Review Article

Flashback and lessons learnt from history of pandemics before COVID-19

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Abstract

With an increasing frequency of infectious disease outbreaks, the COVID-19 pandemic causing mortality around the world and the threat of similar future events looming large, mankind is faced with the herculean task of counteracting such threats with the best possible strategies and public health decisions. It is key that such decisions should be guided by previous examples of similar health emergencies. Here we review some of the significant infectious disease outbreaks, including epidemics and pandemics occurring worldwide in the past including their impact at population and global levels, unique challenges presented by each and the measures taken by authorities worldwide as well as the crucial lessons each epidemic or pandemic provided. This review highlights that throughout history measures such as contact tracing, quarantine and isolation have been incredibly effective in limiting an outbreak in its severity, thus ensuring accurate information flow to the public is as essential as limiting the spread of misinformation. With global populations rising, surveillance for emerging and re-emerging pathogens will play an immense role in preventing future epidemics or pandemics. And finally that even though for novel strains or pathogens, although vaccines are thought to be an irreplaceable defense, but their development and distribution in time to curb an epidemic has seldom been witnessed and remains an important challenge for the future. Hence, we conclude that looking at these past examples not only highlights the important knowledge gained for the strategies to devise, but also the mistakes that can be avoided in the way forward.

Keywords: COVID-19, H1N1, MERS, pandemics, severe acute respiratory syndrome, Spanish flu

Introduction

The microbial world has always laid a hefty price on humanity, and even as medicine keeps advancing, the threat of novel human pathogens arising remains consistent. Currently, we face one of the worst public health crises of the twenty-first century and even though unique and horrifying in its way, the past has been ample with examples of similar events, each presenting new challenges and learning opportunities to populations around the world.

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An epidemic is defined as a sudden more than expected increase in the occurrence of cases of a disease in a community or area. A pandemic, on the other hand, is an epidemic occurring over an extensive area, crossing international boundaries to several countries, and usually affecting a large number of people.[1]

Their causative agents can differentiate these events, the number of infections, the death toll of the disease as well characters like case fatality rates (the number of deaths per number of infections over a period of time) and the basic reproduction number (R_0), an indicator of transmissibility, that is, the average number of subsequent infections caused by a single individual.

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Over the past decades, there has been an increasing emergence of outbreaks leading to global spread[2] which suggests that in future also, humanity is prone to suffer from such incidents, as the population and their interconnectivity increase around the world. It is only justified that we prepare ahead with maximum caution and best strategies to tackle the threats present in nature.

Here, we review some of the significant outbreaks that became epidemics and pandemics, and how each one of them highlighted the substantial lessons that have not only helped shape our fight against the present COVID-19 (coronavirus disease 2019) pandemic but also will aid in preparation for the next deadly outbreak. The statistics of each event is presented along with details like origin, mortality and unique features, measures taken worldwide, vaccine developments, the impact and lessons learned from each epidemic and pandemic.

1918 H1N1 pandemic (Spanish Flu)

Being one of the deadliest pandemics to have ravaged mankind, as well as the most mysterious and odd behaving ones and considered as the mother of all pandemics,[3] its significance was enough to dwarf even the lethality of world war-1 that had harrowed humanity at that time. The various features of each epidemic are compared in Table 1.

The median value of Reproduction number (R_0) was 1.80 for all waves (IQR: 1.47–2.27). The median values of R_0 for first wave, second wave, and third waves were 1.81 (IQR: 1.50–2.28), 1.73 (IQR: 1.39–2.33), and 1.70 (IQR: 1.55–1.76), respectively.

Origin and spread: Contrary to its name the "Spanish" flu did not originate in Spain, rather due to widespread cases in Spain in early 1918 and neutrality in the war, cases were not subject to censorship. The 1918 influenza was unusual to occur in multiple waves of infection throughout the world. The first wave is reported to have begun in March 1918 in the United States with concurrent waves in North America, Europe, and Asia. World War I played a major role in bringing populations together, not to mention poor sanitation and overcrowding in military camps promoted spread around the world.[4,5]

Much was unknown about the virus until it was reconstructed using archaevirology in 2005.[6] The origin of the 1918 virus remains controversial, with some suggesting it was from a reassortment or mixing between H1 genes from human and N1 from avian viruses,[7] while others believe that it was an avian-like virus which directly adapted to humans.[8]

Unique Features: Three extensive waves occurred simultaneously within 1 year (spring, fall, and winter), which was one of the remarkable features of the virus and the waves also differed in severity, with higher transmissibility in spring and significant mortality in fall and autumn waves.

As seasonal influenza (flu) is known to follow a U-shaped curve with older adults and children being more susceptible to severe infection, a most ambiguous aspect of 1918 H1N1 virus was higher mortality among young adults aged 20–40 years.[9] It was suggested that young adults in 1918 were exposed to a distinct circulating H3N2 virus strain in their childhood (1889–1893), while people born before or after 1889–1993 would have been previously exposed to H1 strains similar to the 1918 virus which provided them with some cross-immunity and making them less susceptible.[7]

The major contribution to mortality was due to the increased frequency of secondary bacterial pneumonia, viral pneumonia, and the absence of vaccines, antivirals, and antibiotics added to it.[10] The mortality of major epidemics was presented in Figure 1.

Control measures: Since there was no availability of antibiotics or antivirals, most measures to curb the outbreaks were nonpharmaceutical interventions (NPIs). With global air travel limited, maritime (sea transport) quarantine was one of the measures practiced. However, it was ineffectively implemented in most countries, and deemed ineffective by some countries.[10] Australia has been reported to be successful in the implementation of such measures as the second wave arrived there later, in December 1918,[10] as well as America Samoa which was able to escape the pandemic with no deaths reported.[11]

The closing of schools, shops, churches and restrictions on public gatherings were implemented. Still, their timing and duration

Table 1: Comparison of statistics of each epidemic and pandemic

Name	Timeline	Causative agent	Estimated infections	Death Toll	Case Fatality rates	R_0
Spanish flu Pandemic (3,4)	1918-1919	Influenza virus A H1N1 (1918 pandemic strain)	~500 million	~50 million	2.5%	1.80 for all waves
SARS Epidemic (5,6)	2002-2003	Severe acute respiratory syndrome coronavirus (SARS-CoV)	8096	774	9.6% (overall)	2.2-3.6 (without control measures)
Swine Flu Pandemic (4,7-9)	2009-2010	Influenza virus A H1N1 (2009 pandemic strain)	24% of populations of affected countries	151,700-575,400	<0.001% ->10% (~0.02% overall)	1.46 for both waves
MERS Epidemic (10)	2012-present	Middle Eastern respiratory coronavirus	2494	858	34.3%	<1
Ebola Epidemic (11,12)	2014-2016	Ebola virus "Zaire" species	28,646	11,323	28% in Sierra Leone 67% in Guinea	1.9 for Liberia 1.368 for Sierra Leone
COVID-19 Pandemic (13-16)	2019-present	SARS-CoV- 2	109,426,406	2,419,363	2.2%	2-4 (June 2020)

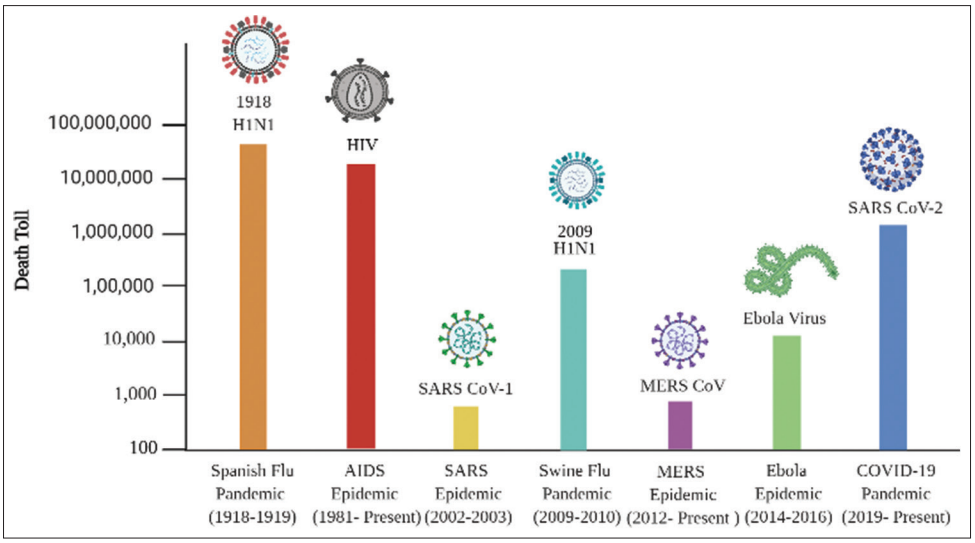

Figure 1: The above graph shows the death toll comparison of significant epidemics and pandemics. (Created with BioRender.com)

played an essential role as most cities introduced them too late and could not maintain more extended periods of NPIs. Their populations remained susceptible primarily to a second wave.[12] Therefore, these interventions only had a moderate impact on mortality.[13]

Use of face masks was implemented, but due to lack of safety criteria met by masks, they were not effective.[10] However, hand washing and hand hygiene practices did play a significant role, for example, in some countries like Japan, where such practices were strictly followed.[10,14]

Impact and lessons learned: Few events have overwhelmed healthcare around the world as the Spanish Flu, which reduced life expectancy in the USA alone by about 10 years.[15] The 1918 virus is thought to have given rise to all influenza pandemic virus strains in the following years (H2N2 in 1957, H3N2 in 1968 and H1N1 in 2009) through the property of genetic reassortment.[16]

In various analyses of the impact of public health interventions[12,13] in 1918, a middle ground was established for the implementation of such measures, that is, while shutting down too late was associated with higher mortality, those cities that closed earlier still had populations susceptible on reopening unless vaccines were available. Also reported was the concept of reactive social distancing, tha is, people reacted more to mortality as compared to the number of infections in terms of hygiene precautions.[13]

The 1918 pandemic had innumerable striking aspects, and its origin seems to have followed an unclear adaptation of the avian-like virus to humans, which gives breath to the warning that in the future, highly lethal avian H5N1 and H7N9 viruses could also adapt for the human to human transmissibility. The preparedness for such threats is determined by the ability to predict them beforehand using previous examples such as that of 1918 Spanish Influenza.

2009 H1N1 pandemic (Swine Flu): Being the first pandemic of the twenty-first century, the 2009 pandemic tested modern medicine's preparedness and abilities to counter havocs of nature's potential. It was important for self-check, where we stand? And how should we prepare further?

Median value for Reproduction number (R_0) was 1.46 (IQR: 1.30–1.70) for both waves, 1.47 (IQR: 1.31–1.71) for the first wave and 1.48 (IQR: 1.30–1.66) for the second wave.

Origin and spread: One of the predictions for the influenza pandemic of the twenty-first century was to be of South East Asia origin. However, such was not the case. Unlike other influenza pandemics, the swine flu pandemic was unique, to begin with, the first cases in Mexico[17] and with subsequent spread to the USA in march 2009, where the first cases were detected.

With modern genome sequencing techniques available, it was revealed that the virus was of swine origin. It was a reassortant virus between Eurasian swine viruses and North American swine viruses[18,19] and contains genes of human, swine, and avian influenza viruses. This was unique, as previous influenza viruses jumping to humans were mostly from avian species (such as H5N1, H9N2).

Unique features: The mortality was not as severe as the 1918 H1N1 pandemic, with considerably lower case fatality rates overall. Unlike seasonal influenza majority of the deaths occurred in people below the age of 65 years[20] and it was reported that people above 60 years maintained cross-immunity due to past exposure to similar strains while younger people had little immunity.[21]

Individuals at high risk for mortality included children under age 5 years, individuals with comorbidities as well as pregnant females.

Not previously thought as a risk factor in infectious disease, obesity was associated with a higher risk for death during the

H1N1 pandemic which was later explained by obesity-induced immunodeficiency in infected individuals.[22]

Control measures: Nonpharmaceutical measures included the closure of schools[23,24] due to high attack rates and the large number of outbreaks occurring through schools reducing transmission as much as by 25% in the UK. This is supported by the fact that children are thought to be efficient vectors of influenza.

A detailed analysis of international response[25] showed that screening, quarantine, and isolation were done only by China, Japan, and Hong Kong SAR, which other countries could not achieve possibly due to logistics and cost-benefits. While most countries encouraged hand hygiene, cough etiquette and self-isolation, face mask use was common only in East Asia.

Pharmaceutical measures: The availability of antiviral drugs for the virus (Oseltamivir) and susceptibility of the virus to them (some strains resistant to Amantadine, rimantadine) made a significant difference as compared to 1918 influenza pandemic. Some countries used chemoprophylaxis as an initial measure which waned towards the latter stages of the pandemic.[25] Although the rapid development of a vaccine was possible, most countries could not receive them early enough and in large enough quantities to have a significant impact at the population level.[25]

Vaccine development: Advantageous over previous influenza pandemics, in 2009 within the first six months of the pandemic, viral vaccines were manufactured due to the process being similar to seasonal influenza vaccine development. The vaccine produced was highly immunogenic and safe.[26] Unluckily, however, the vaccines could not be distributed across most countries in time until the peaks of the pandemic occurred.

Impact and Lessons learned: The example of Hong Kong has been highlighted for reducing transmission, that is, having previously faced 1997 H5N1 and 2003 SARS outbreaks, made the population more sensitized and provided suitable infrastructure and resources to achieve implementation of social distancing and border screening.[25] Hence, countries where previous epidemics have occurred supposedly fare better in achieving stringent control measures.

Behavioural responses of the public were guided by misconceptions about the preventative measures, which was a hurdle in the implementation of appropriate measures.[27]

Vaccine distribution was one of the weak aspects in response to the 2009 pandemic. Despite vaccines being produced at a rapid pace, their coverage was much lower than anticipated. Whereas the USA began vaccination in October, countries like Mexico were not able to begin vaccinating till January.[28] Even in today's times, such rapid development of vaccines is still met by a shortcoming of supply, especially to countries with weak health infrastructures and need to be worked on urgently.

Surveillance of other animals for influenza viruses such as swine other than avian species to detect viruses of pandemic potential have become necessary after the emergence of 2009pm H1N1.

The sharing of clinical data was one of the challenges during the initial stages.[25] Unprecedented transparency and rapid data-sharing are required to devise strategies in time before such a disease can grab a global hold and should be under the guidance and management of a central committee.

The H1N1 was the first test of twenty-first century regarding preparedness for a pandemic threat with multiple strategies being realized, implemented and tested bringing us face to face with the strengths as well as weaknesses of modern medicine.

SARS: The first coronavirus epidemic: Regarded as the first major epidemic of twenty-first century, SARS (severe acute respiratory syndrome) led to a new set of guidelines and consideration of possibilities for multiple risk factors that can lead to an epidemic or pandemic.

Origin and spread: This was the first outbreak caused by a coronavirus, It is believed to have originated in horseshoe bats as the natural reservoir,[29] then to an intermediate host (palm-civets) before spreading to humans through close contact in live-animal markets.[30] The first infections occurred in Guangdong, Southern China, in November 2002.[30] It was not until April 2003 that SARS- CoV was declared as the cause of SARS.[31]

SARS-CoV mainly spread through inhalation of respiratory droplets produced by coughing and sneezing or contact through fomites.[32] However airborne transmission was also a possible route of spread,[33] which can also lead to nosocomial transmission during aerosol-generating procedures (nebulization, bronchoscopy, cardiac resuscitation, intubation, ventilation).

Unique features: The case fatality rates of SARS were higher than influenza viruses, with outcomes ranging from admission to ICU to adult respiratory distress syndrome (ARDS) and death.[34] The risk factors associated with SARS-related deaths included old age (>60 years), occupation (healthcare workers), and male sex.

The epidemic was mainly propagated within hospitals through nosocomial infections in the early stages and largely remained limited to hospitals. Also, healthcare workers attributed to a large proportion of cases[35-37] as they were more likely to be exposed to respiratory secretions of the patients and aerosol-generating procedures.

Multiple Super-spreading events (SSEs) occurred throughout the epidemic, where an infected individual is responsible for transmission to a large number of contacts. One such transmission chain occurred in Beijing wherein a chain of 77 cases, 4 cases were associated with the majority of transmission (>8 secondary infections each) while 86% others did not transmit.[38] Similar events occurred in Hotel Metropole, which was responsible

for the international introduction of the virus; in a flight from Hong Kong to Beijing[39]; in Amoy Gardens apartment complex in Hong Kong[33] and a hospital in Toronto, Canada.[35]

There was an alarming short reemergence of the virus in late 2003, reportedly through zoonotic transmission from civet cats, also from animal markets which was curbed by the rapid response from the health authorities.

Control measures

Non-pharmaceutical measures: These measures were the major response in controlling the disease, and among them, quarantining patients and contact tracing proved to be the most effective intervention.[40] Wearing of masks, frequent hand washing and disinfecting substances were found to be protective and such public health measures were found to limit community-level transmission and help curb the epidemic.[41] In Beijing, where the most significant outbreak occurred, measures implemented included training of HCWs in SARS patient management, use of personal protective equipment and infection control; quarantine of close contacts of patients; closing of sites of public entertainment and schools along with circulation of the necessary information to the public.[36] To prevent the reemergence of the epidemic civets were banned from wet-markets.

Analysis from three countries showed that no cases of SARS (from >35 million) were detected by thermal screening of travellers at airports[40] and screening for cases at transportation sites was overall less effective.[36]

Pharmaceutical measures: Although multiple case studies and observational studies were conducted, the short duration of the epidemic made it difficult to conduct clinical trials. Multiple treatment options were tried as there were no standardized drugs available for SARS coronavirus. These included Ribavirin, lopinavir/ritonavir[42] and convalescent plasma.[43] A review analyzing these treatment options concluded that since the studies performed were not randomized controlled trials, the results were not absolute. Therefore the management remained largely supportive.

Vaccine development: Although studies showed vaccines induced seroconversion and antibody response in mouse models, results were incomplete due to the development of immunopathology on the challenge with the virus.[44] No human trials were conducted further for the vaccine as the epidemic ended shortly.

Impact and lessons learned

SARS highlighted the importance of how close contact between humans and animals can introduce viruses into populations, which has time and again given rise to dangerous and potentially disastrous situations, with previous influenza outbreaks (H5N1), SARS, MERS and now the current SARS-CoV 2.[30] This points to the grim realization about the limits of practices involving contact with infected animals such as live-animal markets.

The principle of super-spreading events played a significant role in the 2003 epidemic. This has a handful of implications for how epidemics or pandemics should be modelled in the future and the contribution such subjects can have toward the development of an epidemic.

It is essential for SARS-like illnesses that in-hospital surveillance of all HCWs be made necessary since they are at high risk and made up for the majority of cases during the epidemic.

Some authors suggested the primary lesson from the SARS epidemic is to realize the importance of the timely flow of information which facilitates policy-making necessary to kill the disease at its source.[45] However, this is challenged by a nation's strive to maintain social and economic stability, such as occurred in China.

Although SARS was not associated with as high a death toll as other epidemics or pandemics previously, it was an essential reminder of the threat that zoonotic diseases present and even in the twenty-first century, how viruses such as SARS-CoV can act as a source of future outbreaks and epidemics or pandemics.

MERS: The second coronavirus epidemic to occur, a decade after the scare of SARS in 2003. MERS was associated with significant severity and an even higher mortality rate than SARS. Unusual to occur in the middle-east, it highlighted the increasing frequency of coronavirus emergence in the world.

Origin and spread: The first case was recorded in Jeddah, Saudi Arabia in June 2012.[46] The virus is thought to have passed on to humans through direct or indirect contact with infected dromedary camels.[47] The origin of the virus, however, is believed to be from bats as a reservoir but is still uncertain. Because viruses with similar genomes to MERS-CoV have been isolated from bats.[48] The most significant outbreaks occurred in the Middle East in 2014 before declining in mid-May 2014.[49] This was followed by another outbreak in South Korea in 2015.[50]

Luckily, the virus is not able to transmit easily between humans and requires close contact, thus limiting community transmission and the majority of cases to healthcare facilities.[49,51,52]

Two possible modes of transmission are camel to human and human to human. The former can occur through camel ownership, training, birthing and milking practices, eating uncooked camel meat, while drinking raw camel milk, a common practice in Saudi Arabia has also been suggested as a source of infection.[49] The transmission is thought to occur through direct or indirect contact with respiratory droplets, or through aerosols rarely, but remains uncertain.[49,52]

Unique features

The presentation ranges from asymptomatic infection or mild respiratory infection to severe acute respiratory disease and death.

Severe infection and mortality risk are higher with old age and comorbidities/pre-existing conditions like diabetes, chronic heart and lung diseases, renal failure and immunosuppression.[49,53]

The MERS outbreak did not develop into a severe epidemic instead remained limited to infection clusters and outbreaks mainly in healthcare facilities. This was due to low transmissibility as the virus had initial R_0 estimates lower than 1[54] which is below epidemic or pandemic threshold (R_0 >1), contrary to SARS which had R_0 values higher than one.[55]

Supers spreading events (SSEs) were reported in the MERS 2015 outbreak in South Korea.[56] Still, SSEs were considered to have a lower incidence than during SARS, and it was suggested that ensuring the limited spread of the disease to the larger number of potential super-spreaders played a role in preventing an epidemic. This has been touted as the thin line between an infection cluster (most cases of MERS) and an epidemic (as occurred with SARS).[56] However, over the years SSEs have played an important role in the outbreaks of MERS.[57]

Unlike its predecessor, the MERS virus was not contained becoming endemic to Middle Eastern countries and still maintains a potential threat for future global spread.

Control measures: Infection prevention and control interventions, especially in hospitals play an essential role in limiting the spread and have been suggested by the WHO as crucial in the prevention of future outbreaks.[58] In hospitals, hand hygiene, stringent use of personal protective equipment, avoidance of overcrowding, aerosol precautions for aerosol-generating procedures, timely screening and isolation of cases in healthcare workers are necessary. Along with this, ensuring proper hygiene in camel handlers or owners is extremely important, with proper washing of hands after handling animals, consumption of pasteurized milk, avoiding close contact with infected camels and surveillance of animals for the virus. Currently, no effective standardized treatment for MERS-CoV exists, and treatment relies mostly on supportive therapy.

Vaccine development: WHO has suggested the preferences for vaccine candidates. These include a vaccine to prevent infection in dromedary camels, and two types of human vaccines: one for long-term protection of high-risk individuals such as health care workers and another vaccine for use in emergency outbreak settings providing rapid immunity.[59] Three kinds of vaccine candidates have been studied and are under development, including DNA vaccines, viral vector vaccines and live/inactive virus vaccines and show promising results.[60] However, concerns with safety and efficacy still remain as vaccines for both SARS and MERS have shown to induce immunopathology[44,61] and been incompletely protective in older animals while efficacious in young ones.[62] As MERS has a higher mortality risk among the elderly, vaccines should be able to induce sufficient immunoprotection in the elderly population but not excess immune activation.

Impact and lessons learned

Factors promoting the emergence of MERS in Qatar included camel ownership being associated with status and wealth, promotion of camel racing, and an essential shift from open-grazing of camels to housing in barns under poor hygienic and biosafety conditions that led to ideal conditions for spillover of such a virus to humans.[63] This provides an essential motivation for animal surveillance for potential zoonotically transmissible viruses and the implications of contacts with such animals that can act as reservoirs for viruses.

One of the critical factors affecting the transmission of MERS was the infection control practices in hospital settings, which can be a weak point in diseases like MERS, as the majority of cases occur in such settings and the importance of adhering to appropriate IPC guidelines (infection prevention and control) is immense.

Although having low transmissibility, the continued persistence of the virus points to the dangers that such a disease can possess if such a virus mutates developing pandemic potential.

Ebola virus epidemic (2013): An example of an outbreak involving a lot more than just medical aspects. The Ebola virus presented a significant realization of the biosafety dangers that developing countries suffer from, where limitation of resources and preparedness can overwhelm all aspects of the population.

Origin and spread: One of the most lethal one on this list, if not the most infectious, the Ebola virus had case fatality rates as high as 70%. Initially mistaken for cholera, it was not until 21st March that the outbreak was assigned to be caused by the Ebola virus, three months after beginning to spread in Guinea, Africa in December 2013.[64] This further involved the countries of Liberia and Sierra Leone as the most impacted countries.

Unique features: A report by WHO[65] highlighted the aspects contributing to the development of an epidemic, such as the hidden spread of the virus for three months. Even though the disease was not new to Africa, the epidemic was unique to occur in West African countries, where previous outbreaks never occurred. Adding to it, densely populated areas with high mobilization of communities as compared to remote rural regions of previous outbreaks; underdeveloped health infrastructure, in countries already ravaged by civil unrest; shortage of health workers; and conventional cultural practices of funeral and burial rites, which are estimated to have been linked to as high as 80% cases in Sierra Leone, caring practices for the ill and dead bodies all made ideal conditions for the upcoming storm to brew. Community resistance was faced due to unfamiliarity of the locals with the control measures, fears and misconceptions regarding the disease and strikes by health care workers due to unsupportive working environment in terms of pay and safety. This, along with a somewhat underpowered capacity of the health systems

in place, led to an epidemic spanning a prolonged duration. Several organizations are worldwide taking on unorthodox roles to tackle the widespread health crisis. The interlinking and interdependence of countries were responsible for the international spread of cases.

Control measures: Cultural burial practice guidelines were authorized by the WHO to reduce transmission through burial rites. Contact tracing had to play an essential role in curbing the outbreak during earlier stages. However, adequate contact tracing could not be achieved.[66] Infection prevention and control (IPC) plans to tackle transmission chains in healthcare facilities were required as these were one of the significant factors fueling the spread. Healthcare workers were a source of infection, as has been suggested that they were about 100 times higher risk for EVD (Ebola virus disease).[67] This was met by a partnership between the ministry of health, WHO, CDC and others to develop on the issues like recruiting and training of staff in IPC; acquiring of equipment (personal protective equipment, safe transport vehicles for Ebola patients and dead bodies) and building of Ebola treatment centres (ETCs).[66,67]

Vaccine development: Ebola had an accelerated vaccine development, which was a new step toward improving epidemic readiness in the future. Many necessary steps were taken, including the foundation of the Coalition for epidemic preparedness innovations, which had the aim for rapid development of vaccines under pandemic and epidemic situations.

Although not in time to contain the ongoing outbreak in the Democratic Republic of Congo, the vaccine was successfully used in the future outbreak of 2018 and proved to be efficacious in preventing infection as well as reducing the severity of the infection.

Impact and lessons learned: Aside from the direct mortality due to the disease, the Ebola epidemic had consequences that don't come to light by looking at the number of cases and deaths. These included post-recovery complications for patients like arthralgia, fatigue, anaemia, ocular issues, etc.[68] A significant impact on the health system was seen with the high number of HCW deaths; diversion of resources from routine health provision to Ebola emergency care, with vaccination campaigns being suspended in all three countries. Socially, the trust between community and healthcare services suffered, the handling of the outbreak led to fear and paranoia. One of the critical events being riots erupting over control activities and quarantine with healthcare workers being threatened and marginalized by the community.

Economically Guinea, Liberia and Sierra Leone were impacted by $2.8 billion as per world bank reports. Some authors, however, suggested that the total social and economic cost of the epidemic was about $53 billion globally.[69] Contact tracing proved to be a handy tool to reduce the severity and achieve mitigation. However, many challenges lay ahead including the development of trust between local communities and healthcare system, reducing myths and stigma associated with contacts of infected persons and regarding the disease itself and meeting the non-clinical needs of contacts to ensure in-time isolation and monitoring.[70] The 2014 Ebola epidemic went on to show that such an event in developing conditions where detection, management and control are met with a handful of shortcomings, can be significantly dangerous and disastrous.

Conclusion

Looking at these examples, we can see that even though infectious agents can be extremely lethal, with coordinated actions and joint measures taken throughout the world, such threats can be tackled and overcome. Thus, primary care practitioners may measures such as contact tracing, quarantine, isolation play immense roles in decreasing the severity of initial outbreaks. In contrast, public sensitization and proper communication of guidelines are exceptionally essential to prevent surges of infections. Rapid and transparent sharing of clinical data is as important as collaboration efforts around the world for the development of strategies and treatments of the disease. Surveillance for novel pathogens with epidemic or pandemic potential in different animal species cannot be emphasized more as these have time and again become significant dangers to humanity. There has been immense importance of vaccines in that they provide the exceptional potential for recovery from these epidemics, albeit the development of vaccines has always been hurdled due to the multiple complexities involved, mostly not in time to end the epidemic or pandemic. Even further, as seen with the 2009 Swine flu pandemic unequal distribution of vaccines can lay waste to the achievement of rapidly prepared vaccines. Thus, for the forthcoming future as well as in the continuing battle against COVID-19, the value of lessons from past outbreaks is immeasurable and should fuel decision making at all levels of response. This paper highlights the importance of non-pharmaceutical infection control strategies for primary care physicians, along with rapid sharing of clinical data internationally in the case of future outbreaks. Health-care providers need to focus on public-sensitization towards accurate information and the rapid development and distribution of vaccines.

Ethical Approval

Not required.

Research involving Human participants or Animals

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent

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