



International Pathology Services:

Going Digital Connects You
to the Rest of the World

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Service at an International Level

International Pathology Services: Going Digital Connects You to the Rest of the World

Over the past several decades, digital pathology has evolved from a simple transmission of microscopic images between two locations to where pathologists can view slides and consult with each other down the hall, in another town or across continents.

Offering improved access to subspecialty pathologists, digital workflows are now used for pathology consultations, quality assurance and image analytics. Pathologists collaborate with their international colleagues for research and can support educational efforts no matter where they are located.

With this technology, patients and their providers can have access to the best diagnostic expertise available anywhere in the world.

A woman with short, light-colored hair, wearing a white lab coat, is looking through a microscope in a laboratory setting. The background is softly blurred, showing laboratory equipment and a window with natural light. An orange circular graphic is overlaid on the image, containing the text 'Part 1'.

Part 1

Doing More With Less:
Changing the Face of Pathology Services

Doing More With Less: Changing the Face of Pathology Services

“In 2012, there were 14 million new cases of cancer reported and 8.2 million cancer-related deaths worldwide. The number of new cancer cases will rise to 22 million within the next two decades.”¹

With cancer among the leading causes of death worldwide, the demand for pathology services is becoming more critical. However, the number of new pathologists entering the field is decreasing while the projected demands of the patient population are expected to grow by more than 150% over the next 20 years.

Hospital networks are forming to share resources and expertise. Individual sites within these networks are no longer duplicating their pathology services. Instead, pathology labs are consolidating, often with a core lab servicing pathologists located throughout the network.

From a financial perspective, many hospital-based laboratories are also looking to expand their outreach services in an effort to position themselves for long-term viability. These mergers offer economies of scale that can reduce costs and improve service across a system. Coupling these efforts with digital access to specialists in consultative outreach services provides a greater opportunity for increasing a laboratory’s market share and improving its chance of survival.

While technology can facilitate these collaborative relationships, on an international scale there are still hurdles to overcome. Telecommunication infrastructures, incompatible software and interoperability issues all

pose challenges for creating a global pathology network. Fortunately, technology is also now available to alleviate some of these issues and offer workflow solutions to serve pathologists and patients worldwide.

Worldwide shortage of pathologists

The growing shortage of pathologists worldwide has been well documented in the literature. Africa and Asia have been experiencing this problem for decades.

In China, it is reported that as of 2015 the ratio of pathologists per patient population was estimated to be 1:133,107. In Myanmar, the ratio is estimated to be 1:170,000. Sub-Saharan Africa has at least five countries with no anatomic pathologist at all.²

South Africa has approximately 100 pathologists serving a population of 55 million. Other countries in the Southern African Development Community are in even more dire circumstances. Zimbabwe has only nine pathologists for its population of 13 million, and Mozambique has only four pathologists for its population of 25 million.³

Pathologist shortages have also been reported in Russia, India, Nepal, Israel and parts of Canada.^{4,5,6}

“Cancer Research UK” reported that the UK’s National Health System cannot keep up with the increasing demand for pathology services. Experts fear that the shortage of pathologists could hamper Britain’s ability to improve its identification of early stage cancers.⁷

In the US, it is projected that by 2030, practicing pathologists will decrease to approximately 3.7 per 100,000. Some of this shortage may be offset with pathologists’ assistants who can perform gross examination of tissue specimens thereby freeing up pathologists for microscopic interpretations. However,

the growing trend towards sub-specialization may cause an even greater deficit in areas such as pediatric, forensic and neuropathology, all of which are seeing fellowship position vacancy rates of more than 40%.⁸

Moreover, the pathologist's workload has not eased over time. On the contrary, it has become more complex due to an aging population and corresponding increases in cancer cases. Increased utilization of special studies including immunohistochemistry and molecular testing require more of a pathologist's time to render a final comprehensive diagnosis.

In the United States, Canada and Europe, medical students entering the field cannot keep pace with the rate of retiring pathologists. Meanwhile, the population they serve continues to grow.

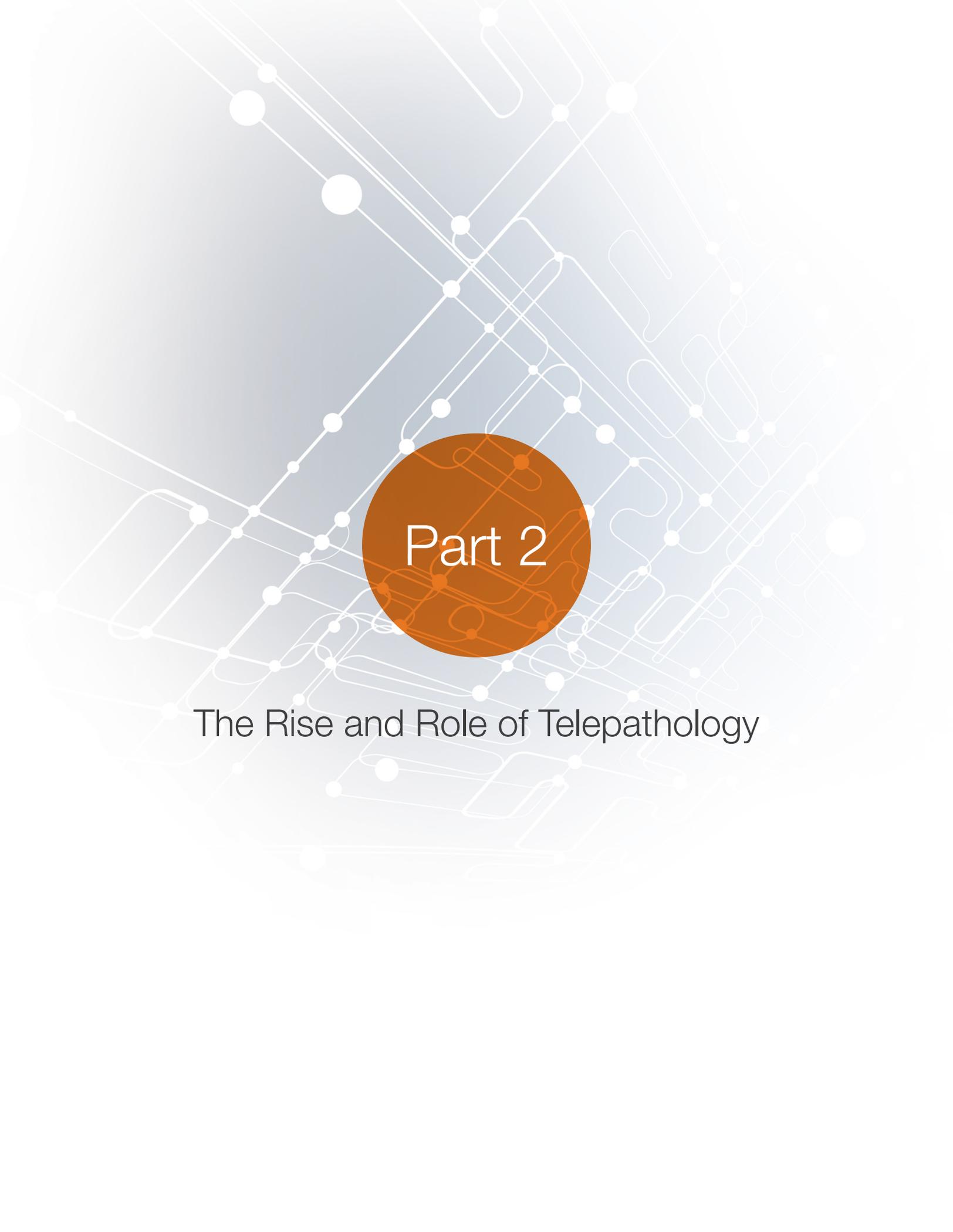
With the capacity of the current pathologist workforce decreasing and demands of the patient population increasing, it is inevitable that quality of care and patient safety may suffer with increased turn-around-time of cases and potential diagnostic error.

A global solution is needed to optimize this precious healthcare resource.

Telepathology has long served the international pathology community by facilitating expert reviews of cases in regions where pathologists are in short supply or absent altogether. As imaging technology and the infrastructure for internet communications continue to improve, global pathology services become even more valuable to ensure that each patient's case reaches the best expert in a timely fashion.

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Part 2

The Rise and Role of Telepathology

The Rise and Role of Telepathology

Many pathology practices associated with academic medical centers have begun using digital pathology to facilitate the sharing of cases through the use of internet services, private networks, and now, cloud technology. As the use of whole slide imaging (WSI) and digital pathology consultations becomes more widespread, hospitals can access experts in any pathology subspecialty from any location around the globe. Secure, web-based access to expert centers and remote subspecialist colleagues is now a reality.¹

One of the earliest clinical uses of telepathology occurred in 1968 between Massachusetts General Hospital and the Logan Airport Medical Station in Boston, Massachusetts. Black and white photos of macroscopic and microscopic images were sent via microwave transmission for expert consultation.²

Since that time, telepathology has been used in many clinical, research and academic applications and encompasses three primary modes of communication: static “store and forward” systems, dynamic (robotic) systems and hybrid systems incorporating the use of virtual slides.^{3,4} With hybrid systems, the slide is typically scanned at a low magnification and forwarded to the pathologist. The pathologist then uses a live telecommunications link to review the regions of interest at a higher magnification.⁵

With the technical evolution from digital cameras mounted on microscopes to whole slide scanners, the utility of digital images versus glass slides has dramatically increased. Pathologists use these images for publications, research collaborations, teaching and even consultations.

As whole slide scanners improve their throughput, quality and affordability, remote access to these digital images is also evolving. Early communications took place by directly connecting to remote scanners or image platforms via standard telephone lines to view the images. As broadband telecommunication networks

have improved and expanded, internet access has become more robust and can better support digital pathology applications.

Digital pathology technology is advancing at a rapid pace offering solutions to the increasing need for pathology services.

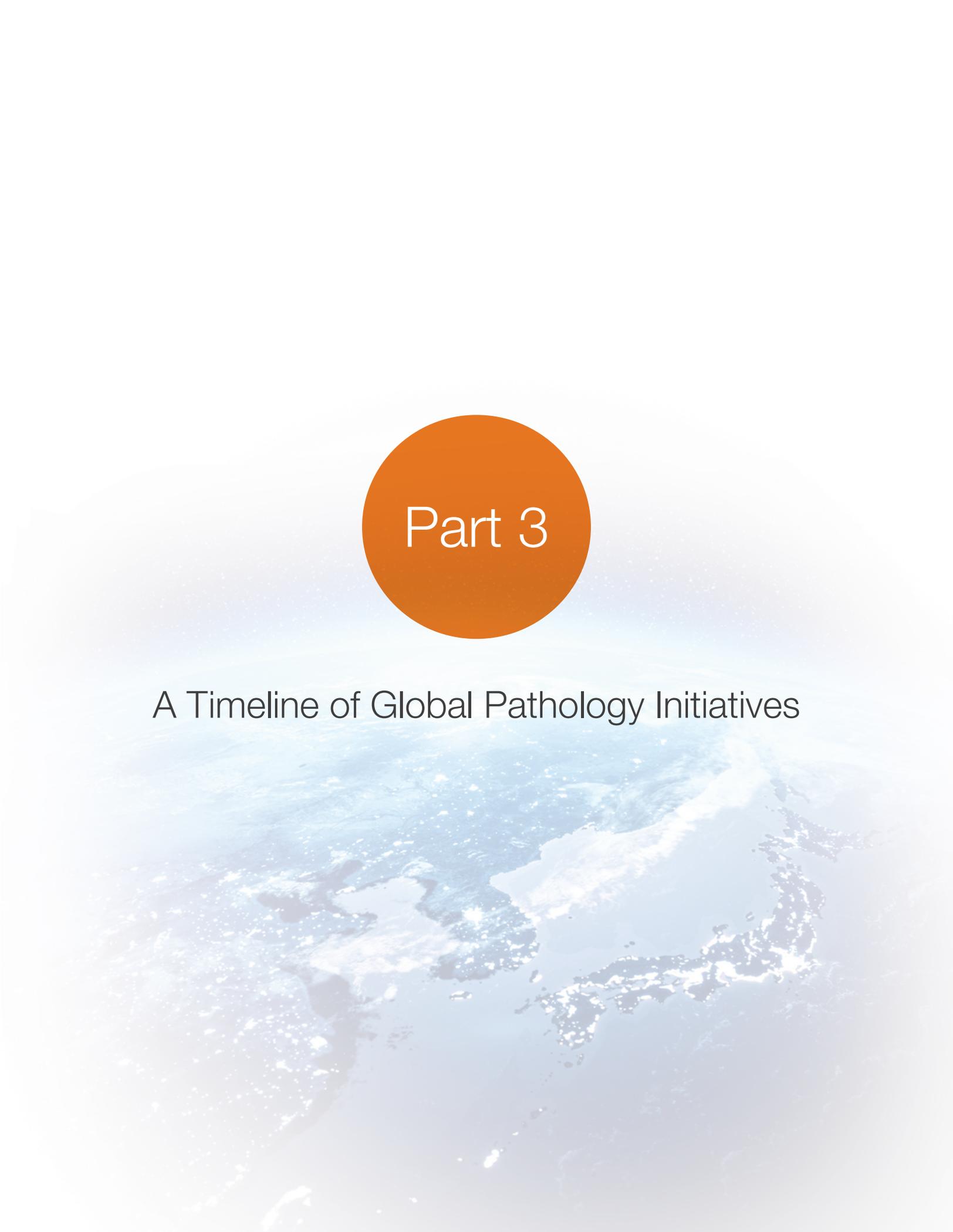
With today’s more sophisticated networks, use of WSI allows the viewing of images using shared servers via transmitting and uploading to a referral center’s server, and more recently, through the use of cloud services.⁶ Applications include providing remote support for fine needle aspiration and frozen section services, consultative services and, where permitted, primary diagnoses. Some hospital laboratories are even making the commitment to move to a 100% digital workflow for their anatomic pathology labs.

Digital pathology technology is advancing at a rapid pace offering solutions to the increasing need for pathology services. Moving to a digital platform allows for consolidation of lab resources, expansion for outreach consultations, and now, the development and application of artificial intelligence algorithms to streamline and assist the pathologist’s diagnostic process.

In concert, initiatives utilizing this technology are becoming more and more common to improve accessibility to pathology services worldwide. As laboratories expand their consultation services across a region, the country or the world, digital pathology networks offer improved access to expert subspecialty pathologists whether within a network of community practices or with an “expert” center located anywhere in the world.

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Part 3

A Timeline of Global Pathology Initiatives

A Timeline of Global Pathology Initiatives

Digital pathology technology is advancing at a rapid pace offering solutions to the increasing need for pathology services. In concert, initiatives utilizing this technology are becoming more and more common to improve accessibility to pathology services worldwide.

For some countries, lack of financial resources has limited access to many pathology resources. More recently, however, digital consultations are becoming a

realistic option for these regions as costs for whole slide imaging decrease and internet access improves. Local health facilities can potentially provide basic access to pathology testing which can then be referred to regional or referral hospitals.¹

The following timeline offers some highlights of the use of digital pathology at the international level in the last 25 years.

1992-1998:

Réseau Internationale de Télémedecine (RESINTEL)- provided “static telemicroscopy” services for isolated areas of France as well as hospitals in India, the Middle East, Morocco and several countries in Africa. Still images captured by video cameras attached to microscopes were transmitted via a network that evolved from a telephone based communication system to a satellite system.²

1994:

Armed Forces Institute of Pathology (AFIP) began providing digital consultation services to Brazil, Mexico and South Africa using static photomicrographs transmitted via the internet.³

2000:

The International Union Against Cancer (UICC) established a Telepathology Consultation Center (UICC-TPCC) in Berlin, Germany to provide diagnostic support to pathologists worldwide. Using store and forward technology, images and clinical data were submitted over the internet to the UICC-TPCC server. The TPCC would then transfer the case to an affiliated international expert for their review and interpretation.⁴

2001:

Arias-Stella Pathology and Molecular Biology Institute in Peru and the Istituto Nazionale per lo Studio e la Cura dei Tumori in Milano, Italy began using static telepathology to perform consultations between the two countries. The Generic Advanced Lowcost transEuropean Network Over Satellite (GALENOS) was also formed. This network supported dynamic intraoperative telepathology in 14 clinics in Bulgaria, France, Germany, Greece, Italy and Tunisia using remote controlled robotic microscopes on a satellite network with a 2 Mbps interface.⁵

2002:

iPATH, an open digital pathology platform developed in Basels, Switzerland, was implemented. Linking experts in Switzerland, Germany and Italy to South Africa, Tanzania, the Solomon Islands and other developing regions of the world, it eventually served more than 150 user groups around the world.^{6,7}

Also in 2002:

The United States' worldwide Military Health Care System (MHCS) used robotic microscopy to perform remote intra-operative consultations between small remote hospitals and Heidelberg Army Hospital in Germany, Walter Reed Army Medical Center and the Armed Forces Institute of Pathology, both of the latter in Washington, DC.

Software installed both on a PC connected to an automated microscope at the remote location and on the consulting pathologist's PC in the expert center communicated via the internet. The consulting pathologist could control the microscope to view the image at the remote location. This successful study validated the use of telepathology for frozen section diagnosis to support surgical services at remote hospitals and laid the groundwork for additional clinical applications throughout the MHCS.⁸

2004:

University Health Network (UHN), an academic medical center in Toronto comprised of three sites, began using robotic microscopy in a dynamic server-client system to perform frozen sections in the absence of an on-site pathologist.

2006:

UHN began using whole slide images viewed on their own network. Pathologists connected directly with the scanner's computer and viewed the slide images from their office workstations. This model also permitted simultaneous viewing of images from multiple workstations if consultation with colleagues was needed.⁹

2010:

UHN established Canada's first telepathology system linking remote northern hospitals to UHN for subspecialty support.¹⁰ Since then, UHN has also begun providing pathology consultation services to Kuwait.¹¹

Also in 2010:

University of California, Los Angeles (UCLA) partnered with the Second Affiliated Hospital of Zhejiang University. This program supported diagnostic consultations and quality initiatives as well as educational and research opportunities. In its first five years, the program expanded to include several other partner hospitals throughout China and had reviewed more than 2200 international clinical cases.¹²

2011:

The international open access forum, Medical Electronic Consultation Expert System (MECES), a platform utilizing whole slide images (WSI) and Web 2.0 technologies, was launched. Utilized by the Virtual International Pathology Institute (VIPI), it provided a flexible information exchange for clinical, educational and research use.^{13, 14, 15}

Also in 2011:

The Pathology Quality Control Center of China and Ministry of Health implemented a nationwide digital pathology consultation and quality control program in China. Cases were submitted with WSI to a web-based consultation platform. Experts accessed the cases stored on the server via the internet and provided their diagnoses, second opinions or quality assessments as requested. After two years of operation, more than 16,000 cases had been submitted. The consultation service had a turn-around-time of less than 48 hours and realized a 40% improvement in cancer diagnosis.¹⁶

2012:

Partners In Health and the Dana Farber/Brigham and Women's Cancer Center collaborated with the Rwanda Ministry of Health to establish the Cancer Center of Excellence (CCOE) at Butaro District Hospital. The first rural based specialty referral facility in East Africa, the CCOE provides pathology services for patients throughout Rwanda and neighboring countries.¹⁷

Also in 2012:

KingMed Diagnostics in China and the University of Pittsburgh Medical Center established a partnership to provide an international digital pathology consultation service using whole slide images transmitted via a telepathology portal. A review of this service after three years demonstrated improved quality of care for patients in China. Diagnoses were revised in 51% of the cases reviewed. 64% of these revised interpretations were cancer diagnoses.¹⁸

2014:

UCLA Department of Pathology and Laboratory Medicine and China's Centre Testing International Corporation created a joint clinical laboratory in Shanghai offering sophisticated laboratory testing not readily available in China. In addition to providing specialized teaching and training exchanges between UCLA and Chinese pathologists, physicians in China are able to consult with UCLA pathologists on complex pathology interpretations.¹⁹

2016-2018:

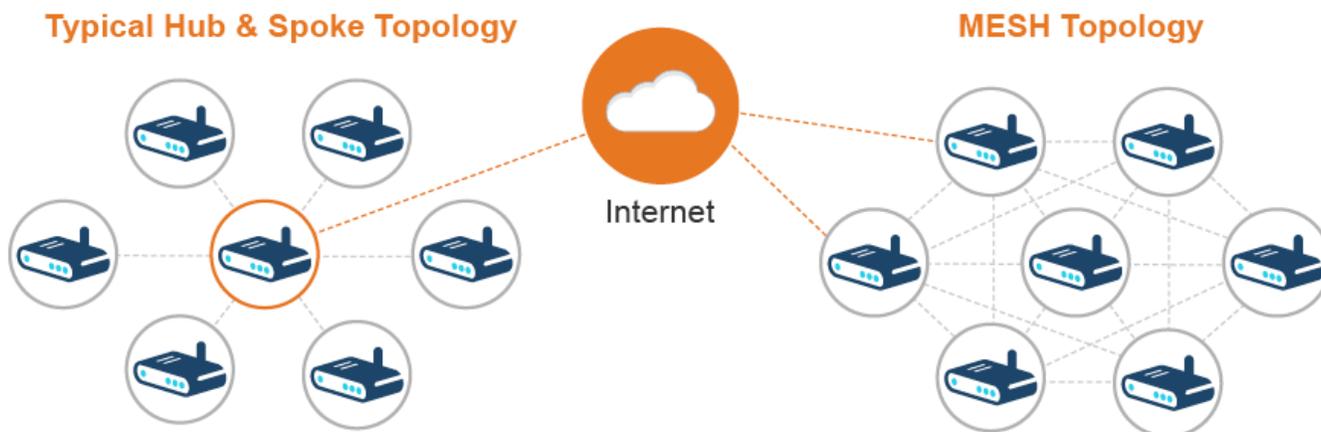
The American Society of Clinical Pathology (ASCP) announced that the Butaro Center of Excellence implemented a cloud-based system to upload WSI of patient biopsies. Diagnoses are now received from pathologists in the United States within 24-72 hours.²⁰ This effort is ongoing, and the ASCP-led Partners for Cancer Diagnosis and Treatment in Africa continues to expand its initiative to include other sites in Sub-Saharan Africa including Rwanda and Tanzania.²¹

As these networks continue to expand, scalability becomes a key factor in providing pathology support whether on a local or international basis. Early networks communicated via dedicated lines between an expert center and the remote hospitals and laboratories it supported. These Virtual Private Network (VPN) connections still serve smaller networks well.

Other configurations have been developed to support more complex networks. Hub and spoke models allow multiple sites to connect to an expert center. Pathologists at the expert center provide subspecialty support and remote assistance for frozen sections and multidisciplinary team meetings at the other facilities within the network.

Mesh networks expand communications between all sites within a network, improving user access, image rendering and turn-around-time of reporting. Experts can be located at any site, and they are accessible to all users. Sub-specialties experiencing severe personnel shortages such as pediatric and neuro-pathology can collaborate with their colleagues no matter where they are located.

With the global shortage of pathologists, digital pathology technology facilitates collaboration, sharing and consultation on difficult cases with subspecialty experts worldwide. In addition, pathologists can benefit by the sharing of best practices and using their digital pathology platform for education and research at an international level.



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Part 4

Challenges to Providing a Digital Pathology
Service at an International Level

Challenges to Providing a Digital Pathology Service at an International Level

No matter where they are located, a pathologist's time is at a premium, and managing consultation cases poses a challenge. From a digital perspective, proprietary viewing software and interoperability issues between viewers and information systems can create technical barriers at a local level and are even more limiting for a globally based network.

Accessing and reviewing cases on remote scanners or digital platforms was the early approach for digital consultations. However, this scanner-based access demanded additional time and effort from the individual pathologist. In addition to managing multiple logins and passwords for each client's system, signing into vendor specific devices or portals required knowledge of how to navigate each unique system to locate the images and data needed to perform the consultation.

With multiple clients from different regions of the world, management of a global digital consultation service can also quickly overburden an expert center's resources.

For an expert center with multiple referral clients, this approach does not scale well. Each platform is limited to the specific scanner's images and does not permit the collection of patient images and related metadata and clinical information. Vendor specific portals don't support whole slide images (WSI) from other vendors due to the proprietary nature of the image formats and associated software.

Further complicating this process is the need to view the images in one system and then report results in a second system such as the expert center's Laboratory Information System (LIS). Once finalized, the report must be transferred back to the client for their review either via fax, courier or postal service. Images and their associated annotations and comments may not be accessible to the referring client. Pathologists need to be able to create their report in a system that can integrate with the clients' and the pathologists' information systems as needed.

To meet this requirement, a digital pathology platform must be able to combine the pathology images and the patient's clinical data without overwhelming the expert laboratory's LIS used for day-to-day operations. The need for a system that can interface with the LIS and issue fast, concise reports for external clients is imperative to ensure smooth and efficient operations. A vendor neutral system allows the management of all consultation cases and their images in one integrated platform.

With multiple clients from different regions of the world, management of a global digital consultation service can also quickly overburden an expert center's resources. In addition, there are logistical obstacles to providing a digital pathology service on an international scale including language, IT infrastructure and regulatory issues.¹

With language differences seen as a significant hurdle for international cancer diagnostics, the American Society for Clinical Pathology (ASCP) and the International Consortium on Cancer Reporting (ICCR) are collaborating to develop standardized templates from which, when coded and standardized, diagnostic

data can be extracted into datasets that can be translated into Spanish, French and Portuguese. These templates, available in October of 2018, allow access to standardized reporting to large parts of Africa and South America and assisting pathologists in countries with limited resources with more effective communication of pathology results.²

Finally, one of the largest obstacles to providing pathology consultation services at a global level is that countries with limited resources are not able to provide even basic diagnostic services. To that end, the ASCP-led Partners for Cancer Diagnosis and Treatment in Africa is leading an effort to provide rapid cancer diagnostics, care and treatment to these underserved countries. Their first site at the Butaro District Hospital in Rwanda now scans all surgical cases processed in the laboratory. These cases are read digitally by the local pathologist who consults with a team of ASCP volunteers on approximately 10% of the cases.³

As the demand for pathology services continues to increase and the number of pathologists continues to decline, digital pathology technology can play a role in addressing this global need. The investment in diagnostics can pay off even for the most resource strapped countries by reducing long-term costs for more serious illnesses complicated by delayed diagnoses.⁴

A digital pathology platform that can be interfaced with any whole slide scanner and any laboratory information system is the ideal solution for managing international relationships. With robust workflows in pathology

consultations and quality assurance applications, patients anywhere in the world can have access to pathology services at a level never before available.

These international partnerships not only provide diagnostic expertise to underserved regions of the world, but they serve as a resource for education and patient management. A digital platform can serve as an extension of a laboratory's AP-LIS, LIS, or HIS and offers shared viewing of images for remote colleagues, a virtual multi-headed microscope for unlimited participants. Images can also be shared and managed for private research groups whose expertise can be spread world-wide.

Pathologists can view slides and consult with each other anywhere in the world. Additional workflows are configurable based upon the needs of the client and include second opinion consultations, quality assurance reviews and, where permitted, primary diagnoses. In addition to diagnostic workflows, the platform permits the sharing of cases for education and research.

As technology and connectivity improve, global access to digital pathology services will become more widespread, even for countries with limited resources. With improved scanners, standardized diagnostic templates, and integrated scanner and LIS platforms, the challenges of global pathology consultation services are beginning to be met.

Patients all over the world will finally gain access to the best pathology expertise no matter where they live.

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