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How often do deadly diseases jump from animals to humans?

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When animals pass on a disease to humans there seems to be an extra element of danger and mystery, perhaps reminders of the dreaded bubonic plague, which was carried by rats and swept through Europe in the Middle Ages killing 25 million people.

There are over 200 'zoonotic' diseases (http://www.merckmanuals.com/vet/zoonoses/zoonoses/zoonotic_diseases.html) — infections caused by viruses, bacteria, parasites, fungi or prions that are transferred directly or indirectly to humans from animals.

These include diseases such as animal influenzas, rabies, haemorrhagic fevers such as Ebola, anthrax, the bubonic plague, and 'mad cow' disease.

The most recent disease to jump from animals to humans causing a shiver of concern is MERS, or Middle Eastern Respiratory Syndrome, which causes coughing, fever and often fatal pneumonia.

First identified in 2012, it is estimated that MERS has infected over 800 people, killing at least 291 of them.

"Of emerging infectious diseases prominent in the last 20 years, 80 per cent are zoonoses", says neurobiologist and public health physician Professor Charles Watson from [Curtin University](http://www.curtin.edu.au/). (<http://www.curtin.edu.au/>) .

"The worrying ones are SARS and MERS and Hendra and Nipah virus, but we tend to forget about the long standing ones like the influenza virus which comes from birds in centre of China."

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Common culprits

Vertebrate animals such as birds, bats and rats spread a wide range of diseases.

MERS, which began in the Middle East and has caused more than 300 deaths worldwide, has been linked to camels, but Watson believes bats are the primary reservoir.

"Bats seem to carry a quite extraordinary range of nasty pathogens, commonly viruses," he says.

"The same virus which causes MERS is also present in bats which live in large caves on the edge of the Arabian Peninsula, and the camels go into those caves to find water and would be exposed to bat droppings or airborne droplets.



Various species of bats are thought to be reservoirs for viral diseases such as MERS, SARS, Ebola, rabies and Hendra (*Source: CraigRJD/iStockphoto*)

Related Stories

MERS virus antibodies identified (</science/articles/2014/04/29/3994266.htm>) , Science Online, 29 Apr 2014

Bats a 'major natural reservoir' of viruses (</science/articles/2013/04/23/3742668.htm>) , Science Online, 23 Apr 2013

New bat virus could hold key to Hendra (</science/articles/2012/08/03/3560044.htm>) , Science Online, 03 Aug 2012

Ebola killing thousands of gorillas (</science/articles/2006/12/08/1806976.htm>) ,

It's not surprising that bats and rodents should be reservoirs for disease, he says, because they exist in such vast numbers.

"If you look at all the mammals in the world half of them are rodents and of the remaining half, half are bats so all the other mammals, lions and tigers and humans and monkeys fit into the last quarter."

Bats he says are at a particular advantage because they are themselves immune to many diseases, and can fly from one place to another.

"For example flying foxes in Malaysia are in a continuous chain with those in Queensland and so they're constantly flying up and down exchanging viruses." Both the Hendra virus, which occurs most commonly in Queensland, and the Nipah virus in Malaysia, are spread by fruit bats.

Science Online, 08 Dec 2006
Ebola virus explained
(<https://www.abc.net.au/news/2014-07-30/ebola-virus-explainer/5635028>) , ABC News
30/07/2014)

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Transmission of disease

Viral or bacterial diseases are often transferred from animal to human by a change in the genetic structure, says Watson.

SARS, for example, is believed to have been caused by a mutation of the coronavirus which had previously only existed in animals.

"There was most likely some sort of change in the structure of the coronavirus, and MERS seems to be a similar story".

Environmental and geographical factors also come into play.

"Some infections are happily living in some remote animal community that then becomes invaded by humans."

The infections can be transferred directly from the animals to humans via contact such as animal bites and scratches, consuming contaminated animal products, breathing in pathogens, or through skin contact.

Insects such as mosquitoes, ticks and flies also transmit a range of diseases from animals to humans including West Nile virus, Lyme disease, bubonic plague and sleeping sickness.

However, not all insect-borne diseases are classified as zoonotic diseases, says Watson.

"Malaria and dengue fever are transmitted from human to human by mosquitoes, but I think because malaria for example has been present for such a long time in humans it tends to not get classified with the more recently emerging zoonoses," says Watson.

Can humans spread diseases to animals? Yes. Globalisation and industrialisation are causing diseases to spread from humans to animals, according to a 2008 study that found a form of the bacteria *Staphylococcus aureus* in chickens originally came from humans.

The study, published in the *Proceedings of the National Academy of Sciences* (<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2780746/>), reports to be the first bacterial pathogens crossing over from humans to animals and then spreading since animals were first domesticated some 10,000 years ago.

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Deadly reputation

Most emerging zoonoses don't affect large numbers of people, but are quite deadly.

In the case of SARS the death rate was estimated as high as 10 per cent, but the MERS virus has killed 40 per cent of humans infected.

"It's not good, but on the optimistic side we're not talking thousands or hundreds of thousands of cases" says Watson.

"The animal toll has been much greater. When the Nipah virus broke out in Malaysia in the late 1990s there were relatively few human deaths but five million pigs had to be slaughtered in order to wipe it out."

Watson says it's unclear why some viruses mutate into deadly variants and some do not.

"It is really unpredictable, however many viruses are successful because they do not kill their human hosts and therefore get better transmission from person to person."

He says in spite of the fear factor around the more recently emerging zoonoses, diseases endemic to humans, like measles, and meningococcal disease remain more deadly

Certainly each new zoonotic disease outbreak poses new challenges to public health, particularly around the time and money required to develop a vaccine.

"There's been a lot of research done on viruses like MERS, SARS and Hendra but it takes a lot of concentrated effort to make a vaccine when it may only be given to a few thousand people each year, so it's a big economic challenge.

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Preventing spread

Watson says the world is protected through an extremely effective international information network.

"The World Health Organization has become much more capable of using data scanning to pick up word of little outbreaks in any part of the world and getting something done immediately. SARS could have been a major international problem but WHO had an experienced coordinator in place within days after each of the outbreaks."

Australia has conquered or controlled many zoonotic diseases, says Watson.

"In the 1930s we had major problems with livestock disease transmitting to humans, like brucellosis, Q fever, hydatid disease and bovine tuberculosis. There used to be a lot of zoonoses all around the place but because of good livestock management and hygiene we're no longer exposed."

Outbreaks in the news Along with MERS, outbreaks of the following diseases have also recently featured in the news:

Anthrax

- * Bacteria spread by the handling or consumption of infected animals
- * Three types: skin (infected through cuts in skin), gastrointestinal (from eating the animal), respiratory (from inhaling spores). The latter is the rarest form.
- * Occurs naturally in both animals and humans in many parts of the world, including Asia, southern Europe, sub-Saharan Africa and parts of Australia. Currently an outbreak in Uzbekistan.
- * It is non-contagious between humans
- * Can be treated with antibiotics, prevented with vaccines.
- * Until the introduction of vaccines anthrax was major cause of fatal disease in cattle, sheep, goats, camels, horses, and pigs throughout the world.

Bubonic plague

- * One of the oldest identifiable diseases
- * Widely distributed in the tropics and subtropics. Most recent outbreaks include remote areas in China (case currently in Yumen), Peru and the Democratic Republic of Congo.

- * Bacteria spread by infected fleas carried on rodents
- * Can be treated with antibiotics. Left untreated can kill within 24 hours from pneumonia

Ebola

- * First identified in 1976
 - * West Africa - Democratic Republic of Congo, Republic of Congo, Gabon. Most recent outbreak in Guinea, Liberia and Sierra Leone has killed 672 people to date.
 - * Five species of virus: Zaire, Sudan, Tai Forest, Bundibugyo and Reston. The Zaire virus, which is involved in the latest outbreak, is the most lethal with 90 per cent fatality rate
 - * Fruit bats are thought to be a reservoir of the disease.
 - * Initial transmission thought to be through handling or consumption of infected animals. Human-to-human transmission happens through direct contact with bodily fluid.
 - * Causes nausea, vomiting, diarrhoea, internal and external haemorrhaging
 - * Also kills large primates such as [gorillas and chimpanzees](https://www.abc.net.au/science/articles/2006/12/08/1806976.htm) (<https://www.abc.net.au/science/articles/2006/12/08/1806976.htm>)
 - * No vaccine yet for humans, but vaccine available for non-human primates
 - * Can be contained with strict quarantine and health protocols
- [Find out more about Ebola](https://www.abc.net.au/news/2014-07-30/ebola-virus-explainer/5635028) (<https://www.abc.net.au/news/2014-07-30/ebola-virus-explainer/5635028>)

Hendra

- * First identified in 1994 in Queensland, current case in horse in Queensland
- * Reservoir is thought to be fruit bats
- * Can kill horses, less often dogs and humans
- * Causes respiratory infection, brain swelling
- * A vaccine is available to prevent hendra in horses

Professor Charles Watson was interviewed by Annie Hastwell

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