Information Management in the Daily Care Coordination in the Intensive Care Unit

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Abstract. This study aimed to explore intensive care shift leaders' daily care coordination related information needs and sources of important information. Information needs were explored with a survey and sources of important information were determined through interviews. The survey response rate was 21 % (n = 20) and nine shift leaders were interviewed. The findings are that charge nurses and physicians in charge have different responsibilities and differing information needs, though, some managerial activities and information needs are shared. Shift leaders use numerous sources to obtain necessary information to support decision-making. Sources were categorized into electronic sources, human sources, manual sources and real-time events. Further, information was located within or outside the ICU or based on the shift leader's knowledge. Information systems should be developed based on shift leaders' information needs regardless of the source to support daily care coordination related decision-making. Shift leaders could further benefit from a real-time hospital-wide shared situational awareness.

Keywords: Intensive care · Care coordination · Information needs · Information management · Multidisciplinary · Decision-making

1 Introduction

Intensive care is provided to critically ill patients who suffer from one or more vital organ failure with a life threatening character. Intensive care units (ICUs) are complex and stressful environments where multiprofessional collaboration is vital [1]. This study focuses on decision-making and information management related to the daily care coordination in the ICU.

Managerial decision-making and information management can be described through strategic, tactical and operational levels [2, 3]. The strategic level refers to long-term planning, the tactical level to planning of concrete functions with a shorter-term goal, and the operational level to planning and execution of functions on a daily base. Information management is interconnected to each of these levels horizontally within

and between units, vertically in the organizational hierarchy, and continuously, when specific information is related to the instant, according to Murtola et al. [4].

Care coordination is defined by McDonald et al. [5] as "*the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services. Organizing care involves the marshalling of personnel and other resources needed to carry out all required patient care activities, and is often managed by the exchange of information among participants responsible for different aspects of care.*" The professionals responsible for the daily care coordination in the ICU are shift leaders, that is, charge nurses and physicians in charge.

A fluent flow of ICU activities requires a large amount of complex combinations of immediate decisions. This care coordination is a complex task as a result of critically ill patients, complex care procedures, constantly changing situations and many professionals involved. The daily care coordination related decisions concern patient admission, specific treatments, material resources, adverse events, human resources, administrative matters, staff knowledge and skills, patient information, medical information, clinical examination findings, diagnoses and patient discharge [6].

1.1 Decision-Making Responsibilities and Information Needs in the Daily Care Coordination

Care coordination in the ICU is conducted in collaboration with the charge nurse and the physician in charge [7, 8]. The charge nurses' responsibilities include to plan and decide up on the allocation of available nursing and material resources based on patient care needs. The physician in charge is responsible for the patients' medical care and in most ICUs, this physician decides about patient admission to the ICU. A difference between ICU shift leaders' decision-making has been reported as the physicians' decision-making related more to patient care when compared to charge nurses' decision-making, which to a great extent was associated with the allocation of resources [8–10].

Information needs related to care coordination concern for example information about the number of incoming patients [8, 9], available material resources [8–10], staff educational background [9, 11], staff experience and critical care skills [9, 11, 12], staffing and skill mix [9, 11, 12], patients and care needs [8–13], and availability of supporting resources [9].

Lundgrén-Laine et al. [9] divided shift leaders' information needs into six dimensions: patient admission, organization and management of work, allocation of staff resources, allocation of material resources, special treatments and patient discharge. They found 57 most crucial information needs for shift leaders and more than one third (22/57) of these were shared between charge nurses and physicians in charge. Furthermore, Lundgrén-Laine et al. [14] compared ICU charge nurses' information needs in Finland and Greece, and found 20 most important information needs that were shared. Most of these (13/20) were staff-related and patient-related connected to the organization and management of work.

1.2   Shift Leaders' Information Management

In user studies, according to Wilson [15], information seeking behavior can be described as starting with an information user who has an information need, which launches an information seeking behavior. The information may be a fact, an advice or an opinion, which may take documented or oral form.

Charge nurses have been found to collect data from several information sources to support their decision-making [8, 16]. Gurses et al. [17] found the existing technology to be insufficient in supporting charge nurses' information needs and hence clinicians assembled paper-based information tools. Further, Lundgrén-Laine et al. [9] found that charge nurses manually updated their information tools several times during a shift. Nonetheless, several information sources are also used by physicians and information systems have shown the potential to reduce the time used for care coordination related information management [18].

Reddy et al. [19] described the importance of the multidisciplinary team members' understanding of the ICU work rhythms as part of a collaborative information seeking behavior to obtain information at the right time when it was needed, not before and not after. Shared information seeking of multidisciplinary ICU teams has also been reported by Gorman and colleagues [20]. Already at that time, they acknowledged a need for digital information management tools to support decision-making.

ICU shift leaders need a vast amount of information and therefore good information management is essential. Furthermore, the format in which information is presented has an effect on both nurses' and physicians' work in the ICU [21]. Effective synthesizing of information can improve communication and decision-making [22] and many information systems have been developed to support decision-making. However, the impact of these systems on managerial decision-making and care processes is yet unclear [4]. The existing body of literature covers to some extent decision-making and information needs in the daily care coordination in the Unites States of America [10, 12], Australia [11, 13], and Europe [7–9, 14]. Research in other countries is needed to verify the generalizability of these findings and to explore possible differences between countries. Yet research exploring ICU shift leaders' sources of information and information management overall is scarce.

1.3   Purpose of the Study

The aim of the study is to explore ICU shift leaders' daily care coordination related information needs and sources of important information. The informants are ICU shift leaders, that is, physicians and nurses in charge, who are responsible for coordinating the daily activities in the ICU during a specific shift. The research questions are:

1. What information do shift leaders need for their immediate decision-making when coordinating care in the ICU and how necessary is this information?
2. What are the sources of the most important information?

2   Methods

2.1   Sample and Setting

This descriptive study was conducted in New Zealand. The study focused on level three ICUs defined by Valentin and Ferdinande [23], to explore information management in the most complex intensive care environments. The ICUs, which were included in the study needed to provide comprehensive care for critically ill adult patients at any time of day, have a designated full-time physician and a senior nurse responsible for the overall management of staff, standards of clinical service provision, and have an academic teaching mission.

All ICUs in New Zealand known by the Intensive Care Nurses Association in New Zealand were contacted and ICUs suiting the inclusion criteria were invited to participate in the study. In total, 29 ICUs were approached from 15 different district health boards. Many Nurse Managers responded to the email but few were from level three ICUs. Five nurse managers from level three ICUs from four district health boards were willing to participate. Two level three ICUs were not interested in participation. The sampling technique was purposive, as the informants needed to have experience of being in charge of daily care coordination in the ICU.

2.2   Data Collection and Analysis

Data were collected in two phases. First, an online survey was used to answer research question one, and second, online interviews were conducted to answer research question two. The interest in phase one lied on the operational decision-making and the order of importance of shift leader's information needs when coordinating care in the ICU. We used a validated questionnaire developed for this purpose by Lundgrén-Laine in 2009. The sources of important information were studied in phase two when the order of importance of the shift leaders' information needs was known.

Data were collected in the first phase with an online questionnaire (Webropol®) between January and May in 2012. The questionnaire was validated in a study by Lundgrén-Laine et al. [9]. It contained seven demographic questions and 122 statements concerning information needed in the decision-making when coordinating care. The scale ranged from 0 (completely unnecessary) to 10 (absolutely necessary). The survey was sent to 95 ICU shift leaders, including charge nurses (N = 61) and physicians in charge (N = 34). The results were used as basis for the interviews in phase two.

Medians were calculated to determine the most important information needs of the respondents. The response rate to the survey was 21 % (n = 20). The medians calculated, provided an order of importance of the information needs. The number of participating physicians remained small (n = 5), and therefore, a larger dispersion between the physicians' important information needs existed in comparison to the charge nurses' information needs. The most important information needs were considered to have a median of 9 and 10 for the charge nurses and a median of 10 for the physicians in charge. This was to ensure that almost all participants considered the information to be absolutely necessary.

Phase two strived to resolve from which sources the most important information is obtained. The data were collected through interviews, which included questions of

background information about the shift leader, the unit, and the responsibility and accountability activities of the shift leaders on the unit. The rest of the interview had a structure derived from the results of the questionnaire and was different for charge nurses and physicians in charge as it was based on their specific information needs.

The interview questions for both groups of shift leaders were determined and pilot tested with six shift leaders, including one physician in charge and five charge nurses from one ICU in Finland. Also, two Webropol® questionnaires were built from interview questions for participants unable or unwilling to participate in an online 'live' interview. After responding to this questionnaire an e-mail exchange occurred between the researcher and the participant containing more detailed information about responses to questions in the questionnaire. These questionnaires were language checked and pilot tested with one charge nurse and one physician in charge. Both pilot tests led to minor changes related to the questionnaire setup and additional instructions.

Interview data were collected between June and November in 2012. Nurse Managers or named coordinators of participating units distributed the information letters concerning the study and links to the survey in their unit. In this way the participants were thought to be able to participate without feeling pressured and employees email addresses remained confidential. Participants were asked to provide an email address at the end of the survey if they were willing to take part in an interview. The interviews were estimated to take 30–40 min and they were conducted by the researcher through software allowing communication through voice, video and writing on the Internet such as Skype®, Connect Pro® and email.

Data collected with interviews were analyzed with thematic content analysis. Content analysis is concerned with more than just counting as it considers meanings and context as well [24]. A concept map was used to facilitate understanding of the whole information management process. Graneheim's and Lundman's [25] work guided the content analysis. Data was first read through to get an idea of the whole data set. Then similar expressions were put together into sub categories. After this, upper categories were formed of sources that were similar and finally main categories were defined. Interview data of physicians and nurses were analyzed separately but the results are presented together due to the small sample size.

2.3   Ethical Review and Organizational Permissions

The need for ethical approval was reviewed by the national coordinator of ethics committees at the Ministry of Health in New Zealand based on the Ethical Guidelines for Observational Studies (National Ethics Advisory Committee 2012) in New Zealand. As the nature of the study was observational and posed only minimal risk to participants, no further evaluation by the national ethics committee was needed. Institutional research approval was applied from all organizations participating in the study.

3   Results

The response rate of the survey was 25 % (n = 15) for charge nurses and 15 % (n = 5) for physicians in charge. All ICUs were mixed units, treating both surgical and medical patients. The mean age of survey participants was 47 years. Six informants were men

and fourteen were women. Their mean working experience in intensive care was 18 years, with a variation from 7 to 30 years. Seventeen of the informants worked as a shift leader more than three times a week. One informant worked as shift leader on average once a week and two worked two to three times a month. Nine shift leaders, including charge nurses (n = 7) and physicians in charge (n = 2), agreed to an interview. Shift leaders were interviewed from all five ICUs that participated in the study.

3.1 Activities of Shift Leaders

The shift leaders were responsible for ensuring safe and fluent care processes during their shift. Charge nurses and physicians in charge had different responsibilities but some managerial activities were similar, such as supporting staff and allocating work. Charge nurses reported more activities related to the organization and management of work when compared to the physicians in charge who reported more activities related to the patients' care. The shift leaders' responsibilities mainly concerned short-term decision-making and daily care coordination, however, some decisions influenced a longer-term time period continuing beyond the ongoing shift, such as quality assessment of delivered care and professional development. The shift leaders worked closely together to ensure good communication, to improve exchange of information and to ensure a fluent flow of care processes and patient transfers. Examples of the daily care coordination related responsibilities of shift leaders in the ICU are described in Table 1.

Table 1. Examples of activities of shift leaders in the daily care coordination in the ICU.

Charge nurses	Physicians in charge
• Maintaining daily rosters, allocating patients to nurses, and arranging nurse staffing • Updating information, such as the on call list, the allocation list, the development requirements, the clinical skills list, and keeping the patient acuity electronic database up to date to reflect true staffing needs • Coordinating patient movement through the unit with the operating theatre, the emergency department and the wards • Contacting wards and units for the transfer of patients • Contacting allied health teams and other services • Supporting staff nurses • Monitoring care delivery • Ensuring appropriate patient isolations • Managing maintenance and equipment • Dealing with adverse events and complaints	• Allocating tasks to doctors • Deciding on responsible persons for special services • Mentoring and supervising junior doctors • Managing resources and clarifying available nursing recourses with the charge nurse • Overseeing the daily management of all the patients on the unit • Triaging patients on the phone • Assessing referred patients • Deciding what to do if there are insufficient resources to care for all patients in need of intensive care • Following up the patients that have been discharged during the last few days • Liaising with other hospitals about patients, deciding patient transportations and coordinating transportations within and outside of the hospital • Communicating with patient's families'

Charge nurses key tasks included provision of professional clinical leadership, ensuring delivery of high quality patient care, demonstrating professional nursing leadership and promoting nursing. They were also responsible for the professional development on the unit and accountable for staff. An important part of their work was to communicate with all nurses as well as with the whole multidisciplinary team in the unit and beyond.

The main responsibilities and accountability activities of the physicians in charge concerned the patients' medical care. However, activities related to the organization and management of work were also reported. This included for example prioritizing and planning for care of the day and bed space use, reporting through medical rounds and handoffs, communication with other professionals and units, and ensuring appropriate admissions and discharges. They were further responsible for appropriate documentation and checking the appropriateness of documentation on the patient's 24-h chart and medication chart. Additionally, they ensured that all patients had been reviewed at least once a day and that the appropriate things and treatments had been conducted. They could furthermore have other responsibilities, which were not directly related to the daily care coordination, such as teaching through bedside or formal sessions with registrars and nurses, and attending senior doctors' meetings for things such as quality assessment and auditing staff.

3.2 Information Needs of Shift Leaders

We identified 42 most important information needs of charge nurses and 39 information needs of physicians in charge. Altogether, 60 % (n = 25) of these were shared between the shift leaders. The distribution between the responses concerning the most important information was small even though the number of respondents remained small. There was a difference between the most important information needed by charge nurses and physicians in charge. Both had most important information needs concerning patient admission, organization and management of work, allocation of staff resources, special treatments and discharge. In addition, charge nurses most important information needs included information about allocation of material resources. The shift leaders most important information needs are presented in Table 2.

3.3 Information Sources of Shift Leaders

Seven charge nurses and two physicians in charge were interviewed concerning the sources of the most important information needs. These interviews included shift leaders from all five ICUs. The collected interview data contained about 50 pages (A4) of transcribed text, with an additional estimated number of 80 pages of email communication and email attachments.

Our thematic content analysis of the information sources resulted in four main categories. These were electronic sources, human sources, manual sources and real time events. These sources were located within or outside of the ICU or were based on the shift leaders experience and knowledge. Both charge nurses and physicians in charge used these sources. The information sources are illustrated in Fig. 1.

Table 2. The most important information needs of shift leaders in the daily care coordination.

| Dimension of decision-making	Information need	Charge nurses	Physicians in charge
When a new patient is admitted to the ICU	The number of planned patients	x	x
	The procedures for planned patients	x	x
	The patient's diagnosis		x
	The need to isolate a patient	x	x
	The method of patient isolation	x	x
	The urgency of a patient's condition	x	x
	The patient's name		x
	The patient's earlier physical capacity		x
	The patient's personal identity code		x
	The patient's need for mechanical ventilation	x	x
	The criteria for patient's admission		x
	The emergency operations	x	
Organization and management of work	Staff absence due to sickness	x	
	New patients admitted to ICU	x	x
	New patients presented for admission to ICU	x	x
	The reasons why a patient was refused admission to ICU		x
	Removal of a patient from isolation		x
	Workloads at the unit	x	
	Compulsory infection samples	x	x
	Special treatments given to patients	x	x
	Patient medications that require intensive monitoring	x	x
	A significant change in the patient's condition during one's shift	x	x
	Number of patients on the unit	x	x
	Scheduled examinations that will require patient transfer	x	
	Complications arising during intensive care	x	x
	Adjustments made to equipment supporting a patient's vital functions	x	x
	A patient's death	x	x
	Staff skills and knowledge	x	
	Nursing staff skill mixes	x	
	A patient's allergy	x	x
	Dosages of medications that require intensive monitoring	x	x
	Infusion rate for patient medications that require intensive monitoring		x

(Continued)

Table 2. (*Continued*)

Dimension of decision-making	Information need	Charge nurses	Physicians in charge
	Changes in patient medications that require intensive monitoring		x
	Start time of patient hydration that requires intensive monitoring		x
	Imaging results		x
	Complications related to the patient's diagnosis	x	x
	A patient's intensive care diagnosis/diagnoses	x	x
	Procedures in case of adverse events		x
	Nurse in charge		x
	Physician in charge		
Allocation of staff resources	Number of nursing staff per patient	x	
	Staff resources that can be released	x	
	Staffing for scheduled rosters	x	
	Skill mix on current shift	x	x
	Staffing level on current shift	x	x
	Staff roster changes	x	
	Backup staff	x	
Special treatments	Special treatments	x	x
	Scheduled dates for surgery or procedures	x	
Allocation of material resources	Products needed for special treatments	x	
	Vacant beds on the unit	x	
When a patient is discharged from the ICU	Transport cancellations	x	x
	A patient being discharged	x	
	A patient's time of discharge	x	
	The planned time of transport	x	x
	The family members have been notified of transfer	x	

Shift leaders combined information from several sources to support their decision-making in the daily care coordination. Some information only existed as knowledge in memory or was based on experience. Charge nurses could assemble important information on their own report sheet, which was constructed based on the ICU bed spaces. This sheet had room for notes for all patients including details concerning vital organ function and need for vital organ support. It further included information concerning staffing, patient flow and important phone numbers. This sheet was manually updated several times during the shift.

Information management problems were caused by wrongly documented information, inaccurate information, missing information, a vast amount of informal information, forgotten information, misplaced information and difficulty with information

Table 3. The sources of shift leaders' important information in the daily care coordination.

Main information source	Information system	Examples
Electronic sources	Care related information systems	Allergy alert system, early warning score system, electronic patient management system, infection alert system, patient database, patient information systems, picture archiving and communication system
	Communication systems	Alert system, electronic event form, email, email bookings, internet, intranet, personal computer, senior nurses drive
	Resource allocation systems	Bed management system, computer program
	Staff allocation systems	Nursing workload tool, patient acuity system, payroll system, roster, workload measurement tool
Human sources	Individuals	Family, nurse (e.g. bedside nurse, charge nurse, ward nurse), other health professional (e.g. pharmacist, receptionist), patient, physician (e.g. physician in charge, surgeon)
	Teams	Bed meeting, infection prevention and control team, medical team, senior nurses meeting, patient at risk service, referring team, retrieval team
Manual sources	Communication boards	Pin board at bed space, unit pin board, whiteboard, charge nurses' book
	Management books	Admissions book, clinical allocations book, diary, roster, record of mandatory competencies, calendar for education, staff request book, staffing book, staffing sheet
	Manuals	Charge nurses' manual, clinical pathway, drug manual, guidelines, handover folder, incidents manual, standard policies
	Notes	Admission notes, charge nurse's notes, charge nurses reporting sheet, competency list, staff skills list, own notes, patient list, sheet of paper, staffing sheet
	Patient documentation	Patient chart, medical records, medical prescriptions, medical alert bracelets, treatment prescription chart, care plan
Real time events	A sudden observation	Alarm sign, assistance bell, examination of patient, intercom, observing care equipment, visual sighting
	Planned rounds	Charge nurse round, coordinator round, medical round, routine screening, ward round
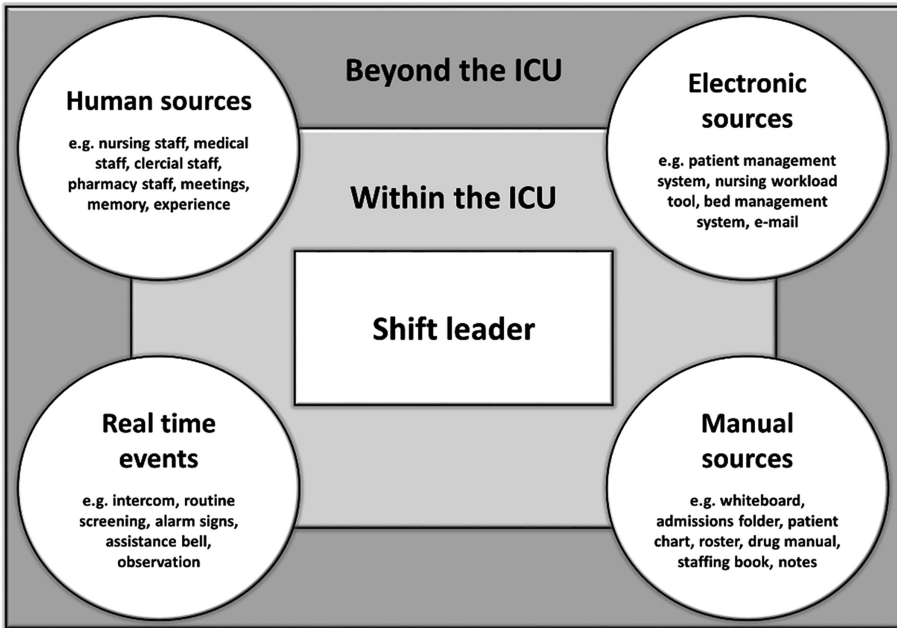
Fig. 1. Information sources of ICU shift leaders in the daily care coordination.

technologies. A need for more accurate information and improvements in information management was recognized. The sources of important information are presented in Table 3.

4   Discussion

The aim of the study was to explore ICU shift leaders' daily care coordination related information needs and sources of important information. The findings are the following. Charge nurses and physicians in charge reported different responsibilities but some managerial activities were similar between charge nurses and physicians in charge. These included allocating work, supporting staff, ensuring quality of care, liaising with others and managing patient flow. The differences were related to the management of material resources, which seemed to only concern the charge nurses, whilst patient medical care related decisions only concerned the physicians in charge. The shift leaders' responsibilities mainly concerned short-term decision-making in care coordination, however, some decisions influenced a longer time period continuing beyond the ongoing shift. This is a new aspect when compared to similar research conducted in Europe [7] and in the United States of America (USA) [10]. Further, charge nurses and physicians in charge shared a great deal (60 %) of important information and they used a variety of information sources to obtain this information to support their decision-making. Used information sources were electronic sources, human sources, manual sources and real time events. The sources were located within or outside of the ICU or were based on the shift leaders experience and knowledge.

The charge nurses' important information needs concerned all six decision-making dimensions whilst physicians in charge had information needs concerning five dimensions, all except the allocation of material resources. This is different when compared to research conducted in Finland [9], where the physicians' information needs only concerned three out of six dimensions, and Greece [14] where charge nurses' information needs concerned five out of six dimensions. In our study, most of the shift leaders' important information needs concerned the organization and management of work. Similar findings were reported in Finland and Greece for charge nurses but not for physicians in charge [9, 14]. The differences in our findings of physicians' information needs may be explained by the small sample size. However, it is clear that charge nurses and physicians in charge have differing information needs, therefore, they would benefit from flexible information management tools that are developed based on their specific information needs.

On the other hand, ICU shift leaders' activities and specific information needs seem alike in different countries. When compared to research conducted in Europe, charge nurses in New Zealand shared 16 out of the 20 most important information needs with charge nurses from Finland and Greece [14]. Further, charge nurses and physicians in charge in New Zealand shared 41 out of the 57 most important information needs with shift leaders from Finland [9].

The most necessary information needed by the ICU shift leaders in daily care coordination was obtained from several sources in different locations. These findings are in line with the work of Wilson [15] concerning user studies. However, in our study the shift leaders additionally obtained important information from real-time events. This new finding should be acknowledged when developing shift leaders' information management. Further, as the ICU shift leaders' information needs and information sources reach beyond their own unit, it seems logic to have a shared situational awareness in the whole care process of the critically ill and not only within the ICU.

Shift leaders reported difficulties with obtaining needed information. Problems with information management might be explained by information systems that do not support shift leaders' information management in daily care coordination related decision-making. Therefore, shift leaders use for example different manual reporting sheets, which they update several times a day with information collected from various sources. Similar findings have been reported both in the USA [17] and in Europe [9]. Generating and updating manual information tools is time consuming [17] and the accuracy of information can be jeopardized as for example information transcription errors may occur. Furthermore, the impact of these tools on care coordination related decision-making is difficult to assess later on as these tools are disposed after use.

Based on the findings of this study, shift leaders' information management is multifaceted and seems to be similar in developed countries in different parts of the world. To date, shift leaders struggle with obtaining necessary information to support their daily care coordination related decision-making. Their need for improved information management is apparent. Shift leaders would benefit from real-time information concerning their most important information needs with easy access and an advanced visualization.

4.1   Limitations

The biggest weakness of the study is the small number of participants. Hence, the results are not generalizable. This study still describes the information sources of the most important information, and even though the results are not conclusive, they provide information of seven intensive care shift leaders' sources of most important information from five different ICUs in different geographical locations in New Zealand on the north and south islands. The participating units also varied in size from small to large and the participants' characteristics varied concerning age, sex, years of working experience and number of days per month when working as shift leader. Therefore, the participants represented a wide range of shift leaders. The internal validity of the questionnaire has been good in a previous study [9] and the interview questions were pilot tested beforehand. Also the questionnaire was pilot tested and language checked before use.

4.2   Significance of Research

The results of this study can be used in further research to improve information management related to the daily care coordination in ICUs. This study provides novel information about the sources of the most important information of shift leaders to be used in the development of information systems to support shift leaders' information management and improve care coordination in the ICU. The study also provides confirmation about similarities of daily care coordination related information management in the ICU in different countries across the globe.

In the future, a larger sample size is needed to validate the preliminary findings of this study. Furthermore, research should be extended to explore shift leaders' information management in the whole critical care setting and beyond, because the development of information and communication technology has the potential to improve care coordination.

5   Conclusions

Charge nurses and physicians in charge have different decision-making responsibilities when coordinating daily care in the ICU and their information needs differ. However, joint managerial activities and information needs also exist, and it seems that at least charge nurses' information needs are alike in different countries. As charge nurses and physicians in charge have differing information needs they can benefit from flexible information management tools developed based on these specific needs. Information systems that support care coordination related decision-making with real-time information are needed and these should be flexible enough to fulfil multidisciplinary demands.

Shift leaders use diverse information sources, which can be categorized into electronic sources, human sources, manual sources and real-time events. As shift leaders' sources of the most important information are located both within the ICU and beyond they could benefit from a shared situational awareness with a hospital-wide

information management approach to the care process of the critically ill. Further, information system development and implementation processes should acknowledge shift leaders' information needs regardless of the source of this information.

References

1. Moreno, R.P., Singer, B., Rhodes, A.: What is an ICU? In: Flaatten, H., Moreno, R.P., Putensen, C., Rhodes, A. (eds.) Organisation and Management of Intensive Care, pp. 7–14. Medizinisch Wissenschaftliche Verlagsgesellschaft, Berlin (2010)
2. Winter, A.F., Ammenwerth, E., Bott, O.J., Brigl, B., Buchauer, A., Gräber, S., Grant, A., Häber, A., Hasselbring, W., Haux, R., Heinrich, A., Janssen, H., Kock, I., Penger, O.S., Prokosch, H.U., Terstappen, A., Winter, A.: Strategic information management plans: the basis for systematic information management in hospitals. Int. J. Med. Inform. **64**(2–3), 99–109 (2001)
3. Winter, A., Haux, R., Ammenwerth, E., Brigl, B., Hellrung, N., Jahn, F.: Health Information Systems: Architectures and Strategies, 2nd edn. Springer, New York (2011)
4. Murtola, L.-M., Lundgrén-Laine, H., Salanterä, S.: Information systems in hospitals: a review article from a nursing management perspective. IJNVO **13**(1), 81–100 (2013)
5. McDonald, K.M., Sundaram, V., Bravata, D.M., Lewis, R., Lin, N., Kraft, S., McKinnon, M., Paguntalan, H., Owens, D.K.: Care coordination. In: Shojania, K.G., McDonald, K.M., Wachter, R.M., Owens, D.K. (eds.) Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies, vol. 7. Technical Review 9 (Prepared by the Stanford University-UCSF Evidence-based Practice Center under contract 290-02-0017). AHRQ Publication No. 04(07)-0051-7. Agency for Healthcare Research and Quality, Rockville (2007)
6. Lundgrén-Laine, H., Salanterä, S.: Think-aloud technique and protocol analysis in clinical decision-making research. QHR **20**(4), 565–575 (2010)
7. Lundgrén-Laine, H., Kontio, E., Perttilä, J., Korvenranta, H., Forsström, J., Salanterä, S.: Managing daily intensive care activities: an observational study concerning ad hoc decision making of charge nurses and intensivists. Nurs. Crit. Care. **15**(4), R188 (2011)
8. Lundgrén-Laine, H., Suominen, H., Kontio, E., Salanterä, S.: Intensive care admission and discharge-critical decision-making points. Stud. Health Technol. Inform. **146**, 358–361 (2009)
9. Lundgrén-Laine, H., Kontio, E., Kauko, T., Korvenranta, H., Forsström, J., Salanterä, S.: National survey focusing on the crucial information needs of intensive care charge nurses and intensivists: same goal, different demands. BMC Med. Inform. Decis. Mak. **13**, 15 (2013)
10. Miller, A., Weinger, M.B., Buerhaus, P., Dietrich, M.S.: Care coordination in intensive care units: communicating across information spaces. Hum. Factors **52**(2), 147–161 (2010)
11. Rischbieth, A.: Matching nurse skill with patient acuity in the intensive care units: a risk management mandate. JNM **14**, 379–404 (2006)
12. Eschiti, V., Hamilton, P.: Off-peak nurse staffing: critical-care nurses speak. DCCN **30**(1), 62–69 (2011)

13. Miller, A., Scheinkestel, C., Joseph, M.: Coordination and continuity of intensive care unit patient care. Hum. Factors: J. Hum. Factors Ergon. Soc. **51**(3), 354–367 (2009)
14. Lundgrén-Laine, H., Kalafati, M., Kontio, E., Kauko, T., Salanterä, S.: Crucial information needs of ICU charge nurses in Finland and Greece. Nurs. Crit. Care **18**(3), 142–153 (2013)
15. Wilson, T.D.: On user studies and information needs. J. Doc. **37**(1), 3–15 (1981)
16. Connelly, L.M., Yoder, L.H., Miner-Williams, D.: A qualitative study of charge nurse competencies. Medsurg. Nurs. **12**(5), 298–306 (2003)
17. Gurses, A.P., Xiao, Y., Hu, P.: User designed information tools to support communication and care coordination in a trauma hospital. J. Biomed. Inform. **42**, 667–677 (2009)
18. Carayon, P., Wetterneck, T.B., Alyousef, B., Brown, R.L., Cartmill, R.S., McGuire, K., Hoonakker, P.L., Slagle, J., Van Roy, K.S., Walker, J.M., Weinger, M.B., Xie, A., Wood, K.E.: Impact of electronic health record technology on the work and workflow of physicians in the intensive care unit. Int. J. Med. Inform. **84**(8), 578–594 (2015)
19. Reddy, M., Pratt, W., Dourish, P., Shabot, M.: Asking questions: information needs in a surgical intensive care unit. In: Proceedings of AMIA Fall Symposium (AMIA 2002), San Antonio, TX, pp. 651–655 (2002)
20. Gorman, P., Ash, J., Lavelle, M., Lyman, J., Delcambre, L., Maier, D., Weaver, M., Bowers, S.: Bundles in the wild: managing information to solve problems and maintain situation awareness. Libr. Trends **49**(2), 266–289 (2000)
21. Miller, A., Scheinkestel, C., Steele, C.: The effects of clinical information on physicians and nurses' decision–making in ICU´s. Appl. Ergon. **40**, 753–761 (2009)
22. Feblowitz, J.C., Wright, A., Singh, H., Samal, L., Sittig, D.F.: Summarisation of clinical information: a conceptual model. J. Biomed. Inform. **44**(4), 688–699 (2011)
23. Valentin, A., Ferdinande, P.: ESICM working group on quality improvement. recommendations on basic requirements for intensive care units: structural and organizational aspects. Intensive Care Med. **37**(10), 1575–1587 (2011)
24. Burns, N., Grove, S.K.: The Practice of Nursing Research: Appraisal, Synthesis and Generation of Evidence, 6th edn. Saunders Elsevier, St. Louis (2009)
25. Graneheim, U.H., Lundman, B.: Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ. Today **24**(2), 105–112 (2004)