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Influenza and other emerging respiratory viruses

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Abstract

Acute respiratory infections are one of the top five causes of mortality worldwide and contribute to >4 million deaths per year. Consequently, emerging respiratory viruses are a continuing threat to global health security and have the potential to affect our economies. Since the millennium, there have been around a dozen different outbreaks, several capturing international interest. The outbreak of severe acute respiratory syndrome coronavirus saw the beginning of an extensive global collaboration and has influenced many outbreak preparedness protocols now in place. Avian influenza is a particular threat, with cases of A(H5N1) and A(H7N9) reported most recently. Middle East respiratory syndrome coronavirus is causing continuing concerns with outbreaks in the Arabian Peninsula. Healthcare facilities worldwide play a crucial role in identifying threats and must be vigilant. Particularly important is identifying and managing emerging respiratory viruses when they are infrequently encountered. Surveillance, continuing research, vaccine and treatment developments are key to guiding the efforts and actions of healthcare workers, international health organizations, governments and other stakeholders. Each individual has a part to play in protecting our global health.

Keywords A(H1N1)pdm09; A(H5N1); A(H7N9); emerging; influenza; MERS-CoV; MRCP; outbreak; respiratory; SARS-CoV; virus

Key points

- Understand risk assessment. Know the key symptoms and signs for the emerging respiratory viruses and their specific management. Uphold basic hygiene principles and use of personal protective equipment
- Know how to contact public health professionals out of hours and inform them of notifiable diseases. Discuss with your local laboratory when an emerging respiratory virus is suspected
- Keep up to date with the latest emerging diseases. The following information sources can help: World Health Organization Disease Outbreak News online, Public Health England website announcement page and ProMED-mail website.

Introduction

A discussion of emerging respiratory viruses would not be complete without reference to the work of the World Health Organization (WHO). This organization closely monitors emerging respiratory viruses and assists countries with preparedness, prevention, response and recovery from these diseases, as well as aiming to reduce the threat to global health security (www.who.int).

A comprehensive list of emerging respiratory viruses is shown in Table 1. Here, we will focus on six key respiratory viruses: influenza viruses A(H5N1), A(H7N9), A(H1N1)pdm09 and seasonal influenza, and severe acute respiratory syndrome and Middle East respiratory syndrome coronaviruses (SARS-CoV, MERS-CoV). These have been selected because of their global impact, with high morbidity and mortality rates, and their importance in understanding emerging respiratory viruses.

In the clinical setting, it is important to be able to recognize symptoms and signs of these diseases, investigate and manage patients appropriately, and have an awareness of the public health impact and continuing research. With increasing globalization, particularly with travel and trade, a small epidemic can quickly develop into a pandemic, with little time to prepare a public health response. Clinicians are at the front line, and rapid recognition is critical in responding to these public health emergencies.

At the time of writing, the respiratory viruses considered as particular public health threats were A(H7N9) and MERS-CoV.[1] Even though it circulates widely, seasonal influenza, including H1N1, is less concerning because of immunity in the population, helped by vaccination; this therefore results in a more benign infection in many individuals.

The influenza viruses, four of which are discussed here – A(H5N1), A(H7N9), A(H1N1)pdm09, seasonal influenza – are grouped into three main types, A, B and C, all associated with human disease. Type A contains two subgroupings depending on the type of surface protein carried by the virus –haemagglutinin (H protein) or neuraminidase (N protein). Type A can infect many different animals as well as humans; its natural reservoir is aquatic birds. Type B circulates only in humans, and type C can infect humans and pigs, although infections are mild.

Influenza is notorious for its ability to change and present itself to the immune system as a newly encountered pathogen against which the body has no immunity. In *antigenic drift*, small genetic changes occur over time as the virus replicates. The changes are usually so small that the virus' antigenic properties remain the same and the immune system is able to recognize the

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Emerging respiratory viruses in chronological order over the past 20 years

Virus	Year	Region
Influenza A(H5N1)	1997	Hong Kong
Influenza A(H9N2)	1999	Hong Kong
Human metapneumovirus	2001	Netherlands
SARS coronavirus	2003	Hong Kong
Human coronavirus NL63	2004	Netherlands
Influenza A(H7N7)	2004	Netherlands
Human coronavirus HKU1	2005	China
Influenza A H1 triple reassortment	2005	USA
Triple reassortment H3N2 influenza A	2005	Canada
Bocavirus	2005	Sweden
Influenza A (H1N1)pdm09	2009	Mexico
Adenovirus 14	2010	USA
MERS coronavirus	2012	Saudi Arabia
Influenza A(H7N9)	2013	China

Source: Adapted from Al-Tawfiq JA et al. (see Further reading).

Table 1

pathogen (known as cross-protection). If these small changes accumulate, an antigenically different virus is produced to which the host has no immunity. The population is therefore able to catch flu more than once, and a new flu vaccine is produced each year according to the evolving viruses.

In *antigenic shift*, a major genetic change occurs resulting in new H or N proteins. Pandemics are often caused by recombinant viruses that derive some of their genetic material from an avian and some from a human influenza virus (known as reassortment). This mixing can occur when a host such as a pig is infected by the two viruses. The H and/or N proteins are derived from the avian virus and are antigenically different from those against which the population has immunity. A pandemic can then occur. Type A viruses undergo both antigenic drift and antigenic shift, whereas type B viruses change by antigenic drift.

Emerging respiratory viruses

Seasonal influenza

Seasonal influenza is a common cause of respiratory infection in humans during the winter months in both the northern and southern hemispheres. However, in tropical and subtropical areas, it can occur all year round. Because these viruses are continually evolving and new ones appearing, the population can become infected multiple times during their lifetime.

The disease is often mild but can sometimes be severe and is a cause of mortality in vulnerable individuals, particularly very young children, pregnant women and those who are elderly or immunocompromised. Worldwide, these annual epidemics result in around 250,000–500,000 deaths.[1] They also have a substantial economic impact through reduced workforce productivity and pressurizing health services. These viruses are transmitted from person to person by respiratory droplets (coughing, sneezing) or by touching infected surfaces.

Generally, two vaccines are developed each year to cover the current most prominent circulating strains for the northern and southern hemispheres. The WHO's Global Influenza Surveillance and Response System (GISRS) meets twice a year to update the vaccine. The 2017–2018 northern hemisphere vaccine currently contains three strains including H1N1, which caused the 2009 'swine flu' pandemic. Influenza types A and B are generally used in the vaccine. Type C strains cause such mild illnesses that they are not included.

The vaccine is available to everyone in the UK and is free for children aged 6 months to 2 years who are at risk of flu, pregnant women, adults at risk of flu, including healthcare workers, and all those aged 65 years and over.[2] The WHO recommends annual vaccination for all high-risk groups, and prioritization of pregnant women.

A(H1N1)pdm09 – swine flu

First identified in Mexico in April 2009, this was called swine flu because its genetic make-up was derived from a quadruple reassortment involving genes from pigs, birds and humans.[1] The virus established human-to-human transmission and spread rapidly through respiratory droplets and touching infected surfaces. However, it mostly caused mild infection because of a level of immunity in the older population. Some severe cases and deaths occurred, particularly in younger persons, including those in good health.

The pandemic was declared over in August 2010.[1] The WHO reported that >214 countries were affected, with >18,449 laboratory-confirmed deaths by the end of the pandemic.[1] The US Centers for Disease Control and Prevention (CDC) later estimated the total number of deaths (not all laboratory confirmed) as 284,000.[3] At the time, the pandemic was a major health concern because of its rapid spread and the lack of vaccine at the outset. H1N1 is now circulating as one of the seasonal flu viruses. With the increasing immunity in the population, it is now considered less of a global health threat.

A(H5N1) – avian flu

An outbreak of A(H5N1) occurred in Hong Kong in 1997. This was the first documented transmission of an avian influenza virus into the human population leading to disease. No cases were confirmed again until 2003, when a handful of cases were identified with a travel history to Fujian Province, China. The virus then spread through poultry in Asia and Europe, and cases have been detected in animals since then. Human cases have also occurred globally since 2003, affecting 16 countries, with Indonesia, Egypt and Viet Nam experiencing most cases and fatalities.[1]

To date, there have been 859 cases, 453 resulting in death.[1] In 2017, up until end July, there were three cases and one death, which were all in Egypt.[1] In the UK, no human cases had occurred and the virus had not been detected in animals since 2008.[1]

Most cases of A(H5N1) have been related to close contact with infected birds or environments. The virus does not transmit well from person to person, but this has occurred from close contact with family members. It is an important threat because of its high mortality rate, 60% in infected individuals, and continued sporadic presence.[1] If the virus mutates to become easily transmissible from person to person, the consequences could be substantial.

A(H7N9) – avian flu

In 2013, human infections with A(H7N9) were reported in southeastern China. As of 7 August 2017, a total of 1582 cases had been

reported, including at least 610 deaths.[1] There is around 40% mortality.[1] There have been five epidemics, one each year during the winter, with the last one, in October 2016, reporting the largest number of cases.[1] Thus, the virus appears to be spreading. Cases have primarily been reported in China but also in travellers returning from China to Hong Kong, Taiwan, Malaysia and Canada.[1]

Transmission is usually associated with direct or indirect contact with live or dead infected poultry. There is no evidence that cooked poultry products transmit the virus. The virus causes little illness in poultry and is therefore only picked up on active surveillance. It has not been detected in poultry outside China. Person-to-person transmission has occurred, but this has been within close family contact.[1]

Vaccines have been developed and stockpiled, but the recent strain circulating in China has now shown resistance to them.[3] A new promising candidate vaccine from the CDC is being shipped to manufacturers. The CDC has also reported resistance to some of the neuraminidase inhibitors. A(H7N9) remains a significant public health concern because of its high mortality and risk of mutating and spreading more easily between humans.

Severe acute respiratory syndrome coronavirus

In 2003, an outbreak of an atypical pneumonia was reported in Guangdong province of southern China. Its cause was found to be a novel coronavirus that was later named SARS-CoV.

It is thought to have arisen from zoonotic transmission, and the outbreak lasted for around 3 months, with 8096 probable or confirmed cases and 774 deaths across 29 countries including in Europe, Asia and the Americas.[1] This included a substantial proportion of healthcare workers. Transmission took place via respiratory droplets and touching contaminated surfaces. However, aerosol-generating procedures were identified to have caused amplification in the healthcare setting. The WHO has declared that there has been no known transmission of SARS-CoV worldwide since May 2004.[1]

Middle East respiratory syndrome coronavirus

This virus was first identified in Saudi Arabia in 2012 and is still causing outbreaks. The largest outbreaks have been seen in Saudi Arabia, the United Arab Emirates and the Republic of Korea.[1] It has been reported in 27 countries, including the UK.[1] Most cases occurring outside the Middle East are in people who have travelled there. As of mid-August 2017 there have been a total of 2066 laboratory-confirmed cases and 720 related deaths, that is, 35% mortality.[1]

Transmission has occurred via person-to-person spread in healthcare settings where close unprotected contact has occurred. Otherwise the virus does not spread easily between humans. Dromedary camels are a major reservoir for the virus and a source of human infection. However, the importance of zoonotic transmission and the exact routes of transmission are not known. Consumption of undercooked camel meat and unpasteurized camel milk poses a high risk of infection. It is believed that the virus originated in bats before infecting camels.[1]

Clinical assessment

This should follow the standard respiratory work-up; however, key features relating to the emerging respiratory viruses should be discussed. Table 2 highlights some key symptoms and signs of each of the viruses, including important investigations and their management. Beware of immunocompromised individuals, who may have atypical presentations. Key aspects include the following.

Recent contact with infected persons — spread is generally by close person-to-person contact from respiratory droplets when a person coughs or sneezes. Viruses can travel around 1 metre to deposit on mucous membranes of the mouth, nose and eyes.[1] Touching an infected surface and then touching these mucous membranes is a common route. Walking past a person or briefly sitting opposite someone is not considered close contact. Two or more cases of confirmed or suspect infection with onset of illness in the same 2 week period and who are epidemiologically linked, should be thoroughly investigated, especially if they involve healthcare workers or patients in the same ward. Documenting these contacts is important.

Other types of contact — contact within 1 metre of live or dead domestic fowl, wild birds, bird markets, or bird droppings, should be noted when considering avian flu.[2] Contact with dromedary camels is relevant for MERS-CoV. Consider contact with other animals and in healthcare settings. Laboratory transmission is also possible.

Raw meat — eating raw meats, such as poultry or camel products, can cause infection.[1]

Recent travel — in the 14 days preceding symptom onset, has the patient travelled to any countries with a current or past outbreak? The virus can still be circulating in the human or animal population from past outbreaks.

Onset of symptoms — document symptoms, specifically those relating to each disease (outlined in Table 2), including history of fever, cough and shortness of breath.

Investigations and management

Table 2 highlights the investigations that are most useful for specific respiratory viral infections. A standard set of investigations comprises:

- oxygen saturation and respiratory rate
- full blood count, cell differential count and C-reactive protein, and serum samples
- blood cultures
- sputum (Gram stain, culture, viral polymerase chain reaction)
- nasal and throat swabs tested for influenza A and B
- *Legionella* and pneumococcal urinary antigen testing
- chest radiograph.

Serial samples of blood or bodily fluids can help demonstrate viral shedding patterns or treatment effect. Always follow local microbiological or public health guidance.

UK National Health Service laboratories can test for influenza A and B and possibly general coronaviruses. Most laboratories cannot, however, test specifically for the viruses discussed. Doctors need to call their laboratory, explain what they wish to test for and inform the laboratory of any infectious samples they may be sending. The laboratory will then liaise with the regional Public Health England (PHE) laboratory, which will orchestrate the sample collection and specify which samples should be taken. If positive results are obtained, samples should be sent to

Emerging respiratory viruses — key symptoms, signs, investigations and management[1–4]

Virus	Symptoms	Signs	Investigations	Management
Seasonal influenza	• Incubation period 2 days • Myalgia, lethargy, headache • Dry cough that can last for 2 or more weeks • Sore throat, rhinorrhoea • Diarrhoea, abdominal pain, nausea, vomiting	• Fever >38°C	• Diagnosis based on signs and symptoms • Nasopharyngeal and throat swabs	• Seasonal influenza vaccination, especially for high-risk groups • Most recover without needing medical attention • Encourage fluid intake • Neuraminidase inhibitors,[a] follow guidance • Resistance to adamantanes
H1N1	• Incubation period 2–7 days • Usual seasonal flu symptoms • Complications: shortness of breath, bloody sputum, chest pain, drowsiness, confusion, dehydration	• Initially fever >38°C	• Diagnosis based on signs and symptoms • Nasopharyngeal and throat swabs	• Monovalent pandemic vaccine available • 2017–2018 seasonal flu vaccine contains H1N1 • Neuraminidase inhibitors,[a] follow guidance
A(H5N1)	• Incubation period 2–5 days, ranging to 17 days • Contact history with birds • History of travel • Cough • Malaise and myalgia • Occasionally abdominal and chest pain, diarrhoea and vomiting • Some patients have bleeding nose and gums • Can progress quickly to shortness of breath, acute respiratory distress syndrome, with altered mental state and seizures • Sore throat and coryza less common	• Fever >38°C • Hypoxaemia • Multiple organ dysfunction • Secondary bacterial and fungal infection • 60% mortality	• Nasopharyngeal and throat swabs are the most sensitive • Chest X-ray consolidation or acute respiratory distress syndrome	• There is some evidence to support that oseltamivir reduces severity and prevents death • Follow treatment guidance • Corticosteroids not recommended unless adrenal insufficiency • Vaccines developed but not available for widespread use. WHO does not have a stockpile
A(H7N9)	• Incubation period 1–10 days, average 5 days • Contact history with birds/poultry • History of travel • Cough • Shortness of breath	• Fever >38°C • Hypoxaemia • Multiple organ dysfunction • Secondary bacterial and fungal infection • 40% mortality	• Nasopharyngeal and throat swabs are the most sensitive	• There is some evidence to support that oseltamivir reduces severity and prevents death but reduced efficacy shown • Resistance shown to adamantanes • Corticosteroids not recommended unless adrenal insufficiency • Vaccines in efficacy and safety trials

	• Occasionally diarrhoea, vomiting, abdominal and chest pain • Some patients have bleeding nose and gums • Sore throat and coryza less common	• Rapidly progressing severe pneumonia		
SARS-CoV	• Incubation period 2—10 days • Headache and myalgia • Shortness of breath • Up to 70% have diarrhoea • After 2—7 days, dry cough develops with pneumonia • Rhinorrhoea, sore throat and chest pain are uncommon • Travel to China, Hong Kong or Taiwan • Contact with SARS-CoV via healthcare work or research	• Initially fever >38°C • Hypoxia • 10% case fatality, 50% in >60 years old • Children less severely affected • Lack of respiratory signs, especially in elderly patients	• Chest X-ray showing pneumonia by day 7—10 of illness (patchy consolidation developing into ground-glass appearance, pneumothorax possible) • Lymphopenia in most cases • Often raised LDH • Nasopharyngeal and throat swabs or aspirate are most sensitive • Sputum, blood, urine and stool samples also possible	• No vaccine • Discuss with experts regarding potential therapies in addition to supportive care. Ideally, these should be studied in the framework of a clinical trial. • Personal protection equipment
MERS-CoV	• Commonly: cough, shortness of breath, fever • Occasionally diarrhoea • Some patients develop severe acute respiratory disease, multiorgan failure and septic shock • Some patients are asymptomatic (often found on contact tracing) • Contact with dromedary camels or consumption of undercooked meat or milk • Travel to a high-risk country or contact with a possible case 14 days before onset of illness • Rarely seen in children	• Fever >38°C • 35% mortality	• Pneumonia may or may not be present, including on chest X-ray • Sputum, aspirate or bronchiolar lavage samples are more sensitive • Nasopharyngeal and throat swabs if above not possible • Broncheolar lavage, EDTA blood, urine, stool and serum tests may be required after initial positive result • Raised LDH/creatinine/liver function, leucopenia, lymphopenia, thrombocytopenia	• No vaccine or treatment available • Supportive management • MERS-CoV antibodies, interferon and lopinavir are possibilities — PHE will advise • Corticosteroids are contraindicated • Isolation of close contacts for 14 days, with daily monitoring and laboratory testing for high-risk contacts

LDH, lactate dehydrogenase.

[a] Oseltamivir (Tamiflu®) and zanamivir (Relenza®) in the UK. In certain countries, other neuraminidase inhibitors are licensed. Peramivir (Rapivab®) and laninamivir are recommended by the WHO in addition to oseltamivir and zanamivir. Peramivir is in development in the UK and recommendations will be published by NICE in September 2018.[1]

Table 2

the national reference laboratory, PHE Colindale. Note that for SARS-CoV, in the absence of current transmission, the positive predictive value of sample testing is low. Thus, samples should only be sent if there is a high index of suspicion.[4]

Basic hygiene is important in management of respiratory viruses. Patients should wear a face mask or cough and sneeze into a tissue, throw it into a non-touch rubbish bin and perform hand hygiene. Individuals coughing in waiting areas can be given a mask and invited to sit a metre away from others. Patients identified as having a severe respiratory virus infection and those for whom there is a high index of suspicion should be placed in isolation. Contacts should be immediately identified, monitored (particularly for fever) and evaluated. Healthcare professionals should uphold infection control practices, including wearing personal protective equipment (PPE) such as an apron, gloves and face mask with eye protection, strict hand hygiene and thorough cleaning of surfaces.[5]

Treatment should include standard management for respiratory presentations, for example correcting hypoxia, encouraging oral intake and pain relief. National treatment guidelines for specific infections are available on the PHE website and are indicated in Table 2. Neuraminidase inhibitors are most effective when given within 48 hours of symptom initiation regardless of laboratory confirmation.[2] The dose and duration of treatment can change on a case-by-case basis. Neuraminidase inhibitors can also be given as prophylaxis to those exposed to avian influenza, including healthcare workers, and should be given for 7–10 days after the last exposure.[1]

Complications can arise from respiratory virus infection. These include secondary bacterial infection, and antibiotics may be required. Acute respiratory distress syndrome, multiorgan failure and septic shock can develop, and ventilation and intensive care may be required. Breastfeeding is generally considered safe if there is influenza or MERS-CoV infection as it provides immunity to the child and remains the best source of nutrition.[1]

Algorithms are available online to help guide management; the most up-to-date versions should always be consulted. The algorithms listed below cover the management of possible cases of avian influenza and MERS-CoV, particularly in the primary care setting, and the identification and management of patients presenting with possible A(H5N1), A(H7N9), SARS-CoV and MERS-CoV:

- www.gov.uk/government/uploads/system/uploads/attachment_data/file/433862/MERS-CoV_algorithm_Primary_Care.pdf – assessment and initial management in primary care of returning travellers and visitors from countries affected by MERS-CoV or avian influenza A, such as A(H5N1), A(H7N9) or A(H10N8), who present with a febrile respiratory illness
- www.gov.uk/government/uploads/system/uploads/attachment_data/file/358675/Case_management_of_suspected_human_case.pdf – investigation and management of possible cases of A(H5N1)
- www.gov.uk/government/uploads/system/uploads/attachment_data/file/358673/Investigation_and_management_of_possible_human_cases_of_avian_influenza_A_H7N9__flow_diagram_July_new.pdf – investigation and management of possible cases of A(H7N9)
- www.cdc.gov/sars/clinical/fig1.html – identification and evaluation of possible SARS-CoV disease in individuals presenting with community-acquired illness
- www.gov.uk/government/uploads/system/uploads/attachment_data/file/585569/MERS-CoV_case_algorithm.pdf – investigation and management of suspected cases of MERS-CoV.

Public health

Under the Public Health (Control of Disease) Act 1984 and Health Protection (Notification) Regulations 2010, it is a statutory duty to report a notifiable disease to the proper officer at the local council or local health protection team. The PHE website lists the relevant officers (www.gov.uk/health-protection-team).

There is also a notification form (www.gov.uk/government/publications/notifiable-diseases-form-for-registered-medical-practitioners). The form should be sent to the proper officer within 3 days, or they should be telephoned within 24 hours if the case is urgent.[4] Clinical suspicion is sufficient, and a laboratory diagnosis is not required.

Of the emerging respiratory viruses, SARS-CoV is on the list of notifiable diseases. Other diseases that can present significant risk to human health can be notified under the category 'other significant disease'; these include A(H5N1), A(H7N9), and MERS-CoV, but not seasonal influenza. A full list can be found on the PHE website (www.gov.uk/guidance/notifiable-diseases-and-causative-organisms-how-to-report).

A global response is pivotal in managing an outbreak of an emerging respiratory virus. Prompt isolation and contact tracing are important. Screening passengers travelling by air from infected countries is also used. For avian and swine influenza, controlling the disease in animals is critical to reducing the risk in humans. It is impossible to eradicate influenza viruses owing to the vast silent reservoir in aquatic birds. Thus, surveillance in animals and humans is essential.

Surveillance occurs at all levels, starting in primary and secondary healthcare settings. PHE collects data from general practitioners, hospitals, schools, other institutions and laboratories. Countries around the world send their data to the WHO to enable surveillance. The WHO's global data-sharing platform Flu Informed Decisions (FluID) links with regional influenza epidemiological data and combines the information into a single global database that health policymakers can access freely. The Pandemic Influenza Preparedness (PIP) framework brings together member states, industry, other stakeholders and the WHO. It allows data to be shared globally on the agreement that manufacturers share some of their products with WHO to be distributed to countries in need. WHO's global laboratory system GISRS collates the data and shares them with manufacturers through PIP. Under the International Health Regulations (2005), all confirmed cases of emerging respiratory viruses should be reported to the WHO.

The 'One Health' concept now envelops the global health response to emerging diseases. It encourages programmes, policies and research to collaborate to improve public health outcomes. Examples of collaborators include the WHO and its programmes, along with the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations.

Research and the future

In a time when emerging respiratory viruses are rife, with over a dozen different outbreaks since the millennium, keeping on top of them is proving difficult. The WHO has stated that in a new pandemic, it would take 4–6 months before a vaccine could be produced. Although this appears fast compared with standard drug development times, viruses can spread rapidly in today's world of globalization, international trade and air travel.

The WHO's Battle against Respiratory Viruses (BRaVe) Initiative was created to propel research on the prevention and treatment of respiratory viruses of public health importance, and to integrate scientific advances and technical innovations promptly so that they are available to the public.

Bodies such as the National Institute for Health Research (NIHR) help to fund health research and translate it into products and treatments for public use. The International Severe Acute Respiratory and emerging Infection Consortium (ISARIC https://isaric.tghn.org) provides open access and data-sharing protocols for researchers to enable a rapid response to emerging diseases. WHO's PIP and GISRS facilitate collaboration between researchers and manufacturers so that effective products are made and can be provided to those most in need.

Through all these global collaborative efforts, from research to treatment provision, we can hope to effectively tackle the next emerging respiratory viruses, which have no borders. ◆

KEY REFERENCES

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3 Centers for Disease Control (www.cdc.gov).
4 Public Health England (www.gov.uk/government/organisations/public-health-england).
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FURTHER READING

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TEST YOURSELF

To test your knowledge based on the article you have just read, please complete the questions below. The answers can be found at the end of the issue or online here.

Question 1

A 42-year-old man presented with a fever, shortness of breath, muscle pains and diarrhoea. His symptoms had started a couple of days after returning from a business trip, during which he had passed through China and the Middle East.

On clinical examination, his temperature was 39°C, pulse 100 beats/minute, blood pressure 125/78 mmHg, respiratory rate 16 breaths/minute and oxygen saturation 94% on air. There were crackles on chest auscultation. His abdomen was soft, and there was no tenderness.

What is the most likely infectious cause of his symptoms?

A A(H7N9)
B A(H5N1)
C A(H1N1)
D MERS-CoV
E SARS-CoV

Question 2

A 36-year-old woman presented to a general practice surgery with shortness of breath on walking, a non-productive cough, a runny nose and pleuritic-sounding chest pain. Twelve days previously, she had been in Saudi Arabia, where she had worked on the respiratory ward at the local hospital as a nurse. She had no past medical history of note.

On clinical examination, her temperature was 38.5°C, heart rate 110 beats/minute, blood pressure 105/79 mmHg, respiratory rate 18 breaths/minute and oxygen saturation 98% on air. She had widespread crackles and wheezing on chest auscultation.

What should be the first action?

A Isolate the patient and put on personal protective equipment
B Take blood samples and respiratory swabs
C Look at the Public Health England (PHE) website for information on how to manage the patient
D Send the patient home and arrange to call her the following day to see how she is
E Notify and discuss the case with the local PHE health protection team

Question 3

A 50-year-old man had returned from China, where he had been visiting markets at which chickens were sold. He was then admitted to hospital with a respiratory infection.

How should nasal and throat swabs be taken and sent?

A Contact the regional Public Health England (PHE) laboratory before taking samples as avian influenza is a concern
B Call the hospital laboratory before taking samples
C Wear personal protective equipment (PPE) to take the samples, and take them to the laboratory yourself
D Wear PPE to take the samples, put the samples in a closed bag and call for a porter to collect them
E Wear PPE to take the samples, and send them to the national PHE laboratory at Colindale