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Kern, Josipa

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Josipa Kern
University Medical School Zagreb, Andrija Stampar School of Public Health,
Zagreb, Croatia

Correspondence to:

Josipa Kern
University Medical School Zagreb
Andrija Stampar School of Public Health
Rockefellerova 4
10000 Zagreb, Croatia

e-mail: jkern@snz.hr

Key Words

Teleconsultation; Evaluation studies

Summary

The aim of this study was to identify criteria used for evaluation of teleconsulatation systems in evaluation studies, and to estimate trend of their changes. Evaluation of teleconsultation systems was made on the basis of 82 evaluation studies from **t**he *Inventory of evaluation studies in medical informatics* consisting of all the ICT evaluation studies published in 1982-2002. In order to estimate trend of changes in using evaluation criteria, the whole period with at least one evaluation study, it means the period of 1995 to 2002 was divided to two of four years, 1995-1998 and 1999-2002. Proportions of evaluation studies according to any single criterion were calculated. Index of changes I_{ci} for i^{th} criterion was defined as difference of proportion of studies evaluating teleconsultation by using a certain criterion in the second period and the same proportion in the first period divided by the number of all studies evaluating teleconsultation systems. This research showed that *Hardware and technical aspects* were the leading evaluation criterion, but it has been decreasing (from 74.2% in the first period to 43.1% in the second one). *Satisfactions* of both health care provider and patient achieved the highest increase in the second period (from 3.2 to 19.6%, and from 0% to 15.7%, respectively). *Appropriateness* and *Cost* of patient care were on the second place (from 22.6% to 33.3%, and, from 16.1% to 23.5%, respectively). Considering defined index of changes it can be concluded that there are four criteria for evaluation of teleconsultation systems, having a positive trend (in frequency of evaluation studies): *User satisfaction* (I_c=0.20), Satisfaction *of patient with patient care*

(I_c=0.19), *Appropriateness of patient care* (I_c=0.13), and *Cost of patient care* (I_c=0.09). *Hardware and technical aspects* shows negative trend in the number of evaluation studies (I_c=-0.38), as well as *Cost of IT* (I_c=-0.10).

Introduction

Evaluation is an attributing value to an intervention by gathering reliable and valid information about it in a systematic way, and by making comparisons, for the purposes of making more informed decisions, understanding causal mechanisms, or general principles [1]. According to Ammenwerth, and more precise definition, evaluation is the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context [2]. Evaluations of technology entering the health care system is necessary and of great importance for all the participants in the health care system [3]. Looking for evidence based information and communication technology (ICT) evaluation is the must of today, especially because a plenty of ICT affect health care process, implying a lot of costs, and changing organization and behaviour of patients, medical staff and decision makers. On one side, new technology offers better service but on the other side, the question is about risks and affording. The aim of evaluation is to find out appropriateness of the system in any phase of its being – from idea to full function. The main dimensions of its appropriateness are suitability or properness of technology in given circumstances, affordability according to costs, satisfaction of users and providers, and benefit or value that could be added to.

Telemedicine supposes the use of new technology. Telemedicine consists of a variety of services, activities and medical professions. Many activities in health care could get prefix *tele* and become *tele-activities* (teleconsultation, telediagnosing, telecare, telesurvellance etc). In the same time, any medical profession could get the same prefix

and become *tele-medical profession* (teleradiology, telepathology, teledermatology etc.). Teleconsultation becomes a very important activity of medical doctors living and working in isolated or not easy accessible areas [4, 5]. It is one face of telemedicine, very important in telediagnosing, telecare, telesurgery, telesurvellance. There are two possibilities for teleconsultation: store-and-forward and videoconferencing. Store-and-forward teleconsultation is older and cheaper than videoconferencing – at least in dermatology [6, 7], but the goal of both of them is to improve the health care delivery.

Cost is the first element in evaluation of a health service, but not the most important from the health care point of view. It should expect that quality of services as well as satisfaction with new technology by both healthcare provider and healthcare user be one of leading criteria in evaluation the services. Quality of services could be evaluated through a variety of criteria, as well as the satisfaction of participants in the activity. There are papers dealing with patient satisfaction with telemedicine [8], economic evaluation of joint teleconsultations for patients referred by their general practitioner for a specialist opinion [9], appropriateness of teletriage nursing advice [10], participants' satisfaction [11], etc. but there is no analysis of studies dealing with evaluation of teleconsultation systems considering the whole set of criteria that were used in such evaluation studies. It could be useful to do an overview of such criteria, to find out the most frequent criteria, the leading ones, as well as trend of usage such criteria during the time.

The aim of this paper was to find out what are the leading evaluation criteria in teleconsultation activities, and is there any trend in using evaluation criteria of teleconsultation systems. Special interest was focused to criteria pointing to the

suitability or properness of technology in given circumstances, affordability according to costs, satisfaction of users and providers, and benefit or value that could be added to.

Data and Methodology

The Inventory of evaluation studies in medical informatics in 1982-2002 was used for analysis [12]. This Inventory was based on a systematic literature search in PubMed, on papers having abstracts. The search was done on April 25th 2003, and updated on July 28th 2003. According to the Inventory, an evaluation study was defined as "the systematic, empirical assessment of a component of a health information system". Further, health information system was defined as "comprising all computer-based components which are used to enter, store, process, communicate, and present health related or patient related information, and which are used by health care professionals or the patient themselves in the context of inpatient or outpatient patient care" [12]. According to these definitions, "telemedical systems based on IT solutions" i.e. teleconsultation systems based on IT solutions should be considered as a type of health information system. Education and administrative systems, medical-technical systems like MRI, terminology systems like UMLS, other conceptual approaches and any system not being a "part of direct patient care" were not included in the Inventory. Considering evaluation criteria chosen for evaluation a teleconsultation system described in a paper, each paper was classified following the taxonomy based on semantically analyzed information on evaluation criteria in title or paper abstract [12]. Other attributes of evaluation studies were: evaluation approach (more quantitative methods used, more qualitative methods used, mixed or unclear), research type (explorative – *gather information, discover relationships*, explanative – *prove*

relationships, test hypotheses, review – *systematic overview on studies*, mixed or unclear), clinical domain (general practitioner, health care centre; normal inpatient care unit; outpatient unit, outpatient clinic; intensive care unit, emergency unit, operation unit; laboratory, pathology, pharmacy, blood bank: radiological unit; trans-institutional; unclear; patient's home, self care), and study environment (laboratory study – *environment is mostly controlled*, field study - *environment is mostly uncontrolled*, mixed or unclear). Following the aim of this paper the "criteria evaluated" was the only attribute of teleconsultation systems analyzed in this paper.

Searching the Inventory was performed in three steps. During the first step, the keyword "telemedicine" was used for searching. The second step included information system type "TC – teleconsultation system (e.g. store-and-forward)", and the third step was performed for 14 criteria (according to Inventory), taking them one by one. These criteria are cited in Table 1.

"Importance" of evaluation criterion will be defined as "important is the criterion reflecting the problem that a lot is written about". Consequently, importance of i^{th} criterion can be measured by P_i or "proportion of studies evaluating teleconsultation systems and using this criterion". Basis for conclusion about importance of evaluation criteria defined in such a way, and trend of changes of these criteria will be examined. Trend of changes will be defined by the following procedure: The whole period will be divided to two sub-periods. Index of changes I_{ci} for i^{th} criterion is defined as:

$$I_{ci} = \frac{P_{2i} - P_{1i}}{N}$$

where

P_{1i} = Proportion of studies evaluating teleconsultation according to i^{th} criterion in the first time period

P_{2i} = Proportion of studies evaluating teleconsultation according to i^{th} criterion in the second time period

N= Number of studies in the whole period observed.

$$I_{ci} = \begin{cases} = 0 & \text{There is no changes} \\ < 0 & \text{The } i^{th} \text{ criterion is becoming less important} \\ > 0 & \text{The } i^{th} \text{ criterion is becoming more important} \end{cases}$$

Index of changes I_{ci} defined in this way has value 0 if both proportions, in both periods, are the same. Negative value of I_c means that the ith criterion became less important – its trend is negative. Positive value of I_c means that i^{th} criterion becomes more important – its trend is positive.

The i^{th} criterion will be the most important criterion if it has the highest value of proportion P_i. Considering a trend of changes, a i^{th} criterion is becoming more important if its index of changes, I_{ci}, is positive and has "high" value. "High value" in this context is not strongly defined. Therefore, this index can be used only for ranking a set of chosen criteria.

Results

Keyword "telemedicine" resulted in 108 evaluation studies. Adding the "TC – teleconsultation system (e.g. store-and-forward)" gave 82 studies dealing with evaluation of teleconsultation systems having at least one of 14 criteria included.

Percentages of 82 teleconsultation studies given by evaluation criteria are shown in Figure 1. Considering the frequencies, the first three positions were taken by *Hardware and technical aspects (n=45)*, *Appropriateness of patient care (n=24)* and *Cost of patient care (n=17).* Two criteria *Quality of documented and processed information* and *Patient related behaviour or knowledge* were included in no study evaluating teleconsultation systems.

The first evaluation study dealing with teleconsultation appeared in 1995. Therefore, dividing the whole period 1995-2002 to two of four years, i.e. 1995-1998 and 1999-2002, it could be seen that some criteria become more important for evaluation than others (Fig.2). Especially *User satisfaction* and *Patient satisfaction with patient care* have the highest increase (*User satisfaction* from 1 in 1995-1998 to 10 evaluation studies in 1999-2002, I_c=0.20, and *Patient satisfaction with patient care* from 0 in 1995-1998 to 8 evaluation studies in 1999-2002, I_c=0.19). *Appropriateness of patient care* has achieved increase from 7 to 17, I_c=0.13, and *Cost of patient care* from 5 to 12 in the period 1999-2002, I_c=0.09). *Hardware and technical aspects* is evaluation criterion having 23 and 22 studies respectively in two consecutive time periods, but taking into account that there were 31 studies in the first periods and 51 studies in the other one, it could be concluded that hardware is becoming not more important evaluation criterion, its trend is negative (it decreased from 74% in 1995-1998 to 43% in 1999-2002; I_c=-0.38). There is also decrease in *Cost of information technology,* I_c=-0.10. Other criteria showed small indexes of changes kept nearly the same position in both periods or were just sporadically included in evaluation studies of teleconsultation systems, so their changes could not be identified.

Considering the other attributes of evaluation studies Table 2 shows corresponding results. Clinical domain of this research is 100% trans-institutional what was expected for teleconsultation systems. Study environment is primarily mostly uncontrolled (76.8%). Type of research is explanative (90.2%), i.e. they are dealing with proving relationships and test hypotheses.

Conclusion

Evaluation of teleconsultation systems was considered in 76% of all evaluation studies dealing with telemedicine, or 8% of studies evaluating health information systems. These evaluation studies were published in medical journals during the twenty-year period, and indexed in Medline. The fact that teleconsultation was the most frequently evaluated telemedical activity is understandable. Teleconsultation is the first and leading teleactivity in healthcare. Telecare or other teleactivities came later.

Evaluation of teleconsultation system means to find out appropriateness of the system in all relevant dimensions. Shortly, these are technology, affordability, usefulness, and satisfaction of all participants in the system. There is variety of possibilities for evaluation: a number of criteria, methods of measurement, analysis, comparisons with some kind of standards. In spite of small sample of studies evaluating teleconsultation systems, especially considering particular evaluation criterion, this research showed that importance of criteria, defined in a way described in Methods, is not constant in time. It is changing in dependence on priorities of a moment, on development of technology, on problems occurring. Equipment was the first criteria for evaluation, as well as cost. Cost was kept also later. Cost is dealing with affordability of such activity – no money, no activity. However, hardware used in teleconsultation is still a leading evaluating

criterion, but it seems, hardware became standard or has been under way to become the standard. Standard implies no need for evaluation. It could be the reason for decreasing the number of studies using *Hardware and technical aspects* (from 74.2% to 43.1%) as a criterion for evaluation the teleconsultation systems. Recently usefulness of the activity started to be more and more important. It means appropriateness of patient care, or requirement of medical profession based on current medical evidences. Appropriateness potentially ensures quality, and implies connection with satisfaction of participants – both patients and health care providers. Satisfied participants can ensure practicing the activity.

This research showed that satisfactions (of both patient and health care provider) achieved the highest increase. Satisfaction of patients as participants in teleconsultation was completely ignored in evaluating teleconsultation systems before the year 1999. 19.6% evaluation studies dealing with satisfaction of health care providers and 15.7% of those for patients in four year period (1999 to 2002) show small but not neglected increase (about 16% for both, patients' and health care providers' satisfaction) of using this criterion as evaluating one. Appropriateness and cost of patient care become the next important evaluation criterion, with index of changes of 0.13 and 0.09 respectively. According to index of changes in using of evaluation criteria in two time studied periods, it can be concluded, that criteria for evaluation of teleconsultation systems *User satisfaction*, *Satisfaction of patient with patient care*, *Appropriateness of patient care*, and *Cost of patient care* are the "coming" criteria for evaluation of teleconsultation systems, criteria that a lot is going to be written about.

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Table 1. Searching criteria (according to Inventory of evaluation studies in medical informatics in 1982-2002)

Keyword:	Telemedicine
Information system type:	TC - teleconsultation system (e.g. store-and-forward)
Criteria evaluated:	Quality of patient care Efficiency of work process Appropriateness of patient care Patient satisfaction with patient care User satisfaction Cost of patient care Hardware and technical aspects Cost of IT Organizational and social aspects General computer knowledge and attitudes Software quality Quality of documented and processed information Patient related behaviour or knowledge Usage patterns

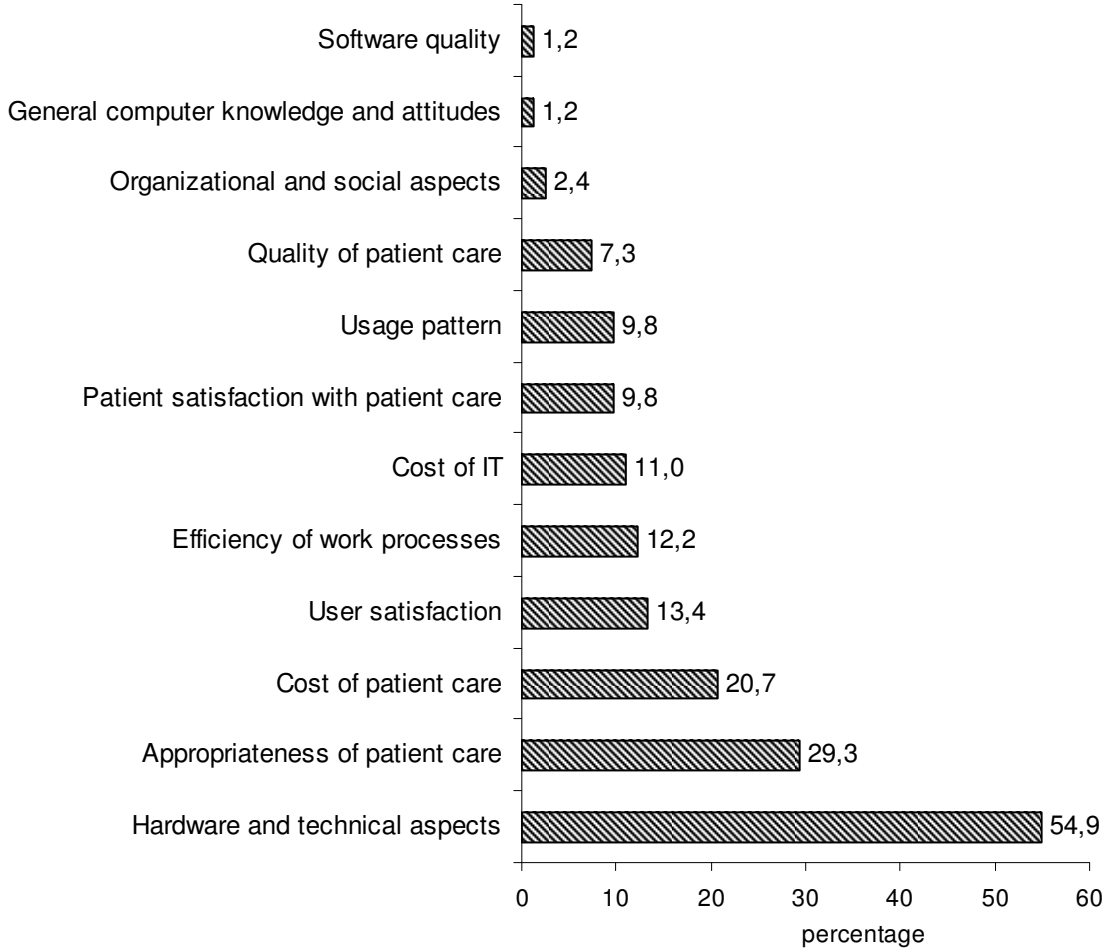

Figure 1. Percentages of evaluation studies according to various criteria

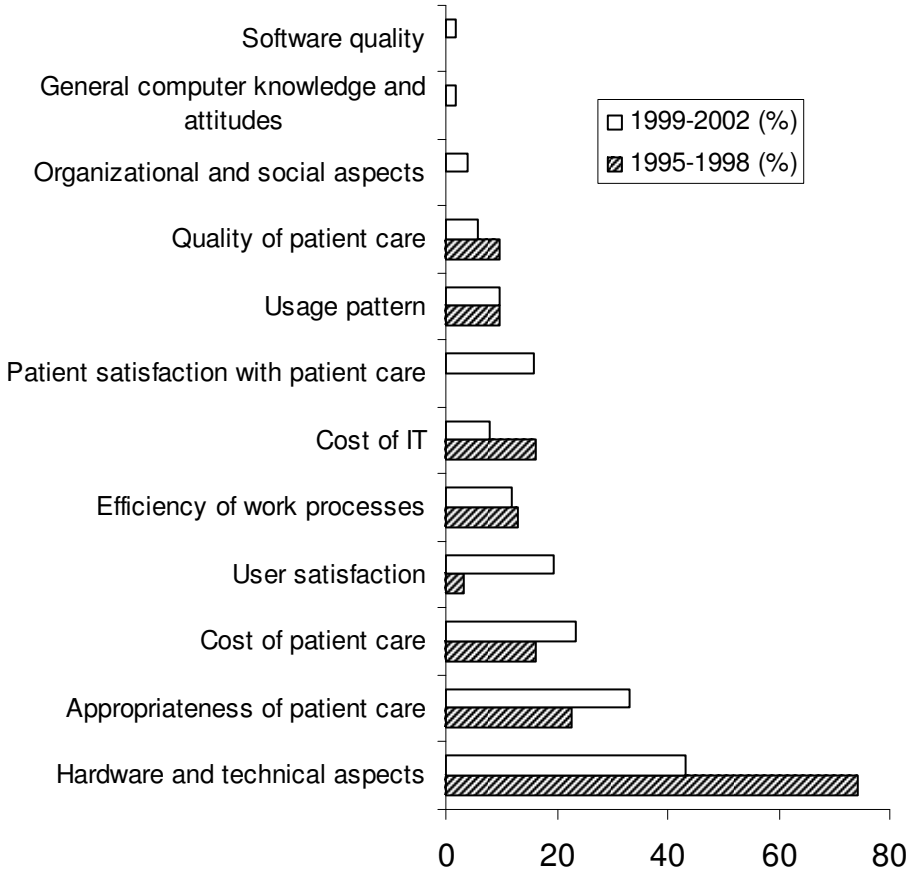

Figure 2. Evaluation criteria according to two periods

Table 2. Research type, clinical domains and study environment of evaluation studies

	Frequency	Percentage
Evaluation approach		
more quantitative methods used	69	84.1
more qualitative methods used	3	3.7
mixed or unclear	10	12.2
Research type		
explorative – *gather information, discover relationships*	-	-
explanative – *prove relationships, test hypotheses*	74	90.2
review – *systematic overview on studies*	2	2.4
mixed or unclear	6	7.3
Clinical domain*		
trans-institutional	82	100
Study environment		
laboratory study – *environment is mostly controlled*	18	22.0
field study - *environment is mostly uncontrolled*	63	76.8
mixed or unclear	1	1.2

*no other clinical domain was indicated