iPath – a Telemedicine Platform to Support Health Providers in Low Resource Settings

K Brauchli*, D O'Mahony**, L Banach*** and M Oberholzer*
*Department of Pathology, University Hospital Basel, Switzerland
**Family Practitioner, Port St Johns, South Africa
***Telemedicine Unit, University of Transkei, South Africa

In many developing countries there is an acute shortage of medical specialists. The specialists and services that are available are usually concentrated in cities and health workers in rural health care, who serve most of the population, are isolated from specialist support[1]. Besides, the few remaining specialist are often isolated from colleagues. With the recent development in information and communication technologies, new option for telemedicine and generally for sharing knowledge at a distance are becoming increasingly accessible to health workers also in developing countries. Since 2001 the Department of Pathology in Basel, Switzerland is operating an Internet based telemedicine platform to assist health workers in developing countries. Over 1800 consultation have been performed since. This paper will give an introduction to iPath - the telemedicine platform developed for this project – and analyse two case studies: a teledermatology project from South Africa and a telepathology project from Solomon Islands.

Keywords: telemedicine, telepathology, Internet, developing countries, knowledge sharing

1. Introduction

Health providers like doctors and hospitals in developing countries often suffer from limited or non-existing access to specialists [1-4]. For example, the National Referral Hospital (NRH) in Honiara, the only major hospital on Solomon Islands serves a population of approximately 450'000 people and there is not a single pathologists or dermatologist. In 2001, a simple histology laboratory was set up in Honiara. Microscopic slides are prepared in the lab and subsequently photographed with a digital camera and submitted via email to an Internet-based telemedicine platform located at the University of Basel, Switzerland. Several pathologists in Europe review these images and within 8.5 hours (median) a diagnosis is made available to the surgeon in Honiara [4].

Following the successful example of telepathology in Honiara, other projects started using that telemedicine platform and now there are approximately 70 consultations from developing countries every month. While pathology had been the first applications, there are now several teledermatology projects in Africa using this platform and also one large project for neonatology consultations in Ukraine.

In all these examples, telemedicine is not used directly by the patient but primarily by doctors and nurses who need the additional input from specialists to improve the services that they are delivering.

2. iPath – a hybrid web and email based telemedicine platform

Since 2001, the Department of Pathology of the University Hospital Basel has been developing the iPath software (http://ipath.ch), an open source framework for building web and email based telemedicine application [5-6]. iPath provides the functionality to store medical cases with attached images and other documents into closed user groups (c.f. Fig 1). Within these groups, users can review cases, and write comments and diagnosis. Additionally, users can subscribe for notifications so that they get an automatic email if e.g. a new comment was added to one of their cases or if a new case is entered into a group.

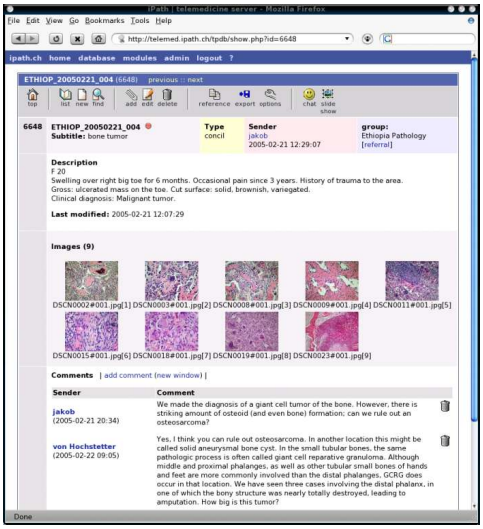

Figure 1. a typical case in iPath. This is an example of a telepathology consultation from Ethiopia. At the top there is the general case information (sender, submission date) followed by a clinical description and an image gallery. Below, specialists can state their comments and diagnosis.

Technically, iPath is a web application written in PHP. From the functionality it is somewhere between a content management system (CMS) and a group-ware tool. All users are organised into several discussion groups. Every discussion group has at least one moderator who can assign other users to the group and who can delete erroneous data. Thus, the system does not need to be administrated centrally as every group is administrating itself [5].

A very useful function of iPath, especially for areas with limited resources is the automatic email import. Users must once specify a group into which they would like to store cases sent by email. Then they can send a case to iPath as an ordinary email from any email client, typing the case title as the subject of the email, the clinical description as main text and simply attaching images. iPath will automatically import such cases into the group specified. Table 1 illustrates that out of 1798 cases submitted from developing countries, 74% were submitted by email (compared to 32% of all case submissions world wide)

The iPath software has been released as an open source project that can be used for regional networks and by other projects. Currently, the main usage of iPath is the telepathology network at the University of Basel with over 1000 users world wide (c.f. Section 2.1). However, we are aware of iPath being used for regional telemedicine networks in South Africa, Nepal, North West US, West Africa, Switzerland and in Germany. However, as the code is freely available, there might be more applications that we are not aware of.

2.1.Telemedicine platform at University of Basel

Since 2001, the Department of Pathology of the University Hospital Basel, Switzerland, is operating an open telemedicine platform based on iPath – http://telepath.patho.unibas.ch [4-6]. In the beginning the platform was mainly used for telepathology projects in Switzerland and for collaboration with some pathologists in developing countries. Meanwhile, the platform has over 1300 users and more than 5000 cases have been discussed so far (c.f. Tab.1). Besides the pathology projects at our department, the platform is used for a wide range of application – from telepathology on Solomon Islands[4] to neonatology discussion in Ukraine (59 users) to teledermatology consultations in Africa (over 50 consultations)

	Users	**Cases**	**Images**	**daily logins** (2004)	**submission by email**
total	1213	5016	33247*	38	32.12%
developing countries	84**	1798	14006		74.17%

Table 1. usage statistics of iPath (24.12.2004)
* average file size 93KB. Besides images there were another 5864 files (pdf, powerpoint etc)
** only 47% of users specified country of origin

Table 1 shows the basic usage statistics of this platform. By the end of 2004 there were 1213 users of which 84 had specified coming from a developing country (only 47% of all users specified a country of origin, so probably there are more form developing countries). Since the start of the project in September 2001 a total of 5016 cases with totally 33247 images have been sent to the server – on average 6.7 images per cases. The average image size was 93KB. If we look at developing countries only, there were 1798 cases submitted

with a total of 14006 images – on average 7.7 images per case. For the year 2004 there was an average of 67 consultations from developing countries submitted every month. Figure 2 illustrates the origin of all these consultations. The largest contribution was from a telepathology project at the Sihanouk Center of Hope in Phnom Penh, Cambodia, which submitted over 700 cases.

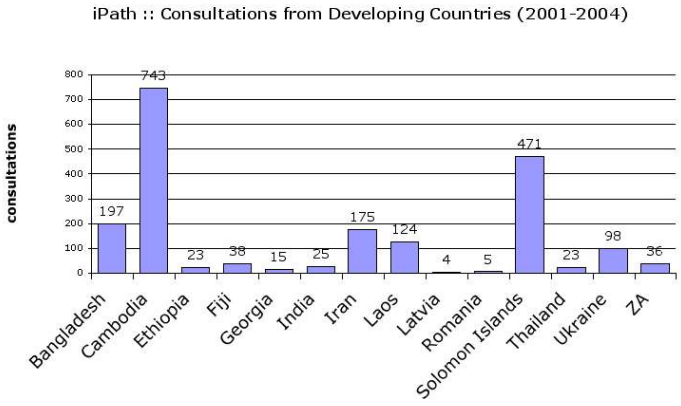

Figure 2. Consultations submitted from developing countries since the start of the iPath server in Basel in September 2001. Two major parts of the submissions are from the telepathology projects in Cambodia (743) and Solmon Islands (471).

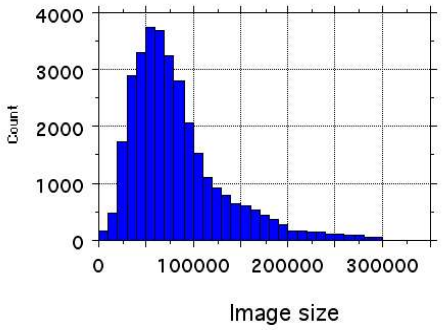

Figure 3. distribution of image size for consultations submitted to the Basel telepathology server. From September 2001 to December 2004 a total amount of 33'247 images with an average file size of 93KB have been submitted. (c.f. Table 1)

3. Case Studies

iPath is used for a wide range of telemedicine applications. To illustrate the practical application and outcome in low resource settings we will study two examples.

3.1.Teledermatology in Port St. Johns, South Africa

Port St. Johns is a small provincial town on the east coast of South Africa. It is located in the former Transkei which used to to be an "independent" homeland during the apartheid. Now, the region is one of the poorest in South Africa. In the rural Port St Johns district, the population numbers about 75 000, the majority of which lives below the poverty line. Primary health care is provided mainly by nurses at state funded clinics, supported by general practitioners in the public and private sectors. In the last decade, the number of doctors in the district has varied between two and six. The referral hospital at Umtata is 100 Km distant but since 1998, has no had a specialist dermatologist permanently. At times the closest dermatology specialists was in East London, 350km from Port St. Johns. Hence, family practitioners have to diagnose and treat practically all dermatology problems (~15% of all consultations). To improve access for patients to dermatological care and to improve family practitioner clinical skills, a teledermatology project was initiated in April 1999 [7]. The project started with email based store-and-forward teledermatology, and since 2002 it is using iPath. In the first year the server in Basel was used but since 2003 the Telemedicine Unit[7,8] of the University of Transkei (UNITRA) in Umtata is running a regional telemedicine network based on the iPath software (http://telemed.utr.ac.za) which is now being used by the teledermatology project in Port St. Johns.

For the telemedical consultations images are captured with a digital camera (first an Olympus C-1400XL and later an Fuji 2 mega-pixel). Images were resized using Adobe Photoshop or GIMP[1]. In the beginning images were submitted by plain email with attached pictures. However, text and pictures easily got separated and misfiled. Thus patient information and images were compiled into an html page which worked well but was a very time consuming process. Finally, using iPath, clinical information and images are sent by plain email to the iPath server, where they are automatically inserted into a database and presented to the dermatology specialist in form of a concise web page. Besides the ease of use, the automatic email notifications system of iPath has also helped to reduce turnaround times. From an average response time of over 30 days, it is now at 6.5 days since consultation are done using the iPath platform at UNITRA.

Since 1999, 110 patients from Port St. Johns have been diagnosed using teledermatology. 76 patients where female and 34 male with an average age of 32 years. In 105 cases a telemedical diagnosis was possible and in 104 cases this assistance was judged helpful by the general practitioner (GP). For 57 cases, the telemedical diagnosis enabled an improvement of the treatment (unpublished data, an evaluation of the project is in preparation). The major outcome however is not only the direct improvement for the patient but also the fact that teledermatology helped the GP to improve his skills in diagnosing and treating dermatology problems appropriately, or, citing the GP: "The number of cases

1 Open Source image manipulation program – http://www.gimp.org

dropped off over the years. This is definitely due to my improved skill in diagnosis due to learning."

3.2. Telepathology on Solomon Islands

The National Referral Hospital (NRH) in Honiara is the only major hospital in Solomon Islands, an independent state with approximately 450'000 inhabitants, tucked away in the south west of the pacific ocean. The NRH is the only referral hospital for the 8 provincial hospitals. The country has about 40 doctors but not a single pathologist and consequently tissue samples for histological examination have to be sent by airmail to the nearest pathology service in Brisbane, Australia and it is not unlikely that the doctors at the NRH have to wait 3-6 weeks before the histological diagnosis is returned from Brisbane. Besides, the state of Solomon Islands consists of over 900 islands, spread out over hundreds of kilometers. Patients from remote islands have to travel by boat for days to reach the hospital on the main island. For many patients it is difficult to return home to wait until a diagnostic result has arrived at the NRH and as a consequence, treatment decisions often have to be made without a histological diagnosis.

A small histology laboratory was established at the National Referral Hospital (NRH) in Honiara, Solomon Islands, in September 2001, allowing the preparation of H&E stained sections. Gross specimen are prepared by the surgeon, processed in the laboratory and the slides are usually ready two or three days later. From the microscopic sections prepared in this laboratory, digital photographs are taken using a Nikon CoolPix 990 Camera mounted on a Nikon OptiPhot 2 microscope. These pictures are usually scaled to approximately 600x400 pixels (typically 20KB - 70KB) then sent via email to the telepathology server at University of Basel[4].

During a two year period from January 2002 and December 2003 a total of 333 pathology consultations where submitted from NRH to the telepathology server in Basel. These consultations were submitted by email with a short clinical description and with images as attachments (average 8.8 images per consultation). In 50% of all consultations a first report from a pathologist was issued in 12h or less (cf. Table 2).

	Phase I	***Phase II***	***total***
Number of consultations	73	260	333
First response after (median)	28h	8.5h	12h
Consultation possible	93.2%	94.2%	94%
Additional images requested	24.7%	10%	13.2%

Table 2. Telepathology consultations from National Referral Hospital in Honiara, Solomon Islands. Phase I are the consultations before the introduction of the virtual institute (cf. text) which is the time from January 2002 to October 2002. Phase II describes the situation from November 2002 to December 2003 after the introduction of the virtual institute. The second line indicates the median time between submission of the case by email and the first response from a pathologist. (Figure from Brauchli et al. 2004)

A major improvement in the project was the introduction of a virtual institute[4,6]. A virtual institute is a group of experts with a duty plan. Every week one specialist is "on call" and the iPath system automatically notifies the "expert on call" about any new cases and also about new comments from other experts. Besides, the expert on call was asked to mark a diagnosis as final if in his or her opinion, a diagnostically conclusive response was possible based on the submitted material. This organisation helped to reduce the turn around time for diagnosis from 28h in the beginning (phase I in table 2) to 8.5h after the introduction of the virtual institute (phase II).

4. Discussion

When iPath was developed it was not primarily intended for telemedicine in low resource settings, however, it turned out that an easy to use telemedicine solution which does not have high demand on bandwidth can be a very helpful tool in developing countries. The platform has been very well used by health professionals working in developing countries to consult with specialists from other parts of the world to overcome the professional isolation often present in remote hospitals and to improve their skill and services they can deliver to their patients.

Looking at the usage of iPath over the past 3 years we can observe a number of different types of applications. Firstly there are remote consultations where typically a doctor at a remote hospital consults with a group of distant specialists. Secondly there is a growing number of general discussion groups (not only on iPath) where specialists working in isolation are sharing knowledge and experience with distant colleagues. Besides, iPath is more and more used for decentralised studies, where a number of partners are jointly collecting data on a special topic (research, quality control, etc). Data can be text, images and also custom forms for capturing structured data. The advantage of an Internet based solution is that every partner can at any time review the whole collection and compile statistics.

As iPath is developed as an open source project and distributed under the General Public License (GPL[2]) its use is not restricted to the telemedicine server of the University of Basel. The open source license allows other projects to use iPath and adapt it to their needs. As telemedicine is primarily used by specialists in centrally located institutions, it bears the risk of inducing a digital divide within a developing country if the periphery of the health system is not involved in the development of the network[9]. Besides there are often cultural differences and language barriers that are difficult to address in large international projects. The open source nature of iPath allows such adaptations and it is easily possible to reproduce working regional solutions as free and open source software can be adapted and distributed.

2 Free Software Foundation - http://www.fsf.org

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