
DIGITAL PATHOLOGY AND TELEPATHOLOGY IN TRANSPLANTATION: FEASIBILITY WITH THE EHR

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Abstract

Digital pathology and telepathology play an emerging role conveying anatomical pathology diagnostic images in the Electronic Health Record. We sought to focus our attention to an innovative project, while identifying standards and practices between clinicians and the EHR (Electronic Health Record). The project aims at developing a second opinion network, based on telepathology, between two major transplantation centres over two years. The health authorities involved are the Hospital Trust of Verona and of Padua (Italy). In 2015 there were 376 renal and liver transplantations for both centres. We expect to significantly improve the transplantation workflow after combining the digital pathology platform with its proper and timely application in the telepathology network. Firstly it will allow the real time second opinion between pathologists in order to assess the suitability of the donor organs, avoiding the glass-slide transfer, with potential damage or loss. The technical partners delivered two slide scanners and software solutions to enable virtual microscopy and web-based digital slide sharing with storage resources. In addition, the project comprises an online survey which focuses on the accountability of the system, the user perception, and a concordance study for the project outcomes evaluation. The technical transactions between all the main actors and digital slides will be reviewed and updated in order to meet the integration standards and guideline according to IHE (Integrating the Healthcare Enterprise) initiative, Digital Imaging and Communications in Medicine (DICOM) and Health Level 7 (HL7). According to the first comparisons, we believe that the efforts to provide this new diagnostic imaging area to the actual EHR developments, will be rewarding and effective for the saving-life transplantation processes.

Keywords: telehealth; informatics; eHealth; telepathology; transplantation

Introduction

Digital pathology and telepathology play an emerging role conveying anatomical pathology diagnostic images and reports in the EHR (Electronic Health Record) in Anatomic Pathology Units, aiming at enhancing the healthcare process.^{1,2} We have a regional platform in Veneto Region (Northeast, Italy), promoting the EHR model as a HIE (Health Information Exchange) System. The electronic record guarantees clinical data are shared with all Local Health Authorities and Hospital Trusts.

The innovation of the proposed model lies in sharing the whole process with professionals working inside the healthcare regional system. This is the result of a bottom-up approach that is intended to make the EHR a working tool capable of answering the professionals' questions in an advanced and efficient way. Once ready, the tool will offer a number of advantages by providing resources to improve healthcare affordable at the regional level. The bottom-up approach is exemplified by a model shared by all the actors of the healthcare system.

We first focussed attention on the identification of standards and practices between clinicians and the EHR model specifically in the transplantation's digital pathology processes. The project aims at developing a second opinion network, based on telepathology, between the two major transplantation centres. The Health Authorities involved are the Hospital Trust of Verona and the Hospital Trust of Padua (Italy).

According to official regional documentation, there were 376 renal and liver transplantations for both centres in 2015, which represents more than ten percent of the Italian transplant activities related to these organs.³

We expect to significantly improve the transplantation workflow after combining the digital pathology platform with the telepathology network and the EHR. Transplantation is an urgent life saving medical activity that can take 12 -24 hours per transplant. It requires 24 hour services supported by 55 employees.

The digital platform will allow the real time second opinion between pathologists in order to assess the suitability of the donor organs, avoiding the time needed to transfer histopathological glass-slides between sites with the associated problems of be transferred, with potential damage or loss.^{4,5} Other features might be added to integrate with the EHR, which is properly linked to the population data according to the regional specifications (Unique Master Patient Index), in order to provide any previous relevant reports. This integration, as well as every step of the process, shall respect the national Privacy regulations.⁶

In the project design, we scheduled eight months for the reliability study application and to assure the second opinion features and functionalities that will follow. The aim of the reliability study is mainly to make the clinicians confident with the new reporting system. Many studies have shown that the WSI (Whole Slide Imaging) during diagnostics compares positively to the conventional glass slide interpretation.⁷⁻⁹

The technical partners of our initiative have delivered two slide scanners with software solutions to enable virtual microscopy and web-based digital slide sharing and storage resources. Each scanner is a compact device which has a two slide slot capacity, with 4x, 20x and 40x objectives. The functionalities include: live microscopy, virtual live microscopy, scan (fast-preview, precise, z-stack) and image storage, slide navigation, upload from the database archive, image analysis modules (membranes, nuclei), image export in JPEG 2000 format, user authentication and login, and barcode reading (1D, 2D). Image analysis is a useful application in this context and it is appreciated by the pathologists.^{10,11} The performance of the device allows scans 5 cm² at 20x, which is the average slide content area, in less than 12 minutes.

According to the project needs, the estimated minimum requirements are: 2 TB of storage per year for the concordance study and second opinion and on average bandwidth of 10 Mbps. The regional network has higher throughput (30 Mbps).¹²

The second opinion is based on a common evaluation grid. The pathologists agreed on the use of a standard scale to quantify the morphological features of the liver and kidney. At the same time the entire reporting sheet takes into account histopathological findings viewed on different organs evaluated during the single transplantation process.

We recorded a training set videos and a dedicated You Tube private channel containing multiple updated tutorials. (Figure 1) Thus the pathologists are able to perform the digitisation and reporting on the digital slide both on site and remotely even if they were formerly trained a while ago. Moreover, the project includes an online survey which focuses on the accountability of the system, the user's perceptions and the concordance study, according to HTA (Health Technology Assessment) methodologies.¹³ The questionnaire is available under the reserved section of a dedicated web portal.



Figure 1. A training session.

Every user who is allowed to submit the questionnaire, is able to log in to the web portal and may submit a survey for every case. Each case is performed with both reporting systems: the traditional one with the microscope and the digital pathology unit. The survey for the concordance is structured around five parts: general study information, traditional reporting with light optic microscope, digital pathology reporting, digitised data and user perception of the reporting. The purpose of each section is to evaluate the effectiveness and workflow benefits of the new reporting activity and the digital pathology system. The survey submissions are conveyed to a database which automatically populates the graphical dashboard, available in the portal.

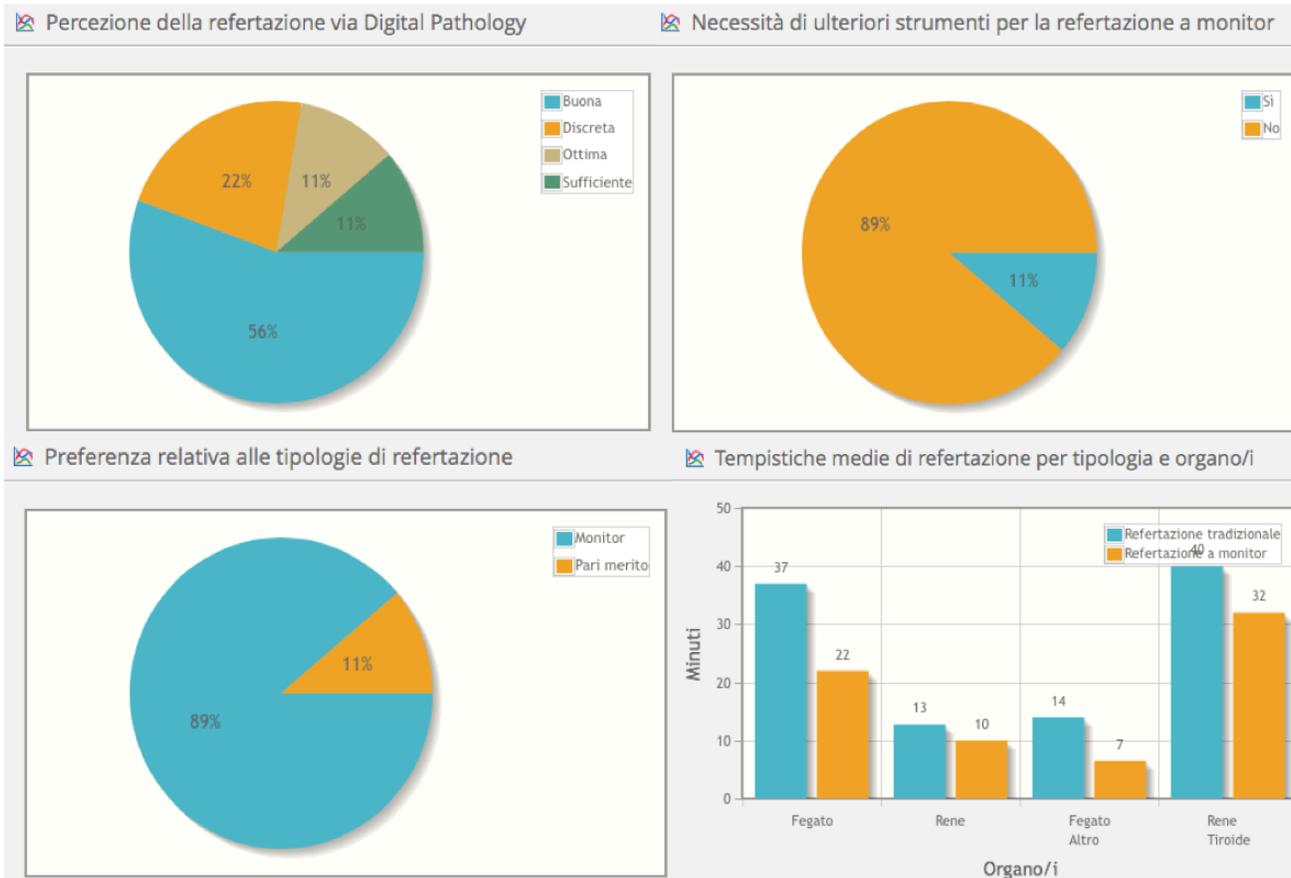


Figure 2. Dashboard reports.

Four examples of plots generated by the online submissions in the dashboard are shown in Figure 2. From the top left in a clockwise direction: Perception of digital pathology reporting (Excellent, Very good, Good, Fair, Poor), Need for more tools in the digital pathology reporting, Average minutes needed for the traditional reporting (blue bar) and digital pathology (orange bar), Preference on the type of reporting (traditional, monitor, neutral).

The goals of the initial project are divided into two main areas: technological and educational. From the first point of view we performed a technical review of the transactions between all the main actors, digital slide scanners and EHR in order to meet the integration standards and guideline according to IHE (Integrating the Healthcare Enterprise), Digital Imaging and Communications in Medicine (DICOM) and Health Level 7 (HL7).¹⁴⁻¹⁶

DICOM is a standard with a cooperative mission and DICOM is a standard with a cooperative mission and works to improve workflow efficiency and

compatibility between imaging systems and information systems (i.e. LIS Laboratory Information System). The DICOM WG (Working Group) dedicated to digital pathology is the WG 26.

The educational component has disseminated the potential of digital pathology between all the pathologists in the two Hospital Trusts involved. The group started with six physicians and by 2017 there were 25 participants and the number is growing. Future evaluation of the surveys will allow re-engineering and upgrade of the workflow, focus the effort on critical path or functions and create the basis for the new reporting method in the actual and future standard use.

According to the first comparisons, we believe that the efforts to provide this new diagnostic imaging area to the actual EHR developments, will be rewarding and effective for the saving-life transplantation processes.

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Conflict of Interest. The authors declare no conflicts of interest.

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