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SECURE WAYS OF CLINICAL DATA DELIVERY AND PRESENTATION TO REMOTE SPECIALIST: THE PROBLEM OF CHOICE

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Telemedicine is a highly IT-demanding branch of healthcare. The development of means which allow medical specialist to consult remotely, i.e. not being on site, is one of the important telemedicine tasks. The advices of remote consultant are based on clinical data which consist of anamnesis, results of clinical examination, and results of other medical tests. Telemedicine system is a set of equipment and software designed to perform medical tests and send the results to remote consultant. Telemedicine system may consist not only of such simple devices as tonometer or electronic thermometer but also of electrocardiograph, rheograph, spirograph, and even electroencephalograph. While telemedicine system is designed to be operated by physician or even nurse, the analysis and interpretation of tests taken by means of latter devices can be performed only by doctor of corresponding specialty, i.e. remote consultant in general case.

This article presents a review of basic secure ways of clinical data delivery via public communications links. Advantages and disadvantages of each of them are also discussed. Security we consider traditionally as confidentiality, integrity, and availability of transmitted data. Also we discuss issues related to clinical data presentation, and show that in some cases the way of data delivery and the way of data presentation are the same.

Problems of establishing of videoconference between physician and remote consultant have been investigated well before [1, 2] so we leave them alone. Here we consider problems related to transmission and presentation of medical tests results, and results of automated analysis performed by software of devices comprising telemedicine system. For short we will use the phrase 'investigation results' to denote these two types of results combined together, and the word 'investigation' to denote a medical test itself.

As mentioned before a telemedicine system consists of automated hardware and software systems designed to carry out different types of investigations. As a rule most of these parts being designed independently and has been finished before the telemedicine system development is started. Creators of the appropriate software were unaware of the future use of their products. In general case there is no way to export investigation results at all, or no way to do it programmatically. Moreover, in the most of fields (electrocardiography, rheography, electroencephalography) there are either no international standards on storage format of investigation results, or, if standards exist, developers do not follow them, preferring to implement their own home-made formats.

Thus, in general case investigation results are available either as a set of screenshots or as a file or a set of files in some proprietary format. All this impose a strong restrictions on the choice of variants of presentation of investigation results to remote consultant. Here they come.

1. Transferring results to consultant's workplace in the original format.

Advantages:

— do not require telemedicine system developer to put efforts on the analysis of formats and writing of converters;

— makes possible to reanalyze investigation data using different initial conditions.

Disadvantages:

— requires to install (possibly buying additional licenses) software of the parts of the telemedicine system at consultant's workplace.

2. Exporting results to some intermediate format with subsequent conversion to the format readable by standard web browser.

Advantages:

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— do not require to install software of parts of the telemedicine system at consultant's workplace.

Disadvantages:

— involves huge overhead on the analysis of proprietary formats and writing of converters;

— not always can be implemented: some parts of the telemedicine system may turn out to be closed systems not providing export functions and even prohibiting making of screenshots.

— exported analysis results are static, it is not possible to reanalyze investigation data using different initial conditions.

3. Transferring results in the original format to web server which run software of the parts of telemedicine system, and publishing html-based version of its GUI using SSL protocol. This way of data presentation at the same time solves the task of data delivery.

Advantages:

— requires only one set of proprietary software installed outside telemedicine system;

— makes possible to reanalyze investigation data using different initial conditions.

Disadvantages:

— it is the most laborious way for telemedicine system software developer, and for parties maintaining system during operations;

— not always can be implemented: for some parts of the telemedicine system such usage may be hampered by technical issues or simply prohibited legally;

— requires the maintenance of web server.

4. Setting up terminal access into telemedicine system internal network or remote desktop access to one of telemedicine system workstations. This way of data presentation also solves the task of data delivery.

Advantages:

— makes possible for remote consultant not only view investigation results, but also take part in their carrying out in real time;

— do not require to install software of parts of the telemedicine system at consultant's workplace;

— makes possible to reanalyze investigation data using different initial conditions.

Disadvantages:

— the terminal client access license may be required;

— the maintenance of terminal server in telemedicine system network may be required;

— telemedicine system must be online at the moment of remote consultation.

Now let us consider the basic ways of investigation results delivery.

1. Electronic mail (e-mail).

There is paradoxical situation around e-mail. Being the most popular way of communication, it is becoming the most unreliable one. The paradox is that not the growing flow of unsolicited messages (spam) is to blame, but the automatic means of fighting it. Typical agreement an ISP offers to sign as a rule has a clause, giving it right to block the reception of e-mails, initiated or transferred by 'blacklisted' sites. In general case an electronic letter may never be delivered to recipient, and what is worse, not recipient would be notified about the attempt of sending something to him, nor sender — about termination of his letter [3]. Thus, nowadays e-mail can not provide availability of data required in telemedicine.

The only exception is to use mail server(s), maintained by telemedicine system developers themselves. But this is degenerate case, functionally indistinguishable from

2. File transfer protocol (FTP).

Advantages: much more reliable than e-mail.

Disadvantages:

— although it is possible to password-protect FTP account, data transfer is carried out in plain form, i.e. to provide required in telemedicine confidentiality and integrity of information it is mandatory for sender to encrypt and sign, and for recipient to verify the signature and decrypt transferred via FTP data using some external tool. This disadvantage can be mitigated by use of

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SFTP (SSH File Transfer Protocol), or FTPS (FTP over SSL), but these protocols less widely in use comparing to original FTP.

— requires the maintenance of FTP server.

3. Publicly available file sharing or webmail resources hosted by huge corporations (e.g. gmail.com, rapidshare.com, mail.ru).

The main advantages is the maximum availability of information placed on them and the fact that server maintenance is performed by very reliable third party, guaranteeing one of the best uptime in the industry [4].

Disadvantages:

— confidentiality and integrity of information are not better than FTP can offer;

— difficulties with or impossibility of automatic data exchange (most of the public file sharing services use CAPTCHAs [5] to prevent automated use).

4. Virtual private network (VPN) technologies.

Allow to include consultant's workstation into telemedicine system network, which make possible to transfer data using shared folders, internal FTP or mail servers etc. The disadvantage is the necessity of maintenance of VPN server in telemedicine system network.

5. SSL-based solutions (see the way of data presentation #3).

6. Terminal or remote desktop access (see the way of data presentation #4).

Three latter ways of data delivery enjoy very important advantage: implemented in their protocol end-to-end encryption.

As you can see, some of the mentioned ways of data delivery can be at the same time the way of data presentation and vice versa. Also most of them allow to combine themselves with others, e.g. it is possible to access remote desktop through pre-established VPN tunnel etc.

In conclusion we should state that at this time there are no unconditionally preferable ways of delivery or presentation of clinical data collected by telemedicine system. Each way has its pros and cons and the choice should be made taking into consideration the following factors:

— tasks of telemedicine system being developed;

— availability of communication links in the area of system deployment;

— features and license agreements of third-party software comprising system;

— the budget for software development;

— the budget for system maintenance during usage period;

— scope of future consultants and easiness of access to their equipment.

We hope this review can be of use to present telemedicine systems developers or parties, who plan to develop ones in the near future.

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