

Short Communication

Diagnosis of Viral Diseases in Sudan: Coronaviruses Unveil the Concealed Venues

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Abstract

Establishing the diagnosis of viral diseases often needs sophisticated settings, equipment, expertise, and strict laboratory methods. In Sudan, as in most developing countries, viral diseases are mostly diagnosed by clinical presentation. As most viral infections are self-limiting and there is no specific treatment for most of them, laboratory diagnosis has not been a focus for improvement, particularly in public sector until the current pandemic of COVID-19. During this pandemic, the vital need for well-equipped clinical virology laboratories is urged. The aim of this work is to highlight the various diagnostic methods and to describe the current situation of clinical virology diagnostics in Sudan.

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1. Introduction

Sudan is a developing country, having only one reference public health laboratory and four regional laboratories, with a limited diagnostic capacity and personnel [1].

Historically, many local viral outbreaks have been reported in Sudan. These include measles, polio, yellow fever, Dengue fever, West Nile, Rift Valley fever, Chikungunya, Crimean–Congo hemorrhagic fever, Ebola, Influenza Poliomyelitis, and lately the pandemic of COVID-19 [2].

There are over 4,000 known viruses in plants, animals, and bacteria. These viruses are generally distributed in 71 families, 9 subfamilies, and 164 genera [3]. Clinical features of viral diseases are, to some extent, similar and therefore need laboratory assays to identify the causative agent. However, viral disease diagnosis is sophisticated and needs specific equipment and strict settings.

In Sudan, as in most developing countries, the diagnosis of viral diseases has not been up to the level of the challenges faced. The aim of this paper is to highlight the various diagnostic modalities of viral diseases and to describe the current situation of clinical virology diagnostics in Sudan.

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2. Methods of Viral Disease Diagnosis

Many laboratory methods are used for diagnosing viral diseases. These include electron microscopy, virus culture (also referred to as cell or tissue culture), immunological tests such as counter immunoelectrophoresis, latex agglutination, co-agglutination, immunochromatography test, enzyme linked-immunosorbent assays (ELISA), precipitation tests, complement fixation, immunofluorescence tests, neutralization tests, western blot and line immunoassays, and antibody avidity assays. Furthermore, antigen detection, viral genome detections, and gene sequencing by molecular techniques are increasingly used in the virology laboratory. Table 1 summarizes the details about the advantages and limitations of the most common laboratory methods [4–8].

3. Diagnostic Virology in Sudan

Public health laboratories in Sudan conduct the most common tests for commonly encountered viral diseases, such as hepatitis B and C, HIV, and few screening tests for congenitally acquired viral diseases. Some tests are available only during epidemics or disease outbreaks. However, private sector laboratories may conduct some of the most uncommon tests, upon request. Table 2 summarizes the most commonly conducted laboratory tests for viral syndromes in Sudan. It is obvious that many tests for viral diseases are not available in public health laboratories in Sudan.

4. Discussion

Oftentimes in large countries such as Sudan, viral infections are missed. It is difficult to establish a confident diagnosis based on clinical findings, as many viruses have similar clinical features. For example, the symptoms and signs of hepatitis can be caused by many viruses. On the other hand, a specific virus may have many different clinical presentations [9]. It is therefore essential to seek specific laboratory diagnosis to enable correct management of patient. Specific viral diagnosis is also important from an epidemiological perspective. It has been shown that even experienced clinicians are not able to clinically diagnose cases of rubella or measles correctly. A specific diagnosis of a viral infection is important, not only for the clinical management of the patient but also for the control of infection, outbreak control, and the public health perspective of continuing to ensure the efficacy of vaccination programs [10].

Diagnostic microbiology in Sudan is at a critical juncture and needs drastic improvement to cope with the growing healthcare complexities. Recent and emerging trends such as changing demographics, exponential growth in medical discoveries, appearance of superbugs are some examples. The diagnostic microbiology has to improve in better direction with best practices. There is a need for additional laboratory tests for the agents of the priority healthcare infections. Currently, there is an urgent need than ever for better viral diagnostics in the light of increased immunosuppressed individuals as a result of non-communicable diseases, chemotherapy, and the widespread use of other immunomodulant medications.

TABLE 1: Overview of viral diagnostic methods: advantages and limitations.

Laboratory method	Technique	Assay time	Advantages	Limitations
Viral isolation	Conventional culture	1–21 days	Allows isolation of many viruses; can detect unexpected or novel viruses; more sensitive than antigen detection	Requires expertise to interpret CPE and maintain cell cultures; some viruses do not grow in routine cultures; biosafety concerns for zoonotic and emerging viruses
Antibody detection	ELISA, EIA, CLIA, IF, IC, IB, IgG avidity testing	<30 min–24 hr	Can document primary, recent, and past infections, and carrier states; can be automated; some tests can be done at point of care; fourth generation HIV tests combine antibody and antigen detection in one reaction	Cross-reactivity between similar viruses is common (e.g., arboviruses); diagnosis often retrospective; IgM assays have moderately high false-positive rates; immunocompromised hosts may not make antibody
Antigen detection	IF ELISA/CLIA IC	1–2 hr < 2 hr < 30 min	Can be done “on demand” as samples arrive in the laboratory; reagents available for eight respiratory and four herpesviruses; can assess sample quality Can be automated; requires less skill than IF Requires no equipment and little expertise; simply add sample and set timer; approved for use at “point of care	Requires substantial expertise for accurate results; manual and labor-intensive; requires an adequate number of target cells for valid results Limited test menu Less sensitive than other methods; limited test menu
NAAT	Conventional PCR Real-time PCR	5–9 hr 1–5 hr	Uses inexpensive conventional thermocyclers; less affected by genome variability and more amenable to multiplex testing than real-time assays Faster, less prone to cross-contamination, readily quantified; lab-developed assays can be readily updated; more commercial kits becoming available, including walk-away tests	Prone to carryover contamination from amplified products since tube is opened after amplification; slower than real-time methods; ethidium bromide used for amplicon detection is toxic More prone to falsely negative or low values due to genetic variations in viral strains; lack of standardization; values obtained in different laboratories can vary by 3 Log ₁₀ ; limited capacity to multiplex

CLIA, chemiluminescent immunoassay; CPE, cytopathic effect; CSF, cerebrospinal fluid; EIA, enzyme immunoassay; ELISA, enzyme-linked immunosorbent assay; HIV, human immunodeficiency virus; IB, immunoblot; IC, immunochromatography; IF, immunofluorescent assay; IgM, immunoglobulin M; NAAT, nucleic acid amplification test; PCR, polymerase chain reaction.

TABLE 2: Common viral syndromes and availability of their diagnostic tests in Sudan.

Clinical syndrome	Viruses	Tests available in public health laboratories in Sudan	Tests not available in public health laboratories in Sudan
Respiratory infections	Influenza	NAAT	Antigen, culture
	Parainfluenza		Antigen, culture, NAAT
	RSV		Antigen, culture, NAAT
	Coronaviruses	Serology, NAAT for SARS-CoV-2, antigen	Serology for other coronaviruses
	Adenoviruses		NAAT, DFA, culture
	Rhinoviruses		NAAT
	Enteroviruses		NAAT, culture
Gastro-intestinal syndromes	Rotavirus		Antigen, NAAT, EM
	Norovirus		Antigen, NAAT, EM
	Enteric Adenoviruses		Serology, NAAT
Nervous System syndromes	HSV-1		Serology, NAAT
	Rabies		Antigen detection, NAAT, culture, serology; histopathology
	Poliovirus	NAAT. Culture	
Systemic infections	HIV	Serology, NAAT	
	Measles	Serology	Culture, NAAT
	EBV	Serology	NAAT
	CMV	Serology	Culture, NAAT
	Chikungunya	Serology	NAAT
	Coxsackie		Serology, NAAT
Hepatitis	HAV	Serology	
	HBV	Serology, antigen, NAAT	
	HCV	Serology	Serology, NAAT
	HDV		Serology, NAAT
	HEV		Serology, NAAT
Hemorrhagic and febrile conditions	Dengue	Serology	NAAT, culture
	Yellow fever	Serology	NAAT
	Ebola		Serology, NAAT
	Rift Valley fever		Serology, NAAT, Isolation
Mucocutaneous, genital, congenital and other syndromes	HSV-1, HSV-2		Culture, DFA, or NAAT
	VZV		DFA or NAAT
	Rubella		Serology, NAAT
	Mumps		Serology, culture, NAAT

CMV, cytomegalovirus; DFA, direct fluorescent assay; EBV, Epstein–Barr virus; EM, electron microscopy; HBV, hepatitis B virus; HSV, herpes simplex virus; NAAT, nucleic acid amplification technique; VZV, varicella-zoster virus.

Factors jeopardizing virology diagnostics include: sophisticated machines and technical difficulties, reagent and supply chain issues, maintenance and training needs, biosafety and ethical dilemmas, and hazardous waste disposal.

The outbreak of COVID-19 pandemic brought to attention the importance for investing in diagnostics of emerging pathogens. In this regard, the need for infrastructure, expertise, and diagnostic tools are the most important. In addition to logistics such as guidelines for handling specimens, personal protective equipment and legislations to deal with highly hazardous pathogens are also required.

Noteworthy points of paramount importance that hamper health sector improvement are: economic constraints, political instability, rapid staff turnover, and brain drain that constitute constant challenges.

The collaboration between the public and private sectors to import the test needs has made it possible for any individual who seeks the diagnostic service for COVID-19 to find it available at hand, whether due to the suspicion of the disease or for travel purposes. The same approach may prove successful for other viral conditions.

5. Conclusion

The diagnosis of viral diseases in public health laboratories in Sudan is beyond the challenges. Many viral diseases cannot be accurately diagnosed due to lack of the diagnostic technology and expertise. Efforts to upgrade the laboratory capacity are urgently needed. These include health policies, human and material resources, in addition to better infrastructure, protocols, and quality control measures.

Ethical considerations

Not applicable.

Competing interests

None.

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