

Chapter XVIII

Telemedicine Consultations in Daily Clinical Practice: Systems, Organisation, Efficiency

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ABSTRACT

This chapter introduces usage of telemedicine consultations in daily clinical practice. Author has describe process of teleconsultation, sample schemes of systems, parties of this process and its roles. Also, main steps of clinical teleconsultation (determination of necessity for teleconsultation, preparation of medical information, observance of ethics and law conditions, preparation of conclusion) are shown. Special part is dedicated to efficiency of teleconsultation – author has propose own complex method for estimation of it. Furthermore, the authors hope that understanding of teleconsultations' process will make it more accessible and easy-to-use for medical practitioners.

INTRODUCTION

In this chapter the author describe approaches to usage of telemedicine consultation in daily clinical practice. First teleconsultations described at

1910s (published in JTT, 1997). Since that time telemedicine is use wide range of technologies – TV, satellite, Internet, cellular etc – for discussion of serious clinical cases at distance (Bashshur et al,1997, Kamaev et al, 2001, Nerlich et al,1999,

Vladzomyrskyy,2004). Annually in the world are spent thousands teleconsultations. It is possible to say that this procedure is most wide spread telemedicine service.

Teleconsultation (telemedicine, remote consultation) – remote discussion of the clinical case via special computer information and telecommunication system to get answers to precisely formulated questions for the help in clinical decisions (Vladzomyrskyy,2003).

Author has propose classification of teleconsultation by 3 main classes: terms of teleconsultation leading, sort (kind) of organisation and technical platform.

1. **By term:**

- **Synchronous:** All parties use the same telemedicine system in the same time (in real time);
- **Asynchronous:** All parties use the same telemedicine system with time delay (sequential use).

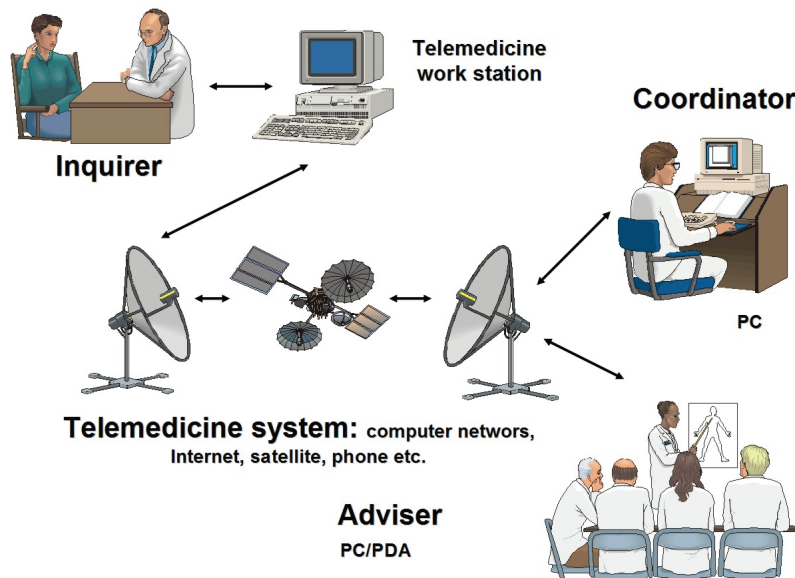
2. **By sort:**

- **Formal:** Two or more organizations were involved under a previously signed contract/protocol/agreement;
- **Informal:** Free discussions of clinical cases in professional Internet societies (via mailing lists, Web-forums);
- **Second opinion:** Teleconsultations for patients who contacted a medical organization by email or via a special online form/forum.

3. **By technical basis:**

- Systems at the base of Internet and its services (e-mails, Web-platforms, mailing lists, IP-phones, IP-videoconferences, chats, messengers etc);
- Systems at the base of special links (satellite, ISDN, ftn-protocol, computer health networks etc);

Figure 1. Sample scheme of teleconsultation



Systems at the base of cellular phoniness and its services (mobile Internet, SMS, MMS, voice etc).

SYSTEMS OF TELECONSULTATION

As we can see in Figure 1, there are 4 main participants of teleconsultation process (Vladzimirsky,2003):

1. **Inquirer** — Legal or physical person representing a clinical case for the teleconsultation. Most frequently inquirer is the “face-to-face” physician/nurse, also -patient or relatives (in case of self-reference for teleconsultation, “second opinion”). Functions of the Inquirer:
 - Granting of the clinical case for teleconsultation, formulation of questions;
 - Registration of the medical documents according to the requirements of the adviser (digitalization, translation into foreign language etc.);
 - Granting the additional information by inquiry of the adviser;
 - Participation in synchronous procedures.
2. **Adviser** — Expert or group of the experts considering the clinical case which was presented for the teleconsultation. Functions of the Adviser:
 - Consideration and consultation of the clinical case in the stipulated terms;
 - Granting the conclusion with use of the standard medical terminology;
 - Participation in synchronous procedures.
3. **Coordinator (dispatcher):** Physician/nurse, expert in the field of computer technologies and telemedical procedures, which provides uninterrupted work on realization of

telemedical procedures. Functions of the Coordinator:

- Primary estimation of the quality of the medical data which were received from inquirer;
 - Check of the data on conformity by the requirements of adviser’s medical establishment;
 - Additional communications with the inquirer (in case of data discrepancy);
 - Choice of the establishment or/and personal adviser for the teleconsultation;
 - Sending electronic case history to the adviser or/and in other telemedical centre;
 - Decision of organizational and financial questions of the telemedical network.
4. **Assistant** — technical expert serving telemedical system. Functions of the Assistant:
 - Maintenance of technical readiness for telemedical system;
 - Elimination of technical failures and malfunctions;
 - Technical support and consultation of other participants of the telemedical procedure.

Technically teleconsultations realized by use of telemedicine work stations which linked by any telecommunication protocol.

Telemedicine work station (TWS)—complex of the hardware and software (multitask workplace) with opportunities of digitalization, input, processing, transformation, conclusion, classification and archiving of the any kinds of the medical information and realization of telemedical procedures (teleconsultation) (Vladzimirsky,2003).

Basic Components of Clinical TWS :

- Computer (PC, notebook, tablet, PDA etc);

- Devices for digitalisation of medical information;
- Communication line (Internet, satellite, cellular etc).

There are three kinds of clinical TWS:

1. **Room unit:** Not moving TWS within the limits of one room (office).
2. **Rollabout unit:** Moving version of TWS mounted on a mobile table. Such TWS can easily be moved from one room to another (from physician's office to patients' yard etc).
3. **Mobile unit:** Moving TWS for outside/out-hospital telemedical procedures.

In daily clinical practice practitioners most often use next systems for teleconsultations:

1. TWS+Internet/Satellite/ISDN link.
2. TWS+special digital diagnostic equipment+Internet/Satellite/ISDN link.
3. TWS+special digital diagnostic equipment+kit for wide format videoconferences+Internet/Satellite/ISDN link.
4. TWS at the base of cellular phone/communicator+Mobile Internet /MMS link.

As an example of decision for clinical teleconsultation system author can propose own Best practice model, which was recognized by International Society for Telemedicine and eHealth (ISfTeH) in 2005.

Best Practice Model for Telemedical Equipment

Background: for any kind of telemedical procedures it's necessary: 1) to create an effective telemedical work station (TWS) with adequate free or/and licensed software, 2) connect TWS to some kind of telecommunication line.

The basic requirements for telemedical equipment: an opportunity of processing of any kind of the medical information, cheapness, standardisation, availability, simplicity and reliability of use, technical and information safety.

Main goals:

- Equipment for telemedical work station,
- Telecommunication lines,
- Software.

Decisions

We are propose a few sets for telemedicine work station.

Classical set for TWS: basis PC, SVGA monitor, multimedia equipment, CDROM/CDRW/DVD, network adapter, high quality scanner, digital photcamera, digital videocamera, Web-camera, high quality colour printer, microphone, dynamics, modem, connector to hospital information system, sets of special digital equipment for diagnostic and treatment, auxiliary equipment.

Clinical set for TWS: basis PC, SVGA monitor, multimedia equipment, CDROM, network adapter, digital photcamera, printer, modem, auxiliary equipment.

Minimal set for TWS: basis PC, SVGA monitor, high quality scanner or digital photcamera, modem.

Optimal clinical set for TWS: basis PC, SVGA monitor, multimedia equipment, CDROM or CDRW, high quality scanner, digital photcamera, Web-camera, printer, modem, auxiliary equipment.

Example: in daily clinical practice we use TWS: PC (1000 Mhz and more) with multimedia equipment, scanner (1200 dpi and more), digital photcamera (1,3-3 mpx), printer (laser, 600x600 dpi and more), film-viewer, Web-camera.

Telecommunication lines - best ways:

- Direct and dial-up Internet lines for any kind of telemedical procedures;

- Mobile phones services for emergency teleconsultations.

Direct Internet lines (256 Kb and more, for videoconferences 512 Kb at least) intercity, interregional communications, communications between big regional hospitals and medical universities. Dial-up Internet lines (56 Kb and more) – for intraregional, intracity, rural-city communications. SMS/MMS services – for any kind of emergency teleconsultations.

Software

Its possible to use special or non-special software for telemedical procedures. We prefer:

- Standard licensed software from Microsoft™;
- Web-application designed with open code (optimal for medical establishments with low financial support);
- Special telemedical application on the base on Internet (for example, “Regional Telemedical System”™).

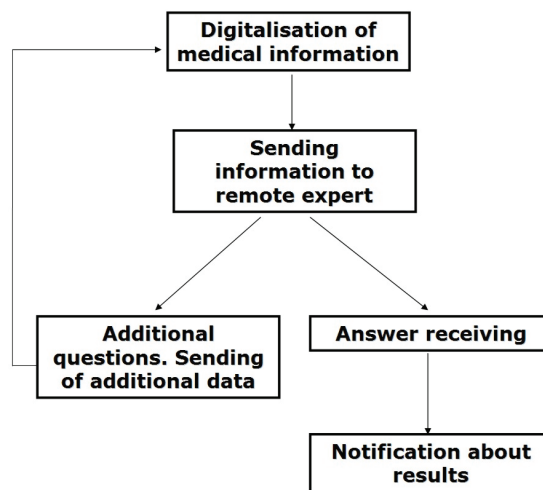
Thus, in general any system for teleconsultation consist from telemedicine work stations, telecommunication lines and human factors (Inquirer, Adviser, Coordinator, Assistant). Gathering of work stations and selection of communication kind should be evidence-based and can be grounded at best practice models of worldwide eHealth organizations.

ORGANISATION OF TELECONSULTATION

Teleconsultation is the process, which consist of two main points:

1. Sending remote expert digital medical information about patients with *maximal*

Figure 2. Main steps of sample teleconsultation



high diagnostic accuracy and with *minimal* volume.

2. Organization of an effective feedback.

In Figure 2, you can see the main steps of teleconsultation: digitalization of medical information, information exchange, notification about results.

As we can understand that for making medical information digital we are need equipment (some

Figure 3. Main steps for choice of the most effective technology for teleconsultation

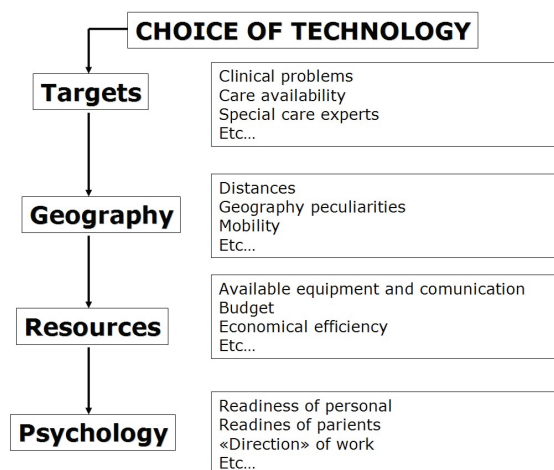
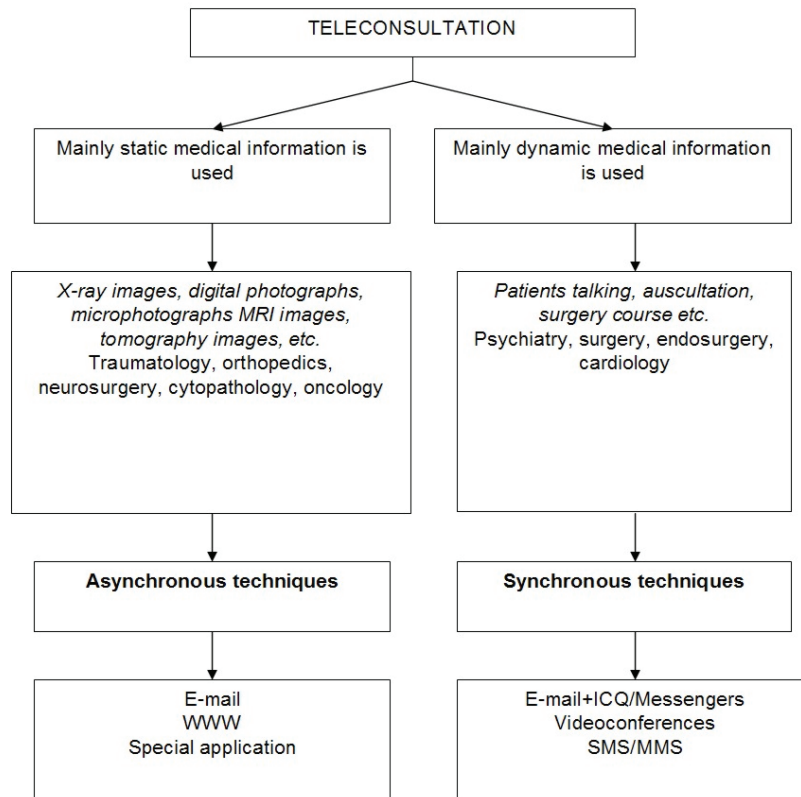


Figure 4. Algorithm for choice of the telemedical technology



telemedicine work station); for digital information exchange we are need telecommunication (some data bearer); and for notification about results of teleconsultation we are need methods for estimation of efficiency. Thus, it is possible to use almost any computer and telecommunication technology/tool for teleconsultation. Only one condition: this technology/tool should support digitalization, data transfer and feedback. So, there are 4 main steps for choice of the most effective technology (Figure.3).

For example, early author had developed the algorithm which enables quick choice of the most suitable telemedical technique for a present clinical situation (Figure 4) (Vladzomyrskyy,2005). Synchronous teleconsultations are most suitable where dynamic types of medical information prevail, e.g. in psychiatry (direct communication between physician and the patient is of impor-

tance) and emergency surgery. Asynchronous teleconsultations are most suitable where static types of medical information prevail, e.g. trauma surgery, orthopaedics, dermatology, cytology, pathology.

In clinical practice teleconsultation include four main steps:

1. Determination of necessity for teleconsultation.
2. Preparation of medical information.
3. Observance of ethics and law conditions.
4. Preparation of conclusion.

For determination of necessity for teleconsultation it is possible to use list of indications for teleconsultation in daily clinical practice (Vladzomyrskyy,2005):

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- Determination (confirmation) of diagnosis;
- Determination (confirmation) of treatment;
- Determination of diagnosis and treatment of rare, severe diseases or diseases with a non-typical course;
- Determination of complication prevention methods;
- Need for a new and/or infrequent surgery (for treatment or diagnosis) or procedure;
- Lack of immediate specialists in the necessary or adjacent medical field or lack of sufficient experience for diagnosis or treatment of the disease;
- The patient doubting diagnosis, treatment and its results, complaint analysis;
- Decrease of diagnostics and treatment cost without impairment of quality and efficiency;
- Search and selection of medical establishment most suitable for urgent and planned treatment of the patient, coordination of terms and conditions of hospitalization;
- Medical care for patients located at considerable distance from medical centres, when geographical distance between the patient and health-care provider cannot be overcome;
- Search for alternative solutions for clinical tasks;
- Obtaining of additional knowledge and skills concerning a given medical problem.

For preparation of medical information practitioner needs equipment and rules for telemedicine case records. As you can see before telemedicine work station is use for digitalisation and exchanging of relevant medical information. Digitalisation could be done by to ways:

- Initial reception of medical data in the digital kind (from special computer aided/digital diagnostic equipment);

- “Manual digitalization” of medical data (by cameras, scanners, digitizers etc).

In clinical practice digital photo/video cameras, scanners, document cameras and film digitizers are widely adopted for preparation of medical information for teleconsultation.

After digitalization special processing should be perform, which include: elimination of not informative areas; reduction of volume without loss of diagnostic value; correction of images without loss of diagnostic value; anonymity.

In short, main targets of such processing – to make medical information with: maximal accuracy, minimal volume, safe. When we have all necessary information about patient in digital form we should to prepare telemedicine case record, which consist from:

- Short case text (identifier of the patient, date, age, sex, diagnosis, brief anamnesis) - text format;
- Relevant visual data (x-rays, CTs, MRIs, clinical photos, videoclips etc) - graphic files or dicom;
- Explanation data (accompanying text, anatomic area, projection, method of colouring, increase, date of research etc.) - text format;
- Relevant text data (clinical tests, opinions of “face-to-face” advisers etc) - text format;
- Questions to the adviser (“diagnosis?”, “tactics of treatment?” etc) - text format;
- Additional information - any format.

The basic requirements for the telemedicine case record:

- Information and methodical conformity of the standard paper/electronic case record;
- As it is possible the smaller size of files with minimal losses of diagnostic value;
- Conformity to standards;

- Flexibility (an opportunity of use at any technological decisions);
- Safety.

3. Observance of ethics and law conditions could be done in frame of telemedicine deontology.

Telemedicine Deontology is a professional etiquette and a complex of moral requirements for the persons practising a telemedicine, principles of behaviour for medical, technical and support personnel.

Main problems of telemedicine deontology:

1. Observance of laws and ethical norms
2. Preservation of Medical Information
3. Attitudes — doctor-patient-information system”
5. Attitudes— inquirer-coordinator-adviser”, “doctor-technician”
6. Physical and information safety of telemedicine systems
7. Standardisation and documentation
8. Information consent

For teleconsultation practice we should understand and adopt next rules:

1. Teleconsultation is used for the help in acceptance of the clinical decision.
2. Last decision must be accepted by the attending physician (inquirer).
3. The attending “face-to-face” physician should bear all responsibility for the patient due to using or not using of recommendations of the distant expert.
4. Information consent and signed agreement of patient should be best practice.
5. Main ways for teleconsultation safety: patients consent, anonymisation, login/password access for all telemedical work stations, digital signature system.

So, after remote discussion expert should prepare formal conclusion, which consist from:

1. General part (identifier of the patient, date and time of inquiry, date and time of conclusion, advisers’ full name, place of work, degrees, posts) - text format.
2. Conclusion (answers to questions of the inquirer, additional information) - text format
3. Appendix (explaining Figures, example of the similar clinical case, the references to the literature and Internet etc.) - any format (text, graphic files, video etc).

Note that the Appendix is most important part, because opinion of expert should have evidence-based background.

Thus, choice of technology for teleconsultation (e-mail, IP-phone, videoconference etc) should be first of all grounded at medical targets, available recourses and clinical situation. Author has propose approaches and decisions for main steps of daily clinical telemedicine, include indications for teleconsultation, ways and methods for digitalisation of medical information, ethical rules, telemedicine case record description.

EFFICIENCY OF TELECONSULTATION

Usually researchers consider financial benefits (Bergmo,1997, PalaninathaRaja,2006), changes of clinical parameters (Chan,2000, Lambrecht,1997, Vladzmyrskyy,2004), moral, technical aspects and management improvements (Aoki,2003, Rosser,2000, Siden,1998, Rendina,1998) of teleconsultations. The complex estimation of quality of telemedical consultation is extremely actual question. Such method should be reliable, simple and accessible for any researcher (scientists, medical doctor, decision maker etc.). It should be the set of objective criteria which it would be possible

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Table 1. Scale for objective judgment of teleconsultation's relevance

1. Terms. Teleconsultation is lead:		
	Before the necessary terms	3
	In the necessary terms	3
	After necessary terms	2
	In terms of full loss of the urgency	1
2. Conformity of answers:		
	Full conformity	3
	Incomplete conformity of answers to questions, an illegibility of formulations and recommendations	2
	Discrepancy of answers to questions	1
3. Presence of the additional confirming information (articles, links, references, similar clinical cases etc), evidence-based recommendations:		
	Yes	3
	No	1
4. Influence on the clinical tactics:		
	Tactics of the adviser is completely accepted	3
	Essential change of own tactics	2
	Acknowledgement of own tactics	2
	Refusal of adviser's recommendations	1
5. Inquiry for additional diagnostic tests:		
	No/ Accessible tests	3
	Accessible tests with an investment of significant expenses (work, money)	2
	Inaccessible tests	1
6. Expert has propose:		
	One clinical program	3
	A few clinical programs	2
	Preconditions for formation of the program	1
7. A few distant experts take a part:		
	Yes	3
	No	1
8. Transportation after teleconsultation		
	Yes	1
	No	3

to use for statistical processing with the purpose of comparison, studying of different kinds of telemedical consultations etc.

Author has propose three groups of parameters: relevance, economic feasibility, quality indicators.

Relevance. In some sources for the characteristic of efficiency of telemedicine the term

“relevance” is used. In modern informatics relevance in information retrieval, measures a document's applicability to a given subject or query. For telemedicine I am offered the following formulation.

Relevance of teleconsultation: Conformity of the distant adviser's answer to information and medical needs of the attending physician (inquirer).

There are two kinds of an estimation of relevance (Rel): subjective and objective. In the clinical practice for value judgment we are use an approximate individual estimation on 3 mark scale: discrepancy of answers to questions - 1 point; incomplete conformity of answers to questions, an illegibility of formulations and recommendations - 2 points; full conformity of answers to questions, presence of the additional confirming information (articles, links, references, similar clinical cases etc) - 3 points. By the given scale it is possible to define quantity and relative density of high, average and low relevant answers in group of homogeneous teleconsultations (by pathology, by technical system etc).

For an objective estimation author had developed the questionnaire (see table). The questionnaire for definition of relevance includes 7 questions with several variants of answers. Each answer is estimated from 1 up to 3 points. The score within the limits of 17-21 points shows on high, 12-16 - average, 7-11 - low relevance of the lead teleconsultation. Also, there is an opportunity to define relevance for telemedical system (Rel_{sys}) for the some period of time:

$$Rel_{sys} = \frac{TK_{rel}}{TK}$$

TK_{rel} - quantity of teleconsultations with specific relevance (high and/or average), TK - total quantity of teleconsultations. Accordingly, in ideal situation this parameter aspires to 1.

Economic feasibility. Most often define the prime price (S_{tk}) and profitability (R_{tk}) of teleconsultations. Definition of one teleconsultation's cost can be spent proceeding according laws and instructions accepted in the given state (at the base of calculation of the cost price of medical service). For example, calculation of cost of simple medical service:

$$S=S1+S2=Z+H+M+I+O+P,$$

S1 - direct charges, S2 - indirect charges, Z - salary, H - taxes, M - charges for medicines,

equipment etc, I - deterioration of materials, O - deterioration of equipment, P - miscellaneous costs.

Also, it is possible to use already developed methods. For example, the cost price of telemedical service (teleconsultation) by Kamaev et al, 2001:

$$S_{tk}=(S1+S2+S3) * (1+S)+A+D+C+G+SO+P,$$

S1- salary of the medical personnel; S2 - salary of the technician personnel; S3 - salary of the other personnel (administrative, auxiliary); S - deductions in social funds; A - amortization of the equipment; D - deterioration of equipment; C - cost of materials; G - general charges of establishment, SO - services of other organizations (providers etc); P- profit.

Profitability (R_{tk}) of telemedicine services of hospital, clinics etc is defined by the formula (where C – price of rendered services, S – prime cost of rendered services):

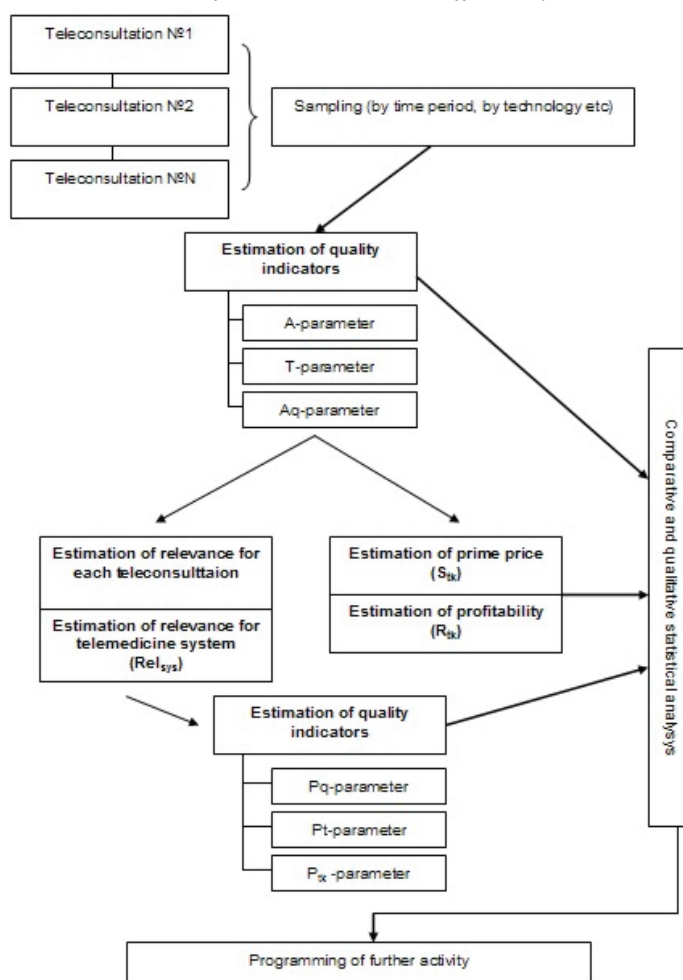
$$R_{tk} = \frac{C - S}{C}.$$

After calculation of S_{tk} and R_{tk} researcher can compare results with other services. For example, there is an opportunity to economically compare telemedical consultation and traditional consultation.

Quality Indicators

Quality indicators estimate for certain sample of teleconsultations. For example, lead in the certain period of time or by specific technology. There are five quality indicators: parameter of presence/absence of the expert's answer (A); parameter of average duration (T); average quantity of the experts' answers (Aq); timeliness of teleconsultations (Pt); quality of teleconsultations (Pq). First three indicators are most simple. The A-parameter can have two values: 0 - absence of the answer, 1 - presence of the answer. It is possible to define

Figure 5. Algorithm for an estimation of teleconsultations' efficiency



a parity of taken place and not taken place teleconsultations by A-parameter. The T-parameter estimate for sample of teleconsultations as an arithmetical mean (in numerator - the sum of durations of all teleconsultations, in denominator - quantity of teleconsultations):

$$\bar{T} = \frac{\sum_{i=1}^n T_i}{n}.$$

The Aq-parameter estimation, at the base of [14] (in numerator - quantity of answers (experts), in denominator - quantity of teleconsultations):

$$\bar{Aq} = \frac{\sum_{i=1}^n Aq_i}{n}.$$

Timeliness of teleconsultations (Pt) estimate on the basis of method by [4] (in numerator - quantity of duly received teleconsultations during certain time, in denominator - total quantity of teleconsultations for the same period of time):

$$Pt = \frac{m(t \leq t_{cert})}{n_t}.$$

Quality of teleconsultations (Pq) also estimate on the basis of method by [4] (m - quantity of

teleconsultations of admissible quality, n - total quantity of teleconsultations):

$$Pq = \frac{m}{n}.$$

It is possible to understand “quality of teleconsultation” as relevance or other certain estimation, for example, the quantity of teleconsultations with more than one answer so on. With help of two last criteria we can calculate probability of effective teleconsultation - (P_{tk}) (Gerasimov et al,2006):

$$P_{tk} = P_t * P_q,$$

In ideal situation this parameter aspires to 1. By P_{tk} - parameter researcher can estimate activity of telemedical system in general and, moreover, predict efficiency of teleconsultation after introduction of some technical, clinical, organizational, economical decision for telemedicine.

In Figure 5 you can see an algorithm for an estimation of teleconsultations’ efficiency on the basis of the offered complex method.

Thus, there are three groups of parameters in complex method for investigation of efficiency (quality) of telemedicine consultations: relevance (Rel , Rel_{sys}), economic feasibility (compare of prime price (S_{tk}) and profitability (R_{tk})), quality indicators (A-parameter of answers, T-parameter of duration, Aq-parameter of answers’ quantity, Pt-parameter of timeliness, Pq-parameter of quality, and also P_{tk} - probability of effective teleconsultation). In clinical practice it is better to use given method by special algorithm.

CONCLUSION

Thus, clinical teleconsultation is the process which include gathering of telemedicine work station, choice of telecommunication kind, participation of four parties (Inquirer, Adviser, Coordinator and Assistant - everyone of them has own special aims and functions), digitalisation of medical

information, generation of telemedicine case record, information exchange, estimation of results and outcomes. Wide improvement of an effective telemedicine consultation systems in daily clinical practice open new ways for increasing of health care quality and capacity, “bring on” special care to rural and remote areas, makes clinical decisions easy and better.

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KEY TERMS

Adviser: Expert or group of the experts considering the clinical case which was presented for the teleconsultation.

Assistant: Technical expert serving telemedical system.

Coordinator: Physician/nurse, expert in the field of computer technologies and telemedical procedures, which provides uninterrupted work on realization of telemedical procedures.

CT: Abbreviation of Computer Tomography.

Inquirer: Legal or physical person representing a clinical case for the teleconsultation. Most frequently inquirer is the "face-to-face" physician/nurse, also - patient or relatives (in case of self-reference for teleconsultation, "second opinion").

IP: Abbreviation of Internet Protocol.

ISDN: Abbreviation of Integrated Service Digital Network.

MRI: Abbreviation of Magnetic Resonance Imaging.

MMS: Abbreviation of Multimedia Messaging System.

Relevance of Teleconsultation: Conformity of the distant adviser's answer to information and medical needs of the attending physician (inquirer).

Teleconsultation (Telemedicine, Remote Consultation): Remote discussion of the clinical case via special computer information and telecommunication system to get answers to precisely formulated questions for the help in clinical decisions.

Telemedicine Deontology: Is a professional etiquette and a complex of moral requirements for the persons practising a telemedicine, principles of behaviour for medical, technical and support personnel.

Telemedicine Work Station (TWS): Complex of the hardware and software (multitask

workplace) with opportunities of digitalization, input, processing, transformation, conclusion, classification and archiving of the any kinds of the medical information and realization of telemedical procedures (teleconsultation).

TWS: Abbreviation of Telemedicine Work Station.