebook	Nurses	Yes	“I have this small notebook where I write all permanent changes, like when some procedures change in some way [...] it would take me ages to find them after a week has passed.”
Shared authority radio network	Nurses	No	“When the message goes to all, then people acknowledge them well and they usually arrive, so that’s where the good experiences come from.”
Digital information systems	Nurses, physicians	No	“And everyone working in the emergency unit can see it.”
<b>Digital operations dashboard</b>			
Prioritizing of information	Nurses, physicians	Yes	“You get defined, correct, reliable information, like, quickly and simultaneously and based on them you can make those judgments, like, predictively.”
Visualization of information	Nurses, physicians	Yes	“It is easier to see where the patient is, who is taking care of them and, and also that have they already been to the x-ray, and you don’t always have to go take a peek to the patient records to see if they have been analyzed or taken [...] and also lab tests.”
Information accessibility	Nurses, physicians	Yes	“When you mark them with an exclamation mark, you don’t need to go and find the nurses, run after them, remind them... Instead, the exclamation mark is in there until the task has been completed.” “When relatives come and ask about how the patient is and so, or where they are, it feels good that you can just take a look at the dashboard and tell them directly, that the patient is there, and you can talk to [...] if you have questions.”
Integration of key information	Nurses, physicians	Yes	“Then I use the dashboard and check the situation, that do we even have a bed for a male or a female patient [...] and we see their name and identification and the arrival report and we can plan, plan the patient in.”

<sup>a</sup> CCL indicates whether the Columna Clinical Logistics system was implemented in all units describing the stories related to the subtheme.

considered as a good way to acquire information in real time and get a good overview of the resources and the skill level of the personnel.

### Operations Models

Protocols compiled for special situations provided well-established examples on fluent information management. When the order of the events was fully described, devised, and rehearsed in advance, everyone was aware of their own roles in the situation. Such protocols were drafted, for

example, for patient cases such as trauma alerts and ST-elevation myocardial infarction patients, but also for planned or unexpected computer outages.

### Interdisciplinary and Multiprofessional Collaboration

Successful information management was presented as being dependent on fluent collaboration between various stakeholders. In a hospital level, deployment of coordinating nurses, who were in charge with arranging patient placements, made it easier for the shift manager to prepare and plan the work

shift. The communication between emergency units and paramedics of an incoming patient was vital, giving the unit time to summon the trauma team, prepare for the patient, gather the equipment, and draft a care plan with necessary imaging and laboratory tests.

### **Communication**

To promote information management in daily operations, the participants stressed the importance of direct and fast interaction between professionals. Participants described oral reporting as a vital addition to printable information sheets as a way of ensuring information flow. Being familiar with and having good relationships between colleagues and co-workers advanced open communication as well as increased situational awareness within the work environment.

## **General Instruments Supporting Information Management**

### **Personal Notebook**

Carrying and making notes to a notebook, Post-It stickers or a printed-out list of recent changes was seen as a necessary memory aid and a vital way to save time from searching up-to-date information.

### **Shared Authority Radio Network**

Authority radio network was used for transmitting messages simultaneously and efficiently to all stakeholders concerned, reducing the need to contact all individually. Radio networks were used both inside the units and between the unit and paramedics.

### **Digital Information Systems**

Digital information systems served as an easy outlet to pass on information to large groups simultaneously. Group text messages were seen as fast and easy ways to communicate with additional staff members on staff shortage needs without having to contact each individually, whereas staff was kept posted on recent changes with weekly e-mails. Important information was also brought to an electronic portal, which was portrayed as easy to navigate.

## **Digital Operations Dashboard**

### **Prioritizing of Information**

All urgent and important information was updated on a digital operations dashboard by the shift managers and displayed in different workstations. The dashboard also served as an important means of communicating relevant information in real time, such as physicians' orders, nurses' notes, the order and the raise of patient urgency class, or a warning of a threatening or aggressive patient.

### **Visualization of Information**

Easily noticeable and informative color codes gave notice to the nurses on physicians' orders or informed the physician when their messages had been acted on. The nurses could also communicate urgent matters to the physicians through a visible "attention"—notice, as well as inform others of pediatric patients or of the patient's special needs. When laboratory tests or medical images were ordered, taken, or analyzed, the information was clearly displayed on the dashboard.

### **Information Accessibility**

Important general and current information posted on the digital dashboard was visible to every team member regardless of their location. Displaying small requests or notions not needing immediate attention reduced the time spent on locating and contacting, but also interrupting the work of different stakeholders, thus promoting communication and information transfer between nurses and physicians. When the dashboard was used in multiple units, interdepartmental communication was also improved.

The knowledge posted on the dashboard was primarily patient information, finished procedures, and task lists, but also the names and contact information of the nurses and physicians responsible for their care. Updating the task list was seen as a fluent way to inform others of what had been planned, what still needed attending, and what had already been done.

### **Integration of Key Information**

Taking just one quick look at the dashboard increased the perception of the overall situation of the unit for the professionals, giving relevant up-to-date information, such as the health problems and care needs of the units' patients.

## **Opportunities for Improvement**

The participants shared stories in which (1) information architecture, (2) quality of information, and (3) technology use provided opportunities for improvement. The example quotes are presented in Table 2. Nurses and physicians described mostly similar situations in which the information management had failed.

## **Information Architecture**

### **Amount of Information**

Participants described feeling overwhelmed with the vast amounts of information, received primarily via e-mail. This resulted in relevant information drowning in the flood of information and important details left unnoticed.

### **Information Location**

Information scattered between multiple different information systems did not support clinical work. The participants felt

**Table 2.** Opportunities for Improvement as Described by the Participants

Opportunities for Improvement	Professionals	CCL <sup>a</sup>	Example Quotes
<b>Information architecture</b>			
Amount of information	Nurses	No	“We get a lot of e-mails, and then like, and these processes are being updated, and so that relevant information gets lost in the flood [...] how could you gather that this is now the newest information.”
Information location	Nurses, physicians	No	“For those patients we have this ‘extra beds’ that we don’t see, it is behind another tab. And we would like for those to be displayed as well, these extra patients.”
Interoperability	Nurses, physicians	Yes	“Now we have two systems where we have, we have patients records [...] have to go always to patient records, and it becomes like a double system.” “They leave them there, and it seems like we have a... a free bed, although we don’t have a free bed, just a patient that is getting some examinations done.”
Shared situational awareness	Nurses, physicians	No	“The lab system changed, and they did organize training, but many didn’t have the time to go [...] the implementation day, it was not informed properly, many samples got lost and such.” “A nurse from acute called and told me ‘I am now going to give you a report on this isolation patient that is coming to you’ [as arranged with a coordinating nurse] and I was like, we don’t have space, our isolation is full.”
<b>Quality of information</b>			
Accuracy and sufficiency of information	Nurses, physicians	No	“Sometimes when a patient comes from acute, some things are left unmentioned [...] essential things that I would like to know beforehand when admitting the patient, so that I can prepare myself.”
Information transfer between professionals	Nurses	No	“We have this [...] who doesn’t know any Finnish, and we have to translate [...] sometimes we are missing the facts or right words.”
Information loss prevention	Nurses, physicians	No	“You wonder why they haven’t come to work, and find out they have informed their absence but that it has not been taken into account, that is, that is a huge problem.”
<b>Technology use</b>			
Situational factors	Nurses, physicians	No	“If they are updating something, that a vital system is out, then we of course have problems regarding information.”
Standards, functionality and usability	Nurses, physicians	No	“When there are several intercommunications systems, it’s like ‘which phone do they answer again?’” “If the [professionals] just write them down to the dashboard, instead of patient records.”

<sup>a</sup> CCL indicates whether the Columna Clinical Logistics system was implemented in all units describing the stories related to the subtheme.

that they did not always have the time to update all different systems, and a lot of information was also left unnoticed. This resulted in the constant need to memorize or write down information.

### Interoperability

The participants described the need for system integration to support information management, as doing double entries to or gathering information from multiple data systems was regarded straining. It resulted also in delay of care or missing information, for example, not having access to patient’s medication lists added to the workload of the nurse gathering relevant patient information. A demand for one universal information system arose in the interviews. Participants also expressed hopes of all inputted data, laboratory results, and

imaging automatically updating to the digital operations dashboard. Information that was clearly visible on the digital dashboard was easily missed when accessing the system using a computer. Not being able to save the information made to the dashboard while discharging the patient was seen as problematic, and the system did not allow the same patient to be registered to multiple units at the same time. All stories describing issues with interoperability were provided by professionals with experience of implementing the digital operations dashboard into their workflow.

### Shared Situational Awareness

The information flow inside the hospital from upper-level management to operational management level, as well as the communication between units, was generally regarded

as nonfunctional. The participants described situations where relevant changes had been made in the organization without a notice in advance or receiving only hearsay of important information.

Inside the unit, the participants also expressed the need to move around to get information, as the information was not accessible to them otherwise, resulting in interruptions to their own work. If the nurse's role varied in different shifts between clinical nursing and shift management, colleagues were at times confused of their roles in the unit. The roles and responsibilities of shift leaders or coordinating nurses were sometimes also unclear, resulting in information being misplaced.

## Quality of Information

### *Accuracy and Sufficiency of Information*

The participants reported incidents during patient transfers, where important information, like possible threat of aggressive behavior or viral infections, was left unmentioned, or the triage classification was uninformative or too low, leaving no time to prepare. Also, information to increase situational awareness, like the amount of free beds or the status of the patients, was seen as insufficient.

### *Information Transfer Between Professionals*

Participants described situations resulting in misunderstandings and change of information in interdepartmental communication, for example, if a patient was being transferred by a nurse not having cared for them, or a patient moving from one hospital to another. Intradepartmental problems arose if more than one professional attended to the same patient, or in case of language barriers between professionals.

### *Information Loss Prevention*

Shift changes were regarded problematic, as unwritten information was sometimes forgotten to convey from one professional to another, or important patient information was not written down to patient records.

## Technology Use

### *Situational Factors*

The participants disclosed that the information flow deteriorated in urgent situations and resulted in haste. Haste in the unit often created delay in recording relevant data, such as nurse assessments, physician's orders, prescribed or received medication, and general patient information. In addition to not finding time to write to the patient records, participants also described problems in having time to read them as well and felt that silent reports were constantly interrupted. Haste also caused mistakes made in the patient records, such as patients dropping out of the unit's patient listing or being

discharged instead of transferred to another unit, resulting in vast amount of extra work. Technical difficulties, such as malfunctioning data systems or breaks in telecommunication, caused significant problems in information management. Updating the data systems during office hours was also seen as problematic.

### *Standards, Functionality, and Usability*

Participants reported problems in information management when means of communication varied between professionals and between units, leaving no universal mean of communication to reach all stakeholders. Differences in practice could also result in break of the information chain, if other stakeholders were accustomed to transmitting patient-related information via patient records, whereas other verbally. Some participants described situations in which the documentation was done in abnormal places, resulting in the information being left unnoticed. This often caused the need to check multiple systems simultaneously and not fully trusting the mutually agreed-on operation models. Participants also described the need for additional training regarding the use of the digital dashboard, as well as detecting resistance to change in some professionals. This resulted in inadequate use of the digital dashboard, adding to the workload of the participants. It also diminished the trustworthiness of the information displayed on the dashboard.

## DISCUSSION

The main findings of this study highlight items that may be targeted to improve information management in daily operations of hospital units in both organizational and individual levels. Strengths of current systems were predominantly refined solutions and protocols to promote the workflow and information transfer, instruments to support information management, and tailored solutions that assemble important information from different sources into one display. The issues reported with opportunities for improvement, in turn, were still unresolved issues related to means of providing or conveying information, or issues related to the end users' abilities of or attitudes toward using the instruments and technologies provided to them.

The results highlight the value of presenting information in an intelligible way, complemented with visualization methods to support the needs of operational management.<sup>22</sup> Research indicates that providing information without considering the quantity of complexity of its presentation poses a threat to achieving comprehensive situational awareness.<sup>23</sup> A study conducted in Finland revealed that the information systems in use did not support either the flow of information or collaboration between different stakeholders across the healthcare setting, and their usability proved to be partly problematic.<sup>24</sup> Another study investigating the usability of

electronic health record systems in the United States revealed that the systems in use acted as a barrier to acquiring information or forming the overall picture of the patients' status.<sup>25</sup> The study findings are further supported by previous work stating that system quality and use are important factors when measuring the success of information systems in hospitals.<sup>26,27</sup> They also underline the importance of understanding applications of information systems from a systems thinking perspective (see, eg, Checkland<sup>28</sup>). These systems are an important part of organizational processes within specific healthcare contexts, influenced not only by the functionality and content of one specific system, but also by how these systems are used by the professionals and how the organizational processes are transformed by implementation of such systems.<sup>29</sup> Research on user acceptance in health information management concludes that when developing and adopting these systems, the perceived usability as well as ease of use should be thoughtfully executed.<sup>30</sup> At system procurement, it is therefore important not only to acknowledge the characteristics of the desired solution but also to consider the whole ecosystem, such as organizational information systems architecture, other stakeholders in the care processes, and competence of users.

Hospital information management is multifaceted, and primary efforts regarding information systems are focused on clinical information systems that support clinical care.<sup>31</sup> Appropriate organization of care on the operations management level is a prerequisite for high-quality and efficient health services, and more efforts are needed to improve the information management to better support organization of care.<sup>32</sup> One common problem is that the voice of the technology end-users in the development lifecycle of information systems is often not comprehensively heard.<sup>33,34</sup> Organizations would benefit from multidisciplinary groups developing information management on all organizational decision-making levels in addition to discerned informatics roles for different clinical professionals (eg, nurse informaticist, medical informaticist) to support not only management, but also clinical work, education, and research.<sup>35</sup> The findings expose the importance of taking the end users' individual needs into account during the development of a technology, but also in the implementation process of novel systems. There is ample research on information needs,<sup>34,36</sup> but less is known about how this information should be presented to best support different end users throughout care processes. The work practices and dynamics of the operating environment should be carefully pre-examined to support not only the purpose the system is developed but also both existing and emerging ways of working.<sup>37</sup> User-centered information system development requires an iterative developmental process involving all end user perspectives from the beginning to the end of the developmental process.<sup>38</sup> This regards important aspect related

to the content, functionality, and intuitiveness of the developed system (the software), but also to the usability, location, and ergonomics related to the use of the system (the hardware).<sup>39</sup> It also highlights the need to consider the key role nursing and medical professionals working in operational leadership roles have in creating the culture to support the adoption,<sup>39</sup> as the system cannot work to its full potential unless all users commit to using the system as intended. It is elemental that the professionals working on these roles are fully committed, and that they have sufficient competencies in health informatics.<sup>40,41</sup> To achieve this goal, continuing education on informatics is vital not only for clinical professionals, but also for professionals in leadership roles in operative, tactical, and strategic levels.

Previous research has shown that implementation of information systems takes a long time in healthcare organizations as learning to use a new system takes time. Appropriate use and sustainability require a well-prepared organizational specific plan where systematic evaluation of success is taken into account as a longitudinal factor in contrast to a cross-sectional at the point of implementation.<sup>42,43</sup> Implementation plans need to acknowledge the knowledge, skills, and attitudes of the users in addition to the perspectives of the new technology itself.<sup>44</sup> Systematic methods, such as the highly adopted RE-AIM (reach, effectiveness, adoption, implementation, maintenance) framework together with PRISM (Practical, Robust, Implementation, and Sustainability Model), could be used to target both individual and organizational factors to support successful implementation of novel technologies not only by examining the outcomes, but also by identifying their predictors.<sup>45</sup> Another established framework used to guide forecasting or explaining the determinants and variables responsible to the effectiveness of implementation is the updated Consolidated Framework for Implementation Research, with domains covering the innovation, inner and outer settings, and the individuals, as well as the implementation process itself.<sup>42</sup> Finally, the Technology Acceptance Model adopted to healthcare could prove useful in further investigating the true barriers and facilitators throughout the implementation and use phase of novel information systems.<sup>43</sup>

The data in this study were collected from specific hospital units, with participation from three out of the 21 hospital districts from different counties around the country, limiting the generalizability of the study results. Hence, international exploration is needed to verify the transferability of the findings. Multidisciplinary research is needed on the effectiveness of different methods on improving information management, as well as deepening the understanding of these technologies on organizational, staffing, and patient outcomes. Research should also be conducted on the essential implementation strategies and core competencies, including knowledge, skills, and attitudes toward both the education on and the use of novel innovations. These recommendations are



supported by the TIGER (Technology Informatics Guiding Education Reform) international recommendation framework for core competencies in health informatics for nurses, highlighting the need to achieve and comprehensive technology literacy regardless of professional role, adapting the information needs and educational methods to best serve the target users.<sup>46</sup>

## CONCLUSIONS

This study highlights the complexity and systemic effects that need to be acknowledged in the evaluation of information management as well as development and implementation of technological solutions to respond to current needs in hospital unit daily operations. The information technology-related infrastructure, the data structures and processes, and user competencies still remain issues deemed to be resolved despite the decades of efforts to provide instruments, protocols, and solutions to support information management in daily operations. Measures must be undertaken in developing and implementing information systems utilizing user-centered strategies and systematic approaches, as well as promoting leadership competence and commitment on all levels in these processes.

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