

# The novel H1N1/swine-origin influenza virus and its implications for autopsy practice

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**Abstract** As fatalities attributable to novel H1N1/S-OIV infections are currently rising, an increasing number of autopsies will have to be performed on these cases. In view of this challenge, adequate safety precautions and recommendations for autopsy procedures and the sampling and handling of specimens have to be established. Based on current literature, procedures for daily autopsy practice are proposed, particularly in regard to personal protection equipment, swab usage, and autopsy hygiene.

**Keywords** Swine-origin influenza virus · S-OIV · Flu · H1N1 · Autopsy practice · Specimen sampling

## Introduction

In April 2009, the Centers for Disease Control and Prevention (CDC) confirmed diagnoses of the first two cases of patients suffering from the current swine-origin influenza A (H1N1) virus (S-OIV, A/California/07/2009)

[5, 15]. Epidemiologic investigation of these cases showed that both affected children had no contact with pigs; a human-to-human transmission was thus assumed. Genetic analysis of the virus strain indicated that the emerging virus resembled a reassortment between two influenza A (H1N1) swine viruses that were themselves products of reassortment through multiple cross-species transmissions [20]. On April 30th, the revised *CDC rtPCR Protocol* was published by the World Health Organization (WHO) [19], which leads to a massive increase in reported cases via local testing in the respective laboratories worldwide.

## Epidemiology (as of 17 November 2009)

In Germany, the increase of new cases reported per week showed a first peak in the week beginning on July 27th, with a consecutive decrease over the following weeks. There was a subsequent new increase in cases in the week beginning on September 14th, with a constant rise in reported incidences ever since [17]. In other European countries, similar patterns in infection incidence were observed [2, 15, 17]. These data are subject to different influences such as the total number of persons tested, the availability of diagnostic tools, and the increasing alertness of health care professionals. Nevertheless, on December 12, 2009, the European Center for Disease Prevention and Control (ECDC) counted a total of 1,227 (from 501 fatal cases on November 12th) fatalities in Europe (and EFTA countries) and 9,340 fatalities worldwide attributable to S-OIV. Initial epidemiological studies showed highest incidence rates for 5 to 35-year-old individuals [2, 17], with decreasing risks of infection for older ages [11]. However, further data from Germany and South Africa indicate that this age distribution (median 33.5–35 years) [2, 17] might

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be significantly higher for fatal than for nonfatal cases (median 15.0 years) [2].

### Consequences for autopsy practice

As fatalities attributable to S-OIV infections are currently rising, an increasing number of pathologic and forensic institutions will have to perform autopsies on these cases. Furthermore, in cases with unknown causes of death and a history suggesting a possible fatal influenza infection, a postmortem may be assigned. Since postmortem contagiousness cannot be excluded and reliable postmortem data are not available up to now, precautions concerning the autopsy procedures are necessary. We, therefore, performed a literature research on the current status of scientific knowledge on S-OIV in general and subsequently focused on autopsy safety precautions and the sampling and examination of postmortem specimens. In addition, existing online information systems from different international, and certain national, health organizations were evaluated (Table 1).

### Recommendations for autopsy practice

Physical presence at the autopsy should be restricted to a minimum number of personnel. In general, standard safety precautions using personal protection equipment, which may differ slightly between institutions and countries, should be applied. Personal protective standard equipment should include double layer gloves, if possible with an interposed layer of cut-proof synthetic mesh, an impermeable, long-sleeved gown, and close-fitting face masks as a physical barrier to airborne infection [3].

In addition, the CDC recommends the use of appropriate eye protection (e.g., goggles, face shield) [4] and respirator systems (e.g., N95/N100 respirators or powered air-

purifying respirators) [4, 6, 14]. Ideally, autopsy settings should provide adequate air-changing systems with an air change per hour rate of at least 6 (ideally 12) and a negative pressure air system with downward exhaust air stream and laminar airflow control [4]. If a respirator system is not available, the use of facemasks is essential for autopsy personnel. It should, however, be kept in mind that these do not filter small fluid particles from the surrounding air.

Moreover, use of warm or hot water hand showers (risk of steam production) and oscillating saws without vacuum drain should be avoided.

To confirm the suspected diagnosis, an rtPCR of swab and tissue samples is recommended, particularly in the light of the published low sensitivities of the currently available rapid influenza diagnostic tests [10, 12]. Specimens should be sampled as soon as possible since reliable data on postmortem detectability are not yet available. Swab samples should be collected from nasopharyngeal and laryngeal mucosa using swabs with synthetic tips (i.e., polyester or Dacron) and stored in sterile tubes with specific viral transport media. Swabs with cotton tips and wooden shafts are not recommended. Swabs containing calcium alginate are not acceptable due to possible virucidal effects. Samples should be stored at 4°C no longer than 4 days [3]. Tissue samples should include specimens from the trachea, lung parenchyma and bronchi, and at least one sample for blood culture from a sterile heart puncture.

After the postmortem, protective clothing should be removed immediately prior to leaving the local area [4, 16] and be placed in an impermeable bag for transport purposes. Washing or cleaning procedures, with disinfection of all surfaces used and touched, are mandatory after the autopsy. However, no additional specific procedures are necessary [4]. A smaller study of Grayson et al. has shown that hand hygiene procedures using alcohol-based hand rubs are not superior to soap and water hand hygiene procedures [13]. Nevertheless, in most European countries

**Table 1** International and governmental public health organizations offering regularly updated online recommendations and/or regular newsletters on S-OIV

Institution/organization	Scope	Weblink
World Health Organization (WHO)	World	<a href="http://www.who.int/csr/disease/swineflu/en/index.html">http://www.who.int/csr/disease/swineflu/en/index.html</a>
Centers for Disease Control and Prevention (CDC)	USA	<a href="http://www.cdc.gov/h1n1flu">www.cdc.gov/h1n1flu</a>
European Center of Disease and Prevention control (ECDC)	Europe	<a href="http://ecdc.europa.eu/en/healthtopics/Pages/Influenza_A(H1N1)_Outbreak.aspx">http://ecdc.europa.eu/en/healthtopics/Pages/Influenza_A(H1N1)_Outbreak.aspx</a>
Robert Koch Institut (RKI)	Germany	<a href="http://www.rki.de/chn_091/nn_205760/DE/Content/InfAZ/1/Influenza/IPV/IPV__Node.html?__nnn=true">http://www.rki.de/chn_091/nn_205760/DE/Content/InfAZ/1/Influenza/IPV/IPV__Node.html?__nnn=true</a>
Health Protection Agency (HPA)	Great Britain	<a href="http://www.hpa.org.uk/web/HPAweb&amp;Page&amp;HPAwebAutoListName/Page/1240732817665">http://www.hpa.org.uk/web/HPAweb&amp;Page&amp;HPAwebAutoListName/Page/1240732817665</a>
Europe Influenza Surveillance (WHO)	Europe	<a href="http://www.euroflu.org/index.php">http://www.euroflu.org/index.php</a>

alcohol-based hand sanitizers, as recommended by the WHO and ECDC, are frequently used as a convenient and highly effective alternative [1, 7]. Hands should be washed for at least 20 s. Disinfection of the autopsy setting should be conducted using appropriate disinfectant products, such as those labeled [9] and listed by the respective governmental agencies (e.g., USA: Environmental Protection Agency, Germany: Association for Applied Hygiene, and Robert Koch Institut) [8, 18]. Autopsy instruments should be decontaminated as soon as possible in the manner usual for medical devices: cleaning–disinfection–autoclavation [3]. Whenever possible, thermal disinfection methods, i.e., autoclaving, should be given preference. When using disinfectants, the use of correct concentrations and the adherence to the minimum contact time, as specified in the manufacture instructions, should be stringently observed. Finally, impermeable body bags are required for the transport of corpses [4].

As scientific knowledge on S-OIV is currently developing rapidly, and information is added on a daily basis, safety recommendations need to be constantly updated (Table 1).

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