Zika and Virus Evolution

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Abstract

This is our second update this year on the Zika virus. While the update is to provide family doctors with the current snapshot of its epidemiology and particularly current precautions for patients, it is a timely reminder that the 'shelf life' (obsolescence) of medical education and information can range from several weeks to years. Shelf life of medical education and information is a particular problem when dealing with emerging viruses. Not only can new strains mutate and develop within short periods of time, the clinical sequelae can often only be revealed over time. Until pregnant women infected with the Zika virus gave birth, the major deforming aspects on the foetus were not apparent, and until a large number of infected pregnant women gave birth, the rate of mutation was not apparent. Until new cases of Zika have been confirmed in new regions, the spread of the virus has not been apparent.

Most recent information on the Zika Virus

This Zika update is born from the fact that it is now certain that transmission of the virus can be made from infected partners of pregnant women, (sexual and non-sexual) not just first line infection from carrier mosquitoes, prompting a new round of warnings and precautionary measures. (1, 2, 3, 4)

Since January 2016, many have advised women who were pregnant or hoping to become so to avoid travel to Zika-affected areas or to take steps to avoid Zika infection. That medical advice expanded over time to include women's partners, especially as it became clear sexual transmission of the virus was more common than had been previously known. (3)

• Practice safe sex," said the World Health Organization (WHO) in a recently released travel and health advisory. The advisory was released to educate authorities, medical practitioners and travellers on safety measures to prevent the spread of Zika virus. (1,2)

On WHO's health and travel advisory, they specifically ordered local authorities to disseminate the following information:

• Provide up-to-date advice to travellers on how to reduce the risk of becoming infected, including preventing mosquito bites and practicing safer sex.
• Advise travellers from areas with ongoing Zika virus transmission to practice safer sex and not to donate blood for at least one month after their return to reduce the potential risk of onwards transmission. (1,2)

It is also a timely reminder that Brazil, host to the Olympic Games in August 2016 is experiencing a Zika outbreak.

With more diseases being linked to the Zika virus, such as microcephaly, Guillain-Barré syndrome and acute disseminated encephalomyelitis (ADEM), preventive measures to alleviate the spread of the Zika virus should be put in place. Pregnant women, who are considered more prone to Zika virus infection, are also advised to exercise great caution.

WHO advises pregnant women whose sexual partners live in or travel to areas with ongoing or recent Zika virus transmission to not only ensure safe sexual practices or preferably abstain from sex for the duration of their pregnancy." (1,2,3) The Center for Disease Control and Prevention (CDC) has reported that traces of Zika virus were found in saliva and urine, making the transmission through sex possible. In early 2016, CDC also issued safe-sex guidelines targeting travellers, especially men. Men who live in or travel to areas of active Zika infections and who have a pregnant sexual partner should use latex condoms correctly, or refrain from sex until the pregnancy has come to term. (3)

However, everything we know about the Zika virus is rapidly changing over time. CDC reports that although it is proven that the Zika virus can be transmitted through bodily fluids, it doesn't necessarily prove that it is 100 percent transmittable that way. (3)

Updated Guidelines

The updated guidelines for women of reproductive age who want to become pregnant include recommendations for Zika virus testing and guidance for women. The guidelines include recommendations for men and women with possible exposure to Zika virus who do not have symptoms, and men and women who have Zika virus disease (3).

There is limited information available about the risk of periconceptional Zika virus infection. Three early case reports suggest there may be adverse outcomes associated with Zika virus infection in early pregnancy, including pregnancy loss and severe microcephaly, although the timing of infection and conception in these cases was often unknown. (3) It is now clear that Zika does cause microcephaly. (3)

An analysis, published in the BMJ in April 2016, involved 23 babies born in the Brazilian state of Pernambuco between July and December 2015, all but one of whom were born to mothers who had a rash during pregnancy, consistent with a Zika virus infection. (5)

The brain damage caused by Zika virus infection in these children was extremely severe, indicating a poor prognosis for neurological function. (5) Other common findings included malformations of cortical development, decreased brain volume, and ventriculomegaly, a condition where the brain cavities are abnormally enlarged. (5)

The WHO has also linked Zika to Guillain-Barré syndrome, a rare sickness of the nervous system in which a person's own immune system damages the nerve cells, causing muscle weakness, and sometimes paralysis. (1, 2)

Zika Timeline

Zika is a perfect example of the evolution of a virus over time. Evolution has occurred in many fields: distribution/spread of the virus, increasingly harmful sequelae, increasing public education and the chain of new information generated by its changing aspects due to discovery, ongoing transmission, evolution of the virus, a wider range of carrier mosquitoes and time itself.

Abbreviated Zika Timeline
(Sourced from: 1,3,4,5, 6,19,)

The following timeline summarizes the spread of Zika infection, country by country, from the earliest discovery in 1947 to the latest information up to April, 17, 2016.

1947: Scientists conducting routine surveillance for yellow fever in the Zika forest of Uganda isolate the Zika virus in samples taken from a captive, sentinel rhesus monkey.
1948: The virus is recovered from the mosquito Aedes (Stegomyia) africanus, caught on a tree platform in the Zika forest.
1952: The first human cases are detected in Uganda and the United Republic of Tanzania in a study demonstrating the presence of neutralizing antibodies to Zika virus in sera.
1958: Two further Zika virus strains are isolated from Aedes africanus mosquitos caught in the Zika forest area.
1964: A researcher in Uganda who fell ill while working with Zika strains isolated from mosquitoes provides the first example, by virus isolation and re-isolation, that Zika virus causes human disease.
1960s-1980s: Zika is being detected in mosquitos and sentinel rhesus monkeys used for field research studies in a narrow band of countries that stretch across equatorial Africa. Altogether, the virus is isolated from more than 20 mosquito species, but mainly in the genus Aedes. Sporadic human cases are identified, mostly by serological methods, but such cases are rare, and the disease is regarded as benign.
1969-1983: The known geographical distribution of Zika expands to equatorial Asia, including India, Indonesia, Malaysia and Pakistan, where the virus is detected in mosquitos. As in Africa, sporadic human cases occur but no outbreaks are detected and the disease in humans continues to be regarded as rare, with mild symptoms. Seroprevalence studies in Indonesia, Malaysia and Pakistan indicate widespread population exposure.
2007: Zika spreads from Africa and Asia to cause the first large outbreak in humans on the Pacific island of Yap, in Micronesia. Prior to this event, no outbreaks and only 14 cases of human Zika virus disease had been documented worldwide. No deaths, hospitalizations, or neurological complications were reported.

2008: A US scientist conducting field work in Senegal falls ill with Zika infection upon his return home to Colorado and infects his wife in what is probably the first documented case of sexual transmission of an infection usually transmitted by insects.
2012: Researchers publish findings on the characterization of Zika virus strains collected in Cambodia, Malaysia, Nigeria, Senegal, Thailand and Uganda, and construct phylogenetic trees to assess the relationships. Two geographically distinct lineages of the virus, African and Asian, are identified.
December 2013: A patient recovering from Zika infection on Tahiti Island in French Polynesia seeks treatment for bloody sperm. Zika virus is isolated from his semen, adding to the evidence that Zika can be sexually transmitted.
2013-2014: The virus causes outbreaks in four other groups of Pacific islands: French Polynesia, Easter Island, the Cook Islands, and New Caledonia. The outbreak in French Polynesia, generating thousands of suspected infections, is intensively investigated. Reports indicate a possible association between Zika virus infection and congenital malformations and severe neurological and autoimmune complications. In particular, an increase in the incidence of Zika infection towards the end of 2013 was followed by a rise in the incidence of Guillain-Barré syndrome.
20 March 2014: During the 2013-14 outbreak of Zika virus in French Polynesia, two mothers and their newborns are found to have Zika virus infection, confirmed by PCR performed on serum collected within four days of birth. The infants' infections appear to have been acquired by transplacental transmission or during delivery.
31 March 2014: During the same outbreak of Zika virus in French Polynesia, 1505 asymptomatic blood donors are reported to be positive for Zika by PCR. These findings alert authorities to the risk of post-transfusion Zika fever.
2 March 2015: Brazil notifies WHO of reports of an illness characterized by skin rash in northeastern states. From February 2015 to 29 April 2015, nearly 7000 cases of illness with skin rash are reported in these states. All cases are mild, with no reported deaths.
29 March 2015: Brazil provides further details on reports of an illness, in four northeastern states, characterized by skin rash, with and without fever.
29 April 2015: Bahia State Laboratory in Brazil informs WHO that samples have tested positive for Zika virus, but full laboratory confirmation is pending.
7 May 2015: Brazil's National Reference Laboratory confirms, by PCR, Zika virus circulation in the country. This is the first report of locally acquired Zika disease in the Americas.
7 May 2015: The Pan American Health Organization and WHO issue an epidemiological alert regarding Zika virus infection.
15 July 2015: Brazil reports laboratory-confirmed Zika cases in twelve states.
17 July 2015: Brazil reports detection of neurological disorders associated with a history of infection, primarily from the north-eastern state of Bahia. Among these reports, 49 cases were confirmed as Guillain-Barré syndrome. Of these cases, all but 2 had a prior history of infection with Zika, chikungunya or dengue.
8 October 2015: Brazil reports the results of a review of 138 clinical records of patients with a neurological syndrome, detected between March and August. Of the 138 patients, 58 (42%) had a neurological syndrome with a previous history of viral infection. Of the 58, 32 (55%) had symptoms that said to be consistent with Zika or dengue infection.
8 October 2015: Colombia reports the results of a retrospective review of clinical records which reveals the occurrence, since July, of sporadic clinical cases with symptoms consistent with Zika infection. A sudden spike is reported between 11 and 26 September. Altogether, 90 cases are identified with clinical symptoms consistent with, but not proven to be, Zika infection.
30 October 2015: Brazil reports an unusual increase in the number of cases of microcephaly among newborns since August, numbering 54 by 30 October.
11 November 2015: Brazil reports 141 suspected cases of microcephaly in Pernambuco state. Further suspected cases are being investigated in two additional states, Paraiba and Rio Grande do Norte.
11 November 2015: Brazil declares a national public health emergency as cases of suspected microcephaly continue to increase.
12 November 2015: Suriname reports 5 PCR confirmed cases of locally acquired Zika infection.
12 November 2015: Panama reports cases with symptoms compatible with Zika.
17 November 2015: The Pan American Health Organization and WHO issue an epidemiological alert asking PAHO Member States to report observed increases of congenital microcephaly and other central nervous system malformations under the International Health Regulations.
17 November 2015: Brazil reports the detection of Zika virus in amniotic fluid samples from two pregnant women from Paraiba whose foetuses were confirmed by ultrasound examinations to have microcephaly. Altogether, 399 cases of suspected microcephaly are being investigated in seven northeastern states.
21 November 2015: Brazil reports that 739 cases of microcephaly are being investigated in nine states.
24 November 2015: El Salvador reports its first 3 PCR confirmed cases of locally acquired Zika infection.
24 November 2015: French Polynesia reports the results of a retrospective investigation documenting an unusual increase in the number of central nervous system malformations in foetuses and infants from March 2014 to May 2015. At the date of reporting, at least 17 cases are identified with different severe cerebral malformations, including microcephaly, and neonatal brainstem dysfunction.
25 November 2015: Mexico reports three PCR confirmed cases of Zika infection, of which two were locally acquired.
26 November 2015: Guatemala reports its first PCR confirmed case of locally acquired Zika infection.
27 November 2015: Paraguay reports six PCR confirmed cases of locally acquired Zika infection.
27 November 2015: The Republic of Venezuela reports seven suspected cases of locally acquired Zika infection.

Four samples test positive by PCR.

28 November 2015: Brazil detects Zika virus genome in the blood and tissue samples of a baby, with microcephaly and other congenital anomalies, who died within 5 minutes of birth.

28 November 2015: Brazil reports three deaths among two adults and a newborn associated with Zika infection. As deaths from Zika infection are extremely rare, these cases are reported in detail.

1 December 2015: The Pan American Health Organization and WHO issue an alert to the association of Zika virus infection with neurological syndrome and congenital malformations in the Americas. The alert includes guidelines for laboratory detection of the virus.

2 December 2015: Panama reports its first 3 PCR confirmed cases of locally acquired Zika infection.

6 December 2015: Cabo Verde reports 4744 suspected cases of Zika. No neurological complications are reported.

14 December 2015: Panama reports four PCR confirmed cases of locally acquired Zika infection, and 95 cases with compatible symptoms.

15 December 2015: Samples taken from patients in Cabo Verde test positive, by PCR, for Zika.

16 December 2015: Honduras reports two PCR confirmed cases of locally acquired Zika infection.

21 December 2015: French Guiana and Martinique report their first two PCR confirmed cases of locally acquired Zika infection.

22 December 2015: Brazilian researchers publish evidence, drawn from case reports in several countries, that depict Zika as "a mild cousin of dengue" may not be accurate due to the possibility of more serious disease symptoms, especially in immunocompromised patients.

30 December 2015: Brazil reports 2975 suspected cases of microcephaly, with the highest number occurring in the north-east region.

31 December 2015: The United States reports the first PCR confirmed case of locally acquired Zika infection in Puerto Rico.

5 January 2016: Researchers report the first diagnoses of intrauterine transmission of the Zika virus in two pregnant women in Brazil whose foetuses were diagnosed with microcephaly, including severe brain abnormalities, by ultrasound. Although tests of blood samples from both women are negative, Zika virus is detected in amniotic fluid.

7 January 2016: Scientists in Guyana publish the results of Zika genome sequencing of viruses from four patients in Suriname whose sera were negative for dengue and chikungunya viruses but positive for Zika virus. Suriname strains belong to the Asian genotype and are almost identical to the strain that circulated in French Polynesia in 2013.

7 January 2016: Ophthalmologists in Brazil report severe ocular malformations in three infants born with microcephaly.

12 January 2016: In collaboration with health officials in Brazil, the United States Centers for Disease Control and Prevention release laboratory findings of four microcephaly cases in Brazil (two newborns who died in the first 24 hours of life and two miscarriages) which indicate the presence of Zika virus RNA (Ribonucleic acid) by PCR and by immunohistochemistry of brain tissue samples of the two newborns. In addition, placenta of the two foetuses miscarried during the first 12 weeks of pregnancy test positive by PCR. The findings are considered the strongest evidence to date of an association between Zika infection and microcephaly.

14 January 2016: Guyana reports its first PCR confirmed case of locally acquired Zika infection.

15 January 2016: Ecuador reports its first two PCR confirmed cases of locally acquired Zika infection. The next day, the country confirms an additional 6 cases.

15 January 2016: Barbados reports its first three PCR confirmed cases of locally acquired Zika infection.

16 January 2016: Bolivia reports its first PCR confirmed case of locally acquired Zika infection.

18 January 2016: Haiti reports its first five PCR confirmed cases of locally acquired Zika.

18 January 2016: France reports the first PCR confirmed case of locally acquired Zika in Saint Martin.

19 January 2016: El Salvador reports an unusual increase of Guillain-Barré syndrome. From 1 December 2015 to 6 January 2016, 46 cases of the syndrome were reported, including two deaths. Of the 22 patients with a medical history, 12 (54%) presented with fever and skin rash in the 7 to 15 days before the onset of symptoms consistent with Guillain-Barré syndrome.

21 January 2016: Brazil reports 3893 suspected cases of microcephaly, including 49 deaths. Of these, 3381 are under investigation. In six cases, Zika virus was detected in samples from newborns or stillbirths.

22 January 2016: Brazil reports that 1708 cases of Guillain-Barré syndrome have been registered by hospitals between January and November 2015. Most states reporting cases are experiencing simultaneous outbreaks of Zika, chikungunya, and dengue.

23 January 2016: The Dominican Republic reports its first 10 PCR confirmed cases of Zika infection, of which 8 were locally acquired and 2 were imported from El Salvador.

25 January 2016: France reports two confirmed cases of Guillain-Barré syndrome in Martinique. Both cases require admission to an intensive care unit. One patient tests positive for Zika virus infection.

25 January 2016: The United States reports the first PCR confirmed case of locally acquired Zika infection in St Croix, Virgin Islands.

27 January 2016: Nicaragua reports its first two PCR confirmed cases of locally acquired Zika infection.

27 January 2016: French Polynesia reports retrospective data on its Zika outbreak, which coincided with a dengue outbreak. From 7 October 2013 to 6 April 2015, 8750 suspected cases of Zika were reported, with 383 PCR confirmed cases and an estimated 32,000 clinical consultations (11.5% of the total population). Tests excluded other known causes of Guillain-Barré syndrome, including Campylobacter jejuni, cytomegalovirus, HIV, Epstein-Barr and herpes simplex viruses. The investigation concluded that successive dengue and Zika virus infections might be a predisposing factor for developing Guillain-Barré syndrome.

28 January 2016: Curacao reports its first PCR confirmed case of locally acquired Zika.

29 January 2016: Suriname reports 1,107 suspected cases of Zika, of which 308 are confirmed, by PCR, for Zika virus.

30 January 2016: Jamaica reports its first PCR confirmed case of locally acquired Zika.

1 February 2016: WHO declares that the recent association of Zika infection with clusters of microcephaly and other neurological disorders constitutes a Public Health Emergency of International Concern (PHEIC).

1 February 2016: Cabo Verde reports 7081 suspected cases of Zika between end September 2015 and 17 January 2016.

2 February 2016: Chile reports its first three PCR confirmed cases of Zika virus on the mainland in travellers returning from Colombia, the Bolivarian Republic of Venezuela, and Brazil.

2 February 2016: The United States reports a case of sexual transmission of Zika infection in Texas. One patient developed symptoms of illness after returning from the Bolivarian Republic of Venezuela. The second patient had not recently travelled outside of the United States, but subsequently developed symptoms after sexual contact with the traveller. This is the third indication that the virus can be sexually transmitted, which appeared at the time, to be a rare event.

4 February 2016: Brazilian health officials confirm a case of Zika virus infection transmitted by transfused blood from an infected donor.

7 February 2016: Suriname reports an increase in Guillain-Barré syndrome, beginning in 2015, with 10 cases of Guillain-Barré syndrome positive for Zika (PCR test on urine sample).

1 March 2016: France reports a probable case of sexual transmission of Zika virus, in the partner of a patient who had travelled to Brazil. The new case tested positive for Zika virus by PCR in saliva and urine; the partner tested positive by PCR in urine.

2 March 2016: Samoa reports 10 additional cases of PCR-confirmed Zika virus infection, none of whom reported any recent international travel.

The United States confirms an additional 5 cases of sexually transmitted Zika virus infection. All cases occurred in women with partners who recently returned from an area with ongoing Zika virus circulation. These additional cases suggest that sexual transmission of the virus may be more common than previously assumed.

3 March 2016: A case report published online in The Lancet describes a 15-year-old Zika-positive girl in Guadeloupe who developed acute myelitis (inflammation of the spinal cord), which caused severe back pain, numbness, and bladder dysfunction. This association suggests that Zika virus preferentially affects the nervous system.

4 March 2016: The New England Journal of Medicine publishes online a study of Zika virus infection in 88 pregnant women in Rio de Janeiro, Brazil. 72 of these women (82%) tested positive for Zika virus in blood and/or urine. Abnormalities of the fetus were detected by ultrasound in 12 Zika-positive women. These abnormalities included two foetal deaths, inability of the placenta to deliver adequate nutrients and oxygen to the fetus (placental insufficiency), poor foetal growth (foetal growth restriction), and injury to the central nervous system, including microcephaly. These findings add to the growing body of evidence linking Zika virus infection to foetal abnormalities.

9 March 2016: Venezuela provides an epidemiological update of the Zika outbreak in that country. A total of 16,942 suspected Zika cases have been reported. Of 801 samples tested by PCR, 352 (44%) were positive for Zika virus. Among the suspected cases are 941 pregnant women. A total of 226 samples from pregnant women were tested, and 153 (67.6%) were positive.

Venezuela also reports 578 cases of Guillain-Barré syndrome, among which 235 have presented with symptoms of Zika virus infection. In addition, 1 case of facial paralysis and 10 cases of unspecified neurological disorders are PCR-positive for Zika virus.

8 March 2016: The second meeting of the Zika Emergency Committee affirms that clusters of microcephaly cases and other neurological disorders continue to constitute a Public Health Emergency of International Concern (PHEIC), and that evidence is increasing of a causal relationship of these disorders with Zika virus. WHO updates its travel recommendations to advise pregnant women not to travel to areas with ongoing Zika virus outbreaks; those whose partners live in or travel to such areas should practice safe sex or abstain for the duration of their pregnancy.

9 March 2016: A letter published online in the New England Journal of Medicine describes a case in France of central nervous system infection with Zika virus associated with meningoencephalitis.

10 March 2016: The United States reports two Guillain-Barré Syndrome (GBS) cases with confirmed Zika virus infection.

10 March 2016: Colombia reports two cases of microcephaly; both mothers and newborns tested positive for Zika virus by PCR.

11 March 2016: Papua New Guinea reports 6 cases of Zika virus infection found through retrospective testing of samples, taken between July 2014 and March 2016, from patients with febrile illness. Cases were confirmed by PCR. These are the first laboratory-confirmed cases of Zika virus infection in Papua New Guinea.

15 March 2016: A retrospective analysis of the Zika outbreak in French Polynesia, which occurred in 2013-2014, is published online in The Lancet. Using serological and surveillance data, the authors calculated the risk of microcephaly in foetuses and babies born to mothers infected with the Zika virus to be 1 in 100, or 1%. This study supports the hypothesis that Zika infection in the first trimester of pregnancy is associated with an increased risk of microcephaly

16 March 2016: First locally acquired cases are reported from Kosrae, Federated States of Micronesia; Dominica; and Cuba.

18 March 2016: Panama notifies WHO of a newborn (31 weeks gestation) with microcephaly and occipital encephalocele who died on 17 March a few hours after birth. The mother had no history of Zika virus infection and tested negative for Zika virus. Samples of the umbilical cord were positive for Zika virus by RT-PCR. This is the first report of Zika virus infection in a newborn with microcephaly in Panama.

24 March 2016: The United States reports the birth of a baby with microcephaly whose mother, a Cape Verde resident, sought medical care in the USA. A serum sample from the mother tested positive for Zika antibodies.

24 March 2016: Martinique reports the first case of Zika virus infection detected in a fetus with microcephaly. Samples of foetal blood and amniotic fluid, taken on 17 March, tested positive by PCR for Zika virus. Serial serological samples from the mother, taken between 7 December 2015 and 11 February 2016 were positive for Zika virus. This report adds to the evidence of the link between microcephaly and Zika virus infection and also shows that the virus can remain in the placenta/amniotic fluid months after infection occurred in the mother.

26 March 2016: Chile notifies WHO of its first confirmed case of sexual transmission of Zika virus. The case's partner had travelled to two countries where Zika virus is currently circulating. The Aedes mosquito is not present in continental Chile.

5 April 2016: Viet Nam notifies WHO of two laboratory-confirmed cases of Zika virus infection. These are the first locally acquired cases of Zika in that country

7 April 2016: Saint Lucia notifies WHO of two laboratory-confirmed cases of Zika virus infection, one in a pregnant woman. These are the first locally acquired cases of Zika in that country.

7 April 2016: Panama confirms to WHO the birth of two newborns with congenital syndrome who tested positive for Zika virus. One was born prematurely and had microcephaly, an enlarged tongue, and a short neck; testing of the mother for Zika virus is pending. The second was born at term and had microcephaly; the mother tested positive by PCR for Zika virus.

8 April 2016: Ecuador notifies WHO of a large die-off of howler monkeys in Pacoche Forest Reserve, Montecristi Canton, Manabi Province, which is close to the Solita community, where about 40 families live. Of 39 monkeys who were found dead 1-10 February 2016, two samples tested positive by RT-PCR for Zika virus.

13 April 2016: A paper published in the NEJM concludes that there is now sufficient evidence to confirm that a causal relationship exists between prenatal Zika virus infection and microcephaly and other serious brain abnormalities.

17 April 2016: Peru reports its first sexually transmitted case of Zika virus. The case's partner had recently returned from Venezuela.

Viruses and Evolution

Humans and viruses have been in a life and death struggle for millennia and scientists are not sure if viruses or cellular life developed first or if they both developed simultaneously. Like cellular life viruses are capable of reproducing themselves but never have (10). Rather they rely on host organisms to spread. One of the first and momentous records of pandemics was the Black Death (Bubonic plague) pandemic starting in 1331 and peaking in Europe in the years 1346-53 (7). The Black Death is believed by many to be viral in and resulted in the deaths of an estimated 75 to 200 million people. For example, sociologist Susan Scott and biologist Christopher J. Duncan claim that a hemorrhagic fever, similar to the Ebola virus, caused the Black Death. Others blame anthrax or say that some now-extinct disease was the culprit. (7)

Modern times have seen some major pandemics and emergence of new globally spreading viruses such as SARS, AIDS, Avian flu, Zika, Ebola, (11, 20) and localised viruses such as L yssavirus, (8) and Hendra (9).

Viruses evolve rapidly and constantly, changing within a lineage and splitting off to form new lineages. As they evolve, they accumulate small changes in the sequences of their genomes. (10)

Influenza viruses circulating in animals pose some of the greatest threats to human health as there is no immune history in human physiology. Animal sourced viruses include avian influenza virus subtypes H5N1 and H9N2 and swine influenza virus subtypes H1N1 and H3N2. The primary risk factor for human infection appears to be direct or indirect exposure to infected live or dead animals or contaminated environments. (15)

More recent viruses such as Hendra virus have been found to be transferred from horses that have contracted it from infected fruit bats (flying foxes). This is a rare disease that can be passed from an infected horse to a human. This type of illness is called a zoonotic disease. There is no evidence of bat-to-human, human-to-human or human-to-horse spread of Hendra virus. (8,9)

All viruses have an evolutionary cycle. Most have either evolved from animal viruses that have evolved and moved into human hosts or have come from other sources and been delivered by animal carriers, such as mosquitos, bats, horses, and civets (9).

The previously unknown SARS virus generated global panic in 2002 and 2003 when the airborne germ caused 774 deaths and more than 8000 cases of illness. In May 2003, attention focused on civets, cat-like mammals. SARS-infected civets were discovered at live animal markets in southern China but were found to not be the original source of the virus, rather they were infected by another animal, which turned out to be horseshoe bats. The bats were found to be the carriers of the SARS virus, but the virus is probably only passed to humans through intermediate hosts, like civets, when bats are captured and brought to market. Figuring out the genetic lineage required reconstructing the evolutionary history of the virus. (10, 11)

Viruses seem to frequently make the jump from bats to human hosts. Bats appear to be the natural reservoirs for many human viruses, including the Ebola, Hendra, SARS, Lyssavirus and Nipah viruses. Bats also tend to have migratory habits, allowing for the wider dissemination and spread of these viruses. (3, 11, 12, 13, 20)

Avian influenza (AI), commonly called bird flu, is an infectious viral disease of birds. Most avian influenza viruses do not infect humans; however some, such as A(H5N1) and A(H7N9), have caused serious infections in people. (3,15)

In April 2009 H1N1 was first detected in the United States. The virus was a unique combination of influenza virus genes never previously identified in either animals or people. The virus genes were a combination of genes most closely related to North American swine-lineage H1N1 and Eurasian lineage swine-origin H1N1 influenza viruses. Because of this, initial reports referred to the virus as a swine flu virus. However, investigations of human cases did not identify exposures to pigs and quickly it became apparent that this new virus was circulating among humans and not among pigs. (3, 15)

Discussion

All aspects of medicine can change over time, with new therapeutics and new techniques altering education even in anatomical medicine, but emerging and evolving viruses have always caused the greatest concerns to the health of humans and animal species as they can affect human and animal populations en masse and have the risk of causing extinctions.

While there are viruses specific to humans and particular animal species, the problematic viruses have become those that have spread from animals to humans due to mutation. Some of these mutations have then gone on to human to human transmission. (11)

No part of the world is immune to either locally developing viral outbreaks or strains of viruses brought by animals, travellers, or migrant workers into the local population. (11)

Slight changes of the mutation rate can also determine whether or not some virus infections are cleared by the host immune system and can produce dramatic differences in viral fitness and virulence, clearly stressing the need to have accurate estimates. (11)

Ideally, as in the case of smallpox which was declared eradicated in 1980 following a global immunization campaign led by the World Health Organization, we can start to tackle both the initial outbreaks and the spread of the more life threatening viruses. (11, 16)

When looking at the epidemiology of viral disease, time always plays an important factor in determining the spread and reach of a disease, its health sequelae and its ongoing virulence.
Over time, viruses can evolve from what is a mild form of disease in animal hosts to virulent disease in humans.

This can make definitive articles on patterns of disease, especially new disease such as Zika, problematic with some articles being out of date by the time they are published, or soon after. Their success also depends on seasonal outbreaks, life cycles of carriers, and migration patterns of carriers.

Ultimately with the usual building up of resistance in animal and human afflicted populations viruses will diminish in threat. Thereafter it usually becomes a battle between immune systems and mutation patterns of the virus.

Mankind has fought viruses since the dawn of time in an internal physiological battle. Once it was the human immune system that combated their lethal effects until some immunity was built up. Viruses on the other hand have continued to mutate to overcome such immunities in human and animal populations. Currently medicine and science has assisted in this battle and some few diseases seem to have been eliminated altogether.

Biological control tests on the main carriers of the Zika and Dengue viruses, the Aedes aegypti mosquito have been promising. The same mosquito is responsible for carrying the Zika virus and the chikungunya virus as well as Dengue fever. (18) The biological control involves releasing populations of mosquitoes that have been infected with a commonly occurring species of bacteria, called Wolbachia.(18)

We still may not have the full picture on Zika, and other viruses, until the viruses themselves complete their evolutionary life cycles. While first line and advanced advice can forestall medical outcomes , until the full picture is seen across time, and trends established, symptoms, sequelae and therefore treatment will vary. This is why it is always prudent to stay on the side of caution and precaution, especially from the point of view of family doctors, and the route of no harm is always the wisest.

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