Success of Teleradiology as a Confirmation of Radiological Excellence

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Abstract. This paper proposes criteria for success of teleradiological solutions. Criteria for integration of teleradiology solution in the complete radiological workflow were especially considered, and we have shown that teleradiology is an inseparable part of complete radiological workflow. Success of integrated ris/pacs teleradiology solution is also shown by example.

Keywords: teleradiology, RIS/PACS, radiological workflow, web enabled teleradiology

1. Introduction

Teleradiology is defined as electronic transmission of radiological images from imaging station to remote station with a purpose of examining radiological images, write report or teleconsult with another radiologist.

Beside necessity and numerous benefits of teleradiology, its usage is still not common in Croatian practice and broader. Successful implementations are few.

In this paper we will propose criteria for successful teleradiology implementations and analyze importance of complete radiological workflow.

2. Success of teleradiology

2.1. Successful teleradiology

Minimal conditions that describe successful teleradiological solutions are:

1. Time of image retrieval must be practical enough to enable normal functioning.
2. Solution must be robust and reliable, without repeating actions and system errors during image retrieval or image processing.
3. Images have to be transmitted and received in full diagnostic quality – DICOM, lossless compression.
4. Image processing and reporting must be practical and enabled with minimum number of logical and intuitive steps.
5. Solution supports 2D and 3D set of image processing tools.
6. Teleradiological solution must be safe and secure.
7. Solution must be integrated in complete radiological workflow of a head institution, because of integrity of radiological exam and unique connection of patient with exam, images and report.

Specified conditions can be grouped in those depending of telecommunication infrastructure (1-3), software solution (4-6) and complete radiological workflow of a head clinic/hospital (7).

2.2. Unsuccessful teleradiology

Teleradiological solutions that have not emerged in practical everyday usage and don't fulfill above mentioned minimal conditions, cannot be called successful.

Usual barriers for successful implementation of teleradiological solutions are problems in telecommunication infrastructure, high prices and/or unavailability of broadband internet. Even in cases when there isn't this barrier, teleradiological solutions are usually too complicated, unpractical for usage and without needed functionalities.
2.3. Benefits of successful teleradiology

With successful appliance of teleradiology significant benefits are carried out [1] to all participants: patients in the first place, local radiologists, remote specialists, investors and to whole society. Benefits for patient are:

- availability of top specialists,
- there are no costs of traveling and accommodation,
- no need for carrying and saving images,
- without absence on workplace,
- shorten time of anxiety
- report is written in very short time

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Local radiologists with such solutions have support from remote radiologists and can make personal professional progress through cooperation with remote radiologists.

Remote radiologists or other specialists don't need to travel to institutions and can also make personal professional progress because of higher possibility to handle statistically rare clinical cases.

Outcome for investors is: decreased need for local specialists, optimization of resource allocation, and elimination of travel and accommodation costs, accumulation of knowledge. Greater availability of offered services means greater income. Greater quality of offered services means attraction of greater number of patients, and lowered film costs.

For whole society successful teleradiology brings greater quality, effectivness and availability of health care. Possibility of offering top health services in remote rural places, such as Croatian islands, is great benefit. With that comes possibility of employment health care workers in such remote locations. Indirect results are lower illness and mortality, lowered absence from workplace.

2.4. Success of teleradiology in Croatia

Teleradiology in practice has started during nineties of past century. Image transfer has been established between hospitals in Zagreb, Split and Dubrovnik. Images have been transferred as a JPEG images in non diagnostic quality, until 2007 when Infomedica has established first Croatian DICOM based teleradiology system. Nowadays there are different foreign vendors in

![Figure 1. Example of radiological workflow](image-url)
Croatia that offer teleradiology solutions, but only Infomedica's solution works in everyday practice.

3. Teleradiology as part of complete radiological workflow

3.1. Radiological workflow

Paper is going to show diagram of simple radiological workflow which consolidates all segments of radiological department/clinic work process. Shown workflow consists of patient admission, modality work list generation, imaging procedure and image storing in archive with collection all additional exam information, image retrieval, processing, report generation and expenses charging.

It is considered that there are widely accepted and well-known advantages of integrated radiological workflow [2], therefore it will be not considered here. It will be highlighted that world practice has shown that integrated RIS/PACS solutions are optimal regarding independent RIS and PACS systems, because they allow implementation of optimal and for user very useful radiological workflow[3]. In such way they introduce base for radiological excellence.

3.2. Teleradiology position in radiological workflow

We will consider an example of typical teleradiology task, where remote specialist has to write report based on images retrieved from RIS/PACS archive.

If we extract part of the process which is oriented towards reporting and represents task for remote specialist – it can be noticed that there is not such process just for itself, but it exchanges images and data with other processes in workflow.

Elaboration of teleradiological reporting:
1. to provide teleradiologist his worklist with all exams which are waiting for reporting,
2. on demand provide exams DICOM images,
3. to provide all tools for image processing and analyzing,
4. to provide reporting and to store written report,
5. signal to system that report has been written.

Work process on radiological department/clinic will not differ in this case from already shown typical radiological workflow, and it is clear that teleradiology is just a way of technological implementation of one part of radiological workflow in radiology department/clinic – and that it completely depend on complete radiological workflow.

3.3. Different teleradiological scenarios

Except already mentioned reporting, there are many other work processes that can be implemented as a teleradiological solution:
– second opinion
– consultant opinion
– report and exam insight by general practice physicians
– expansion of mentioned scenarios by chat, video chat or whiteboard
– more complex solution for teleradiological centers
– post image processing on demand (3D reconstructions, virtual endoscopy...)
– remote image printing

All scenarios represent only different variations of basic radiological workflow and by their decomposition this papers basic thesis, that teleradiological systems are just part of complete radiological workflow, is confirmed. Therefore, successful teleradiological solution can be viewed solely in context of successful radiological workflow.

4. Example of successful teleradiology practice

Successful platform for teleradiology over Internet is shown on practical example of
radiological clinic in which is implemented integrated HIS/RIS/PACS system. All radiological and work processes are completely digitalized and informatitized according to DICOM standard.

Because of radiologist shortage on radiological clinic geographical location, management of clinic has made contract with radiologists from other cities in Croatia, to establish reporting for patients imaged on MR and CT devices. Radiologists, using only internet browser, completely accomplish teleradiological workflow:

1. Radiologist using internet browser (Internet Explorer, Mozilla Firefox...) enters internet address of teleradiological system.
2. Using unique username and password, radiologist logins into the system.
3. Radiologist accepts worklist for patient exams he/her needs to write report for.
4. For every single patient radiologist chooses series of DICOM images and by click retrieves them from RIS/PACS server and loads them into the 2D/3D

![Diagram](image)

**Figure 3.** Example of teleradiological system in case of radiological clinic, shows teleradiological workflow, which is based on integrated HIS/RIS/PACS system, and figure shows complementarity of both systems.
image viewer.

5. Image analysis and processing is next step in workflow

6. Radiologist write report / second opinion / consultant opinion

7. Exit from system.

Using described teleradiological system, specialists are provided with possibility of using internet browser only from remote locations, to analyze images in full diagnostic quality and write reports or second opinion. Described teleradiology system is web enabled ris/pacs system.

5. Conclusion

Successful implementation of teleradiological solution is based on idea of diagnostic quality images available by security rights, uniquely identified by exam information, retrieved to remote location in the fastest, safest and most acceptable way for user - without compromise in quality and image processing functionalities and reporting.

Technological solution of image transfer from one to another location is important, but only one of the parts of the whole system necessary to make teleradiological system successful. Teleradiology is not isolated part of radiological workflow, but it is integral part success of which depends on successful implementation of complete radiological workflow.

6. References

