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Identification of tele-ICU system requirements using a content validity assessment

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ABSTRACT

Objectives: Telemedicine in intensive care (tele-ICU) involves the use of information technologies to deliver care instructions from a command center to remote hospitals. To ensure acceptance and usability, clinicians should participate early in the design. This study surveyed clinical professionals to identify and rank important functions for a tele-ICU system.
Methods: This cross-sectional, prospective, structured, two-round survey included European intensive-care professionals that were not familiar with tele-ICU systems. In the first round, statements of system function specifications were evaluated for validity; in the second round, unclear items were rephrased and new items were added. Item-level content validity indexes (I-CVI) were calculated, and values above a 0.75 threshold were considered relevant. Weighted ranking points (WRP) was calculated from the ranking data.
Results: A total of 26 responses were received from professionals for four European countries; the majority were intensive-care specialists (77%). A total set of 50 items were selected for the survey. Thirty-six functional specifications were identified with I-CVIs above 0.75, including online access to all patient data (13 items), related risks and alarms (8 items), audio-visual contact for consultations and for monitoring patient beds (5 items), information security (5 items), and resource allocation (5 items). The highest ranking system functions were real time monitoring, alarms, audio-visual connections, and data security.
Conclusions: Professionals not familiar with tele-ICUs regarded full patient data access, alarms, data security, and audio-visual connections the most important functions in pre-implementation phase.

1. Introduction

Intensive Care is defined as care for patients with one or more acutely threatened or disturbed vital functions (eg. acute respiratory failure, severe sepsis, acute renal failure) [1] (Valentin A ICM 2011). These critically ill patients depend on pharmacological and device-related organ support as well as continuous monitoring. Intensive care is provided by a dedicated Intensive care unit, trained medical specialists and specialized nurses. Telemedicine in intensive care (tele-ICU) can enable a team of telemedicine-intensivists and telemedicine-nurses to aid and monitor multiple, remote intensive care units (ICUs) through a system that provides online access to relevant patient data and communications with on-site personnel and patients [2]. tele-ICU is a new technical platform to create an ICU-cockpit by integrating data from different Patient Data Management systems in remote ICUs thus an overview is given over medical conditions of many ICU-patients and locations in remote ICUs. Telemedicine can provide quality care to remote locations, where expert knowledge is not easily acquired or maintained.

Studies have shown that tele-ICU systems could reduce ICU mortality and shorten the length of stay [2–5]. These improvements were particularly large in hospitals that had problems acquiring ICU-specialists and had low-level baseline performance; in contrast, ICUs with ample resources did not show significant improvements [6]. However, one study conducted in an academic hospital showed that tele-ICU improved the existing traditional approaches [7]. Several studies also suggested that implementing a tele-ICU system could be cost-effective [8–10].

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Table 1
Demographic data for 26 respondents in the first-round survey on tele-ICU system requirements.

Demographic	*n* (%)
Gender	
Male	19 (73%)
Education	
MD/intensivist	20 (77%)
Nurse	6 (23%)
ICU work experience	
0–	2 (8%)
6–	5 (19%)
11–	13 (50%)
21+ years	6 (23%)
Nationality	
Finland	7 (27%)
Germany	6 (23%)
Netherlands	5 (19%)
Spain	8 (31%)
ICU size	
1–	3 (12%)
9–	2 (8%)
12–	3 (12%)
25+ beds	18 (69%)
Hospital type	
University referral teaching hospital	22 (85%)
Non-university referral hospital	1 (4%)
Non–university central hospital	2 (8%)
Cancer center	1 (4%)
Information systems (electronic/digital)	
Medical record	18 (69)
Intensive care information system/patient data management system	21 (81)
Lab result system	22 (85)
Radiological image viewing system	23 (88)
Other	1 (4)

Clinicians should participate early in the design and implementation of tele-ICU systems to ensure that the system is suited to their needs [3]. Staff acceptance of tele-ICU systems have generally been high, but some concerns have been discovered, particularly prior to implementation, due to a lack of information or unclear protocols and a fear of being monitored [6]. After implementation, there may be conflicts when the protocols and roles are not clear between the tele-ICU personnel and the on-site personnel. However, most studies have suggested that, in practice, most individuals tend to relate favorably to tele-ICUs [3,6].

About 11% of ICUs use telemedicine in the US [11] however, there are few published studies on European implementations. A need has been identified to find a suitable tele-ICU solution to fit European healthcare environments. Its goal would be to facilitate multinational data-analysis and improve evidence-based decision making and quality of treatment. To meet this need, the Thalea-project (www.thalea-pcp.eu) was initiated. The project aims at those ICUs that already use patient data management systems (PDMS). Core functionality is providing a data integration service that will be able to transform various data formats received from different subsystems (PDMS, electronic health records) into one central data format This is essential for data presentation at tele-ICU but in addition a common data format could also enable European wide treatment result analysis and benchmarking. The system is planned as a complementary additional layer to extend the existing local system environment. The project aims to develop a suitable tele-ICU system with a pre-commercial procurement method (http://ec.europa.eu/digital-agenda/en/pre-commercial-procurement) which shares the risks and benefits between procurers and suppliers.

In this study data was acquired solely from clinical professionals as to find out an end user opinion of the system requirements. This study aimed to identify and rank important functions for a tele-ICU system, which could guide system procurement and specifications.

2. Methods

2.1. Design

This study was conducted as a cross-sectional, prospective, structured survey, between January and March, 2014. The target

Table 2
Single-patient-level tele-ICU system functions, ranked according to the item-level content validity index (I-CVI) and weighted ranking points (WRP). Data are presented in order of descending I-CVI values.

id	Patient level	I-CVI (rank)	WRP (rank)
2.1	A curve history and numerical values of all relevant measurements should be presented by the system	1.00 (3.5)	220 (3)
2.2	Patients' laboratory results should be available directly in the system	1.00 (3.5)	160 (5)
2.3	Radiological images should be directly accessible from the system	1.00 (3.5)	30 (15.5)
2.4	The system should display clinical notification alarms (prolonged anti-microbial medication, positive microbiological findings, delirium risk, sepsis criteria)	1.00 (3.5)	80 (11)
2.5	Risks (e.g., transmitting infections, allergies, anti-coagulation therapy, DNAR) associated with the patient should be clearly visible	1.00 (3.5)	140 (6)
2.6	System should display all patient medication and drug infusion rates	1.00 (3.5)	210 (4)
2.7	System should show basic monitoring values online in real time[a]	0.96 (7)	640 (1)
2.8	Trends for all relevant measurements should be visualized by the system	0.96 (8.5)	450 (2)
2.9	Patients' clinical records should be available in the system	0.96 (8.5)	130 (7.5)
2.10	The system should display ventilator settings	0.92 (11)	30 (15.5)
2.11	The system should display fluid infusion rates and urine output	0.92 (11)	10 (17)
2.12	The system should display basic alarms (e.g., RR, HR, BP, SatO2)	0.92 (11)	100 (9.5)
2.13	System should show advanced monitoring values[b]	0.92 (13.5)	50 (14)
2.14	The system should support monitoring for advanced care such as ECMO and CRRT	0.92 (13.5)	0 (19)
2.15	The system should display advanced monitoring alarms (eg., cardiac output, ischemia and rhythm analysis, CPP)	0.88 (15)	60 (12.5)
2.16	Each unit/hospital should be able to create custom alarms according to their needs	0.83 (16)	130 (9.5)
2.17	A calculated severity scoring (e.g., SOFA, SAPS II, APACHE II-IV) should be presented	0.81 (17.5)	0 (19)
2.18	The system should identify treatment protocol violations	0.81 (17,5)	60 (9)
2.19	Audio-visual connections from remote devices to individual patient beds should be supported	0.79 (19)	100 (12,5)
2.20	It should be shown when discharge criteria has been met, and the patient can be transferred from the ICU	0.54 (20)	0 (19)

[a] Non invasive or invasive blood pressure, ECG, SpO2, Temperature, Central venous pressure.
[b] Pulmonary artery pressures, Cardiac output, Intracranial pressure, EEG.