



## Review

## A review on acute, severe hepatitis of unknown origin in children: A call for concern



Olivier Uwishema<sup>a,b,c,\*</sup>, Ashraf Mahmoud<sup>a,d</sup>, Jack Wellington<sup>a,e</sup>,  
Suhaila Mamdouh Mohammed<sup>a,f</sup>, Tularam Yadav<sup>a,g</sup>, Mirna Derbieh<sup>a,h</sup>, Sara Arab<sup>a,i</sup>,  
Barakat Kolawole<sup>a,j</sup>

<sup>a</sup> Oli Health Magazine Organization, Research and Education, Kigali, Rwanda

<sup>b</sup> Clinton Global Initiative University, New York, USA

<sup>c</sup> Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkey

<sup>d</sup> Faculty of Medicine, Kilimanjaro Christian Medical University College, Kilimanjaro, Tanzania

<sup>e</sup> Faculty of Medicine, Cardiff University School of Medicine, Cardiff University, Cardiff, UK

<sup>f</sup> Faculty of Medicine, Sohag University, Sohag, Egypt

<sup>g</sup> Accident and Emergency Department, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

<sup>h</sup> Medical Laboratory Science, Faculty of Health Sciences, American University of Beirut (AUB), Beirut, Lebanon

<sup>i</sup> Faculty of Medicine and Surgery, Beirut Arab University, Beirut, Lebanon

<sup>j</sup> Kwara State University, Kwara State Polytechnic, Ilorin, Nigeria

## ARTICLE INFO

## Keywords:

Adenovirus  
Children  
Non-hep (A-E)  
Severe hepatitis  
Unknown aetiology

## ABSTRACT

Hepatitis is defined as the inflammatory reaction of the liver parenchyma. It is either acute, which resolves within six months or may be chronic. An outbreak of severe, acute hepatitis of unknown origin in children was reported in nearly all World Health Organisation (WHO) regions except in the Africa. As per the recent update on the 26th of May, approximately 650 cases have met the WHO's probable criteria. While some are yet to be confirmed, the WHO warns that the figure may be underestimating the real situation. The observed clinical presentation includes outstanding immoderate levels of transaminases, vomiting from the previous presentation, pale/mild stools, and jaundice. So far, the viruses which can cause viral hepatitis, like Hepatitis A, B, C, D, and E, have not been detected in any of the identified cases. Some literature reported human enteric adenovirus type 41F in the majority of cases aged sixteen or younger, with few cases of co-infection with SARS-CoV-2. Currently, only several hypotheses have discussed the causality of the outbreak. However, no consensus has been reached. During this outbreak, it is important to adhere to both hand and body hygiene, general infection and control prevention strategies, and lastly, case presentation matching the criteria of case definition set by the WHO. Said identified cases should be reported to concerned health authorities on an urgent basis and must be kept under proper surveillance.

## 1. Introduction

Hepatitis is an inflammatory reaction of the liver that is caused by a multitude of infectious viruses and noninfectious microorganisms. This may lead to a spectrum of health problems, some of which are lethal to human life. Among viruses, five strains have a known association with hepatitis, namely types A, B, C, D and E. While all strains cause liver disease, they vary in several ways. These include the modality of viral transmission, fatality of the illness, geographical pattern of occurrence, and prevention methods specific to said strain. To note, types B and C are

associated with chronic liver disease in individuals worldwide, together leading causes of liver cirrhosis, hepatocellular carcinoma, and viral hepatitis-related deaths. Approximately 354 million individuals globally live with hepatitis B or C, and for the majority, diagnosis and treatment remain far beyond attainability [1].

Recently there has been a report across countries regarding the severe, acute hepatitis of unknown origin (AHUO) in formerly healthful children. This has transpired in human health awareness and a rapid swift addressment to find out what the fundamental causation(s) could be. The most affected age group by the recent outbreak is between 0 and

\* Corresponding author. Oli Health Magazine Organization, Research and Education, Kigali, Rwanda.

E-mail address: [uwolivier1@ktu.edu.tr](mailto:uwolivier1@ktu.edu.tr) (O. Uwishema).

16 years. Presently, the outbreak has resulted in 17 children undergoing liver transplantation, with more children being affected every day [2]. Currently, approximately 600 cases of AHUO has been reported worldwide.

In March 2022, Scotland, the public health sector identified AHUO in five children, ages 3–5 years, with an aetiology of a 3-week period. The health cluster for sure had new cases of fewer than five per year [3]. At this time, a forewarning has been announced by the European Centre for Disease Prevention and Control (ECDC) and the (CDC) on AHUO in children [4,5].

The clinically-reviewed groups in Scotland had varying presentations: outstanding immoderate levels of transaminases, vomiting from previous episodes, pale/mild stools, and jaundice [6]. Among other countries, the identified clinical syndromes among severe hepatitis in children are liver inflammation with expanded liver enzymes (i.e., aspartate transaminase and alanine aminotransferase), gastrointestinal symptoms including nausea, lethargy, diarrhoea, and abdominal pain. At present, among the viruses that cause viral hepatitis like hepatitis A, hepatitis B, hepatitis C, hepatitis D and hepatitis E viruses, these have not been identified in affected populations. Likewise, global immigration and travelling are being recognized as associated risk factors [1].

Furthermore, some forms of hepatitis can be prevented via vaccine administration. A WHO report detailed that approximately 4.5 million premature deaths could be avoided in low- and middle-income countries by 2030 through authorised vaccine dissemination, specific diagnosis, adequate treatment or medical supplies, and education campaigns [1]. Thus, the WHO's global hepatitis strategy, adopted by all WHO Member States, is directed toward the reduction of new hepatitis infections by 90% and deaths by 65% between the years 2016–2030, respectively. This commentary aims to provide a concise explanation of AHUO in children, its epidemiology and aetiology, and efforts undertaken to combat the disease. We provide key recommendations to the global community on ways to mitigate its spread.

### 1.1. Epidemiology and outbreak of acute hepatitis of unknown origin

Recent disease outbreak remarks by the WHO reveal that approximately 650 probable instances of AHUO have been reported by 33 countries belonging to WHO European, Americas, Western Pacific, South-East and Eastern-Mediterranean regions [1]. Surprisingly, the African region has not reported even a single case of AHUO among children.

Many of recorded cases are from the European region (22 countries) making a total of 374 cases where almost 60% of these cases are from the United Kingdom (UK) of Great Britain and Northern Ireland alone. Cases depicted in this figure are probable in the sense that they meet the WHO criteria for diagnosis but have not yet been confirmed and classified accordingly. Such cases are from the region of the Americas that has recorded approximately 240 cases, followed by 34 cases in the Western Pacific, 14 cases in the South-East, and lastly the Eastern Mediterranean, with 5 cases as shown in Fig. 1 below [1].

The cases range in age from one month to sixteen years [1]. Regarding aetiology, the causes of the occurrences are still being investigated. Laboratory testing is being conducted to determine the underlying mechanism and any possible links between the instances and infectious diseases, poisons, chemicals, and toxins [1]. The most widespread causes of viral hepatitis of acute nature include hepatitis viruses A, B, C, D, and E, which were not found in any of these patients. In addition, global linkage to other nations has not been recognized as an element based on currently available data. However, adenovirus has been found in at least 75% of the 35 tested cases, with 27 of those typified as F-type 41 on the basis of molecular testing [7]. Besides that, SARS-CoV-2 was found in 20 individuals who were examined, taking into consideration that the COVID-19 vaccine has not been administered in most of the instances reported. Furthermore, 19 cases were co-infected by SARS-CoV-2 and adenovirus [8].

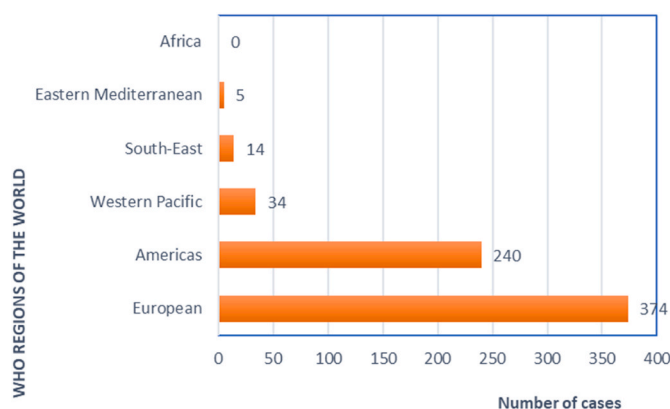


Fig. 1. As of May 26, 2022, the following table shows the WHO region by region distribution of cases of AHUO among children.

Following modest rates of infection circulation early in the COVID-19 pandemic, the UK, where the number of cases had been reported, has lately experienced a significant spike in adenovirus infections in the population (particularly in faecal samples from children) [1]. Moreover, the Netherlands reported an increase in community adenovirus circulation [1]. Nonetheless, because of refined viral laboratory testing, this could be the identification of a previously undetected unusual consequence that is now being discovered because of greater testing.

Given the spread of the yellow fever virus in numerous places, as well as the existence of malaria-endemic areas in the Americas, testing for these illnesses, in addition to hepatitis A-E tests, needs to be undertaken [1].

### 1.2. Aetiology

The alarming increase of AHUO in children, now termed non-hepatitis A–E viral hepatitis recorded in 19 countries worldwide, is a reason for concern. It demands close monitoring and coordinated efforts to identify the underlying aetiology, potential transmission pathways, and infectious agents implicated in this growing public health crisis [1, 9].

## 2. Possible aetiology hypotheses

### 2.1. Adenovirus

Currently, the most reasonable hypothesis indicates adenovirus infection having a role in the outbreak of acute non-hepatitis A–E viral hepatitis in children [9,10]. The increased sensitivity induced by lower adenovirus exposure during the COVID-19 pandemic, as well as the widespread use of non-pharmaceutical methods and a concomitant decrease in exposure to a range of pathogenic agents [10], are possible cofactors.

The role of the adenovirus variant is another plausible explanation for acute non-hepatitis A–E viral hepatitis; however, this theory assumes that a new viral strain is responsible for the infection. The fact that adenoviruses were found in more than three-quarters of the confirmed incidents [9,10] supports the argument that adenoviruses play a role in the disease process. It is suggested that scientists and clinicians need to investigate whether the virus's genome has changed, allowing for hepatotropic tendencies that may lead to severe liver inflammation [11].

Another possibility is that the control mechanisms imposed during the ongoing pandemic of COVID-19 caused young children to be exposed to adenoviruses, leading to a stronger immunological response and in turn causing severe hepatic damage [10].

## 2.2. COVID-19

Potential confounding coronavirus infection is one of several theories currently being considered in acute non-hepatitis A–E viral hepatitis origin [10]. A new variant of this virus could play a role. However, given the lack of current or previous SARS-CoV-2 positivity in most cases, this hypothesis does not appear to be plausible. Eight of the 13 subjects confirmed in Scotland were not found to be positive for SARS-CoV-2, and only two cases had positive results three months or prior to hospital admission [12].

## 2.3. COVID-19 vaccination

Non-hepatitis A-E viral hepatitis cases do portray a potential association with the COVID-19 vaccination's adverse effects. However, this theory seems remote and implausible given that many of the cases have occurred among children who had not received the COVID-19 vaccine [2]. The prevalence rate of acute non-hepatitis A-E viral hepatitis among children five years and under not authorized to get the COVID-19 vaccination almost excludes chances of COVID-19 vaccination playing a role in this emerging concern [13]. Since the median age of UK children with idiopathic hepatitis was under 5 years old, most of them had not gotten the COVID-19 vaccine. However, the fact that infection following natural immunity could cause hepatocyte destruction should be considered [35].

## 2.4. Unknown infectious agent aetiology

Possible contribution of an unknown infectious agent, particularly of viral origin, should be contemplated. RNA viruses appear to be the most likely candidates, given their rapid evolution, and abilities to successfully cross species boundaries, adapt to new niches, and change virulence rapidly [14].

## 2.5. Foodborne aetiology

Recent remarks from the European Society of Clinical Microbiology and Infectious Diseases addressed the possibility that current cases may be linked to a foodborne illness outbreak. Given that food processing can be a centralized process with transmission from a single manufacturer to numerous sites worldwide, the idea that the agent may be food-related needs to be investigated [11]. As foodborne illnesses are linked to immediate severe hepatotoxicity in persons who have been subjected to aflatoxins, they seem to be the most likely suspect in this case situation [15]. *Aspergillus* spp., the fungus that produces aflatoxins, colonizes with one another and produces aflatoxins, that pollute grains and cereals at different stages of harvest or storage [33]. There is a possibility of fungus contamination, transportation, and storage throughout harvest. Humans become infected with AFTs after eating foods contaminated with aflatoxins, including poultry, meat products, and milk products [34].

## 2.6. Toxic agents

When comparing subjects ( $n = 11$ ) and controls ( $n = 16$ ) in an exploratory inquiry on a likely connection between acute hepatitis and possibly hazardous chemicals in the UK, no significant findings were found [10]. This could indicate that a link between hepatotoxic factors and the present cases is less likely [9]. However, the toxicological examination is still ongoing, and the possibility of toxic agents playing a causal part is still being investigated [10].

Non-infectious or toxicological causes have yet to be discovered. However, they cannot be ruled out completely. A preceding SARS-CoV-2 infection triggering an immunologically-mediated response leading to a more severe adenovirus infection is another hypothesis that should be investigated further. Serological case-control investigations may aid in

the identification of a real signal [16]. According to a survey by the UK Health Security Agency, 75% of children with known data were given paracetamol, and 70% were subjected to dogs. However, the importance of both is uncertain [16]. In previous research, children with acute hepatic failure of unclear aetiology were shown to be infected with several viruses [17]. During the current crisis, children showed signs of infection with a wide spectrum involvement of other common respiratory and gastrointestinal viral diseases [16–18]. It can be challenging to detect the causative agents, and past attempts to detect viruses using next-generation sequencing haven't always been successful [17].

## 3. Current efforts to mitigate acute hepatitis of unknown origin

A study conducted by the ECDC (2022) suggests that reinforcing effective hygiene practices is an effective control measure to reduce the exposure of children to said virus. Reasons comprise increased likelihood of exposure to faecal-oral viruses, including adenoviruses [9]. These involve personal hygiene (i.e., hand and body hygiene) as well as hygiene for surroundings (i.e., cleaning and sterilization of surfaces). Moreover, Jules L. Dienstag (2022) in his detailed the importance of proper hygiene in the control of the spread of AHUO [19]. In addition, Dienstag stated the importance of first-line agents, entecavir (ETV), pegylated interferon alfa (PEG-IFN- $\alpha$ ), and tenofovir disoproxil fumarate (TDF), in treating hepatitis [19].

Another study led by Olson et al. (2011) introduced liver support devices as a promising technology for organ dysfunction in acute-on-chronic liver failure [20]. In contrast, according to Dienstag (2022), most cases of acute viral hepatitis do not require specific treatment [19]. Restricting physical activity seemed helpful for some patients although not necessary for full recovery. Besides, a high-calorie diet is favoured since some patients experience unbearable nausea throughout the day. Also, one conservative measure in the acute phase of the virus is intravenous feeding, especially if the patient cannot sustain oral intake and is repeatedly vomiting. Additionally, medication might cause adverse drug reactions, such as cholestasis, and drugs that are processed by the liver should be avoided. If the patient has severe pruritus, the bile salt-sequestering resin cholestyramine can assist. Furthermore, in normal and even in severe cases of acute viral hepatitis, glucocorticoid medication is ineffective and may even be harmful, increasing the chance of chronicity seen in acute hepatitis B infection.

## 4. Recommendations

As the exact aetiopathogenesis of AHUO remains unidentified, specific, and efficient control measures cannot be explained at this stage. In otherwise healthy children, adenovirus causes mild symptoms comprising rhinitis, fever, throat problems, respiratory tract infection, keratoconjunctivitis, and gastroenteritis. But, in the latest outbreaks of AHUO, adenovirus had been identified in most cases. It is, therefore, recommended to reinforce adequate hygienic practices in settings attended by young children [21–23]. Such practices may limit the spread of the virus through direct contact with infected persons, respiratory droplets, faecal-oral route, or indirectly via exposure to contaminated households or objects. If children aged sixteen years or below present with signs and symptoms of AHUO, diagnoses should pertain to hepatitis A-E virus, adenovirus, SARS-CoV-2, and other viruses screening alongside investigating toxins containing foods causing hepatitis [24,25,40].

Case presentation matching the criteria of case definition set by the WHO should be reported to concerned health authorities on an urgent basis. Such cases must be kept under proper surveillance [26–29,40]. Moreover, the healthcare providers must be made aware of the current situation, and standardized case reporting proforma should be used alongside timely reporting to concerned health departments [30–32, 36–39]. As adenovirus is a non-enveloped virus, alcohol-based disinfectants have limited effectiveness. Adenovirus may survive for longer periods on surfaces or skin, so decontamination needs specific agents

including chlorine, bleached-based solutions (10%), and heat treatment of surgical or medical instruments. In every healthcare environment, standard and strict precautionary measures should be followed for all suspected and identified cases.

## 5. Conclusion

Although extensive research has not been conducted on the rapidly-progressing AHUO in children, current literature has reported human enteric adenovirus type-41F in most cases aged sixteen or younger. Some cases have documented co-infection with SARS-CoV-2. Adenoviruses are mostly transmitted through interpersonal contact and frequently cause respiratory illness. However, according to the specific type, they may cause additional illnesses, such as gastrointestinal problems, conjunctivitis, and bladder infection. In many children reported to date, jaundice appeared earlier than nausea, vomiting, and diarrhoea. Suitable specimens (faeces, nasopharyngeal swab, trachea-bronchial lavage, conjunctival secretion, urine, or liver biopsy) can be used for diagnosis. Children demonstrating clinical pictures of severe hepatitis and jaundice should be managed in a tertiary care centre. So far, most patients have recovered fully, and in extreme cases have required liver transplantation.

An ongoing consensus indicating a cofactor affecting young children which was known to cause normal mild adenovirus infection now causes more severe infection and triggers immunopathology. It may be due to the decrease in social exposure and virus dissemination in the pandemic period, history of infection with SARS-CoV-2 (including the Omicron variant), restricted affect, a toxin, drug, or environmental exposure. If we suspect a novel pathogen that may arise from mutations in existing adenovirus, these may affect hepatocytes accordingly. Hence, further research is warranted.

## Ethics approval

Not Applicable.

## Funding

We have not received financial support for this manuscript.

## Authors' contributions

**Olivier Uwishema** – Conceptualization, Project administration, Writing-review and Designing, **Ashraf Mahmoud** – Collection and assembly of data, **Olivier Uwishema** – Reviewed and edited the first draft, supervisor, **Jack Wellington MSc (LSHTM) FGMS** – Reviewed and edited the second draft, **Olivier Uwishema** – Reviewed and edited the final draft.

## Registration of research studies

Name of the registry: **Not Applicable**  
 Unique Identifying number or registration ID: **Not Applicable**  
 Hyperlink to your specific registration (must be publicly accessible and will be checked): **Not Applicable**

## Consent

Not Applicable.

## Guarantor

Not Applicable.

## Data availability statement

Not Applicable.

## Declaration of competing interest

None.

## Acknowledgment

None.

## References

- [1] World Health Organization, Disease Outbreak News; Multi-Country – acute, severe hepatitis of unknown origin in children, Available at: <https://www.who.int/emergencies/disease-outbreak-news/item/DON-389>, 27 May 2022. (Accessed 20 June 2022).
- [2] World Health Organization, Disease outbreak news; multi-Country Acute, severe hepatitis of unknown origin in children, Available online: <https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON376>, 23 April 2022. (Accessed 28 April 2022).
- [3] S. Braccio, A. Irwin, A. Riordan, D. Shingadia, D.A. Kelly, S. Bansal, M. Ramsay, S. N. Ladhani, Acute infectious hepatitis in hospitalized children: a British Paediatric Surveillance Unit study, *Arch. Dis. Child.* 102 (2017), 624628 [CrossRef] [PubMed].
- [4] Centers for Disease Control and Prevention. CDC Health Advisory, Recommendations for adenovirus testing and reporting of children with acute hepatitis of unknown etiology, Available at: <https://emergency.cdc.gov/han/2022/han00462.asp>. (Accessed 25 April 2022).
- [5] European Centre for Disease Prevention and Control, Update: hepatitis of unknown origin in children, Available at: <https://www.ecdc.europa.eu/en/news-events/update-hepatitis-unknown-origin-children>. (Accessed 25 April 2022) (View in Article. Google Scholar).
- [6] K. Marsh, R. Tayler, L. Pollock, K. Roy, F. Lakha, A. Ho, D. Henderson, T. Divala, S. Currie, D. Yirrell, et al., Investigation into cases of hepatitis of unknown aetiology among young children, Scotland, 1 January 2022 to 12 April 2022, *Euro Surveill.* 27 (2022), 2200318 [CrossRef] [PubMed].
- [7] World Health Organization, Acute hepatitis of unknown aetiology – the United Kingdom of Great Britain and northern Ireland, 2022. Disease Outbreak News [Internet]. 2022 Apr 15; Available from: <https://www.who.int/emergencies/disease-outbreak-news/item/acute-hepatitis-of-unknown-aetiology-the-united-kingdom-of-great-britain-and-northern-ireland>.
- [8] W.H.O. PAH, Epidemiological alert: acute, severe hepatitis of unknown origin in children, April 2022 -. ReliefWeb. Retrieved May 15, 2022, from, <https://reliefweb.int/report/world/epidemiological-alert-acute-severe-hepatitis-unknown-origin-children-29-april-2022>, 2022, April 30, 29.
- [9] European Centre for Disease Prevention and Control, Increase in severe acute hepatitis cases of unknown aetiology in children, 28 April 2022. [Online] Available at: <https://www.ecdc.europa.eu/en/publications-data/increase-severe-acute-hepatitis-cases-unknown-aetiology-children>. (Accessed 16 May 2022).
- [10] UK Health Security Agency, Acute hepatitis: technical briefing. Online, Available at: <https://www.gov.uk/government/publications/acute-hepatitis-technical-briefing>. (Accessed 16 May 2022).
- [11] M. Sallam, A. Mahafzah, G.O. Şahin, Clusters of Hepatitis of Unknown Origin and Etiology (Acute Non HepA–E Hepatitis) Among Children in 2021/2022: A Review of the Current Findings, 2022.
- [12] K. Marsh, R. Tayler, L. Pollock, K. Roy, F. Lakha, A. Ho, N. Phin, Investigation into cases of hepatitis of unknown aetiology among young children, Scotland, 1 January 2022 to 12 April 2022, *Euro Surveill.* 27 (15) (2022), 2200318.
- [13] WHO | World Health Organization, Coronavirus disease (COVID-19): vaccines, Online. Available at: [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirusdisease-\(covid-19\)-vaccines](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirusdisease-(covid-19)-vaccines). (Accessed 16 May 2022).
- [14] C.R. Parrish, E.C. Holmes, D.M. Morens, E.C. Park, D.S. Burke, C.H. Calisher, P. Daszak, Cross-species virus transmission and the emergence of new epidemic diseases, *Microbiol. Mol. Biol. Rev.* 72 (3) (2008) 457–470.
- [15] P. Kumar, D.K. Mahato, M. Kamle, T.K. Mohanta, S.G. Kang, Aflatoxins: a global concern for food safety, human health and their management, *Front. Microbiol.* 7 (2017) 2170.
- [16] UKHSA, Investigation into acute hepatitis of unknown aetiology in children in England—technical briefing 2.2022, Online. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1073704/acute-hepatitis-technical-briefing-2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1073704/acute-hepatitis-technical-briefing-2.pdf). (Accessed 17 May 2022).
- [17] S. Somasekar, D. Lee, J. Rule, S.N. Naccache, M. Stone, M.P. Busch, C.Y. Chiu, Viral surveillance in serum samples from patients with acute liver failure by metagenomic next-generation sequencing, *Clin. Infect. Dis.* 65 (9) (2017) 1477–1485.
- [18] J.M. Baker, Acute Hepatitis and Adenovirus Infection Among Children—Alabama, vol. 71, *MMWR. Morbidity and Mortality Weekly Report*, 2022. October 2021–February 2022.

- [19] J.L. Dienstag, Acute viral hepatitis, in: J. Loscalzo, A. Fauci, D. Kasper, S. Hauser, D. Longo, J. Jameson (Eds.), *Harrison's Principles of Internal Medicine* 21e, McGraw Hill, 2022. <https://accessmedicine.mhmedical.com/content.aspx?bookid=3095&sectionid=264532564>.
- [20] Olson, b Jody Ca, Patrick Kamath, Sb Acute-on-chronic liver failure: concept, natural history, and prognosis, *Curr. Opin. Crit. Care* 17 (2) (April 2011) 165–169, <https://doi.org/10.1097/MCC.0b013e328344b42d>. [https://journals.lww.com/co-criticalcare/fulltext/2011/04000/Acute\\_on\\_chronic\\_liver\\_failure\\_concept\\_natural.14.aspx](https://journals.lww.com/co-criticalcare/fulltext/2011/04000/Acute_on_chronic_liver_failure_concept_natural.14.aspx).
- [21] O. Uwishema, R. Badri, H. Onyeaka, M. Okereke, S. Akhtar, M. Mhanna, B. Zafar, A. Zahabioun, K.A. Said, M.R. Tovani-Palone, Fighting Tuberculosis in Africa: the Current Situation amidst the COVID-19 Pandemic. *Disaster Medicine and Public Health Preparedness*, vols. 1–12, Advance online publication, 2022, <https://doi.org/10.1017/dmp.2022.142>.
- [22] O. Uwishema, H. Onyeaka, B.A.A. Alshareif, M.E.A. Omer, A.L.R. Sablay, R. Tariq, et al., Current context of pneumonia amidst the COVID-19 pandemic in Africa, *J Contemp Stud Epidemiol Public Health* 2 (2) (2021), ep21007, <https://doi.org/10.30935/jconsep/11281>.
- [23] O. Uwishema, L.F. Adriano, E. Chalhoub, H. Onyeaka, M. Mhanna, S.C. David, Y. Nasrallah, L. Ribeiro, C. Berjaoui, Bird flu outbreak amidst COVID-19 pandemic in South Africa: efforts and challenges at hand, *J. Med. Virol.* 93 (10) (2021) 5676–5679, <https://doi.org/10.1002/jmv.27124>.
- [24] O. Adekunbi, O. Uwishema, I. Adanur, H. Onyeaka, Prospect of acute hepatitis E virus outbreak in the context of the COVID-19 Pandemic in Africa: a contingency plan, *Annals of Medicine and Surgery* (2022), <https://doi.org/10.1016/j.amsu.2022.104084>.
- [25] O. Uwishema, B. Alshareif, M. Yousif, M. Omer, A. Sablay, R. Tariq, A. Zahabioun, R.M. Mwazighe, H. Onyeaka, Lassa fever amidst the COVID-19 pandemic in Africa: a rising concern, efforts, challenges, and future recommendations, *J. Med. Virol.* 93 (12) (2021) 6433–6436, <https://doi.org/10.1002/jmv.27219>.
- [26] J. Sun, O. Uwishema, H. Kassem, M. Abbas, L. Uweis, A. Rai, R. El Saleh, I. Adanur, H. Onyeaka, Ebola virus outbreak returns to the Democratic Republic of Congo: an urgent rising concern, *Annals of Medicine and Surgery* (2022), <https://doi.org/10.1016/j.amsu.2022.103958>.
- [27] O. Uwishema, E.M. Nnagha, E. Chalhoub, G. Nchasi, R.M. Mwazighe, B.T. Akin, I. Adanur, H. Onyeaka, Dengue fever outbreak in Cook Island: a rising concern, efforts, challenges, and future recommendations, *J. Med. Virol.* 93 (11) (2021) 6073–6076, <https://doi.org/10.1002/jmv.27223>.
- [28] O. Uwishema, E. Chalhoub, T. Torbati, S.C. David, C. Khoury, L. Ribeiro, Y. Nasrallah, B.K. Bekele, H. Onyeaka, Rift Valley fever during the COVID-19 pandemic in Africa: a double burden for Africa's healthcare system, *Health science reports* 5 (1) (2022) e468, <https://doi.org/10.1002/hsr2.468>.
- [29] O. Uwishema, E. Chalhoub, A. Zahabioun, S.C. David, C. Khoury, T.H. Al-Saraiheh, B.K. Bekele, R.M. Mwazighe, H. Onyeaka, The rising incidence of African swine fever during the COVID-19 pandemic in Africa: efforts, challenges and recommendations, *Int. J. Health Plann. Manag.* 37 (1) (2022) 561–567, <https://doi.org/10.1002/hpm.3357>.
- [30] O. Uwishema, G. Ayoub, R. Badri, H. Onyeaka, C. Berjaoui, E. Karabulut, H. Anis, C. Sasmour, F. Mohammed Yagoub, E. Chalhoub, Neurological disorders in HIV: hope despite challenges, *Immunity. Inflam. Dis.* 10 (3) (2022) e591, <https://doi.org/10.1002/iid3.591>.
- [31] O. Uwishema, H. Onyeaka, R. Badri, A.N. Yücel, A.K. Korkusuz, A.O. Ajagbe, A. Abuleil, C. Chaaya, B. Alhendawi, E. Chalhoub, The understanding of Parkinson's disease through genetics and new therapies, *Brain and behavior* 12 (5) (2022) e2577, <https://doi.org/10.1002/brb3.2577>.
- [32] L. Greene, O. Uwishema, A. Nicholas, A. Kapoor, C. Berjaoui, E. Adamolekun, C. Khoury, F. Mohammed, H. Onyeaka, Crimean-Congo haemorrhagic fever during the COVID-19 pandemic in Africa: efforts, recommendations and challenges at hand, *African journal of emergency medicine : Revue africaine de la medecine d'urgence* 12 (2) (2022) 117–120, <https://doi.org/10.1016/j.afjem.2022.02.004>.
- [33] A.A. Kader, A.M. Hussein, Harvesting and postharvest handling of dates, *ICARDA, Aleppo, Syria* 4 (2009) 15.
- [34] S. Piermarini, L. Micheli, N.H.S. Ammida, G. Palleschi, D. Moscone, Electrochemical immunosensor array using a 96-well screen-printed microplate for aflatoxin B1 detection, *Biosens. Bioelectron.* 22 (7) (2007) 1434–1440.
- [35] D.A. Kelly, Z. Stamataki, Sudden onset hepatitis in children, *Nat. Rev. Gastroenterol. Hepatol.* (2022) 1–2.
- [36] O. Uwishema, C. Berjaoui, I. Correia, H. Anis, E. Karabulut, D. Essayli, M. Mhanna, A. Oluyemisi, Current management of acute ischemic stroke in Africa: a review of the literature, *Eur. J. Neurol.* 10 (2022), <https://doi.org/10.1111/ene.15495>, 1111/ene.15495. Advance online publication.
- [37] O. Uwishema, A. Mahmoud, J. Sun, I. Correia, N. Bejjani, M. Alwan, A. Nicholas, A. Oluyemisi, B. Dost, Is Alzheimer's Disease an Infectious Neurological Disease? A Review of the Literature. *Brain and Behavior*, Advance online publication, 2022, e2728, <https://doi.org/10.1002/brb3.2728>.
- [38] Aishwarya Umesh Pradhan, et al., A review of stem cell therapy: an emerging treatment for dementia in Alzheimer's and Parkinson's disease, *Brain and behavior* (August. 2022), <https://doi.org/10.1002/brb3.2740>.
- [39] Olivier Uwishema, et al., The impact of COVID-19 on patients with neurological disorders and their access to healthcare in Africa: a review of the literature, *Brain and behavior* (August. 2022), <https://doi.org/10.1002/brb3.2742>.
- [40] Olivier Uwishema, et al., The burden of monkeypox virus amidst the Covid-19 pandemic in Africa: a double battle for Africa, *Annals of medicine and surgery* 80 (2022) (2012), 104197, <https://doi.org/10.1016/j.amsu.2022.104197>.