Nebraska Isolation and Quarantine Manual
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Respiratory Diseases
Potentially Warranting Care
In a High-Level Containment Care Unit

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This chapter reviews the management of respiratory diseases that are associated with outbreaks and have pandemic potential. Although patients with these illnesses may be managed in a high-level containment care (HLCC) unit, several factors may affect this decision, including available resources and the number of cases. A guiding principle is that suspect or confirmed cases should be isolated and ideally cared for in a negative-pressure room, with attention paid to infection control and appropriate use of personal protective equipment (PPE) to prevent nosocomial disease propagation.

Severe Acute Respiratory Syndrome

Causative Agent. Severe acute respiratory syndrome (SARS) is caused by the SARS-coronavirus (SARS-CoV) a single-stranded (+) RNA virus (lineage B coronavirus) that emerged in Foshan in Guangdong Province, China, in November 2002. SARS was recognized as a syndrome in February 2003, and the causative coronavirus was identified in late March
2003. Bats are believed to be the reservoir, with the virus crossing species barriers and transmitting to other mammals (e.g., civets). Initial human infection is thought to be related to exposure to live, caged animals in game markets in southern China.

**Historical Outbreaks and Current Status.** The 2002–3 Guangdong outbreak spread by international travel, with major outbreaks occurring in Hong Kong, Vietnam, Singapore, Taiwan, and Toronto. The pandemic resulted in more than 8,096 cases and 774 deaths in 33 countries on 5 continents. The global outbreak was declared contained by the World Health Organization (WHO) on July 5, 2003. The virus continued to cause sporadic infections in Guangdong, with the last cluster related to infection acquired in a research laboratory in Beijing, which ended in May 2004.

No further cases have been detected worldwide since.

**Route of Transmission, Attack Rates, R\textsubscript{0}, and Nosocomial Acquisition.** Spread between humans is primarily by mucosal contact with infectious droplets or fomites; the risk is heightened during aerosol-generating procedures (intubation, noninvasive ventilation, bronchoscopy, and nebulization). Airborne spread via infectious air plumes and fecal-oral contact facilitated by faulty sewage systems have been hypothesized in a large community outbreak in Amoy Gardens in Hong Kong and on aircraft. “Super-spreading events” noted in the outbreak were likely due to multiple factors including delay in isolation and the degree of viral shedding.

SARS has a basic reproduction number (R\textsubscript{0}) of 3, which means that an infected individual would, on average, spread the disease to 3 others, if infection control measures are not instituted. One study noted an attack rate of 10–60% among nursing staff prior to recognition of the outbreak, and another 6.2% attack rate in households. A disproportionate number of health care workers (HCWs) were infected in this outbreak (40% in Singapore, 43.6% in Hong Kong), with the majority infected before recognition of this disease or the availability of a diagnostic test. One study found asymptomatic seroconversion in 7.5% of exposed health care workers. In the same study, asymptomatic SARS (seroconversion without clinical illness) was determined to be ~13% overall, but these cases were not thought to contribute significantly to secondary spread.
**Case Fatality Rate.** SARS has an estimated overall case fatality rate (CFR) of 9.6%. The CFR increases with age and is estimated to be ~15% in those 45–64 years, and > 50% in those 65 or older.

**Isolation Precautions.** Patients should be cared for in a negative-pressure isolation room (with 6–12 air changes per hour, an independent air supply and exhausted outside or HEPA filtered before recirculation), with the doors closed. Care in an HLCC unit is reasonable, given the high attack and case fatality rates. If not available, a regular isolation/single room with its own bathroom is an alternative, followed by a designated ward to cohort cases if the numbers increase. The disease is unforgiving if allowed to spread, so there is a strict need to follow appropriate infection control measures. For SARS, airborne (including droplet) and contact transmission precautions are advocated.

**Personal Protective Equipment and Monitoring of Health Care Workers and Exposed Persons.** HCWs should don gloves, gowns, and respiratory protection. It is not as clear whether eye protection is needed to prevent transmission, but goggles or a face shield are routinely recommended when within 3 feet of a SARS patient. For respiratory protection, disposable particulate respirators (N-95 or higher) or a powered air-purifying respirator (PAPR) are recommended, the latter especially for aerosol-generating procedures. Temperature monitoring for staff (e.g., twice to thrice daily) is recommended for up to 10 days after caring for a potential/confirmed SARS patient to detect HCW infection early.

**Quarantine.** Quarantine may be considered for 10 days from the last known exposure, depending on local regulations, for exposed (but asymptomatic) persons. Any HCW with potential exposure who develops symptoms should be evaluated promptly in an appropriate location for respiratory protection for SARS.

**Transport of Patients.** Movement of patients out of their rooms should be minimized. If this becomes necessary, patients should don a surgical mask and a clean patient gown and perform hand hygiene prior to transport. Considerations for ground and air transport, including the use of portable isolation units, can be found in the references and are addressed in detail in chapter 18.

**Definitions for Suspect Cases (PUIs).** SARS-CoV may reemerge and should be suspected in cases or clusters of severe and otherwise unex-
plained respiratory infections (fever > 38°C, cough/dyspnea and chest X-ray infiltrates) with a history of travel to areas of likely reemergence, such as mainland China, Hong Kong, or Taiwan (or contact with an ill traveler from those areas), exposure to a potential animal host (including exposure to or consumption of wild/exotic game animals), or work in an at-risk occupation, such as HCWs or laboratorians involved in SARS-CoV research. Once SARS-CoV reemerges anywhere in the world, the index of suspicion should be heightened and SARS should be suspected in patients with compatible symptoms and potential epidemiologic exposure.

**Key Points in Clinical Care:**

- **Incubation period:** An incubation period averaging 6.4 days (range 2–10 days, maybe as long as 16 days).

- **Clinical symptoms:** An influenza-like illness, fever > 38°C (in most patients), lower respiratory tract symptoms (cough, dyspnea); a minority of cases may be present with mild or atypical presentations (e.g., diarrhea or lack of fever).

- **Diagnosis:** Laboratory testing is usually via RT-PCR, with an oro- or nasopharyngeal swab and a second specimen source, such as serum/plasma in the first week of illness, and stool after the first week of illness. Confirmation requires two positive specimens (from different sources or the same source, on different days). PCR may be falsely negative in respiratory samples especially early in the course of illness (before day 3–5) as viral shedding increases and peaks only around day 11. Paired serology using immunofluorescent antibody (IFA) or enzyme-linked immunosorbent assay (ELISA) may also be helpful. These are positive usually only after the end of the second week of illness. Lymphopenia and a raised lactate dehydrogenase level are also common among SARS patients, the latter portending a poor prognosis.

- **Treatment:** Treatment is supportive. Ribavirin, steroids, and lopinavir/ritonavir, interferon (type I), intravenous immunoglobulin, and convalescent sera have been utilized, but efficacy is unknown and some treatments may even cause harm (e.g., secondary infections with steroids). No vaccine is available. Ex-
tracorporeal membrane oxygenation (ECMO) may be helpful in acute respiratory distress syndrome (ARDS), extrapolating from the experiences with H7N9 influenza and Middle Eastern respiratory syndrome (MERS).

- Period of infectivity: Patients should be considered infectious until 10 days after resolution of symptoms (e.g., fever and respiratory). Dried virus in the environment may be infective for an estimated 6 days.

- Management of patient waste: Medical waste has not been associated with spread of disease; therefore, SARS-CoV contaminated medical waste is handled as per facility-specific/state/local procedures for routine medical (biohazardous) waste.

- Cautions: Avoid cough-inducing procedures and use of noninvasive positive pressure ventilation (e.g., BiPAP), as these may lead to aerosolization of infectious particles. A hydrophobic submicron viral/bacterial filter should be placed between the endotracheal tube and the ventilator circuit tubing and a second filter in the expiratory limb of the ventilator to minimize risk of aerosolization.

**Middle East Respiratory Syndrome**

*Causative Agent.* MERS was first recognized in June 2012 in a Saudi patient with acute respiratory distress syndrome (ARDS) and renal failure who expired 11 days after admission. The causative agent, the novel MERS-coronavirus (CoV; the first lineage C coronavirus known to infect humans), was identified in September 2012. The earliest human cases were identified retrospectively in a Jordanian nosocomial outbreak in April 2012. Dromedary camels are the reservoir, and zoonotic transmission is thought to be primarily due to close animal-human contact (e.g., contact with respiratory secretions or consumption of raw camel milk, urine, or meat).

*Historical Outbreaks and Current Status.* Since its emergence (and as of the end of July 2018), there have been a total of 2,237 laboratory-
confirmed cases of MERS in 27 countries worldwide with 793 deaths (CFR 35.5%), with 80% reported from Saudi Arabia. Travel-related cases have occurred outside the Middle East, with a large and notable outbreak in South Korea in May–July 2015, in which 186 confirmed infections arose from an ill returned traveler from Saudi Arabia. Cases continue to be reported in the Arabian Peninsula.

**Route of Transmission, Attack Rates and $R_0$, and Nosocomial Acquisition.** Although MERS-CoV has an estimated overall $R_0$ of < 1 and appears to be less transmissible than SARS-CoV, infections have occurred in the young and healthy, and it has a predilection for the immunocompromised, including diabetics and persons with renal failure and chronic lung disease, leading to a higher overall CFR. MERS-CoV transmission is thought to occur primarily via droplets, but transmission by fomites and aerosols may also occur. Amplification in health care settings has been a significant issue, with attack rates (seroconversion) found to range between 2.4% (physicians) and 29.4% (radiology technicians) in one Saudi hospital. Since July 21, 2018, 38% (17 of 45) of secondary cases reported to the WHO were health care–associated (occurring in HCWs, other exposed patients, family visitors); 66% (37 of 56) of community-acquired MERS cases were associated with dromedary contact (direct or indirect).

**Case Fatality Rate.** MERS has a crude CFR of 35.5%, and risk of mortality is higher in older males with underlying medical conditions (e.g., diabetes, renal failure, and hypertension).

**Isolation Precautions.** As with SARS, patients should be cared for with the doors closed in a negative-pressure isolation room (with 6–12 air changes per hour, an independent air supply and exhausted outside or HEPA filtered before recirculation), and precautions should be taken for airborne (including droplet) and contact transmission. Care in an HLCC unit, if feasible, is a reasonable consideration.

**Personal Protective Equipment and Monitoring of Health Care Workers and Exposed Persons.** HCWs should don gloves, gowns, and respiratory and eye protection. For respiratory protection an N-95 disposable particulate respirator or a PAPR is recommended, especially for aerosol-generating procedures. Temperature monitoring for staff (e.g., twice daily) has also been used to detect HCW infection, and such monitoring
should continue for up to 14 days after caring for a potential/confirmed MERS patient, regardless of the individual’s use of PPE. Staff with unprotected exposures to MERS patients may need to be placed under controlled monitoring for development of illness or potential exclusion from work for 14 days.

**Transport of Patients.** Avoid movement of patients out of their isolation rooms as much as feasible. As with SARS, if this becomes necessary, patients should don a surgical mask and clean gown, and perform hand hygiene before movement out of rooms. Guidance regarding air transport may be found in the references, while ground transport recommendation follows that for SARS.

**Definitions for Suspect Cases (PUIs).** MERS should be suspected in persons with severe illness (fever and pneumonia/ARDS) who have traveled (or who are contacts of an ill traveler with a respiratory illness) to the Arabian Peninsula within 14 days of symptom onset, or who are part of a suspect MERS cluster. MERS should also be suspected in persons with milder illness (e.g., fever or respiratory symptoms) with exposure to a health care facility in the Arabian Peninsula where there has been recent MERS transmission or who are contacts of a known MERS case, within 14 days of symptom onset.

**Key Points in Clinical Care:**

- Incubation period: 2–14 days (median 5–6 days), however, in rare cases (e.g., immunocompromised) may extend to as long as 21 days.

- Clinical symptoms: Mild cases—Low grade fever, rhinorrhea, sore throat, myalgias, influenza-like illness. Severe cases—dyspnea, ARDS.

- Diagnosis: Multiple specimens (whenever possible, both upper AND lower respiratory specimens, ideally within 7 days of onset of illness) should be obtained for PCR-based testing. As ~21% of cases may be mild or asymptomatic, WHO recommends testing of all close contacts of MERS patients (including HCWs). Lower respiratory specimens (e.g., bronchoalveolar lavage, sputum, and tracheal aspirates) contain the highest viral loads. Upper
respiratory specimens (e.g. naso- or oropharyngeal swabs) may also detect the virus, but every attempt should be made to test lower tract specimens in patients strongly suspected for MERS and/or who have lower tract disease. A single negative test does not satisfactorily rule out disease, and repeat testing is recommended. Serologic testing (e.g., IFA, ELISA, with confirmation via a neutralization assay) may also be useful (single sample if > 14 days have elapsed since illness onset, or paired samples 3–4 weeks apart) in diagnosing cases and for detecting asymptomatic transmissions, although cross-reactions with other coronaviruses may be problematic. The CDC suggests serum for RT-PCR testing in the first 10–12 days of illness; however, lower levels of viremia may make serum/plasma less useful as a diagnostic specimen for MERS as compared to SARS. Limited data from 21 patients presenting with a median of 2 days (range 0–12 days) from symptom onset to diagnosis in the 2015 Korean outbreak found viremia in only 7 (33%) of patients, but this was associated with a worse outcome, including mortality.

- **Treatment**: Treatment is supportive, and patients with ARDS may benefit from ECMO, which may lower mortality. The efficacy of ribavirin, steroids, lopinavir/ritonavir, interferon, and intravenous immunoglobulin are uncertain and should not be used outside of a clinical trial. Convalescent sera may be helpful, but robust clinical data are lacking and titers in recovered individuals may not be sufficiently high. Several early vaccine and immunotherapy trials are under way.

- **Period of infectivity**: The duration of infectivity is unclear. It is currently recommended that patients be placed on transmission-based precautions for at least 24 hours beyond the resolution of clinical illness, with two respiratory specimens (preferably lower respiratory tract) negative for MERS-CoV by PCR collected 24 hours apart.

- **Management of patient waste**: MERS-CoV–contaminated medical waste is handled as per facility-specific/state/local procedures for routine medical (biohazardous) waste.
• Cautions: Avoid cough-inducing procedures and use of noninvasive positive pressure ventilation (e.g., BiPAP) as these may lead to aerosolization of respiratory secretions. A hydrophobic submicron viral/bacterial filter should be placed between the endotracheal tube and the ventilator circuit tubing and a second filter in the expiratory limb of the ventilator to reduce the risk of aerosolization.

**Novel/Avian Influenza**

*Causative Agent.* Influenza is caused by a single-stranded (−) RNA virus, and novel lineages, mostly of avian or swine origin, emerge periodically due to genetic reassortment. These have caused human disease, including pandemics (e.g., the 2009 H1N1 virus). H5, H7, H9, and H10 avian subtypes are primarily zoonoses with limited transmission to humans. H5N1 and H7N9, which have caused severe disease and, to date, limited outbreaks in humans, will be the focus of this section. Concerns remain regarding the possibility that novel influenza strains might further adapt to humans, causing another pandemic.

*Historical Outbreaks and Current Status.* H5N1 emerged in Hong Kong in 1997 and reemerged in mainland China in 2003, while H7N9 emerged in 2013 in China. Both viruses have spilled over from birds and caused human infections, but person-to-person spread is currently limited and non-sustained. H5N1 is a highly pathogenic avian influenza (HPAI) causing severe disease in poultry and has spread geographically due to migratory birds, while H7N9 has emerged as a lowly pathogenic avian influenza (LPAI) causing little or no symptoms in poultry, but HPAI variants emerged in November 2016, and these have also caused human infections. As of July 2018, WHO has reported 860 cases of H5N1 in 16 countries, with 454 deaths (52.8% mortality).

Since February 2013, H7N9 has caused annual winter outbreaks in China. As of March 2018, there have been 1,567 H7N9 laboratory-confirmed cases with 615 (39.2%) deaths. Most H7N9 cases have occurred in mainland China with the worst wave thus far in 2016–17, and the few cases (numbers in parentheses) from other territories/countries
were linked to travel to mainland China: Hong Kong (21), Macao (2), Taiwan (6), Malaysia (1), and Canada (2).

**Route of Transmission, Attack Rates and $R_0$, and Nosocomial Acquisition.** Human infection with avian influenza is primarily via exposure with infected birds (live or dead); about 60–75% of human H5N1 and H7N9 infection report recent exposure. Potential routes of infection include inhalation of infectious droplets, airborne droplet nuclei, and possibly self-contamination of facial mucous membranes following fomite contact, or ingestion. Person-to-person transmission is thought to be rare and is not sustained, occurring only when there is prolonged and close contact. The estimated $R_0$ is 1.14 for H5N1 and between 0.1 and 0.47 for H7N9. The household attack rate for H5N1 was estimated to be 18.3% and secondary attack rate to be 3.1–4.5% in an Indonesian study. The secondary attack rate of H7N9 has been estimated to be ~1.3–2.2%. HCW acquisition of H5N1 has been reported in a Vietnamese nurse who developed clinical illness, and asymptomatic seroconversion to H5N1 has been found in 4% of exposed HCWs in Hong Kong, but this appears to be low as several studies have found a lack of clinical illness or seroconversion in exposed HCWs. Small clusters of patient-to-patient and probable patient-to-HCW nosocomial spread of H7N9 have been described, but as in the case of H5N1, no sustained transmission has been observed.

**Case Fatality Rate.** It is not entirely clear why H5N1 has an overall higher CFR of 52.8% (to date, as of July 2018), compared to H7N9 (39.2%, as of March 2018), despite the latter’s predilection for older individuals.

**Isolation Precautions.** Similar to patients with SARS and MERS, patients should be cared for in a negative-pressure isolation room with the doors closed (with 6–12 air changes per hour, an independent air supply and exhausted outside or HEPA filtered before recirculation), and precautions should be taken against airborne (including droplet) and contact transmission. Cohorting may be considered when there are large numbers of infected patients requiring isolation.

**Personal Protective Equipment and Monitoring of Health Care Workers and Exposed Persons.** Health care workers should don gloves, gowns, and respiratory and eye protection. For respiratory protection an N-95 disposable particulate respirator or a PAPR is recommended, especial-
ly during aerosol-generating procedures. Staff caring for patients with suspected/confirmed novel influenza should be monitored for illness. Analogous to SARS/MERS, temperature monitoring for staff (e.g., twice daily) may be considered to detect HCW infection. Symptom monitoring should continue for up to 10 days after caring for a potential/confirmed novel influenza patient. Staff/persons with unprotected exposures to novel influenza patients should be excluded from work for 10 days and be monitored for development of illness. Extended monitoring for a further 10 days (i.e., 20 days total) was used in a Hong Kong unit for 70 HCWs with unprotected exposures to H7N9, but no HCW infections were noted.

**Transport of Patients.** Avoid movement of patients out of their isolation rooms if possible. If movement becomes necessary, patients should don a surgical mask and clean gown, and should perform hand hygiene before movement out of rooms. Avoid aerosol-generating procedures during ground transportation, and disinfect the cabin of the ambulance and equipment with phenolics, bleach, or quaternary ammonium compounds after the patient is transferred out. No specific guidance for air or ground transport is available from the CDC for avian influenza, although the guidelines for MERS/SARS are available as references.

**Definitions for Suspect Cases (PUIs).** Novel/avian influenza should be suspected in persons with an influenza-like illness, and in particular, patients with clinical or radiologic evidence of pneumonia or a severe, unexplained respiratory illness who have had a potential exposure within the preceding 10 days, such as close contact with a confirmed or suspect case of avian influenza, travel to at-risk areas where avian influenza is circulating, exposure to infected birds/animals, or work in a laboratory that handles novel/avian influenza.

**Key Points in Clinical Care:**

- Incubation period: H7N9 influenza, median 6 (range, 1–10 days), H5N1 influenza, median 4 (range 2–8 days).
- Clinical symptoms: An influenza-like illness (fever, with cough or sore throat). Fever (≥ 38°C) and cough are the most common symptoms but are less common in H5N1 (65% and 54%, respec-
tively) compared to H7N9 (79% and 71%, respectively). Sore throat seems to be uncommon for both H5N1/H7N9 influenza (5–9%). Severe cases—pneumonia, dyspnea, ARDS.

- Diagnosis: Obtain respiratory specimens (nasopharyngeal swab or nasal aspirate/wash, or oropharyngeal swab; lower respiratory tract specimens are preferred if there is pneumonia, e.g., bronchoalveolar lavage or endotracheal tube aspirate) as soon as possible after the onset of illness (before day 7 of illness if possible) for testing via PCR. It is prudent to obtain multiple specimens from different sites on at least two consecutive days. Commercial assays may yield an “influenza A, unsubtypeable” result or may fail to detect novel influenza due to lower analytic sensitivity. Patients with suspected novel/avian influenza or unsubtypeable influenza A results should have further testing performed at state or public health laboratories (e.g., the CDC or a WHO collaborating center).

- Treatment: The neuraminidase inhibitors (NAIs) are the mainstay of pharmacotherapy for patients with novel influenza, and antiviral treatment should be started as soon as possible regardless of time elapsed from illness onset (but ideally within 48 hours) for all confirmed and probable cases, as clinical benefit may still be derived. Treatment should not be delayed because of pending laboratory results, and may be extended (e.g., 10 days or longer) in severely ill or immunocompromised patients who may shed virus for longer periods and who are at risk of developing resistant virus.

- Chemoprophylaxis: Both the CDC and WHO recommend antiviral chemoprophylaxis at treatment doses (e.g., with oseltamivir 75 mg BID for 5 days if renal function is normal), rather than the usual seasonal influenza prophylaxis doses (e.g., oseltamivir 75 mg daily for 10 days) for close contacts based on the assumption that infection may have already occurred and given the concerns of emergence of antiviral resistance in cases of prophylaxis failure as seen in the 2009 H1N1 pandemic. Close contact is defined as unprotected exposure within 6 feet/2
meters of an infected person for a prolonged time or contact with infectious secretions 1 day before onset of clinical illness till resolution of illness. Chemoprophylaxis may be extended (e.g., to 10 days) if exposure is likely to be ongoing (e.g., due to potential prolonged shedding of virus in undiagnosed contacts).

- Other treatments: Convalescent plasma or hyperimmune immunoglobulin may be helpful. Corticosteroids have increased the risk of secondary bacterial infection and mortality, and their use cannot be recommended routinely. Other immunomodulatory treatments such as statins, sirolimus, and macrolides have been utilized, but there is currently no clear evidence of benefit versus harm. Patients with ARDS may benefit from ECMO, which may lower mortality.

- Antiviral resistance: H5N1 and H7N9 are generally susceptible to NAIs. Although uncommon, resistance may occur; for example, in H7N9 the R292K mutation confers resistance to oseltamivir and peramivir, with decreased susceptibility to zanamivir. The H275Y mutation confers high-level resistance to oseltamivir, and reduced susceptibility to peramivir in H5N1 viruses (zanamivir retains susceptibility). Some H5N1 strains may be susceptible to the M2 inhibitors (amantadine and rimantadine), although most H7N9 strains are not. The NAI laninamavir (administered by inhalation, approved in Japan) shows a similar profile to zanamivir and is undergoing phase III trials. Favipiravir, a viral RNA-dependent RNA polymerase inhibitor, has activity against NAI-resistant strains and broad activity against RNA viruses and has been approved for stockpiling in Japan. The role of the new viral PA subunit polymerase inhibitor baloxavir (FDA-approved in 2018) remains to be defined but holds promise given its novel mechanism of action, rapid virological effect, single-dose strategy, and potential for synergy with NAIs, but emerging resistance remains a concern.

- Vaccines: Not widely available, but some countries, including the United States, stockpile H5N1 and H7N9 vaccines. These may be considered for first responders to human/animal outbreaks.
or in designated referral facilities for novel influenza, but it is uncertain whether these vaccines would be adequately immunogenic matches to an eventual outbreak strain caused by an ever-evolving virus.

- **Period of infectivity:** For seasonal influenza, patients are considered infectious for 7 days from the onset of illness or at least 24 hours after resolution of fever and respiratory symptoms, whichever is longer. Less information is available for avian influenza; however, recent data from patients with H7N9 indicate a median duration of RNA detection from respiratory specimens of 15.5 days, and this could extend up to 30 days in those who are immunocompromised, receive corticosteroids, had a delay in NAI treatment, and had a fatal course. H5N1 RNA has also been detectable for up to 27 days in the lower respiratory tract in patients with fatal disease. No specific recommendations are available for novel influenza, but given these data, patients with novel influenza should be placed on isolation precautions for ≥ 24 hours after resolution of clinical illness (or ≥ 7 days from onset of illness, whichever is longer), and units may consider testing (e.g., evaluation by PCR for two negative respiratory samples 24 hours apart as for MERS-CoV) prior to removing from isolation.

- **Management of patient waste:** Medical waste from patients with novel influenza is handled as per facility-specific/state/local procedures for routine medical (biohazardous) waste.

- **Cautions:** Avoid cough-inducing procedures and use of noninvasive positive pressure ventilation (e.g., BiPAP) as these may lead to aerosolization of secretions. A hydrophobic submicron viral/bacterial filter should be placed between the endotracheal tube and the ventilator circuit tubing and a second filter in the expiratory limb of the ventilator to reduce risk of aerosolization.