Telepathology: Role in improving laboratory techniques, diagnosis and research in low resource countries

Ilunga J[1], Raphael M[2], Hurwitz N[3], Leoncini L[4], Jessie Gitanga J[5], Bienvenu Lebwaze[1], Chumba D[5], Anani L[6]

ABSTRACT

Background: Telepathology, the practice of pathology at a distance, uses telecommunications technology to facilitate the transfer of image-rich pathology data between remote locations for the purposes of diagnosis, education and research. It has great potential to improve on patient care in low resource countries.
Objectives: To demonstrate the potential of telepathology for pathologic diagnosis and research in low resources countries as exemplified by DR Congo.
Methodology: Retrospective review of 57 cases submitted for second opinion on internet network (I-Path). The reviewers were a panel of experts from African and non-African countries. The images were scored and the diagnosis noted. Statistical analysis was made by describing the median and relative frequencies for quantitative and qualitative parameters.
Results: From September 2009 to January 2014, a total of 57 cases were reviewed, out of which 41 were haematologic malignancies. The quality of the images was too poor to make a diagnosis in 6 cases (14.6%), while the number of images sent were insufficient for interpretation in 8 cases (19.5%) leaving 27 cases (65.9%) suitable for interpretation. Of the 41 patients, 19 (46.3%) were males and 17 (41.5%) were females while in 5 cases (12.2%) the sex was unknown. The patients ages ranged from 1 to 74 years (median 21.5 years) and 19 (46.3%) were children aged <18 years. Eighteen (66.7%) of the 27 cases were lymphoid malignancies, 4 (14.8%) non-lymphoid malignancies and 5 (18.5%) reactive processes. All the children diagnosed with malignancy following the review were treated using the Franco-African Pathology protocol.
Conclusions: Telepathology can be used to mitigate the lack of pathologists in low income countries. Training of technical staff for better specimen preparation is also possible using telepathology. The problem of poor quality or insufficient images may hinder the quality of diagnosis.

Key words: Telepathology, Diagnosis, Research, Low resource countries

[1]Pathologist, University of Lubumbashi, DR Congo
[2]Haematopathologist , University of Paris-Sud, Alliance Mondiale Contre le Cancer (AMCC), International Network for Cancer Treatment and Research (INCTR), France
[3]Haematopathologist, University of Basel INCTR, Switzeland
[4]Haematopathologist, University of Siena, INCTR, Italy
[5]Haematopathologist, University of Nairobi, Kenya
[6]Hematolopathologist, University of Cotonou , Benin

Corresponding author:
nijulien2011@yahoo.com
Uninersity of Lubumbashi, Democratic Republic of Congo

INTRODUCTION

The Democratic Republic of Congo is a large country of about 2.345.409 km^2 with an estimated population of 75,507,808 inhabitants. It is one of the low income countries with a Gross Domestic Product (GDP) of about of 15 US billions[1]. Before 2014, the country was divided into 11 provinces. The entire country depends on only 5 pathologists practicing in two cities, three in Kinshasa and two in Lubumbashi. This highlights the difficulties of providing pathology consultant services in DR Congo and, consequently, most of the patients are treated without any specialist input. Medical workers usually work alone and often complain of loneliness at their workstations.

Low resource countries face many challenges in improving the quality of health of their population in the areas of technical skills, diagnosis, education and research amongst others. Opportunities for meeting these challenges have been proffered through collaboration with the International Network for Cancer Treatment and Research (INCTR) and the Alliance Mondiale Contre le Cancer (AMCC).

The objective of the study was to demonstrate the potential of telepathology for pathologic diagnosis and research in low resources countries like in DR Congo.

This was a retrospective study carried out from September 2009 to January 2014 of haematological cancers diagnosed using telepathology through the INCTR I-Path programme or internet networks amongst pathologists.

MATERIALS AND METHODS

We evaluated 57 cases submitted for online consultation on I-Path between September 2009 and January 2014. Review of the cases was by an online network of practicing haematopathologists from African countries and France, Germany, Italy and Switzerland who volunteered for online consultation and gave their expert opinions. A technician from a University in Germany helped the local technician to improve on technical skills such as smear making and staining of specimens.

The equipment used to capture the images was a light microscope with a digital camera, a lap top, and internet access. The specimens consisted of smears obtained by fine needle aspiration and imprints of biopsies of lymph nodes, peripheral blood and bone marrow aspirates which were stained using May Grunwald Giemsa (MGG) stain. The images were initially downloaded at 1400 pixels (6 cases) and later at 640 pixels (51 cases) on recommendation by the German technician. Transmitted images were scored as either suitable or not suitable for evaluation (poorly stained, insufficient number of images). Pathology classification was based on the World Health Organization (WHO) classification. Statistical methods for analysis included median and relative frequencies for quantitative and qualitative parameters.

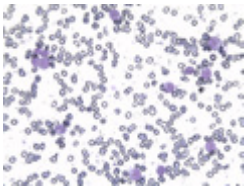
RESULTS

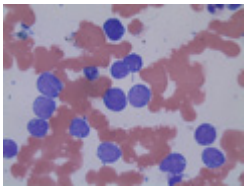
From September 2009 to January 2014, a total of 57 cases were reviewed, out of which 41 were haematologic malignancies. The quality of image was too poor to make a diagnosis in 6 cases (14.6%) while the number of images sent were insufficient for interpretation in 8 cases(19.5%) and 27 (65.9%) were good for interpretation (Table 1 and Figure 1). Of the 41 patients, 19 were males (46.3%) and 17 were females (41.5%) while in 5 cases (12.2%) the sex was unknown. The patient ages ranged from 1 to 74 years (median 21.5 year). Eighteen (66.7%) of the 27 cases were lymphoid malignancies, 4 (14.8%) non lymphoid malignancies and 5 (18.5%) reactive processes.

Table 1: Quality of images (N=41)

Quality	No.	(%)
Poor images	6	(14.6)
Insufficient numbers	8	(19.5)
Good images	27	(65.9)
Total	41	(100)

Figure 1 : (a) shows a poorly stained bone marrow aspirate using MGG. (b) a well stained bone marrow aspirate using MGG





Age and sex distribution of patients: Table 2 shows the age and sex distribution of the 41 patients. Gender records for thirty six patients and age records for forty patients were available. There were 19 males (46.3%) and 17 females (41.5%). The patient age ranged from 1 to 74 years (median 21.5 year). Nineteen patients (46.3%) were aged less than 18 years and 21 (51.2%). were adults (greater than 18 years).

Table 2: Age and sex distribution of cases (N=41)

	Sex			Age		
	M	F	U	<18 years	> 18 years	U
No	19	17	5	19	21	1
(%)	46.3	41.5	12.2	46.3	51.2	2.5

U= Unknown M = male F = female

Morphological data: Out of the 27 evaluable cases, 18 (66.7%) were lymphoid malignancies, 4 (14.8%) non lymphoid malignancies and 5 (18.5%) reactive processes (Table 3).

Table 3: Morphological diagnosis (N=27)

	Lymphoid Malignancies	Non lymphoid malignancies	Reactive Process	Total
No	18	4	5	27
(%)	66.7	14.8	18.5	100

Samples were taken from lymph Nodes (N), Peripheral Blood (PB), Bone Marrow (BM) or both Bone Marrow And Peripheral Blood (BMPB). In Table 4, we report data by site, age, gender and diagnosis for 18 patients. There were 4 cases of chronic myeloid leukemia (CML), 3 cases of Acute Myeloid Leukemia (AML), 1 Chronic Lymphoid Leukemia (CLL), 2 Acute Lymphoid Leukemia (ALL) and 1 Burkitt ymphoma (BL). The other diagnosis made were acute Myelo-Monoblastic Leukemia (AMML), Large Cell Non Hodgkin Lymphoma (LCNHL), Acute -Megakaryoblastic Leukemia (AMKL) and Multiple Myeloma (MM). All the children who were diagnosed with haematological malignancy following the review were treated using the Franco-African Group of Pediatric Oncology (GFAOP) protocols.

Table 4: *Morphological classification of haematological malignancies (N=18)*

Case	I-Path ref	Site of origin	Age (year)	Gender (M/F)	Diagnosis
1	527515	BM, PB	57	M	CML
2	513069	BM, PB	62	M	AML
3	512393	BM, PB	53	F	CML
4	508730	NODE	56	F	LCNHL
5	477376	PB	7	F	AML
6	471966	Face	4	M	BL
7	421168	BM, PB	26	M	CML
8	403516	BM, PB	62	M	AMKL
9	387489	BM, PB	8	F	ALL/BL
10	372314	BM, PB	34	F	AMML
11	353268	BM, PB	53	F	AMML
12	349762	PB	10	M	ALL
13	23379	PB	52	F	CML
14	21567	BM, PB	11	M	ALL/BL
15	19092	PB	64	F	MM
16	12043	NODE	12	F	LCNHL
17	11417	BM, PB	61	M	CLL
18	533907	BM, PB	11	F	AML

DISCUSSION

The aim of this study was to show the application of tele-networking in pathology (telepathology) for diagnosis and research.

Reference to Telemedecine was made around year 1999. It has been widely discussed as a means of communication, education and publication in pathology with most of the published data reported in the year 2000[2-6]. Data published by Giambrone *et al*[5] indicate that teledermatopathology has significant impediments in its application that hinder its widespread use, mainly the diagnostic accuracy, licensure requirements and reimbursement. However, despite these shortfalls, our study, like others, has shown that telepathology has definite benefits[2-7]. Bernard *et al*[7], in 2014 showed that the use of telepathology for clinical applications is increasing in Canada and has steadily become more attractive over the last 10 years, driven largely by its potential to provide rapid pathology consulting services throughout the country regardless of the location of a particular institution.

Some of the controversies encountered in telepathology were lack of observance of patient rights, difficulties of getting enough patients details from one actor to another as observed in case of exchange between a simple medical technician and the pathologist. This did not apply in our study as only pathologists were involved in transmitting the images and discussing the diagnoses. Indeed the INCTR I-Path program has more ethical agreement and data are transmitted and discussed by medical experts bound by the fundamental ethical guidelines of practice of medicine.

Telepathology aids in improving laboratory techniques. It can be used to enhance the technical aspects of loading images. We were provided with recommendations for improved downloading of images. I-Path recommends pictures downloaded at the lesser pixels (640 pixels). In this study, the initial images were taken at 1040 pixels and all were not available for interpretation as it took a long time to download. In addition, our technician received input for better staining and subsequent review of the staining enabled better images to be submitted.

Telepathology aims at improving patient care by giving an accurate diagnosis within a minimum turn-around-time. It is now possible to have the diagnosis discussed within a short time and rapidly initiate patient treatment in low resources countries McCarthy *et al* [6] reported that telepathology can be used in the laboratory to improve diagnostic processes and patient care. Following successful diagnosis, all the children who were diagnosed with malignancy were treated using the GFAOP protocols.

Telepathology combined with teleconferencing may be used to improve research by increasing the number of acting experts. It can also be used for education of junior pathologists. Pathologists in low resource countries often experience loneliness and isolation as they often work alone. Telepathology is a means of increasing their contact with other pathologists and offering an avenue for consultation. This study is the work of more than ten experts from more than six countries.

CONCLUSIONS AND RECOMMENDATIONS

Telepathology has been demonstrated to improve technical staining methods, patient's care, research and education in low resource countries. It can be recommended for all pathologists, particularly those who are working alone.

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