

The Role of Infection Prevention in Monitoring and Preventing Healthcare-Associated Viral Respiratory Infection



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KEYWORDS

- Influenza • Respiratory syncytial virus • SARS-CoV-2 • COVID-19 • Coronavirus
- Middle east respiratory syndrome • Respiratory virus • Infection prevention

KEY POINTS

- Health care–associated viral respiratory infections are common with increased patient morbidity and mortality.
- Multicomponent infection control measures, consisting of education, hand washing, isolation, consistent use of personal protective equipment, cohorting patients, and cohort nursing, reduce transmission of respiratory infections.
- Health care personnel influenza vaccination is recommended with condition of employment vaccination policies becoming more common.

INTRODUCTION

Although the threat of viral respiratory infection was underscored by the COVID-19 pandemic, respiratory viruses have a significant impact in health care settings even under normal circumstances, resulting in increased patient morbidity, mortality, and health care costs.^{1,2} Approximately 3 to 4 cases of health care–associated (HA) viral respiratory infection occur for every 1000 admissions, amounting to an estimated 19,000 cases each year in the United States.^{1,2} More than 20% of respiratory virus infections in hospitalized patients are considered to be health care associated.² Respiratory viruses can be transmitted through multiple pathways, including contact, droplet, and airborne routes, with the relative contributions of each route depending on the viral species and environmental factors. In 2024, the World Health Organization

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Abbreviations	
AGP	aerosol-generating procedure
CDC	Centers for Disease Control and Prevention
FDA	Food and Drug Administration
HA	health care–associated
HCoV	human coronavirus
HCP	health care personnel
ICU	intensive care unit
IDSA	Infectious Diseases Society of America
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
RSV	respiratory syncytial virus
WHO	World Health Organization

(WHO) proposed changes to terminology describing particle transmission. The report suggests use of an umbrella term “infectious respiratory particles” transmitted via either “airborne transmission/inhalation” versus “direct deposition” onto mucous membranes.³ It remains to be seen whether this alternate terminology will be widely adopted, so this article uses terms currently in use (ie, airborne, droplet, and so forth). Controlled laboratory studies to determine which transmission routes are possible and epidemiologic studies to determine which routes most contribute to real-world transmission are both needed to inform prevention and control. In this review, the authors describe the current understanding of the epidemiology, transmission, and role of infection prevention in the control of HA viral respiratory infections.

SARS-CoV-2 AND OTHER HUMAN CORONAVIRUSES
Epidemiology

Among the human coronaviruses (HCoVs), there are 4 seasonal viruses (229E, OC43, NL63, and HKU1) that cause annual epidemics of primarily mild respiratory infections.⁴ In addition, several novel coronaviruses have emerged from zoonotic reservoirs in recent decades causing severe lower respiratory disease, most notably the SARS-CoV-2 virus responsible for the recent COVID-19 pandemic.

As of August 30, 2025, the COVID-19 pandemic caused by the SARS-CoV-2 coronavirus has resulted in 778,572,430 confirmed cases and 7,101,070 deaths worldwide, with the United States accounting for approximately 13% of the cases and 17% of the deaths.⁵ HA COVID-19 is estimated to occur 0.39 to 5.8 times per 1000 patient-days and has been associated with increased cost and length of stay.⁶ Characterizations of nosocomial outbreaks early in the pandemic noted that mortality among patients with HA COVID-19 was much higher than in the general population, potentially reflecting older age and poorer health.⁷ Introduction of vaccines led to a decrease in HA COVID-19 mortalities, previously observed as 32% to 36% in several studies.^{8,9} Continued high mortalities (8%–11%) have been observed with HA COVID-19 owing to more recent delta and omicron variants, likely related to the higher transmissibility of these variants.¹⁰

Although the COVID-19 pandemic is the first documented pandemic caused by an HCoV, there are other recent examples of novel HCoV emergence causing epidemics. In 2002 to 2003, the novel SARS-CoV caused an epidemic of severe respiratory illness (coined “SARS” or “Severe Acute Respiratory Syndrome”) resulting in 8096 cases globally and 774 deaths (9.6% case fatality ratio) with notable nosocomial outbreaks in Singapore and Toronto.^{11,12} Middle East Respiratory Syndrome Coronavirus (MERS-CoV) was identified in the Arabian Peninsula in 2012.¹³ As of August 2025, 2628 cases in 27 countries have been reported with 948 deaths (36% case fatality

ratio).^{14,15} Although direct contact with dromedary camels has remained a major risk factor for MERS, there have been MERS nosocomial outbreaks.¹⁵ As of 2019, incidence of HA MERS had decreased compared with 2015, owing to improved infection prevention practices; however, 19% of cases still reported as occurring in health care personnel (HCP).¹⁶

Nosocomial infection with seasonal coronaviruses has also been described, including large outbreaks among patients and HCP in pediatric and neonatal intensive care units (ICUs).^{17,18}

Transmission

The median incubation period of SARS-CoV-2 is 3 to 4 days with symptoms developing within 12 days in 97% of symptomatic infections.^{19,20} An estimated 40% of infected individuals (30% among HCP/in-hospital patients) remain asymptomatic, based on a large meta-analysis of almost 20,000 individuals with COVID-19.²¹ A review of cases among symptomatic and asymptomatic individuals demonstrated culture positivity peaks on or just before the day of symptom onset/diagnosis through day 5, followed by a steep decline.²² Data are mixed regarding asymptomatic cases, with some studies finding they may have higher or comparable viral loads compared with symptomatic patients but also may have shorter duration of shedding.²³ Those immunocompromised or unvaccinated may have longer duration of shedding.²³ Taken together, the long incubation period, high proportion of asymptomatic infections, pre-symptomatic shedding, and long duration of shedding contribute to a high proportion of unobserved transmission.

SARS-CoV-2 is predominantly transmitted through close contact via large respiratory droplets generated by an infected person, and individuals become infected via direct contact with these droplets.^{24,25} However, there is evidence that SARS-CoV-2 may be transmitted over longer distances and periods of time via smaller droplets or aerosols following respiratory emission events, that is, coughing, sneezing, or during certain procedures.^{26,27} Aerosol-generating procedures (AGPs), such as bronchoscopy, airway suctioning, cardiopulmonary resuscitation, and emergent intubation, may generate increased amounts of infectious respiratory droplets and aerosols that can lead to transmission without proper precautions.²⁸ Elective intubation and extubation are not considered AGPs based on data demonstrating these procedures produce greater than 35-fold less detectable aerosol than a volitional cough.²⁹ Studies have also shown frequent contamination of surfaces with prolonged infectivity up to 72 hours on nonporous surfaces and up to 24 hours on cardboard.²⁶ However, actual instances of indirect fomite transmission have not been conclusively documented.

In contrast to SARS-CoV-2, MERS-CoV has low human-to-human transmission potential. However, inadequate or inconsistent infection control measures have been cited as factors in MERS-CoV transmission during nosocomial outbreaks.³⁰ MERS-CoV may transmit by large droplets, contact, and aerosols following AGPs.³¹

The seasonal HCoVs, unlike their higher-severity counterparts, appear to be largely spread by droplet transmission.³² Performing AGPs and contact with pediatric patients have been identified as risk factors for HCP infection with seasonal HCoV.³³

Prevention and Control

The Infectious Diseases Society of America (IDSA) and Centers for Disease Control and Prevention (CDC) recommend nucleic acid amplification testing for all individuals, hospitalized or in the community, with symptoms of COVID-19.³⁴ Negative results in

symptomatic hospitalized patients should be treated with suspicion with repeated testing, including specimens from the lower respiratory tract if possible. Testing is no longer recommended for asymptomatic patients on hospital admission or those undergoing procedures, as it adds unnecessary burden to hospital and laboratory staff capacity and causes delays in patient care with unclear benefit when added to other infection prevention practices.^{35–37} Testing of asymptomatic patients may be considered during periods of high community transmission.

Patients with suspected or confirmed SARS-CoV-2 infection should be placed in single rooms with a closed door and dedicated bathroom.³⁴ Patients undergoing AGPs should be placed in airborne infection isolation rooms if possible. The CDC currently recommends that, in addition to standard precautions, HCP entering the room of SARS-CoV-2 patients should use an N95 equivalent or higher-level respirator, eye protection, gloves, and a gown (as a part of contact and airborne precautions; **Tables 1** and **2**).³⁴ The requirement for gown and gloves has been questioned owing to consensus on the predominance of transmission via respiratory particles in the air and the lack of data demonstrating transmission via fomites on surfaces.^{38,39} Unnecessary use of expanded personal protective equipment leads to increased cost and provider burden and may detract from focus on high-yield source control maneuvers (ie, appropriate masking, hand hygiene, distancing).⁴⁰

Although the SARS-CoV-2 research base evolved quickly early in the pandemic, there remain gaps in the knowledge of SARS-CoV-2 epidemiology, transmission, and infection control best practices. The CDC *Guideline for Isolation Precautions* has been under review for updates by the Healthcare Infection Control Practices Advisory Committee; however, the termination of this advisory committee in the spring of 2025 leaves the status of these updates unclear. As of September 2025, four vaccines for the prevention of COVID-19 are approved by the Food and Drug Administration (FDA).⁴¹ Recommendations may vary, but, in general, those who are immune compromised or otherwise at risk for complications are recommended to receive vaccination.

Although seasonal HCoVs are not specifically mentioned in CDC infection prevention guidelines, droplet and contact precautions may be considered based on likely routes of transmission.³²

SEASONAL INFLUENZA

Epidemiology

Influenza infects approximately 2% to 10% of the US population annually, resulting in 120,000 to 700,000 hospitalizations and 6300 to 51,000 deaths.^{42,43} Studies estimate 0.4% to 35.6% of cases of influenza in hospitalized patients are HA.^{44–46} These patients are more likely to require ICU admission, mechanical ventilation, and longer hospital stays and are more likely to die in the hospital.⁴⁴

Transmission

The incubation period for influenza is approximately 1 to 2 days.⁴⁷ Viral shedding begins 1 to 2 days before symptom onset, peaks between days 1 and 2 of clinical illness, and usually declines rapidly thereafter.⁴⁸ Virus is typically no longer detectable 6 to 7 days after symptom onset. Viral shedding may be prolonged in children and immunocompromised adults and shorter in those who are asymptomatic.^{47,48}

The possibility for influenza transmission through direct contact, indirect contact with fomites, large droplet, and aerosol routes has been demonstrated in both

Table 1
Precautions for preventing transmission of respiratory infections

Precautions	Component	Recommendation
Standard	Hand hygiene	Wash hands with soap and water or use an alcohol-based hand rub: • Before and after contact with a patient, • After contact with respiratory secretions, and • After contact with potentially contaminated items in the patient's vicinity, including equipment and environmental surfaces
	Respiratory hygiene	Instruct staff and visitors with signs and symptoms of a respiratory infection to • Cover their mouth and nose when sneezing or coughing, • Perform hand hygiene after soiling hands with respiratory secretions, • Wear masks when tolerated, and • Maintain spatial separation from others (>3 feet) when in common waiting areas, if possible
	Gloves	Wear when contact with respiratory secretions could occur
	Gowns	Wear during procedures and activities when contact of clothing or exposed skin with respiratory secretions is anticipated
	Masks and eye protection	Wear during procedures and activities likely to generate splashes or sprays of respiratory secretions
Contact ^a	Patient placement	Place patient in a single-patient room, if possible, or cohort with other patients infected with the same organism Limit patient movement to medically necessary purposes
	Gloves and gowns	Wear upon room entry whenever contact is likely with the patient, patient's respiratory secretions, or potentially contaminated items in the patient's vicinity, including equipment and environmental surfaces
	Masks and eye protection	As per Standard Precautions
Droplet ^a	Patient placement	Place patient in a single-patient room, if possible, or cohort with other patients infected with the same organism Limit patient movement to medically necessary purposes, and patients should wear a mask and follow respiratory hygiene during transport
	Gloves, gowns, and eye protection	As per Standard Precautions
	Masks	Wear a surgical mask upon room entry if close contact (eg, <3 feet) with the patient is anticipated

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Table 1 (continued)		
Precautions	Component	Recommendation
Airborne ^a	Patient placement	Place infected patients in a single-patient airborne infection isolation room ^b Limit patient movement to medically necessary purposes, and patients should wear a mask and follow respiratory hygiene during transport
	Gloves, gowns, and eye protection	As per Standard Precautions
	Masks	Wear a fit-tested N95 respirator before room entry.

^a Contact, Droplet, and Airborne Precautions include hand hygiene and respiratory hygiene as per Standard Precautions.

^b Airborne infection isolation room consists of negative pressure relative to the surrounding area, 6 to 12 air changes per hour, and air is exhausted directly to the outside or recirculated through HEPA (high-efficiency particulate air) filtration before return.

From Siegel JD, Rhinehart E, Jackson M, et al. Health Care Infection Control Practices Advisory C. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. *Am J Infect Control* 2007;35:565–164.

laboratory and field studies.⁴⁹ However, in both the community and health care settings, large droplet and direct contact transmission predominate.⁴⁹

Prevention and Control

In addition to standard precautions, the CDC recommends implementation of droplet precautions to prevent HA influenza (see [Tables 1](#) and [2](#)).⁵⁰ Droplet precautions should continue for 7 days after illness onset or until 24 hours after the resolution of fever and respiratory symptoms, whichever is longer, but may be extended for immunocompromised or other patients who may have prolonged viral shedding.⁵⁰ Randomized controlled trials have demonstrated no significant advantage of N95 respirators over surgical masks for standard clinical care.^{51,52} The exception is during AGPs, which may generate increased amounts of infectious respiratory droplets and aerosols and increase risk of transmission to HCPs involved or in close proximity to the procedure.⁴⁷ WHO and CDC recommend the use of respirators and airborne isolation rooms when feasible during AGPs on influenza-infected patients.⁵⁰

HCP are often implicated as index cases for nosocomial outbreaks.⁵³ One study found that nearly 90% of influenza-infected HCP were asymptomatic or mildly symptomatic with no fever or cough.⁵⁴ Another recent study found that 15% of influenza-infected HCP tested positive on days they were asymptomatic, and several tested positive despite never having symptoms, further supporting data indicating the presence of asymptomatic shedding of virus.⁵⁵ On top of this, HCP often work while symptomatic for a variety of reasons.^{56,57}

Annual influenza vaccination is recommended for HCP and is a required quality reporting metric to the Centers for Medicaid Services for acute care hospitals.⁵⁸ Improved HCP vaccination coverage has been associated with decreased mortality and HA influenza rates among patients ([Fig. 1](#)).^{59–61} Condition of employment influenza vaccination policies increase HCP vaccination rates, and multiple professional societies and safety advocacy organizations have endorsed these policies ([Box 1](#)).⁶² Between 2017 and 2021, the proportion of hospitals with mandatory influenza vaccination programs increased from 61% to 74% in nonfederal hospitals and from 4% to 96% in Veterans Affairs hospitals.⁶³ Following the SARS-Co-V-2 pandemic, annual HCP

Table 2
Infection prevention recommendations for viral respiratory pathogens

Common measures for reducing transmission in the health care setting

Hand hygiene

Respiratory hygiene/cough etiquette

Standard precautions

Restrict ill visitors^a

Restrict ill personnel (prevent "presenteeism")

Cohort nursing

Prompt diagnosis of respiratory infections among patients by diagnostic tests^b

Restrict elective admissions of patients during outbreaks in the community and/or facility

Surveillance for an increase in activity of viral infections within the community

Universal source control with well-fitting masks

Measures for reducing transmission of specific pathogens in the health care setting

Intervention	RSV	Adenovirus	Parainfluenza virus/HMPV	Rhinovirus	Influenza Seasonal	Novel	Novel coronavirus
Precautions							
Contact	●	●	●	○ ^c		●	●
Droplet		●		●	●		●
Airborne					○ ^d	●	●

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Table 2 (continued)				
Eye protection			●	●
Vaccination	●	●		●
Chemoprophylaxis	○ ^e	○ ^f	○	

Closed circles (●) denote recommended measures. Open circles (○) denote measures recommended in certain circumstances.

Abbreviation: HMPV, human metapneumovirus.

^a Institutions may restrict only young children and/or screen all visitors for illness by using trained HCP to assess for signs and symptoms or by using an educational patient information list to advise ill visitors.

^b To control outbreaks, institutions may perform preadmission screening of patients for infection.

^c The addition of contact precautions is recommended for rhinovirus if copious moist secretions and close contact are likely to occur.⁸⁰

^d The CDC recommends an N95 respirator for HCP performing AGPs.

^e RSV antibodies are available for infants if their mother did not receive the vaccine and for other infants and children at high risk of severe RSV disease.⁸²

^f During a facility outbreak of influenza, administer antiviral chemoprophylaxis to all patients in the involved unit, regardless of vaccination status, and to unvaccinated HCP working in the involved unit. If feasible, administer facility-wide chemoprophylaxis for all residents in long-term care facilities. Chemoprophylaxis may also be administered to vaccinated HCP when the outbreak strain is not well matched by the vaccine.

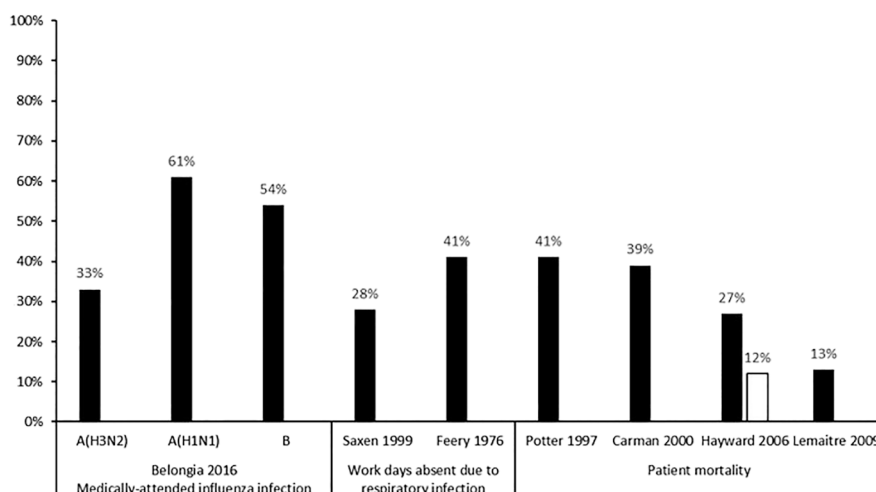


Fig. 1. Percent reduction in noted outcomes in HCP receiving influenza vaccination. All values were statistically significant ($P < .05$) compared with an unvaccinated control group. Patient mortality data from Hayward and colleagues⁹² are from 2 different seasons. A multi-variate analysis of the Lemaitre study showed that HCP vaccination was a significant independent predictor of patient mortality.⁹³ (Adapted from Talbot et al.⁵³; Talbot TR, Bradley SF, Cosgrove SE, et al. Influenza vaccination of healthcare workers and vaccine allocation for healthcare workers during vaccine shortages. *Infect Control Hosp Epidemiol.* 2005;26(11):882–890. <https://doi.org/10.1086/502512>.)

Box 1

Professional societies and safety advocacy organisms that recommend condition of employment health care personnel influenza immunization

American Academy of Family Physicians (AAFP)
 American Academy of Pediatrics (AAP)
 American College of Physicians (ACP)
 American Hospital Association (AHA)
 American Medical Directors Association (AMDA)
 American Nurses Association (ANA)
 American Pharmacists Association
 American Public Health Association (APHA)
 Association for Professionals in Infection Control and Epidemiology (APIC)
 Infectious Diseases Society of America (IDSA)
 National Association of County & City Health Officials (NACCHO)
 National Business Group on Health
 National Patient Safety Foundation (NPSF)
 Society for Healthcare Epidemiology of America (SHEA)
 Veterans Health Administration (VHA) Department of Veterans Affairs

Influenza vaccination coverage has decreased, from 90.7% in 2019 to 2020 to 81.1% in 2022 to 2023, potentially related to vaccine hesitancy issues.^{63,64}

Influenza testing is recommended on admission for all hospitalized patients with acute respiratory illness during the influenza season.⁶⁵ IDSA and the CDC recommend providing antiviral chemoprophylaxis to all exposed patients or residents in the case of long-term care facilities, regardless of vaccination status, during an institutional influenza outbreak.^{65,66} Chemoprophylaxis should be continued for 14 days or for at least 7 days after the onset of symptoms in the last person infected, whichever is longer.^{65,66} HCP chemoprophylaxis may be considered, especially for those who are unvaccinated or high risk during an institutional outbreak.⁶⁵

In addition to vaccination and antiviral chemoprophylaxis, general interventions for prevention of respiratory virus infections are recommended for influenza, as described later in the agnostic prevention section.

NOVEL PANDEMIC INFLUENZA

Over the past 125 years, there have been 4 major influenza pandemics caused by novel viruses resulting from reassortment of human influenza genes with those of avian or swine strains: 1918 to 1919 A (H1N1), 1957 to 1958 A (H2N2), 1968 to 1969 A (H3N2), and 2009 A (H1N1). Several zoonotic influenza viruses are currently being monitored for pandemic potential including avian H5 and H7 viruses.

Human infection with avian influenza (H7N9) was first reported 2013 in China, resulting in greater than 1500 cases with case fatality proportion of approximately 40%. The most recent case was reported in China in 2019.⁶⁷ Highly pathogenic avian influenza A (H5N1) virus was first reported to cause human infections in 1997 in China; however, no other human infections were reported until the virus reemerged in Hong Kong in 2003.⁶⁷ Since that time, it has caused greater than 900 infections worldwide with an approximately 50% case fatality proportion. Only 1 annual case was identified worldwide in 2019 to 2021; however, a recent outbreak in 2024 has resulted in 70 cases and 1 death in the United States to date with the large majority of cases associated with bird or cattle exposure.^{67,68}

The CDC has issued interim guidelines for infection control for patients with suspected novel influenza A H5N1 infection.⁶⁹ Avian influenza should be suspected in patients with acute respiratory illness or conjunctivitis and recent contact with potentially infected birds, livestock, or other animals within the last 10 days before symptom onset. Contact and airborne precautions with the use of eye protection should be used for patients with suspected novel influenza (see [Tables 1](#) and [2](#)).⁶⁹ Antiviral chemoprophylaxis for 5 days should also be considered for HCP with unprotected exposures, if the exposure was not ongoing.⁶⁹

RESPIRATORY SYNCYTIAL VIRUS

Epidemiology

Respiratory syncytial virus (RSV) contributes to significant disease burden in patients at extremes of age, resulting in an estimated annual rate of death greater than 100,000 deaths globally in children under the age of 5 and greater than 10,000 deaths in the United States in adults over the age of 65.⁷⁰ Health care outbreaks of RSV have been described, especially among neonates and immunocompromised patients.^{71,72} In a single-center study conducted over an influenza season, 27.3% of RSV infections were considered HA.⁷³ A recent study found similar rates of ICU admission and mechanical ventilation for HA and community-onset RSV infection, but patients with HA RSV had longer hospital stays following RSV detection and

higher proportion of deaths and were more likely to require discharge to a skilled nursing facility.⁷⁴

Transmission

Transmission of RSV occurs primarily through direct contact or by self-inoculation after touching contaminated fomites.⁷⁵ Although recent data demonstrate that aerosols up to 5 m away contain RSV particles, currently there is no evidence of clinical transmission of RSV via aerosols.⁷⁶ The incubation period for RSV is approximately 4 to 6 days, and viral shedding may begin 1 to 2 days before symptom onset.⁷⁷ Viral shedding may continue for 1 to 2 weeks with symptomatic infections especially in young children and patients with compromised immune systems having more prolonged shedding.^{77,78} RSV-infected HCP are often symptomatic, but asymptomatic shedding of RSV occurs in 15% to 20%, putting patients at risk for nosocomial transmission.⁷⁹

Prevention and Control

In addition to standard precautions, the CDC recommends contact precautions to prevent HA RSV (see [Tables 1](#) and [2](#)).⁸⁰ These should continue for the duration of illness but may be extended for immunocompromised patients owing to prolonged viral shedding. Eye protection may further reduce transmission given the importance of the eye as a portal of entry. The first vaccine for prevention of RSV was approved by the FDA in 2023.⁸¹ As of July 2025, there are 3 RSV vaccines available in the United States, and they are recommended for all adults aged 75 years and older and for those ages 50 to 74 with increased risk for severe RSV.⁷⁷ There is also a vaccine available for pregnant women, and there are RSV antibodies that can be given to infants after birth if their mother did not receive the vaccine or other infants and children at high risk of severe RSV disease, as recommended by the American Academy of Pediatrics.^{77,82}

OTHER RESPIRATORY VIRUSES

Adenovirus

HA outbreaks of adenovirus have been reported from various settings with high secondary attack rates among patients and HCP, especially when appropriate transmission-based precautions are not used.^{83,84} Adenoviruses are transmitted through large respiratory droplets and self-inoculation after contact with contaminated fomites. In addition to standard precautions, the CDC recommends contact and droplet precautions to prevent HA adenovirus infection (see [Tables 1](#) and [2](#)).⁸⁰

Parainfluenza Virus

Parainfluenza can cause severe respiratory illnesses, especially in patients at extremes of age and with immune compromise. A tertiary care hospital monitored nosocomial parainfluenza infections over 7 respiratory virus seasons and found that 24.3% of parainfluenza infections detected were HA.⁸⁵ These cases tended to occur in patients who were elderly or had underlying malignancy or immunosuppression. Transmission of parainfluenza primarily occurs by direct person-to-person contact. The CDC recommends contact in addition to standard precautions for the prevention of HA parainfluenza infection (see [Tables 1](#) and [2](#)).⁸⁰

Rhinovirus

Among studies with broad molecular respiratory virus identification, rhinoviruses are typically the most common HA respiratory viral infection among both children and adults.^{1,2,18} Nosocomial rhinovirus infections have been linked with increased need for respiratory support and longer lengths of stay in high-risk neonates and deaths

in long-term care facilities.^{86,87} Rhinovirus is transmitted by contact with large respiratory droplets. The CDC recommends droplet precautions for the prevention of HA rhinovirus infection, with the addition of contact precautions if copious moist secretions and close contact are likely to occur (see [Tables 1](#) and [2](#)).⁸⁰

Human Metapneumovirus

Nosocomial outbreaks of human metapneumovirus have been described in various settings particularly affecting children, the elderly, and those immune compromised.^{88,89} Human metapneumovirus is presumed to transmit via direct contact and contaminated fomites owing to its close relation to RSV and data regarding its survival on surfaces.^{80,90} The CDC recommends contact precautions for the prevention of HA human metapneumovirus infection (see [Tables 1](#) and [2](#)).⁸⁰

GENERAL GUIDANCE FOR PATIENTS WITH SUSPECTED OR CONFIRMED RESPIRATORY VIRAL INFECTIONS

Empiric Precautions

Empiric transmission-based precautions are recommended for patients presenting to the health care setting with suspected respiratory viral infection. If SARS-CoV-2 is suspected, HCP should use empiric airborne and contact precautions with eye protection, until SARS-CoV-2 is ruled out. For other respiratory viral infections, the CDC recommends empiric contact plus droplet precautions until viruses specifically requiring droplet precautions can be ruled out.^{34,80} Empiric treatment with influenza antiviral medications is also recommended for any patient with suspected or confirmed influenza infection who is hospitalized, has severe illness, or is at high risk of complications.⁶⁵

Diagnostic Testing

Diagnosing a respiratory virus infection has implications for infection prevention, as described above, but can also support clinical treatment and may improve antibiotic stewardship. In addition to virus-specific guidance previously discussed for SARS-CoV-2 and influenza, IDSA recommends respiratory virus panel testing of immunocompromised patients who are hospitalized and advises that panel testing can be used more broadly in hospitalized patients if it might influence clinical care or infection prevention.⁶⁵ The diagnostic landscape continues to rapidly evolve, and more research is needed on testing best practices, clinical interpretation, and cost-effectiveness.⁹¹

Other Methods in Infection Prevention

The following are general infection prevention strategies and tools that health care facilities may consider using to reduce HA transmission of respiratory viruses, especially during times of increased transmission in the community. Many of these strategies were used during the COVID-19 pandemic, lessons from which could be considered in general for use during nonpandemic respiratory virus seasons.

- Source control (ie, masking), with consideration for expanded mask mandates during periods of high community transmission
- Excellent adherence to hand hygiene and other basic infection prevention principles
- Cohorting of patients and HCP
- Reduction of presenteeism (ie, exclusion of ill HCP through comprehensive sick leave policies)

- Robust entry screening for visitors and limiting visitation during times of high community transmission
- Early diagnostic testing of symptomatic patients
- Telehealth strategies to reduce in-person medical visits when possible

SUMMARY

Transmission of respiratory viruses occurs in a variety of health care settings, resulting in increased patient morbidity and health care costs. Different viruses have different modes of transmission, and prevention of transmission requires early recognition of symptomatic patients and prompt institution of appropriate transmission-based precautions, in addition to adherence to basic infection control practices, such as hand hygiene. In addition to administrative and environmental controls, vaccination of HCP is a priority for prevention of HA SARS-CoV-2 and influenza infection.

CLINICS CARE POINTS

- Asymptomatic transmission is possible for many respiratory viruses, highlighting the importance of foundational infection prevention practices, such as standard precautions and hand hygiene.
- Influenza-infected patients should be placed on airborne precautions when undergoing AGPs.
- Vaccines are available to prevent severe infection with influenza, SARS-CoV-2, and respiratory syncytial virus.
- Annual influenza vaccination is recommended for all health care providers and has been associated with decreased mortality and HA influenza rates among patients.
- Empiric transmission-based precautions are recommended for all patients presenting with suspected respiratory virus infection with adjustments to precautions directed by diagnostic testing.
- Facility-directed broader infection prevention strategies (ie, universal masking, cohorting, entry screening, and use of telehealth strategies) should be guided by facility and community-based transmission rates.

DISCLOSURE

M.M. Lee has no disclosures. T.R. Talbot has the following disclosure: serves on the Board of Directors for OmniSolve.

REFERENCES

1. Choi HS, Kim MN, Sung H, et al. Laboratory-based surveillance of hospital-acquired respiratory virus infection in a tertiary care hospital. *Am J Infect Control* 2017;45(5):e45–7.
2. Chow EJ, Mermel LA. Hospital-Acquired respiratory viral infections: incidence, morbidity, and mortality in pediatric and adult patients. *Open Forum Infect Dis* 2017;4(1). <https://doi.org/10.1093/ofid/ofx006>.
3. Global Technical Consultation Report on Proposed Terminology for Pathogens That Transmit through the Air. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO.
4. Human Coronavirus Types | CDC. 2021. Available at: https://archive.cdc.gov/www_cdc_gov/coronavirus/types.html. Accessed September 21, 2025.

5. COVID-19 deaths | WHO COVID-19 dashboard. datadot. Available at: <https://data.who.int/dashboards/covid19/cases>. Accessed September 21, 2025.
6. Drewett GP, Suleiman M, Gust A, et al. Hospital-acquired COVID-19 is associated with increased length and cost of stay in an Australian health care setting. *Am J Infect Control* 2025;53(9):1001–3.
7. Duffaydar H, Beaumont A, Pham MC, et al. COVID-19: a retrospective cohort study of nosocomial transmission in a district general hospital. *Cureus* 2022;14(11):e31245. <https://doi.org/10.7759/cureus.31245>.
8. Shiwani HA, Bilal M, Shahzad MU, et al. A comparison of characteristics and outcomes of patients with community-acquired and hospital-acquired COVID-19 in the United Kingdom: an observational study. *Respir Med* 2021;178:106314. <https://doi.org/10.1016/j.rmed.2021.106314>.
9. Rickman HM, Rampling T, Shaw K, et al. Nosocomial transmission of coronavirus disease 2019: a retrospective Study of 66 hospital-acquired cases in a London teaching Hospital. *Clin Infect Dis* 2021;72(4):690–3.
10. Helanne H, Forsblom E, Kainulainen K, et al. Incidence and outcome of hospital-acquired COVID-19 infections in secondary and tertiary care hospitals in the era of COVID-19 vaccinations. *Antimicrob Steward Healthc Epidemiol ASHE* 2023; 3(1):e216. <https://doi.org/10.1017/ash.2023.489>.
11. Goh KT, Cutter J, Heng BH, et al. Epidemiology and control of SARS in Singapore. *Ann Acad Med Singapore* 2006;35(5):301–16.
12. Varia M, Wilson S, Sarwal S, et al. Investigation of a nosocomial outbreak of severe acute respiratory syndrome (SARS) in Toronto, Canada. *CMAJ Can Med Assoc J* 2003;169(4):285–92.
13. Zaki AM, van Boheemen S, Bestebroer TM, et al. Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. *N Engl J Med* 2012;367(19):1814–20.
14. WHO EMRO - MERS outbreaks. Available at: <https://www.emro.who.int/health-topics/mers-cov/mers-outbreaks.html>. Accessed November 23, 2025.
15. Hui DS, Azhar EI, Kim YJ, et al. Middle East respiratory syndrome coronavirus: risk factors and determinants of primary, household, and nosocomial transmission. *Lancet Infect Dis* 2018;18(8):e217–27.
16. WHO EMRO - MERS situation update. 2019. Available at: <https://www.emro.who.int/pandemic-epidemic-diseases/mers-cov/mers-situation-update-february-2019.html>. Accessed September 21, 2025.
17. Gagneur A, Vallet S, Talbot PJ, et al. Outbreaks of human coronavirus in a pediatric and neonatal intensive care unit. *Eur J Pediatr* 2008;167(12):1427–34.
18. Petrie JG, Lauring AS, Martin ET, et al. Hospital associated respiratory virus infection in children and adults: it does not just occur during cold and flu season. *Open Forum Infect Dis* 2020;7(6). <https://doi.org/10.1093/ofid/ofaa200>.
19. Lauer SA, Grantz KH, Bi Q, et al. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Ann Intern Med* 2020;172(9):577–82. <https://doi.org/10.7326/M20-0504>.
20. Song JS, Lee J, Kim M, et al. Serial intervals and household transmission of SARS-CoV-2 omicron variant, South Korea, 2021. *Emerg Infect Dis* 2022;28(3):756–9.
21. Ma Q, Liu J, Liu Q, et al. Global percentage of asymptomatic SARS-CoV-2 infections among the tested population and individuals with confirmed COVID-19 diagnosis: a systematic review and meta-analysis. *JAMA Netw Open* 2021;4(12):e2137257. <https://doi.org/10.1001/jamanetworkopen.2021.37257>.

22. Oordt-Speets AM, Spinardi JR, Mendoza CF, et al. Duration of SARS-CoV-2 shedding: a systematic review. *J Glob Health* 2024;14:05005. <https://doi.org/10.7189/jogh.14.05005>.
23. Puhach O, Meyer B, Eckerle I. SARS-CoV-2 viral load and shedding kinetics. *Nat Rev Microbiol* 2023;21(3):147–61. <https://doi.org/10.1038/s41579-022-00822-w>.
24. Tabatabaei SN, Keykhaee Z, Nooraei S, et al. SARS-CoV-2 and coronaviruses: understanding transmission, impact, and strategies for prevention and treatment. *Drugs Drug Candidates* 2025;4(1):5.
25. CDC. About COVID-19. COVID-19. 2025. Available at: <https://www.cdc.gov/covid/about/index.html>. Accessed September 21, 2025.
26. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med* 2020;382(16):1564–7.
27. Bourouiba L. Turbulent gas clouds and respiratory pathogen emissions: potential implications for reducing transmission of COVID-19. *JAMA* 2020;323(18):1837–8.
28. Pasnick S, Carlos WG, Dela Cruz CS, et al. SARS-CoV-2 transmission and the risk of aerosol-generating procedures. *Am J Respir Crit Care Med* 2020;202(4):P13–4.
29. Brown J, Gregson FKA, Shrimpton A, et al. A quantitative evaluation of aerosol generation during tracheal intubation and extubation. *Anaesthesia* 2021;76(2):174–81.
30. Assiri A, McGeer A, Perl TM, et al. Hospital outbreak of Middle East respiratory syndrome coronavirus. *N Engl J Med* 2013;369(5):407–16.
31. Otter JA, Donskey C, Yezli S, et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *J Hosp Infect* 2016;92(3):235–50.
32. Diseases ACOI. Red Book (2018). In: Kimberlin DW, Brady MT, Jackson MA, editors. Report of the committee on infectious diseases. 31st edition. American Academy of Pediatrics; 2018. <https://doi.org/10.1542/9781610021470>.
33. Cummings DAT, Radonovich LJ, Gorse GJ, et al. Risk factors for healthcare personnel infection with endemic coronaviruses (HKU1, OC43, NL63, 229E): results from the respiratory Protection effectiveness clinical trial (ResPECT). *Clin Infect Dis* 2021;73(11):e4428–32. <https://doi.org/10.1093/cid/ciaa900>.
34. CDC. Infection control guidance: SARS-CoV-2. COVID-19. 2025. Available at: <https://www.cdc.gov/covid/hcp/infection-control/index.html>. Accessed September 22, 2025.
35. Hanson KE, Caliendo AM, Arias CA, et al. The infectious Diseases Society of America Guidelines on the diagnosis of COVID-19: molecular diagnostic testing. *Clin Infect Dis* 2021;ciab048. <https://doi.org/10.1093/cid/ciab048>.
36. Talbot TR, Hayden MK, Yokoe DS, et al. Asymptomatic screening for severe acute respiratory coronavirus virus 2 (SARS-CoV-2) as an infection prevention measure in healthcare facilities: challenges and considerations. *Infect Control Hosp Epidemiol* 2023;44(1):2–7.
37. SHEA. Pre-Procedure and pre-admission COVID-19 testing No longer recommended for asymptomatic patients – SHEA. Available at: <https://shea-online.org/pre-procedure-and-pre-admission-covid-19-testing-no-longer-recommended-for-asymptomatic-patients/>. Accessed September 22, 2025.
38. Goldman E. SARS wars: the fomites strike back. Elkins CA. *Appl Environ Microbiol* 2021;87(13). <https://doi.org/10.1128/AEM.00653-21>. e00653-21.
39. Rabin AS, Marr LC, Blumberg HM. Doff Thy Gown—Shedding contact precautions for COVID-19. *Clin Infect Dis* 2024;79(3):585–7.

40. Stern RA, Bashaw K, Shackelford CE, et al. The unintended burden of transmission-based precautions for suspected COVID-19 in the ambulatory setting. *Infect Control Hosp Epidemiol* 2025;1–3. <https://doi.org/10.1017/ice.2025.10229>.
41. Commissioner O of the. Coronavirus Disease 2019 (COVID-19). FDA. 2025. Available at: <https://www.fda.gov/emergency-preparedness-and-response/public-health-preparedness-and-response/coronavirus-disease-2019-covid-19>. Accessed October 7, 2025.
42. Rolfes MA, Foppa IM, Garg S, et al. Annual estimates of the burden of seasonal influenza in the United States: a tool for strengthening influenza surveillance and preparedness. *Influenza Other Respir Viruses* 2018;12(1):132–7.
43. CDC. Flu disease burden: past seasons. Flu Burden 2025. Available at: <https://www.cdc.gov/flu-burden/php/data-vis/past-seasons.html>. Accessed November 23, 2025.
44. Cummings CN, O'Halloran AC, Azenkot T, et al. Hospital-acquired influenza in the United States, FluSurv-NET, 2011–2012 through 2018–2019. *Infect Control Hosp Epidemiol* 2022;43(10):1447–53.
45. Mangas-Moro A, Zamarrón-de-Lucas E, Carpio-Segura CJ, et al. Impact and characteristics of hospital-acquired influenza over 10 seasons in a third-level university hospital. *Enfermedades Infecc Microbiol Clin Engl Ed* 2023;41(7):391–5.
46. El Guerche-Séblain C, Amour S, Bénet T, et al. Incidence of hospital-acquired influenza in adults: a prospective surveillance study from 2004 to 2017 in a French tertiary care hospital. *Am J Infect Control* 2021;49(8):1066–71.
47. Paules C, Subbarao K. Influenza. *Lancet* 2017;390(10095):697–708.
48. Ip DKM, Lau LLH, Chan KH, et al. The dynamic relationship between clinical symptomatology and viral shedding in naturally acquired seasonal and pandemic influenza virus infections. *Clin Infect Dis* 2016;62(4):431–7.
49. Brankston G, Gitterman L, Hirji Z, et al. Transmission of influenza A in human beings. *Lancet Infect Dis* 2007;7(4):257–65.
50. CDC. Infection prevention and control strategies for seasonal influenza in health-care settings. Influenza (Flu) 2025. Available at: <https://www.cdc.gov/flu/hcp/infection-control/healthcare-settings.html>. Accessed October 28, 2025.
51. Radonovich LJ, Simberkoff MS, Bessesen MT, et al. N95 respirators vs medical masks for preventing influenza among health care personnel: a randomized clinical trial. *JAMA* 2019;322(9):824–33.
52. Loeb M, Dafoe N, Mahony J, et al. Surgical mask vs N95 respirator for preventing influenza among health care workers: a randomized trial. *JAMA* 2009;302(17):1865–71.
53. Talbot TR, Bradley SF, Cosgrove SE, et al. Influenza vaccination of healthcare workers and vaccine allocation for healthcare workers during vaccine shortages. *Infect Control Hosp Epidemiol* 2005;26(11):882–90.
54. Bénet T, Amour S, Valette M, et al, AFP Study Group. Incidence of Asymptomatic and Symptomatic Influenza Among Healthcare Workers: A Multicenter Prospective Cohort Study. *Clin Infect Dis* 2021;72(9):e311–8. <https://doi.org/10.1093/cid/ciaa1109>.
55. Tamò R, Turk T, Böni J, et al. Secondary attack rates from asymptomatic and symptomatic influenza virus shedders in hospitals: results from the TransFLUas influenza transmission study. *Infect Control Hosp Epidemiol* 2022;43(3):312–8.
56. Chow EJ, Mermel LA. More than a cold: Hospital-Acquired respiratory viral infections, sick leave Policy, and A need for culture change. *Infect Control Hosp Epidemiol* 2018;39(7):861–2.

57. Jiang L, McGeer A, McNeil S, et al. Which healthcare workers work with acute respiratory illness? Evidence from Canadian acute-care hospitals during 4 influenza seasons: 2010-2011 to 2013-2014. *Infect Control Hosp Epidemiol* 2019;40(8): 889-96.
58. Advisory Committee on Immunization Practices, Centers for Disease Control and Prevention (CDC). Immunization of health-care personnel: recommendations of the Advisory Committee on immunization Practices (ACIP). *MMWR Recomm Rep Morb Mortal Wkly Rep Recomm Rep* 2011;60(RR-7):1-45.
59. Ahmed F, Lindley MC, Allred N, et al. Effect of influenza vaccination of healthcare personnel on morbidity and mortality among patients: systematic review and grading of evidence. *Clin Infect Dis* 2014;58(1):50-7.
60. Amour S, Bénet T, Regis C, et al. Effect of influenza vaccination among healthcare workers on hospital-acquired influenza in short-stay hospitalized patients: a multi-center pilot study in France. *Infect Control Hosp Epidemiol* 2022;43(12):1828-32.
61. Osorio-López EA, Rivera-Buendía F, Nevárez-Luján J, et al. Nosocomial influenza in patients with cancer before the coronavirus disease 2019 (COVID-19) era and one year after the pandemic: can we do any better in hospitals? *Infect Control Hosp Epidemiol* 2022;43(11):1723-5.
62. Wang TL, Jing L, Bocchini JA. Mandatory influenza vaccination for all healthcare personnel: a review on justification, implementation and effectiveness. *Curr Opin Pediatr* 2017;29(5):606-15.
63. Greene MT, Fowler KE, Ratz D, et al. Changes in influenza vaccination requirements for health care personnel in US hospitals. *JAMA Netw Open* 2018;1(2): e180143. <https://doi.org/10.1001/jamanetworkopen.2018.0143>.
64. Lymon H, Meng L, Reses HE, et al. Declines in influenza vaccination coverage among health care personnel in acute care hospitals during the COVID-19 pandemic — united States, 2017-2023. *MMWR Morb Mortal Wkly Rep* 2023;72(45):1244-7.
65. Uyeki TM, Bernstein HH, Bradley JS, et al. Clinical Practice Guidelines by the infectious diseases Society of America: 2018 update on diagnosis, treatment, chemoprophylaxis, and institutional outbreak management of seasonal influenza. *Clin Infect Dis* 2019;68(6):e1-47.
66. CDC. Influenza Antiviral Medications: summary for clinicians. Influenza (Flu); 2025. Available at: <https://www.cdc.gov/flu/hcp/antivirals/summary-clinicians.html>. Accessed November 13, 2025.
67. CDC. Reported human infections with Avian influenza A viruses. Avian Influenza (Bird Flu) 2025. Available at: <https://www.cdc.gov/bird-flu/php/surveillance/reported-human-infections.html>. Accessed November 13, 2025.
68. CDC. Global human cases with influenza A(H5N1), 1997-2025. Avian influenza (bird flu). 2025. Available at: <https://www.cdc.gov/bird-flu/php/surveillance/chart-epi-curve-ah5n1.html>. Accessed November 13, 2025.
69. CDC. Highly pathogenic Avian Influenza A(H5N1) virus: interim recommendations for prevention, monitoring, and public health investigations. Avian Influenza (Bird Flu) 2025. Available at: <https://www.cdc.gov/bird-flu/prevention/hpai-interim-recommendations.html>. Accessed November 13, 2025.
70. Respiratory syncytial virus (RSV). Available at: [https://www.who.int/news-room/fact-sheets/detail/respiratory-syncytial-virus-\(rsv\)](https://www.who.int/news-room/fact-sheets/detail/respiratory-syncytial-virus-(rsv)). Accessed November 13, 2025.
71. Kelly SG, Metzger K, Bolon MK, et al. Respiratory syncytial virus outbreak on an adult stem cell transplant unit. *Am J Infect Control* 2016;44(9):1022-6.

72. Mosalli R, Alqarni SA, Khayyat WW, et al. Respiratory syncytial virus nosocomial outbreak in neonatal intensive care: a review of the incidence, management, and outcomes. *Am J Infect Control* 2022;50(7):801–8.
73. Kestler M, Muñoz P, Mateos M, et al. Respiratory syncytial virus burden among adults during flu season: an underestimated pathology. *J Hosp Infect* 2018; 100(4):463–8.
74. Hill-Ricciuti A, Walsh EE, Greendyke WG, et al. Clinical impact of healthcare-associated respiratory syncytial virus in hospitalized adults. *Infect Control Hosp Epidemiol* 2023;44(3):433–9.
75. Hall CB, Douglas RG. Modes of transmission of respiratory syncytial virus. *J Pediatr* 1981;99(1):100–3.
76. Kulkarni H, Smith CM, Lee DDH, et al. Evidence of respiratory syncytial virus spread by aerosol. Time to revisit infection control strategies? *Am J Respir Crit Care Med* 2016;194(3):308–16.
77. CDC. Respiratory Syncytial Virus (RSV). Respiratory syncytial virus infection (RSV). 2025. Available at: <https://www.cdc.gov/rsv/index.html>. Accessed November 13, 2025.
78. Munywoki PK, Koech DC, Agoti CN, et al. Influence of age, severity of infection, and co-infection on the duration of respiratory syncytial virus (RSV) shedding. *Epidemiol Infect* 2015;143(4):804–12.
79. Weinstein RA, Hall CB. Nosocomial respiratory syncytial virus infections: the “Cold War” has not ended. *Clin Infect Dis* 2000;31(2):590–6.
80. Siegel JD, Rhinehart E, Jackson M, et al. Health care infection control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. *Am J Infect Control* 2007; 35(10, Supplement 2):S65–164.
81. Commissioner O of the. FDA approves first Respiratory Syncytial Virus (RSV) vaccine. FDA. 2024. Available at: <https://www.fda.gov/news-events/press-announcements/fda-approves-first-respiratory-syncytial-virus-rsv-vaccine>. Accessed November 13, 2025.
82. Committee on Infectious Diseases. Recommendations for the prevention of RSV disease in infants and children: policy statement. *Pediatrics* 2025;156(5):e2025073923. <https://doi.org/10.1542/peds.2025-073923>.
83. James L, Vernon MO, Jones RC, et al. Outbreak of Human Adenovirus type 3 infection in a pediatric long-term care Facility—Illinois, 2005. *Clin Infect Dis* 2007;45(4): 416–20.
84. Lessa FC, Gould PL, Pascoe N, et al. Health care transmission of a newly emergent adenovirus serotype in health care personnel at a military Hospital in Texas, 2007. *J Infect Dis* 2009;200(11):1759–65.
85. Martin D, Hönemann M, Liebert UG. Dynamics of nosocomial parainfluenza virus type 3 and influenza virus infections at a large German University Hospital between 2012 and 2019. *Diagn Microbiol Infect Dis* 2021;99(3):115244. <https://doi.org/10.1016/j.diagmicrobio.2020.115244>.
86. Zinna S, Lakshmanan A, Tan S, et al. Outcomes of nosocomial viral respiratory infections in high-risk neonates. *Pediatrics* 2016;138(5):e20161675. <https://doi.org/10.1542/peds.2016-1675>.
87. Louie JK, Yagi S, Nelson FA, et al. Rhinovirus outbreak in a long term care facility for elderly persons associated with unusually high mortality. *Clin Infect Dis* 2005; 41(2):262–5.

88. Liao RS, Appelgate DM, Pelz RK. An outbreak of severe respiratory tract infection due to human metapneumovirus in a long-term care facility for the elderly in Oregon. *J Clin Virol* 2012;53(2):171–3.
89. Kim S, Sung H, Im HJ, et al. Molecular epidemiological investigation of a nosocomial outbreak of human metapneumovirus infection in a pediatric hemato-oncology patient population. *J Clin Microbiol* 2009;47(4):1221–4.
90. Kutter JS, Spronken MI, Fraaij PL, et al. Transmission routes of respiratory viruses among humans. *Curr Opin Virol* 2018;28:142–51.
91. Hanson KE, Azar MM, Banerjee R, et al, America (IDSA) for the DC of the IDS. Molecular testing for acute respiratory tract infections: clinical and diagnostic recommendations from the IDSA's Diagnostics Committee. *Clin Infect Dis* 2020;71(10):2744–51.
92. Hayward AC, Harling R, Wetten S, et al. Effectiveness of an influenza vaccine programme for care home staff to prevent death, morbidity, and health service use among residents: cluster randomised controlled trial. *BMJ* 2006;333(7581):1241.
93. Lemaitre M, Meret T, RothanTondeur M, et al. Effect of influenza vaccination of nursing home staff on mortality of residents: a cluster-randomized trial. *J Am Geriatr Soc* 2009;57(9):1580–6.