Readiness Assessment of Tele-ICU implementation in Technical and Human Aspects in Teaching Hospitals with ICUs Affiliated to Isfahan University of Medical Sciences in 2015

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Abstract
Tele-ICU is a solution to shortage of intensive care specialists providing simultaneously health care services in several ICUs. The study aimed to determine readiness of Tele-ICU implementation in technical and human aspects in teaching hospitals affiliated to Isfahan University of Medical Sciences (IUMS).
This research was a descriptive analytical study. Samples included 16 anesthesiologists and 120 nurses having experience in ICU, that were chosen through convenient sampling. This method was not conducted for information technology (IT) officials due to their society limitations, and census was performed, instead. For data gathering, questionnaires and checklists were used. Content and face validity were confirmed by IUMS health information technology (HIT) and computer professors. The average correlation reliability coefficient for physicians-nurses and IT officers questionnaires were 0.93 and 0.96, respectively. Technical checklists were completed through researcher's direct observation. Collected data were analyzed using descriptive statistics (frequency, mean, percentage) and inferential statistics methods (t-test, ANOVA) by SPSS software.

Given infrastructure-hardware facilities, technical readiness were assessed as moderate (mean positive responses was 54.7%). The level of knowledge was measured with seven questions, and third quartile (above 75%) of correct answers was considered as desired knowledge that included 56.6 % of samples. The problems and barriers of implementation of this project from the perspective of samples were found to be "high cost to set up and resources constraints" as main obstacle to set up tele-ICU with 65.2%.

Improving technical infrastructures, developing comprehensive strategic plan and the deployment of tele-ICU standards and creating electronic record, organizing training courses to raise knowledge and promote culture of applying tele-technologies are recommended.

Keywords: Tele ICU, HIT, Teaching Hospital, Implementation, Technical and Human Dimensions

Introduction

One of the most important events related to technology in the late twentieth century has been simultaneity of human growth and emergence of telecommunications. Telemedicine as one of the means of telecommunication, deals with the use of technology in the treatment field to improve care (Nezamzade and Saghafi 2011). Providing telemedicine services actually involves high scope concepts in communications technology and medical services. These concepts are so comprehensive that telemedicine is deemed as a culture in employing communication notions' features in order to present health care and remedial services rather than a mere service (Oh et al. 2005).

ICU is one of the specialized wards at a hospital that require specific facilities, employing sub-specialist and specialist physicians and nurses with special skills, and patients with critical conditions due to acute and dangerous illnesses whether outside the hospital or other wards in-patients, needing hospitalization and care. Because of the limited number of intensive care beds, ICU has a special position among the hospital wards, and it is always in a state of emergency situation (Goran 2010).

In the current circumstances, intensive care is in high demand. Several major factors are involved together in the demand including increasing aged population requiring more intensive care services, rising trauma-caused injuries, decreasing the number of available specialists for the provision of such services (Wood 2011), as well as predictable retirement trend of healthcare staff in the next decade, that will face intensive care units with more problems (Dracup and Bryan-Brown 2004).

Totally, there are 291 beds in ICU wards in Iran. Published statistics shows that currently there is 1.6 ICU bed per one hundred thousand of population in public and private hospitals, and ICU bed Gini coefficient is 0.17 In Iran (Montazeri et al. 2015). Now, a patient hospitalized in ICU, cardiac ICU and liver transplant patient require 18, 24 and 28-30 hours during 24 hours, respectively. However, the number of nurses per hospital bed is less than one. Sub-specialized field of intensive care is a new discipline whose students were accepted in 2005 in three universities for the first time in Iran. In 2007, the first graduates were employed. At present, out of 80 graduates of this field, 45 graduates are working in ICU.

The abilities of organizations providing health care services in order to improve patient safety are seriously compromised by shortage of physicians and nurses (Goran 2012). Shortage of ICU nurses can increase the risk of pneumonia and re-intubation, rise length of stay in hospital and increase rates of medical complaints and medication errors. Medical staff in ICU work environment are continuously affected by distracting factors such as a constant warning signs leading to fatigue that will increase the likelihood of errors (Goran 2010).

Healthcare organizations are required to continuously develop new strategies to meet the complex challenges of available resources and quality of care in intensive care units (Goran 2010). Labor force shortage and rising demand for services cause hospitals to seek innovative strategies to improve in-patient care (Goran 2012). Providing proper service to patients hospitalized in intensive care units involves developing resources; especially trained personnel and full-defined processes to ensure that all tasks are done correctly and in a timely manner (Breslow 2007).

In such situations where medical resources and expertise are limited, telemedicine can be the perfect solution for related problems. Traditionally, one of the problems in providing equitable access to health care was physically obligatory attendance of physician and patient in an individual place, but new developments in information and communication technologies have provided unique opportunities to overcome this problem. As a result of this communicational progress, telemedicine has improved management of emergency situations, ensured quality care services, supervision and training of health care providers (Hashemi 2010).

Telemedicine is one of the important and applied branches of medicine. Terms such as tele-ICU, virtual ICU, remote ICU and electronic ICU share the same concept. They consist of central ICU outside the hospital, connected with hospital ICU by IT and communication systems with audio and video facilities and computer equipment remotely. The central intensive care team can monitor and provide support multiple hospital ICU centers that are located in geographically dispersed areas (Goran 2010).

Tele-ICU is employed as a solution in order to compensate for the lack of specialists for patients needing special care provided from a remote place simultaneously for multiple patients in intensive care units (Franzini et al. 2011). A number of studies show improvement in therapeutic processes and quality of care, as well as reduced mortality and length of stay in ICU ward (Blanch et al. 2013).

In a study conducted on 6290 patients admitted to seven tele-ICU centers in the U.S, It has been shown that using tele-ICU has certain clinical therapeutic benefits. This study was performed in seven ICUs including three internal ICUs, three surgery ICUs and one cardiovascular ICU, indicating mortality rate reduction from 13.6% to 11.8%, and decreased hospital stay length from 13.3 to 9.8 days (Leonard et al. 2004).

Considering the experiences of the leading countries in using this technology, as well as the current needs of the country, it is necessary to identify required facilities and the strengths and weaknesses of health care centers having ICU in Isfahan in order to solve problems and improve quality of health care providing services. Readiness assessment is a tool and systematic process, and a scale assessing development capabilities and the risk associated with a technology (Rama 2013).

Therefore, the study aimed to determine the technical and infrastructure preparedness needed to implement tele-ICU and to assess the readiness of physicians and nurses working in ICU and to recognize obstacles in implementing tele-ICU from the viewpoints of physicians, nurses and IT officials working at teaching hospitals affiliated to Isfahan University of Medical Sciences.

Materials and Methods

This research was a cross-sectional descriptive-analytical study carried out in 2015. Al-Zahra hospital, having four ICUs, Kashani hospital with two ICUs, Noor and Ali Asghar hospitals having ICU for poisoned patients and internal ICU, Isabne Maryam and Dr. Chamran hospitals

with open heart ICU and Imam Musa Kazim burning hospital having burning ICU in Isfahan were chosen, and the study was conducted in these centers. Using a convenient sampling, the study samples consisted of 16 ICU specialist and 120 registered nurses with job experiences in ICU of educational remedial hospitals in Isfahan. The stratified sampling was used, and for the hospitals' information technology personnel, sampling was not used because the studied population was certain and limited. Instead of using sampling, census was considered.

A checklist and a questionnaire were used for collecting technical data and readiness of staff that the researcher extracted questions after studying the papers related to this field in Iran and other countries, such as studies of Sadoughi et al. (2014) (Survey Of Telepathology Implementation Feasibility in the Teaching Hospitals Affiliated to Tehran University of Medical Sciences), Jebraeili et al. (2010) (Personnel Readiness Assessment: Electronic Health Record), Judi et al. (2009) (Feasibility and Critical Success Factors in Implementing Telemedicine) and enjoying the views of experts in the field. Then, they were prepared based on local hospitals' conditions in the country. Technical checklist consisted of 25 questions in the areas of communications and the internet facilities, the equipment with the capability to share data, protective, security and software backup systems. The staff readiness questionnaire was provided in three parts including a) 37 questions on demographic characteristics (gender, age, job experience, education and workplace), b) 34 questions on assessing the readiness of human forces (including knowledge, skills and attitude), c) 13 questions on obstacles and problems in implementation of tele-ICU from the users' views.

Content-related and face validities were verified by health information technology and computer professors of Isfahan University of Medical Sciences, and reliability was determined by test-retest method. Questionnaires were distributed twice to 20 subjects out of the main sample, with ten day interval. Average correlation reliability coefficient was 0.93 for physicians-nurses' questionnaires and 0.96 for information technology officials' questionnaires. Personnel readiness questionnaire was distributed among physicians and nurses. Also, the questionnaires of obstacles and problems implementation tele-ICU were delivered to information technology officials.

After filling out the questionnaires by statistical population, data were entered through SPSS 22 software, and they were analyzed using descriptive statistics ways including frequency, mean and frequency percent, and inferential statistics including t-test, ANOVA, Friedman and Kendall and Cochran tests.

Results

There were a total of 142 respondents, including 30 males and 112 females. Questionnaires were distributed among 16 physicians, 120 nurses and six hospital information technology engineers. Respondents' age range was 25-56 years with a mean age of 34 years. Respondents' job experience ranged from 1 to 23 years with mean of 8 years. Findings from the collection of technical checklists indicated that the highest amount of feasibility of tele-ICU implementation technically was provided with a computer expert, network connected to internet with bandwidth of at least 500 kilo bits per second and a closed circuit TV with resolution of 640×480 and emergency electricity generator. Backup files were provided on the basis of a policy and formulated executive method in determined intervals. Online updating of antivirus softwares was performed, and remote access to all hospitals' ICU computer systems was possible.

Table 1:
Frequency of Technical Readiness for Tele-ICU Implementation

No.		Yes		No	
		Frequency	**Percent**	**Frequency**	**Percent**
	Technical Facilities				
1	Computer engineer is available at hospital	6	100	0	0
2	Network and telecommunication specialists are available	6	100	0	0
3	Hospital has a Local Area Network (LAN)	6	100	0	0
3-1	Hospital network is connected to the internet	6	100	0	0
3-2	Internet bandwidth of department is at least 500 kbps	6	100	0	0
3-3	Backup system to connect to the Internet via Dial up back up is possible	1	16.7	5	83.3
4	The hospital has direct phone line	5	83.3	1	16.7
5	Hospital has CCTV system	6	100	0	0
5-1	Each bed at intensive care unit is equipped with camera	3	50	3	50
5-2	The hospital is equipped with a CCTV with resolution of, at least, 480 x 640 at 30 frames per second	6	100	0	0
5-3	IP Base Camera is available	0	0	6	100
6	Hospital uses generator for emergency electricity	6	100	0	0
6-1	ICU uses generator for emergency electricity	6	100	0	0
7	Very important computers such as hospital servers use UPS at outage time	4	66.7	2	33.3
8	ICU computer uses UPS at outage time	1	16.7	5	83.3
9	Vital medical equipment (monitoring, ventilators, pumps) use UPS at outage time	3	50	3	50
10	Central monitoring system has the capability to share or transfer data to other devices	1	16.7	5	83.3

11	Patients' bed monitors have the capability to share or transfer data to other devices	0	0	6	100
12	Ventilators have the capability to share or transfer warnings to other devices	0	0	6	100
13	Pump syringe has the capability to share or transfer warnings to other devices	0	0	6	100
14	Feeding pumps have the capability to share or transfer warnings to other devices	0	0	6	100
15	Facilities to receive (record) sound in ICU are available	0	0	6	100
16	Facilities to play sound in ICU are available	5	83.3	1	16.7
17	The hospital is equipped with video conferencing system	5	83.3	1	16.7
17-1	ICU is equipped with a video conferencing system	4	66.7	2	33.3
18	Hospital Information System is available	6	100	0	0
18-1	ICU has a Hospital Information System	0	0	6	100
18-2	Hospital Information System has the capability to register medical orders electronically	0	0	6	100
19	PACS is available at hospital	2	33.3	4	66.7
19-1	ICU at hospitals with PACS has access to its data	2	33.3	4	66.7
20	Antivirus server has been set up	5	83.3	1	16.7
20-1	Online updating of anti-virus is performed	6	100	0	0
21	Online updating of security patches is performed	1	16.7	5	83.3
22	Firewall has been installed for hospital's computers	4	66.7	2	33.3
22-1	Video data are prioritized in data transmission	0	0	6	100
22-2	A firewall is a hardware one	1	16.7	5	83.3
23	It has a backup server	3	50	3	50
24	In Computers, backup files are prepared at regular intervals	6	100	0	0
25	It has Remote Access system	6	100	0	0
	Total	**130**	**55.55**	**104**	**44.44**

At least, 5 questions related to knowledge in assessing staff readiness were answered correctly by 56.6% of subjects. With regard to the third quartile (above 75%) of correct answers to questions as knowledge desirable level, 56.6% of subjects had desirable knowledge.

No significant difference was observed between knowledge level in men and women of the sample population using the two-sided t-test (P-Value=0.677). But mean deviation in men and women had significant difference using Fisher's test (1.27 for women, 1.2 for men). Furthermore, the two-sided t-test was used in order to examine probable difference between physicians and nurses knowledge. The results showed that physicians had more knowledge compared to nurses, and this difference between these two groups was significant (P-Value=0.016).

On average, half of the study population have attended computer, Windows operating system, Word and PowerPoint softwares and Internet educational courses. Also, on average 57.7% of samples passed the ICDL seven skills courses, and were using computer and the internet in their home and workplace.

Two-sided t-test was used in order to measure the probable difference between amount of getting benefit from computer skills courses by the physicians and nurses. The results showed no significant difference between the two groups in terms of the amount of getting benefit from the courses (P-Value=0.755). Also, two-sided t-test results indicated significant difference between the two groups with regard to amount of mastering in these skills (P-Value=0.007), so that nurses were more mastered remarkably in using computer. According to these results, it can be suggested that despite physicians attend educational courses, they are less mastered in these skills than nurses because of the type of work.

To assess the attitude of physicians and nurses, 15 questions of the questionnaire were assigned to this purpose. The mean attitude score in the studied samples showed that 94.1% of participants had negative attitude (middle and lower) toward tele-ICU implementation.

To measure the possible difference between the attitude of physicians and nurses towards running tele-ICU, two-sided t-test was used. The results showed significant difference between the two groups physicians and nurses in terms of attitude (P=0.048). The mean acceptance by nurses was higher than that in physicians, although totally none of them had positive attitude to that.

Table 2:
Staff Assessment Summary of Effects of Each Probable Obstacle and Problems in Implementing Tele-ICU

Obstacles and Potential Problems	Very Effective		Relatively Effective		Unimportant	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
High initial cost to set up and limited financial resources	92	65.2	43	30.5	6	4.3
The impossibility of convenient implementing the system	54	38.3	75	53.2	12	8.5

Lack of insurance coverage in the new health care services and not to accept it	79	56.8	51	36.7	9	6.5
Increased expenses for patients	65	47.4	56	40.6	16	11.7
The lack of a specialized suitable and efficient software systems and web-based systems	74	53.6	56	40.6	8	5.8
Organization senior managers' intolerance and their little flexibility	74	52.8	58	41.4	8	5.8
The absence of legislation related to telemedicine services, especially tele- ICU	72	51.4	56	40	12	8.6
Lack of confidence in communications systems and softwares to timely and accurate exchange of information	53	37.9	74	52.9	13	9.3
Failure to comply with reasonable security issues and privacy of information of patients	53	38.1	69	49.6	17	12.2
The absence of a culture of acceptance of new technologies in staff (physicians, nurses, ...)	46	33.3	69	50	23	16.74
Lack of patients' and their families trust to the effectiveness of tele-ICU services	46	33.1	75	54	18	12.9
Technical and infrastructure problems in network and internet communications	70	50.4	55	39.6	14	10.1
Problems associated with electronic documentation and the lack of electronic medical records (EMR)	65	46.8	68	48.9	6	4.3

In order to determine the most important obstacles and problems facing the implementation of the tele-ICU in hospitals under study, 13 questions were included in the questionnaire. The obstacles were classified in two categories of related laws and infrastructure facilities. Generally, the most important obstacle to set up tele-ICU was identified to be "high cost and resources constraint" with 65.2%. It was followed by "lack of insurance coverage about the new health care and not to admit a patient", "lack of appropriate and effective specialized software systems and web-based systems"," organization senior managers' intolerance and inflexibility", "lack of laws related to offer remote medical services specially tele-ICU", "technical and infrastructure problems in network and internet communication" and finally " increase in patients' expenses as the very effective obstacles.

Discussion and Conclusion

Until now, no study has been conducted to assess the implementation of the tele-ICU in Iran, and other studies have been performed on the feasibility of the telemedicine generally or other branches related to telemedicine. What distinguishes this study is specialized consideration to technical readiness and assessment of human resources and possible barriers in setting up specialized branch of tele-ICU.

Mencarelli in his study suggested that structured data transmission network with a proper and guaranteed bandwidth connection is essential prerequisite in order to establish an efficient remote system (telepathology). He assumed IT resources including communication lines, wireless network and the internet as one of the most important resources for tele-medicine network setting up (Torani et al. 2011). Kannan in his study expressed that technical and communication equipment including communication lines are among the most important facilities for establishing telemedicine. Judi et al. pointed out in their study that in addition to human resources, communication lines and equipment are among the most important telemedicine technology facilities. Sadoughi et al. in their study on the feasibility of tele-pathology in teaching hospitals of Tehran University of Medical Sciences indicated that 50% of available bandwidth is appropriate in their centers to run tele-pathology. Torani et al. in their research entitled "The Ability of Specialized Hospitals of Iran University of Medical Sciences in Establishing Remote Medical Advice" showed that 60% of the studied hospitals had communications equipment needed to run the medical counseling network. In this study, 100% of hospitals had LAN that 50% of it connected to the internet, and in 83.3% of the internet bandwidth, at least 500 kbps based on the implementation protocol of tele-ICU was found to be appropriate, and 50% of hospital ICU had direct-line phone that it was somewhat consistent with the results of Mencarelli's study. Mazhari in his study concluded that the widespread readiness and feasibility study were required for the use of communication technology in offering mental health services in Iran, and relatively good telecommunication infrastructure is among incentives for using tele-medicine (Khamrnia 2010), that the results of his study were consistent with those in the current study. It was concluded that 60% of the studied hospitals had communications equipment required for telemedicine (Khamrnia 2010) that this study results corresponded with those in the present study.

It was shown that equipment quality and efficiency are among the important factors in the success of telemedicine employed in pathology (Hosch 2011). The results of the study of Hosseini et al, as well as of the Sadoughi et al, about limited facilities in medical equipment in the studied centers, were consistent somewhat with the results obtained in the current study indicating that there was medical equipment lacking sharing or transferring data and warning systems capability (monitoring system adjacent to patient bed, ventilator, pump syringe and feeding pump) in ICU ward.

Three criteria of knowledge, familiarity and skills in computer use and personal attitudes were used to measure and assess personnel readiness. Other studies on knowledge, such as current study, consider staff knowledge as one of the most important factors in setting up telemedicine systems. It was acknowledged that assessing the readiness of e-health is as a part of the assessment before implementing it, and it is the first priority in its implementation (Ajami et al. 2011). Meher et al. in their study stated that the majority of physicians in India have a moderate to high level of knowledge about telemedicine consultation (Jebraeily et al. 2010). In the present study, the level of knowledge of respondents was also favorable. The results of this study showed that there was no significant relationship between tele-ICU knowledge and demographic factors, but men population were more homogenous compared

with women one in terms of knowledge, and higher difference from the mean was observed among women, and there was a significant difference between knowledge and higher education. Anesthesia specialists had more knowledge than the ICU nurses. The study conducted by Jebraeili showed that the mean knowledge of respondents about EHR is above the mean (Varkey et al. 2008) that was, to a large extent, consistent with the current results about the knowledge of the level of health services provider team knowledge.

Varky et al. concluded in their study that physicians and nurses become proficient through attending short-term educational courses of computer and technology skills (Jarrah and Kloot TE 2010). Also, it was stated that educational programs for hospitals' physicians are among the important measures in setting up telemedicine (Meher et al. 2009). The results of this study showed that more than half of them have, on average, passed the ICDL seven-skill courses, and use computer and internet at home and workplace. Physicians use computer slightly more than nurses, but mean master and skill in nurses are higher than those in physicians. According to the results of this study, readiness and skill of human resources in the field of tele-ICU technology related issues are desirable.

Experts and users should be convinced of the benefit and feasibility of new ways, and also their active participation is very important in providing remote services to make them interested and to support the project. It was concluded that one of the most important factors in the utility of telemedicine network is taking advantage of interested staff, physicians' eagerness and users' willingness to cooperate (Kannan 2008).

Medical staff disagreement has been deemed as an important factor in tele-medicine implementation failure (Jennett et al. 2003). Mohammad Hossein Hayavi Haghighi et al. in their study entitled with "Feasibility study of telemedicine implementation in Hormozgan University of Medical Sciences, expressed that staff attitude with 41.1% is one of the major obstacles in setting up this system. This attitude with 38.3% was deemed as minor obstacle. In a preliminary study conducted in Shahid Beheshti University of Medical Sciences, Mohammad Reza Masjedi et al. suggested that not being admitted in remote counseling and physicians' priority for traditional counseling accounted for one of the problems. In another study performed in Australia, physicians prefer to give medical advice in the traditional way, especially older ones. Hu et al. studied the technology acceptance by physicians working in hospitals and showed that the acceptance was in the intermediate level. In general, physicians' positive attitude towards the use of telemedicine in clinical practice was moderate (Chau and Hu 2002). In this study, the mean attitude score indicates moderate and lower score towards tele-ICU implementation was 94.1%. Nurses' score was higher than that in physicians', though totally none of them had positive attitude towards that. Based on studies, staff motivation and attitude to work in providing healthcare services through telemedicine are emphasized, therefore creating conditions to increase the interest for cooperation and activity is an important factor in the successful implementation tele-ICU. Changes in knowledge of nurses and physicians towards monitoring updated trends and patients' care with the use of technology and created the conditions for acquiring practical experience for the use of telemedicine that can improve this problem to some extent. Training interested professionals is needed in adopting the technology for patient care for using tele-ICU at Isfahan teaching hospitals. In this regard, the results of this study are consistent with those in the study of Mohammad Hossein Hayavi Haghighi et al.

Comparing the present study's results with those in other studies indicates the importance of education of physicians and nurses about the role and impact of tele-ICU in monitoring and optimum care of patients. It seems that lack of knowledge and little experience in this area

have developed a negative attitude among employees of Isfahan hospitals in utilizing tele-ICU services.

Comparing the results of this study with similar ones indicates that nearly most obstacles mentioned are the same as in other studies, but the ranking of the barriers has been somewhat different from that in this study that could result from differences in attitudes, mechanism of service delivery and infrastructure in those communities. In a study entitled "Telemedicine in England", it was suggested that telemedicine implementation barriers in the United Kingdom were financial constraints, lack of infrastructure, concerns about the legislation and resistance to change (Debnath 2004). In a study entitled "Telemedicine Model in Africa Sahara" Mengistu et al. expressed lack of resources, poor infrastructure for telecommunications, human factors, standards and policies and social and economic issues as existing obstacles.

Hayavi Haghighi et al. stated that the major obstacles from the viewpoint of physicians were initial costs, insurance problems and repayments, current costs and medical staff and educational personnel shortage, as well as staff attitude and licensing problems, and their disagreement in privacy issues. On telemedicine pilot system obstacles in Malaysia and its failure, it was expressed that lack of coordination of traditional systems and telemedicine and weakness in enhancing the management of changes were the problematic factors (Wootton and Tahir 2004), and issues related to licensing and laws have been recognized as one of the major problems in implementation of teleconsultation in the U.S (Norris et al. 2002).

Bush stated that the first barrier to set up telecommunication lines were shortage of related equipment and financial support for operations, and lack of continuous financial investment is a major challenge. In another study, Davar examined the barriers in telemedicine models in India. In this study, the main obstacles to telemedicine acceptability were found to be cost constraints, lack of standard software programs, lack of resources for mutual learning and knowledge exchange, offered programs and standard equipment to increase the acceptability of this technology in India. Alharthi studied the status of telemedicine in eight countries including New Zealand, Australia, the U.S, Canada, Great Britain, Malaysia, China and India. The results of this study suggested that removing barriers such as standardization, rules and regulations, commercial models and assessment programs, financial constraints and more specialized education to human resources in telemedicine can be effective factors in the success of organizations (Alharthi 2012).

It was stated that organizational culture is the biggest problem in the implementation of eHealth (Hostgaard and Nohr 2004). Behnam in his study expressed that the organization responsible for formulating and applying telemedicine should seriously consider the privacy and security, accountability and law verification (Khamrnia 2010), which this is consistent with the objectives of this study. Also, Hajavi et al. concluded in their study that change in the modalities, physician-patient communication and the change in requirements for maintenance, privacy and documentation of medical records are the major obstacles to the development and applying telemedicine, that removing these barriers involves formulating definitions, design and development of new guidelines to medical rules keep pace with these changes (Sadoughi et al. 2014). In a study, Pour Azin stated that using application softwares is indispensable in telehealth (Khamrnia 2010). The present study results showed that there are no tele-ICU software facilities in the selected hospitals that have been a part of the major obstacles expressed by physicians, nurses and IT officials.

On the feasibility of implementing telemedicine according to the components of strategic planning at Isfahan University of Medical Sciences, it has concluded that factors involved in

failure of telemedicine projects were unavailability of required human resources, lack of credit allocated to telemedicine projects, problems related to social acceptance of new ways that were exactly consistent with the organization's weaknesses and threats (Keshvari et al. 2015).

In this study, the obstacles were classified in two categories of related laws and infrastructure facilities. The most important obstacle to set up tele-ICU was identified to be "high cost and resources constraint" with 65.2%. It was followed by "lack of insurance coverage about the new health care and not to admit a patient", "lack of appropriate and effective specialized software systems and web-based systems"," organization senior managers intolerance and inflexibility", "lack of laws related to offer remote medical services specially tele-ICU", "technical and infrastructure problems in network and internet communication" and finally " increase in patients' expenses as the very effective obstacles. According to this and other similar studies' results, it can be concluded that setting up an effective tele-ICU system requires effective change management.

Mahmoudzadeh Sagheb concluded that the threatening confidentiality of patient information resulted from making transmitted data and their storage transparent is seen as an obstacle against this technology. Medical records and patient's information exchange between the two establishments of providing health care increases the risk of unauthorized access to patient's data and changes common concepts of information privacy and confidentiality (Khamrnia 2010), that the results of this study are consistent with those of the current study. According to the study's results, the hospitals affiliated to Isfahan University of Medical Sciences have a technically moderate readiness to implement tele-ICU plan. The knowledge level of experts has been desirable in order to establish tele-ICU system, however, the studied population mean attitude score in the table 2 indicates negative attitude (moderate and lower) to implement tele-ICU.

The obstacles such as "setting up high cost and resources constraint", "lack of insurance coverage about the new healthcare and not to admit a patient", "lack of appropriate and effective specialized software systems and web-based systems", "organization senior managers intolerance and inflexibility", "lack of laws related to offer remote medical services specially tele-ICU", "technical and infrastructure problems in network and internet communication" and finally " increasing patients' expenses were assessed as very effective obstacles.

Therefore, within the current situation, if the province health sector implements projects in the field of telemedicine, especially tele-ICU, regardless of considering these and adopting proper strategies to reduce weaknesses and threats and using the strengths and opportunities effectively, it will probably fail, and time, effort and finances of the health sector will waste. On the other hand, considering these factors can play a decisive role in the success of telemedicine projects. In the near future, removal of barriers will result in presenting healthcare services with the help of information and communication technologies and the use of its advantages for promoting equity in offering monitoring and remedial healthcare services.

Following solutions are recommended to improve hospitals' levels to apply this medical system:

➤ In addition to strengthen existing facilities, required infrastructures must be improved continuously, and an appropriate budget allocated for this purpose.
➤ The necessary educational courses must be held for physicians and medical staff to raise their knowledge and promote the culture of applying teletechnologies, and

managers and supervisors participate at seminars and conferences related to new technologies and E-health.

➢ Policy of confidentiality and patient's privacy must be developed.

➢ The laws related to the provision of telemedicine services, especially tele-ICU should be formulated according to the local culture of the country to protect the rights of patients and healthcare service providers, leading to better performance of this system, and insurance coverage must be developed on this type of service.

➢ Comprehensive strategic plan, policies and guidelines as well as required standards for tele-ICU in medical universities and affiliated hospitals must be established.

➢ Developing Iranians health electronic record must be accelerated, and the needed prerequisites for designing related softwares including comprehensive software tele-ICU must be a priority.

Universities of Medical Sciences and affiliated hospitals using the framework of readiness assessment made in this study can identify the own existing situation and define improvement projects in the field of skills and technology to enhance the ability and acceptance potential of tele-ICU, and then assess readiness improvement and new organizational situation on the basis of audit period. This process should continue until a highly desirable situation be achieved, then its implementation time will be determined with more certainty.

Acknowledgement

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