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REVIEW

## Swine flu (Influenza A/H1N1)

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**Abstract :** Swine flu is a respiratory disease caused by a new strain of influenza virus. It spreads rapidly from human to human, which leads to a pandemic flu outbreak. Pandemic flu is different from ordinary flu because it's a new flu virus that appears in humans and spreads very quickly from person to person worldwide. The World Health Organization (WHO) has declared an outbreak of human cases of influenza A/H1N1 a public health emergency of international concern. Before 2009 the Influenza A/H1N1 virus was not previously detected in swine or humans, containing a mix of swine, human and avian influenza virus genes. Three pandemics occurred due to influenza virus in the previous century, in 1918, 1957 and 1968. The 1918 pandemic was the most devastating, taking a toll of 30-40 million lives worldwide. The subsequent pandemics were relatively milder, each killing around 1 million people. In 2009 influenza outbreak, more than 414000 cases and about 5000 deaths had been reported to WHO by 195 countries worldwide. In humans the clinical symptoms are pneumonia, acute respiratory distress syndrome, fever, chills, cough, sore throat, runny or stuffy nose, muscle or bodyache, headache, joint pain, fatigue and sometimes vomiting and diarrhea. It may cause multi-organ failure and death. No effective treatment is available against swine flu. However, vaccines and antivirals can be used to reduce the spread of disease. There are two types of flu vaccines *viz.*, the trivalent and quadrivalent flu vaccines. The trivalent flu vaccines protect against influenza A virus H1N1, H3N2 and influenza B viruses. The quadrivalent flu vaccine protects against influenza A and B viruses. The vaccines are available as nasal flu spray and flu shots. Two antivirals namely, Tamiflu (Oseltamivir) and Relanza (Zanamivir) can be used to limit the spread of infection. The WHO, FAO, OIE and CAC has recommend good hygienic practice to prevent the spread influenza virus. Pork and pork products should be handled with good hygiene. The meat from sick pigs or pigs found dead should not be processed or used for human consumption.

**Key words :** Swine flu virus, Epidemiology, Current outbreaks, Transmission, Management

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## INTRODUCTION

A/H1N1 is a flu virus. When it was first detected in 2009, it was called "swine flu" because the virus was similar to those found in pigs (USDHHS, 2009). Swine Influenza (swine flu) is a respiratory disease of pigs caused by type A influenza virus that regularly causes outbreaks of influenza in pigs. Swine flu viruses can cause high levels of illness in pig herds, but cause few deaths in pigs. Swine influenza viruses can circulate among swine throughout the year, but

most outbreaks occur during the late fall and winter months similar to outbreaks in humans.

Pigs can become infected with influenza viruses from a variety of different hosts such as birds and humans, therefore, they can act as a “mixing vessel,” facilitating the reassortment of influenza genes from different viruses and creating a “new” influenza virus. The concern is that such “new” reassortant viruses may be more easily spread from person to person, or may cause more severe disease in humans than the original viruses. Three pandemics occurred due to influenza virus in the previous century, in 1918, 1957 and 1968. The 1918 pandemic was the most devastating, taking a toll of 30-40 million lives worldwide. The subsequent pandemics were relatively milder, each killing around 1 million people (WHO, 2009a). In March 2009, another novel strain of influenza virus A/H1N1, resulting from triple re-assortment, emerged in Mexico and the USA (Narain and Bhatia, 2009 and CDC, 2009a).

### **Etiology :**

Swine flu is caused by Influenza A/H1N1 virus. The virus belongs to the family Orthomyxoviridae. On the basis of nucleoprotein and Matrix (M) capsid protein, influenza virus is of three types *viz.*, Type A, Type B and Type C. There are two types of protein that is haemagglutinin (H) and neuraminidase (N). Haemagglutinin is of seventeen types (1-17), while neuraminidase of ten types (1-10). On the basis of combination of haemagglutinin and neuraminidase proteins, the Type A influenza virus has been categorized into several subtypes *viz.*, H1N1, H1N2, H2N2, H3N1, H3N2, H3N8, H5N1, H5N2, H5N3, H5N8, H5N9, H7N1, H7N2, H7N3 H9N2 and H10N7. These can infect several species such as human, avian, swine equine etc.

Influenza A virus undergoes mutation that takes place within the genome (antigenic drift)/or reassortment among the genetic materials of subtypes (antigenic shift) resulting in a new virus. Antigenic drift is responsible for new seasonal strains that make necessary surveillance to detect these strains and to prepare new seasonal influenza vaccine (yearly basis). Antigenic shift may result in a new virus easily transmissible from man to man for which the population has no immunity that results in pandemics. Influenza A virus causes pandemics, epidemics, seasonal flu outbreaks and sporadic infections. This virus caused many pandemics as follows :

- Spanish flu [A(H1N1)] : 1918-19
- Asian flu [A(H2N2)] : 1957-59
- Hong Kong flu [A(H3N2)] : 1968
- Swine flu [A(H1N1)] : 2009-10.

Influenza virus Type B has no subtypes. Antigenic variations are infrequent in this virus. It infects humans. It causes epidemics and seasonal influenza. Influenza virus Type C has also no subtypes. This virus is antigenically stable. It causes mild respiratory disease and does not cause epidemics.

### **Epidemiology :**

Swine influenza virus had never been identified as a cause of infections in people before the H1N1 pandemic in 2009. Genetic analyses of this virus have shown that it originated from animal influenza viruses and is unrelated to the human seasonal H1N1 viruses that have been in general circulation among people since 1977 (WHO, 2010). After early outbreaks in North America in April 2009 the new influenza virus spread rapidly around the world. In a study conducted during the initial phase of the pandemic in the USA, higher hospitalization rates were observed among pregnant women (Jamieson *et al.*, 2009).

There are three main influenza A virus subtypes (H1N1, H1N2 and H3N2) that have been isolated in pigs in the United States (CDC, 2015). H1N1 and H3N2 swine flu viruses are endemic among pig populations in the United States and something that the industry deals with routinely. Outbreaks among pigs normally occur in colder weather months (late fall and winter), but can occur year round. Swine-origin influenza A (H1N1) virus in humans have been identified in swine in the United States since 1998 (Olsen, 2002 and Vincent *et al.*, 2008) and 12 cases of human infection with such viruses were identified in the United States from 2005 through 2009 (Shinde *et al.*, 2009).

In 2009 influenza outbreak more than 414000 cases and about 5000 deaths had been reported to WHO by 195 countries worldwide (WHO, 2009a). In India the state of Maharashtra was the worst affected, followed by Karnataka (Table 1). In Europe, the estimated attack rates were in the range of 20 per cent- 30 per cent (Health Protection

**Table 1: Cases and deaths due to influenza A H<sub>1</sub>N<sub>1</sub> (Swine flu): State and year wise (DGHS, 2013)**

Sr. No.	State/UT	2009		2010		2011		2012		2013	
		C	D	C	D	C	D	C	D	C	D
1.	Andaman and Nicobar	25	0	2	0	0	0	0	0	0	0
2.	Andhra Pradesh	777	52	733	49	11	1	326	34	37	4
3.	Arunachal Pradesh	47	1	5	1	0	0	0	0	0	0
4.	Assam	0	0	0	0	0	0	0	0	0	0
5.	Bihar	7	0	0	0	1	0	0	0	0	0
6.	Chandigarh	257	8	75	0	0	0	1	0	37	5
7.	Chhattisgarh	46	2	50	12	0	0	10	3	0	0
8.	Dadra and Nagar Haveli	1	1	2	0	0	0	0	0	0	0
9.	Daman and Diu	1	0	0	0	0	0	0	0	0	0
10.	Delhi	8439	72	2725	77	25	2	78	1	1506	16
11.	Goa	63	5	61	1	7	0	9	0	0	0
12.	Gujarat	697	125	1682	363	7	4	101	30	1029	195
13.	Haryana	1888	34	216	16	6	4	18	5	448	41
14.	Himachal Pradesh	14	7	10	3	14	3	2	2	0	0
15.	Jammu & Kashmir	93	2	20	2	13	1	0	0	76	2
16.	Jharkhand	1	0	1	0	0	0	0	0	0	0
17.	Karnataka	1872	138	2575	116	100	12	878	48	59	5
18.	Kerala	1579	32	1533	89	210	10	623	14	10	1
19.	Lakshadweep	0	0	0	0	0	0	0	0	0	0
20.	Madhya Pradesh	20	8	395	110	9	4	191	26	103	31
21.	Maharashtra	4594	270	6814	669	26	5	1551	135	382	84
22.	Manipur	1	0	1	0	0	0	0	0	0	0
23.	Meghalaya	8	0	0	0	0	0	0	0	0	0
24.	Mizoram	4	1	0	0	0	0	0	0	0	0
25.	Nagaland	2	0	0	0	0	0	0	0	0	0
26.	Orissa	26	3	92	29	0	0	2	0	0	0
27.	Pondicherry	87	6	50	6	1	0	63	2	0	0
28.	Punjab	114	33	139	14	46	14	13	4	183	42
29.	Rajasthan	3032	150	1710	153	36	11	343	60	847	163
30.	Sikkim	0	0	0	0	0	0	0	0	0	0
31.	Tamil Nadu	2062	7	1184	13	34	4	750	40	24	3
32.	Tripura	0	0	0	0	0	0	0	0	0	0
33.	Uttarakhand	129	10	25	7	0	0	1	1	2	0
34.	Uttar Pradesh	1215	14	376	29	57	0	124	0	74	8
35.	West Bengal	135	0	121	4	0	0	0	0	3	0
	Total	27236	981	20604	1763	603	75	5044	405	4820	600

Abbreviations: C= cases and D= deaths

Agency, 2009). In Australia and New Zealand, the attack rate was 20 per cent. In the USA and the UK, attack rates among the elderly were lower due to some exposure to the virus in the past. In India, the predominant influenza virus circulating this season is not the A (H3N2) but the A (H1N1) pandemic 2009 or swine flu (WHO, 2015).

### Influenza at the human-animal interface :

Influenza viruses circulating in animals pose threats to human health (WHO, 2015). Humans can be exposed to these viruses such as avian influenza virus subtypes H5N1 and H9N2 and swine influenza virus subtypes H1N1 and H3N2 in the following ways :

- When people's work brings them in contact with infected animals.
- When people contact infected animals during their everyday lives, such as when visiting live animal markets or when these animals are kept as part of the household.
- When people handle or slaughter infected animals, or work with raw meat and by-products from infected animals.
- When people contact things around them, such as animal housing areas and equipment, ponds and other water sources, faeces and feathers, if these things are contaminated with influenza viruses.

In some cases these zoonotic infections result in severe disease or even death in humans, but often these infections result in only a mild illness or appear to cause no illness at all. All of the past four pandemic influenza viruses have contained gene components originating in animals (WHO, 2015). The actual public health risks posed by influenza viruses circulating in bird, swine and other animal populations are not completely understood. Recent findings suggest

**Table 2 : Number of cases and deaths due to swine flu in 2014-15 (data up to Mar, 2015): (PTI, 2015)**

Sr. No.	State/UT	Reported cases	Number of deaths
1.	Andhra Pradesh	72	22
2.	Assam	10	1
3.	Chhattisgarh	-	17
4.	Delhi	4137	12
5.	Goa	7	1
6.	Gujarat	6495	428
7.	Himachal Pradesh	-	20
8.	Jammu & Kashmir	109	16
9.	Karnataka	2733	82
10.	Kerala	25	12
11.	Madhya Pradesh	2185	299
12.	Maharashtra	4000	394
13.	Manipur	5	2
14.	Mizoram	4	-
15.	Nagaland	1	-
16.	Orissa	22	5
17.	Punjab	227	53
18.	Rajasthan	6559	415
19.	Tamil Nadu	320	14
20.	Telangana	2140	75
21.	Uttar Pradesh	165	36
22.	Uttarakhand	-	11
23.	West Bengal	58	24
	Total	33761	2035

Abbreviation: "-" = Unreported

that influenza viruses in animals and humans increasingly behave like a pool of genes circulating among multiple hosts, and that the potential exists for novel influenza viruses to be generated in swine and other animals. This situation reinforces the need for close monitoring and close collaboration between public health and veterinary authorities. WHO continues to work vigilantly with national ministries of health and animal health sector partners globally to identify and mitigate these influenza public health risks at the human-animal interface (WHO, 2015).

### **Transmission :**

Swine flu is transmitted as easily as the normal seasonal flu and can be passed to other people by exposure to infected droplets expelled by coughing or sneezing that can be inhaled, or that can contaminate hands or surfaces. There is also potential for transmission through contact with fomites that are contaminated with respiratory or gastrointestinal material (Bean *et al.*, 1982 and Boone and Gerba, 2005). There is a risk that people may also acquire infection by touching something that is contaminated by the virus and then touching their nose or mouth. Food is not yet known to be a vehicle for the transmission of this new influenza virus. Rapid spread among the population has been observed, especially in crowded places such as schools. In school outbreaks in the UK, around 30 per cent–50 per cent of students have been affected. In the USA, the attack rate in schools has been lower at around 20 per cent. The secondary attack rate in households was consistently ranged from 18 per cent to 30 per cent in countries where data are available (WHO, 2009b).

Swine flu viruses are thought to be spread among pigs mostly through close contact and possibly from contaminated objects moving between infected and uninfected pigs. Infected swine herds, including those vaccinated against swine flu, may have sporadic disease, or may show only mild or no symptoms of infection. The pandemic (H1N1) 2009 virus has not been shown to be transmissible to people through eating properly handled and prepared pork or other products derived from pigs.

### **Disease in the pigs :**

Swine influenza is a highly contagious acute respiratory disease of pigs (Aiello, 2008). The virus is spread among pigs by aerosols, through direct, indirect contact and also by asymptomatic carrier pigs. Swine influenza seen predominantly in the mid-western United States (and occasionally in other states), Mexico, Canada, South America, Europe (including UK, Sweden, and Italy), Kenya, Mainland China, Taiwan, Japan and other parts of eastern Asia and in various parts of India. The disease in the pigs is characterized by high fever, nasal discharge, redness or inflammation of eyes, lethargy, sneezing, breathing difficulties, coughing (barking like sound) and anorexia. Some pigs infected with influenza, however, may show no signs of illness at all.

### **Disease in the humans :**

The clinical spectrum of infection with the H1N1 virus is broad and ranges from mild upper respiratory tract illness to severe complications. The majority of people with pandemic influenza experience mild illness and recover fully without treatment. Severe complications include pneumonia resulting in respiratory failure, acute respiratory distress syndrome (ARDS), multi-organ failure and death (Health Protection Agency, 2009). Gastrointestinal symptoms such as diarrhoea have been reported in 20 per cent–50 per cent of patients and do not require hospitalization (WHO, 2009b). Other symptoms are fever, chills, cough, sore throat, runny or stuffy nose, myalgia or bodyache, headache, joint pain, fatigue and sometimes vomiting and diarrhea.

### **Diagnosis :**

Samples for laboratory tests should be taken from the deep nasal passages, nasopharynx, throat or bronchial aspirate. Reverse transcriptase-polymerase chain reaction (RT-PCR) provides the most timely and sensitive evidence of infection.

### **Prevention and control in swine :**

Overcrowding and low humidity provide ideal conditions for rapid transmission of disease. Therefore, overcrowding

in the swine herds should be avoided in order to minimize the transmission of disease. Adopt high standards of hygiene at swine farms. Imported swine should be subjected to quarantine so that clinically inapparent swine may come in the overt disease. Good biosecurity measures should be adopted to prevent disease outbreaks. Proper ventilation system in the animal houses is also helpful in the prevention of disease. A flu vaccine for pigs can help but not 100 per cent effective. Sometimes the vaccine used may not protect against viruses circulating in the pigs. In addition, current vaccines may not be effective in young pigs due to interference from antibodies received from the sows.

### **Prevention and control in humans :**

#### *Avoid contacts :*

The virus pose a potential risks to those who are likely be in close contact with pigs especially pig handlers, abattoir workers and veterinarians. Avoid contact with infected pigs.

#### *Safety precautions during swine flu outbreak :*

- Stay at home and rest. Avoid close contact with healthy people within the family or public place in order to avoid transmission of disease in other persons.
- Drink plenty of water and other clear liquids to prevent fluid loss (dehydration).
- Treatment according to the symptoms such as fever and cough.
- In severe infection, pregnancy and higher risk of flu complications like asthma, consult with doctor.

#### *Vaccination :*

Annual vaccination is the most effective solution for combating seasonal influenza infections such as swine flu. It is recommended that people get a flu vaccine even during seasons when drifted viruses are circulating. It's because vaccination can prevent some infections and can reduce serious ailments that can lead to hospitalization and death (WHO, 2015). The flu vaccine is available by shot or nasal spray (USDHHS, 2009). There are two different types of flu vaccines, trivalent and quadrivalent. Trivalent vaccines protect against 3 strains of the flu (A/H3N2, A/H1N1 and influenza B). Trivalent vaccines are available in traditional flu shots, approved for anyone 6 months and older. Intradermal shots, which use a shorter needle, approved for anyone 18-64. Cell based shots created using viruses grown in animal cells and approved for anyone over 18. Recombinant shots created using DNA technology, approved for people 18-49 with severe egg allergies.

Quadrivalent vaccines protect against 4 strains of the flu (A/H3N2, A/H1N1 and 2 strains of influenza B). These are available in traditional flu shots, approved for anyone 6 months and older nasal spray, approved for healthy people from 2-49, except pregnant women. The recommended components for the 2014-15 Northern Hemisphere influenza trivalent vaccines are an A/California/7/2009 (H1N1)-like virus, an A/Texas/50/2012 (H3N2)-like virus and a B/Massachusetts/2/2012-like (B/Yamagata lineage) virus (Grohskopf *et al.*, 2015). For quadrivalent vaccines, an additional component, B/Brisbane/60/2008-like (B/Victoria lineage) virus is recommended (Grohskopf *et al.*, 2015).

### **Side effects of swine flu shot vaccine :**

Possible mild side effects of the flu shot include soreness, redness and swelling at the injection site, fainting mainly in adolescents, headache, fever and nausea. Possible serious side effects of vaccination include difficulty in breathing, hoarseness, swelling around the eyes or lips, paleness, weakness, racing heart, dizziness, behaviour changes and high fever. Possible mild side effects of the nasal spray include runny nose, wheezing, headache, vomiting, muscle aches and fever.

### **Precautions while taking swine flu vaccines :**

If a person is sick with the fever, he/she should wait until fever is gone before getting a flu shot. However, a flu shot can be given if there is a respiratory illness without fever, or another mild illness. The nasal-spray flu vaccine can be given to people with minor illnesses such as diarrhea, a mild upper respiratory tract infection, with or without a fever. If there is nasal congestion, it should be waited to get the nasal-spray flu vaccine because nasal congestion may

limit vaccine's ability to reach the nasal lining.

*Use of mask :*

Guidelines on use and the correct procedure of wearing triple layer surgical mask for health care workers, patients and members of public has been recommended by MOHFW (2015) as follows :

- Place over nose, mouth and chin.
- Secure with tie strings (upper string to be tied above the ears and lower string at back of the neck).
- Change the mask after six hours or as soon as they become wet.
- While removing mask great care must be taken not to touch potentially infected outer surface.
- Disposable masks are never to be reused and should be disposed off.

*Proper disposal of used masks :*

- Used mask is potentially infected medical waste which should be disposed off in the identified infectious waste disposal bag/container.
- In community settings where medical waste management protocol cannot be practiced, it may be disposed off either by burning or deep burial.
- Masks used by patients/care givers should be disinfected using bleach solution or sodium hypochlorite solution or quaternary ammonium then disposed off either by burning or deep burial.

*Treatment :*

Treatment with influenza antivirals is recommended as early as possible for patients with confirmed or suspected influenza (CDC, 2011). Tamiflu (Oseltamivir) and Relenza (Zanamivir) are neuraminidase inhibitors. In clinical trials with seasonal influenza, these antiviral drugs have been shown to reduce the symptoms and duration of illness (WHO, 2010). Tamiflu is the best medicine to treat pregnant women who have H1N1 flu (CDC, 2009b). Amantadine and Rimantadine are M<sub>2</sub> inhibitors and can be effective for treating seasonal influenza.

*Supportive care :*

Supportive care at home includes resting, drinking plenty of fluids and using a pain reliever for aches and pains is adequate for recovery in most cases. A non-aspirin pain reliever should be used for children or adolescents under age 18 (WHO, 2010). Supportive therapy includes antipyretics such as paracetamol or acetaminophen, for fever or pain, and fluids, as needed.

*Epidemiological surveillance :*

Surveillance is an important component of programmes designed to investigate the pandemics or epidemics of influenza at international level. It has three objectives as follows :

- Determination of the virus types circulating in the population at a given time so that appropriate virus variants are selected to develop vaccine.
- Collection and analysis of morbidity/mortality data on the disease.
- Early detection of a new variant to evolve a system for forecasting of influenza epidemics.

**Guidance for occupational groups :**

To protect the commercial swine farmers, pork producers and other workers where they are in close contact with pigs, the following guidance has been recommended by OSHA (2010).

*Hygiene practices :*

Influenza viruses typically spread through coughing or sneezing and through contact with surfaces contaminated by flu viruses. It is important to recognize the signs of flu both in live swine and in swine farm workers so that appropriate precautions can be taken. Workers should be instructed in the following good hygiene practices-

- Cover the nose and mouth with a tissue when coughing or sneezing. Throw used tissues in trash.
- Wash the hands with soap and water. Use alcohol-based sanitizer if soap is not available.
- Shower and change the clothes when entering and leaving work.
- Workers should be instructed to wash their hands before and after contact with pigs, contaminated equipment or surfaces, before and after use of personal and protective equipment.

#### *Personal protective equipment (PPE):*

Compliance with personal protective equipment recommendations can protect workers, protect live swine from people with flu, and reduce the chances of carrying the flu virus outside the worksite. The following PPE is recommended for swine production workers when working with known or suspected flu-infected pigs :

- Uniforms or coveralls.
- Rubber, polyurethane boots or disposable shoe covers.
- Disposable gloves, safety goggles and lightweight head or hair covers.
- Personal protective equipment should be laundered, disinfected or discarded at work and should never be taken home or worn outside of work area.

#### *Respirator recommendations :*

Disposable N95 or higher NIOSH-certified filtering face-piece respirators are the minimum level of respiratory protection that should be worn by workers in contact with known or suspected flu infected pigs. Workers must be medically cleared, must be fit tested with the respirator model that they will wear and must be instructed in proper use and cleaning of the respirator.

#### *Cleaning and decontamination :*

Commonly used disinfectants, such as quaternary ammonium compounds or 10 per cent bleach solutions will kill flu viruses. Cleaning chemicals can cause skin, eye, nose, throat and lung irritation. Manufacturer's instructions should be followed for use of disinfectants. Workers should be provided with proper protective equipment when using cleaning chemicals.

#### *Swine farm biosecurity recommendations :*

Workers with a flu-like illness should stay home for at least 24 hours after the fever ends without the use of fever-reducing medicine. Biosecurity practices (e.g., shower-in/shower-out procedures, proper use, removal, cleaning or discarding of personal protective equipment, disinfectant footbaths) should be enforced.

#### *Education and training :*

Workers should know the followings :

- Importance of good hygiene, protective equipment, biosecurity and other practices to prevent the spread of flu from pigs to people and workers to pigs.
- Importance of the flu vaccination for workers.
- Symptoms associated with flu in humans and clinical signs of flu in pigs.
- Proper fitting, use, cleaning and disposal of personal protective equipment.

#### **Conclusion :**

Swine flu is a highly contagious zoonotic disease. Therefore, the effort should be made to prevent spread of disease in animals as well as in humans. In swine, the disease can be prevented and controlled by avoiding overcrowding in the swine herds, adaptation of high standards of hygiene and biosecurity measures at swine farms and vaccination of pigs. In humans, the disease can be effectively prevented or controlled by adopting high standard of hygiene, use of face masks, wearing personal protective equipment, education and training in occupational groups, avoid consumption of pork and pork products from infected swine, disinfection of contaminated materials and their proper disposal and



treatment with antiviral drugs. Moreover, emergence of new seasonal strains makes necessary surveillance to detect these strains and to prepare new seasonal influenza vaccine on yearly basis.

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