Community Mitigation Guidelines to Prevent Pandemic Influenza – United States, 2017

Technical Report 2: Supplemental Appendices 1-7

The boxes, figures, and tables referred to in these appendices are in the affiliated MMWR RR report.

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Appendix 1. Glossary of Terms

The definitions for the terms in this glossary originate from the 2007 *Community Strategy*, CDC glossaries (https://www.cdc.gov/ophss/csels/dsepd/ss1978/glossary.html; https://www.cdc.gov/flu/glossary/index.htm; https://www.cdc.gov/az/a.html), and on-line medical sources (e.g., http://www.healthline.com).

Absenteeism rate: Proportion of employed persons absent from work at a given point in time or over a defined period of time.

Acute respiratory illness or infection: A serious infection that prevents normal breathing function. It usually begins as a viral infection in the nose, trachea (windpipe), or lungs and, in some instances, it can spread to the entire respiratory system.

Antiviral medications: Medications presumed to be effective against potential pandemic influenza virus strains, and which may prove useful for treatment of influenza-infected persons or for prophylactic treatment of persons exposed to influenza to prevent them from becoming ill. Antiviral medications include the neuraminidase inhibitors oseltamivir (Tamiflu®) and zanamivir (Relenza®).

Attack rate: A form of incidence that measures the proportion of persons in a population who experience an acute health event during a limited period (e.g., during an outbreak). It is calculated as the number of new cases of a health problem during an outbreak divided by the size of the population at the beginning of the period, usually expressed as a percentage or per 1,000 or 100,000 population.

Attack rate, secondary: A measure of the frequency of new cases of a disease among the contacts of known patients.

Case-fatality rate: Proportion of persons with a particular condition (e.g., patients) who die from that condition. The numerator is the number of cause-specific deaths among those persons. The denominator is the number of persons with the condition.

Case-hospitalization ratio: Proportion of persons with a particular condition (e.g., patients) who need to be hospitalized due to that condition. The numerator is the number of cause-specific hospitalizations among those persons. The denominator is the number of persons with the condition.

Childcare programs: Childcare programs discussed in this report include: 1) centers or facilities that provide care to any number of children in a non-residential setting; 2) large family childcare homes that provide care for seven or more children in the home of the provider; and 3) small family childcare homes that provide care to six or fewer children in the home of the provider.

Children: In this report, children are defined as 17 years of age or younger unless an age is specified or 12 years of age or younger if teenagers are specified.

Cleaning: The process of removing germs, dirt, and impurities from surfaces or objects by using soap or detergent and water. This process does not necessarily kill germs, but by removing them, it lowers their number and the risk of spreading infection.

Clinical severity: The degree of illness and risk of disease manifested by patients.

Community mitigation strategy: A strategy for the implementation at the community level of interventions designed to slow or limit the transmission of a pandemic virus.

Contact rate: Rate at which an infected individual infects a susceptible individual.

Contaminate: To make something impure or unclean by putting it in contact with something harmful.

Control group: In a case-control study, the group of persons without the health problem under study.

Critical infrastructure: Systems and assets, whether physical or virtual, so vital to the United States that the incapacitation or destruction of such systems and assets would have a debilitating impact on national security, economy, or public health and/or safety, either alone or in any combination. Specifically, it refers to the critical infrastructure sectors identified in Homeland Security Presidential Directive-7 (HSPD-7).

Disinfection: The process of killing germs on surfaces or objects by using chemicals. This process does not necessarily clean dirty surfaces or remove germs, but by killing germs on a surface after cleaning, it can further lower the risk of spreading infection.

Drug resistance: A decrease in the effectiveness of a drug due to a bacteria, virus, or fungus able to grow in the presence of a drug that would normally kill them or limit their growth.

Early, targeted, and layered nonpharmaceutical interventions (NPIs) strategy: A strategy for initiating NPIs *early* in a pandemic before local epidemics demonstrate exponential growth; *targeting* NPIs toward those at the nexus of transmission (in affected areas where the novel virus circulates); and *layering* NPIs together to reduce community transmission to the greatest extent possible.

Emulsifier: A substance that stabilizes a fine dispersion of minute droplets of one liquid in another in which it is not soluble.

Environmental surface cleaning measures: Interventions that remove viruses, bacteria, or microorganisms from frequently touched surfaces and objects in homes, schools, or workplaces.

Evidence base: The available body of data, facts, or information about the effectiveness of NPIs.

Facemask: Disposable surgical or procedure mask covering the nose and mouth of the wearer and designed to prevent the transmission of large respiratory droplets or particles that may contain infectious material. Disposable facemasks come in two basic types. The first type is affixed to the head with two ties and typically has a flexible adjustment for the nose bridge. This type of mask may be flat/pleated or duck-billed in shape. The second type is pre-molded or cup-shaped, adheres to the head with a single elastic strap, and usually has a flexible adjustment for the nose bridge.

Faith-based organization (FBO): Any organization that has a faith-inspired interest.

Fomite transmission: Transmission of infectious diseases by objects (also known as indirect transmission).

Hand hygiene: Hand washing with either plain soap or antimicrobial soap and water, or use of alcohol-based products (gels, rinses, foams containing an emollient) that do not require the use of water.

High-risk: A group of persons whose risk for a particular disease, injury, or other health condition (e.g., influenza) is greater than that of the rest of their community or population (e.g., children younger than 5 years of age, adults 65 years of age and older, pregnant women).

Hospitalization-fatality ratio: Proportion of persons hospitalized with a particular condition (e.g., patients) who died due to that condition. The numerator is the number of cause-specific deaths among those persons. The denominator is the number of persons hospitalized with the condition.

Incubation period: The time interval from exposure to an infectious agent to the onset of symptoms of an infectious disease.

Infection control: Hygiene and protective measures to reduce the risk of transmission of an infectious agent from an infected person to uninfected persons (e.g., respiratory etiquette, hand hygiene, use of personal protective equipment such as facemasks, and disinfection).

Infectious: Communicable or able to spread in the community; capable of causing infection from one person to another or from one part of the body to another.

Infectious disease: A virus, bacteria, or microorganism that is capable of being passed from one person to another.

Influenza pandemic: When a novel virus emerges for which a majority of the population has little or no immunity. Influenza pandemics are facilitated by sustained human-to-human transmission, and global spread follows over a relatively short period of time.

Influenza-related complications: Serious health problems or adverse events that are a direct result of having pandemic influenza (e.g., pneumonia, bronchitis, sinus infections).

Initial assessment: An element of the Pandemic Severity Assessment Framework (PSAF). Using multiple PSAF measures, an initial assessment of the transmissibility, clinical severity, and potential impact of an emerging pandemic will be prepared.

Isolation of ill people: Separation of infected persons to prevent transmission to susceptible ones, or separation of sick people with a contagious disease from people who are not sick.

Institutions of higher education: Post-high school educational institutions (i.e., colleges and universities providing education beyond the 12^{th} grade).

Intervention fatigue: The state of being very tired from efforts to promote behaviors that optimize mental and physical health or discourage or reframe behaviors considered potentially health-averse.

Jurisdiction: The power or right to govern an area.

Mass gathering: A public event where a large number of people are gathered for a set amount of time.

Medical countermeasures: Refers to pre-pandemic and pandemic influenza vaccines and antiviral medications.

Modeling: Method of simulating real-life situations with mathematical equations to forecast their future behavior.

Mortality rate: A measure of the frequency of occurrence of death among a defined population during a specified time interval.

Nasal or oral mucosa: The mucous membrane of the nasal cavity, or cavity of the mouth, including the gums.

Nonpharmaceutical intervention (NPI): Mitigation measure implemented to reduce the spread of an infectious disease (e.g., pandemic influenza) but one that does not include pharmaceutical products, such as vaccines and medicines. Examples include social distancing and community infection control measures.

Pandemic Severity Assessment Framework (PSAF): A new assessment framework that uses multiple clinical and epidemiologic indicators to create a comprehensive picture of the potential impact of an emerging pandemic.

Pandemic vaccine: Vaccine for a specific influenza virus strain that has the capacity for sustained and efficient human-to-human transmission. This vaccine can only be developed once the pandemic strain emerges.

Personal protective equipment (PPE): PPE is any type of clothing, equipment, or respiratory protection device (respirators) used to protect workers against hazards they encounter while doing their jobs. PPE can include protection for eyes, face, head, torso, and extremities. Gowns, face shields, gloves, face-masks, and respirators are examples of PPE commonly used in healthcare facilities. When PPE is used in a workplace setting to protect workers against workplace hazards, its use must be consistent with regulations issued by the Occupational Safety and Health Administration (https://www.osha.gov/).

Pre-pandemic vaccine: Vaccine against strains of influenza virus in animals that have caused isolated infections in humans and which may have pandemic potential. This vaccine is prepared prior to the emergence of a pandemic strain and may be a good or poor match (and hence of greater or lesser protection) for the pandemic strain that ultimately emerges.

Prophylaxis: Prevention of disease or of a process that can lead to disease. For pandemic influenza, this specifically refers to the administration of antiviral medications to healthy individuals for the prevention of influenza.

Quarantine: The separation of well persons who have been exposed, or are suspected to have been exposed, to a communicable disease to monitor for illness and to prevent potential transmission of infection to susceptible persons during the incubation period. Quarantine may be applied voluntarily (preferred) or on a compulsory basis, dependent on legal authority.

Rapid diagnostic test: Medical test for rapidly confirming the presence of infection with a specific influenza strain.

Reassortant: Viruses containing two or more pieces of nucleic acid (segmented genome) from different parents. Such viruses are produced in cells co-infected with different strains of a given virus.

Refined assessment: An element of the Pandemic Severity Assessment Framework (PSAF). Once additional data are available, a refined and more robust assessment of pandemic severity will be prepared based on PSAF scores that use clinical and epidemiologic measures.

Reproductive number (R_0): Average number of infections resulting from a single case in a fully susceptible population without interventions.

Resilience of communities or individuals: Measure of the sustained ability of a community or individuals to utilize available resources to respond to, withstand, and recover from adverse situations.

Respiratory etiquette: Covering the mouth and nose while coughing or sneezing; using tissues and disposing in no-touch receptacles; and washing of hands often to avoid spreading an infection to others.

Risk: The probability that an event will occur (e.g., that a person will be affected by, or die from, an illness, injury, or other health condition within a specified time or age span).

Schools (K-12): Refers to public and private schools spanning the grades kindergarten through 12th grade (elementary through high school).

School closure or dismissal: The act or process of closing a school or blocking access to a school.

Seasonal influenza: Influenza virus infections in familiar annual patterns.

Second- and third-order consequences, effects, or impacts: Chains of effects that may arise as a consequence of an intervention and which may require additional planning and interventions to mitigate. These terms generally refer to foreseeable unintended consequences of an intervention. For example, dismissal of students from schools may lead to workplace absenteeism related to child-minding responsibilities. Subsequent workplace closings due to high absenteeism may lead to loss of income for workers, a third-order effect that could be detrimental to families living at or near subsistence levels.

Sector: A subdivision (sociological, economic, or political) of society (e.g., public or private sector).

Self-inoculation: The act of transferring a disease from one part of your body to another.

Small droplet nuclei: Particles 1-10 mcm in diameter, implicated in spread of airborne infection. The dried residue formed by evaporation of droplets coughed or sneezed into the atmosphere or by aerosolization of infective material.

Social distancing: Measures to increase the space between people and decrease the frequency of contact among people (e.g., cancelling after-school sports activities or providing remote-meeting options).

Strategic National Stockpile (SNS): Large quantities of medicine and medical supplies to protect the American public if there is a public health emergency (e.g., terrorist attack, influenza outbreak, earthquake) severe enough to cause local supplies to run out.

Surge capacity: Refers to the ability to expand provision of services beyond normal capacity to meet transient increases in demand. Surge capacity within a medical context includes the ability of healthcare or laboratory facilities to provide care or services above their usual capacity and to expand manufacturing capacity of essential medical products and supplies to meet increased demand (e.g., vaccine).

Telework: Refers to activity of working away from the usual workplace (often at home) through telecommunication or other remote access means (e.g., computer, telephone, cellular phone, fax machine).

Transmissibility: The ability of a material to pass along fluids and germs.

Transmission: Any mode or mechanism by which an infectious agent is spread to a susceptible host.

Viral RNA: Viruses with ribonucleic acid as their genetic material.

Viral shedding: Discharge of virus from an infected person.

Virulence: The ability of an infectious agent to cause severe disease, measured as the proportion of persons with the disease who become severely ill or die.

Voluntary: Acting on, or done of, one's own free will without legal compulsion (e.g., voluntary home quarantine or self-quarantine).

Appendix 2. Guidelines Development Process: List of Contributors and Their Roles*

We sincerely thank the following individuals for their contributions to the guidelines development process:

CDC Community Mitigation Guidelines Work Group
Convened in October 2012, the CDC Community Mitigation Guidelines Work Group provided technical oversight and coordination of the guidelines development process. They communicated via e-mail and in-person meetings (a total of nine times). They reviewed multiple versions of the NPI White Paper; reviewed the NPI rating scheme process, recommendations, and rationale statements; helped draft or update select chapters and sections of the draft planning guidelines; reviewed the pre-clearance version of the draft guidelines; helped facilitate and guide the internal CDC formal clearance process of the draft guidelines; and helped guide the consultation and vetting process with external partners/stakeholders.

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CDC Coordination Team
Beginning in October 2011, three members of the CDC Community Mitigation Guidelines Work Group provided overall coordination and support of the guidelines development process. They scheduled, prepared for, facilitated, and followed-up the nine Work Group meetings; drafted and revised multiple versions of the NPI White Paper; developed and drafted the NPI rating scheme process, recommendations, and rationale statements; helped draft or update select chapters and sections of the draft planning guidelines; and revised the draft guidelines based on comments and edits received during the pre-clearance review process and the internal CDC formal clearance process.

Alexandra Levitt, PhD, Office of Infectious Diseases; Neha Kanade, MPH, and Noreen Qualls, DrPH, Division of Global Migration and Quarantine, National Center for Emerging and Zoonotic Infectious Diseases. Narue Wright-Jegede, MPH, joined the team in September 2015 to work on the MMWR-RR.

CDC Abstraction Team
Working in pairs for quality control purposes, Community Interventions for Infection Control Unit (CI-ICU) staff members reviewed, abstracted, and entered ~191 articles into MS Excel spreadsheets to help establish the overall NPI body of literature, including the evidence base for NPIs; and revised, as needed, the corresponding text in the draft planning guidelines. They also developed the NPI "body of evidence" summary table (see Appendix 5).

Yao-Hsuan Chen, PhD, Charissa Dowdye, MPH, Hongjiang Gao, PhD, Narue Wright-Jegede, MPH, Neha Kanade, MPH, Jasmine Kenney, MPH, Erin Keyes, MPH, Tiffani Phelps, MPH, Noreen Qualls, DrPH, Jeanette Rainey, PhD, Jianrong Shi, MD, Karen Wong, MD, and Yenlik Zheteyeva, MD, Community Interventions for Infection Control Unit, Division of Global Migration and Quarantine, National Center for Emerging and Zoonotic Infectious Diseases.

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*This list of CDC contributors reflects each person's affiliation at the time of their involvement in developing the guidelines.

CDC Consultation Team
The guidelines presented here were vetted with CDC subject matter experts (SMEs) as the guidelines progressed. This internal iterative process included a critical review of the NPI White Paper, the NPI rating scheme process, recommendations, and rationale statements, the pre-clearance version of the draft planning guidelines, and/or the internal CDC clearance version of the draft guidelines.

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External Partners/Stakeholders Consultation Team
The overall direction and key principles and concepts of the pre-clearance draft planning guidelines were critically reviewed by SMEs external to CDC. They represented professional societies, including the Association of State and Territorial Health Officials, the Council of State and Territorial Epidemiologists, the National Association of County and City Health Officials, and the National Public Health Information Coalition. They also represented federal agencies, including the U.S. Department of Health and Human Services (the Assistant Secretary for Planning and Evaluation, the Centers for Medicare and Medicaid Services, the Food and Drug Administration, and the National Institutes of Health/National Institute of Allergy and Infectious Diseases), the U.S. Department of Agriculture, the U.S. Department of Education, the U.S. Department of Labor/Occupational Safety & Health Administration, the U.S. Department of Transportation, the U.S. Department of Veterans Affairs (Carter Mecher, MD, CDC Liaison), the U.S. Environmental Protection Agency, and the U.S. Postal Service.

Note: A federal advisory committee was not used in the development process for these guidelines.

Appendix 3. Methods for Developing NPI Recommendations

Guidelines Development Process

The *Community Mitigation Guidelines to Prevent Pandemic Influenza – United States, 2017* were developed through a collaborative process that gathered input from a variety of sources, including peer-reviewed scientific literature, current research, CDC subject matter experts (SMEs), and external stakeholders (e.g., Federal agencies, public health officials, and business and education community partners). Development of the updated planning guidelines involved participation by multiple groups, including the following CDC groups – the Community Mitigation Guidelines (CMG) Work Group, the Coordination Team, the Abstraction Team, and the Consultation Team – plus the External Partners/Stakeholders Consultation Team.

A Work Group composed of staff from CDC's Office of Infectious Diseases provided technical oversight and coordination of the guidelines development process and met periodically to review and discuss process-related issues such as feedback on the NPI White Paper, development of the NPI rating scheme, and external partner/stakeholder outreach, engagement, and consultation activities. Staff from CDC's Community Interventions for Infection Control Unit reviewed, abstracted, and synthesized approximately 191 articles to establish the overall NPI body of literature, including the evidence base for NPIs. CDC SMEs reviewed and provided feedback on the NPI White Paper, which served as the foundation for internal CDC discussions on updating the NPI recommendations, and on the NPI rating scheme process, updated recommendations, and corresponding rationale statements. Federal and public health stakeholders reviewed and provided feedback on the overall direction and key principles and concepts of the updated guidelines.

Input from the Work Group members, SMEs, and stakeholders was considered and incorporated during the writing of the guidelines. The guidelines development process, which lasted from October 2011 through October 2016, is outlined in Table 7 in the MMWR-RR. The list of contributors and their roles in the guidelines development process is presented in Appendix 2.

Evidence-based Synthesis Process

In the aftermath of the influenza A (H1N1)pdm09 virus pandemic (hereafter referred to as the 2009 H1N1 pandemic), many new studies on NPIs were published, enhancing the evidence base in CDC's initial 2007 guidance and strengthening the evidence base for the 2017 updated planning guidelines. The updated guidelines are based on a review of the best available evidence concerning the effectiveness and feasibility of NPIs, from journals searched dating back to 1990 through September 2016 (see Table 8 in the MMWR-RR for the number of articles reviewed for each NPI). To help guide the evidence-based synthesis process, a logic framework – based on the potential severity and transmissibility of circulating influenza strains – depicts the resulting recommended NPIs and expected outcomes (see Figure 5 in the MMWR-RR). The evidence-based synthesis process was carried out in three phases: 1) an initial literature search; 2) a CDC SME review; and 3) a final literature search. Each phase is briefly described below.

<u>Literature Search Strategies and Study Selection Criteria</u>

Phase 1: Initial Literature Search

The initial literature search was conducted in June 2011 to draft a 5-year NPI research agenda by identifying major research gaps, insufficient data, and outstanding questions related to NPIs. The resulting literature also was used to formulate a White Paper on options for updating guidance on the planning and implementation of NPIs (aka the NPI White Paper), which was the basis for the current updated planning guidelines.

For the initial literature search, articles were divided into four NPI categories based on the major focus of the project or study described in the article: 1) respiratory etiquette; 2) hand hygiene; 3) facemasks; and 4) surface cleaning. Articles addressing personal protective measures in general – such as factors related to adherence and compliance – were added as a fifth category. Settings of interest included childcare or daycare facilities, schools, colleges, universities, businesses, worksites, and mass gatherings.

Various combinations of MeSH headings were searched in biomedical, infection control, and operational research journals dating back to 1990. Additional searches were performed for review articles from select journals from 2000 to June 2011. Below is a summary of the databases searched, search terms used (MeSH headings and NPI-related keywords), and inclusion/exclusion criteria for the studies extracted from the initial literature search.

Databases searched: CINAHL via EBSCO Host, EconLit, Embase, Eric, Google Scholar, JSTOR, Medline, Medline via Ovid, PsycINFO, PubMed, and WoK

Search terms used: anniversaries and special events, world cup, games, festival, championships, hajj, olympics, big event, mass event, large event, crowd, large crowd, public event, social event, social gathering, social distancing, public gathering, mass gathering, respiratory syncytial virus, parainfluenza virus, ILI, flu-like, acute respiratory tract infection, acute respiratory infection, sars, severe acute respiratory syndrome, coronavirus, adenovirus, rhinovirus, common cold, flu, influenza, pandemic influenza, H1N1 influenza pandemic, seasonal influenza prevention and control, nonpharmaceutical interventions, non-vaccine and non-antiviral community mitigation, workplace social distancing, computer simulation, workplace nonpharmaceutical interventions, workplace infection control, cost effectiveness of nonpharmaceutical interventions, paid sick leave, schools, school closure, monitoring, absenteeism, childcare facilities, daycare, closure, universities, colleges

Inclusion/exclusion criteria of studies extracted:

- English-only
- Date range from 1990-2011
- Must be related to personal protective measures in general; school closure effectiveness and unintended consequences; school absenteeism; spread of disease in childcare facilities, colleges, and universities; impact of mass gatherings; or role and impact of NPIs in non-healthcare workplace settings

Phase 2: CDC SME Review

Between May 2012 and June 2013, 10 CDC SMEs reviewed and provided feedback on drafts of the NPI White Paper. As part of their review process, they suggested additional literature and relevant studies for inclusion.

Phase 3: Final Literature Search

The final literature search was conducted in three stages – retrieving studies published between July 1, 2006 and June 30, 2013 (stage 1), July 1, 2013 and December 31, 2014 (stage 2), and January 1, 2015 and September 30, 2016 (stage 3) for further review. A literature search algorithm developed by CDC's Influenza Division was used with NPI-related keywords. Below is an example of the algorithm used.

Influenza[tiab] AND English[language] AND 2006/07/01:2013/06/30[Entrez date] AND school closure[tiab]. The highlighted portion of the algorithm varied based on the search term. Below is a summary of the databases searched, search terms used (MeSH headings and NPI-related keywords), and inclusion/exclusion criteria for the studies extracted from the final literature search.

Abstracts were read to eliminate studies unrelated to the effectiveness or feasibility of implementing NPIs. Remaining studies were read in full and then incorporated into the NPI body of literature (see Table 8 in the MMWR-RR). By including English-only literature, some key NPI-related studies and findings – published in other languages – may have been missed. However, the primary focus was to include literature pertinent to the U.S. context and to avoid translation costs.

Databases searched: PubMed

Search terms used: Environmental cleaning, facemask, hand hygiene, hand soap, home isolation, mass gathering, nonpharmaceutical intervention, school closure, surface disinfection, voluntary home quarantine, workplace policies

Inclusion/exclusion criteria of studies extracted:

- Keyword(s) must be in title and abstract for consideration
- English-only
- Human-only conducted studies
- No limits on publication type
- Date range from July 1, 2006-September 30, 2016
- Must be related to use of NPIs as public health strategy, or effectiveness or feasibility of implementing NPIs in community settings

Data Extraction and Synthesis

To facilitate data extraction and synthesis, a spreadsheet template was developed using Microsoft Excel. The data fields included: study goals, study design, study setting, target population, sample size, health outcomes of interest, study results, study conclusions, and study limitations. Before undertaking data extraction, a draft table and sample entries were shared with the CDC CMG Work Group and CDC's Office of the Associate Director for Science (Guidelines and Recommendations Activity) for their review and feedback.

Thirteen staff members from CDC's Community Interventions for Infection Control Unit reviewed, abstracted, and synthesized approximately 191 articles to establish the overall NPI body of literature, which was composed of three broad categories of articles:

1) Rationale for the use of NPIs as a public health strategy;
2) Evidence base for the effectiveness of NPIs in slowing the spread of seasonal or pandemic influenza; and
3) NPI implementation issues, particularly their acceptability, feasibility, and potential secondary consequences.

The staff members worked in pairs to facilitate review, abstraction, and synthesis of the articles, and to ensure a sufficient level of accuracy and quality control. Data were extracted as originally written in the source articles. Upon completion, each pair revised (as needed) the corresponding text in Chapter 3 in Technical Report 1. The summary table of the evidence base for the effectiveness of NPIs is presented in Appendix 5.

The evidence-based papers cited in the *NPI Toolbox* in Chapter 3 in Technical Report 1 include 14 systematic literature reviews and meta-analyses composed of approximately 475 individual studies that were reviewed and analyzed by their respective authors. CDC CI-ICU staff did not re-review them. However, these studies are listed in Appendix 6 as they contribute to the overall body of literature on NPIs, and help support the evidence base on the effectiveness of NPIs.

Basis for Rating NPI Recommendations: Applying the Community Guide Approach

In July 2012, CDC's Office of the Associate Director for Science published the CDC primer on guidelines and recommendations to set standards that CDC guideline documents should meet. Key steps regarding evidence include: selecting the relevant literature; abstracting and synthesizing the evidence; and assessing the evidence quality (both individual study quality and quality of the body of evidence). To meet these standards, the updated guidelines summarize the evidence base for NPIs, assess the quality of the evidence, and rate the strength of the NPI recommendations. The strength of the NPI recommendations takes into consideration the effectiveness of the intervention when used alone or in combination with other NPIs, the ease of implementation (including unintended consequences), and the importance of the intervention as a public health strategy.

To assess evidence quality and develop recommendations, the Guide to Community Preventive Services approach (aka the *Community Guide* approach) was adapted and applied to NPIs. The U.S. Community Preventive Services Task Force used this same approach to conduct a systematic review of the available evidence on the impact of school dismissals to reduce the transmission of pandemic influenza, which was completed in August 2012: https://www.thecommunityguide.org/findings/emergency-preparedness-and-response-school-dismissals-reduce-transmission-pandemic-influenza. A 5-step NPI rating scheme process was developed by adapting and applying the *Community Guide* approach to:

1) Identify NPI evidence-based papers from NPI body of literature,
2) Assess study quality for each NPI: Suitability of study design and quality of execution,
3) Assess strength of body of evidence of effectiveness for each NPI: Body of evidence and demonstration of effectiveness,
4) Formulate recommendation based on body of evidence of effectiveness for each NPI, and
5) Accept recommendation as is or modify recommendation for each NPI.

Before undertaking the NPI rating scheme process, a draft methods approach (Appendix 4) and sample entries were shared with CDC's Office of the Associate Director for Science (Guidelines and Recommendations Activity) and CDC's Community Guide Branch for their review and feedback. Steps 1-4 were completed by three members of the CDC CMG Work Group. Step 5 was completed by the remaining Work Group members and invited CDC SMEs. Each step is briefly described below. For more details about the NPI rating scheme process and methods, see Appendix 4.

Step 1: Identify NPI evidence-based papers from NPI body of literature

As previously described, staff from CDC's Community Interventions for Infection Control Unit reviewed, abstracted, and synthesized approximately 191 articles (from journals searched dating back to 1990 through September 2016) to establish the overall NPI body of literature, including the evidence base for NPIs. The evidence-based papers included systematic literature reviews, meta-analyses, epidemiologic studies, laboratory experiments, and modeling simulations published in English-language, peer-reviewed journals through September 2016. There is an existing evidence base for the following NPIs – voluntary home isolation/quarantine, hand hygiene, use of facemasks in community settings, school closures/ dismissals, social distancing measures, and environmental surface cleaning measures – though it is extremely limited for some NPIs. There is no direct evidence base for respiratory etiquette. Two key questions guided the review and rating of the evidence base for NPIs:

1) Are NPIs effective in reducing and/or slowing the transmission of (pandemic) influenza within the community?
2) Does the effectiveness of NPIs vary by the presence or absence of additional interventions?

Step 2: Assess study quality for each NPI: Suitability of study design and quality of execution

Each evidence-based paper from Step 1 was divided into one of three "suitability of study design" categories, as determined by its study design – greatest, moderate, or least. Each paper was then divided into one of three "quality of execution" categories, as determined by its number of study limitations – good, fair, or limited. Finally, the "body of evidence" was synthesized by displaying in a table the distribution of the evidence-based papers by "suitability of study design" and "quality of execution." For more details about Step 2 and the study design definitions, study limitation examples, and tabular displays, see Appendix 4.

Step 3: Assess strength of body of evidence of effectiveness for each NPI: Body of evidence and demonstration of effectiveness

The synthesized "body of evidence" from Step 2 was used to demonstrate the effectiveness of each NPI and to characterize the body of evidence of effectiveness. Demonstrating the effectiveness of each NPI (across its body of evidence) involved two sub-steps: a) assessing the consistency of the reported intervention effect in direction and size as either "yes" (consistent), "no" (inconsistent), or "not applicable"; and b) assessing the meaningfulness of the reported intervention effect as either "statistically significant positive outcomes," "demonstrates a positive trend (but not statistically significant)," or "little or no evidence of effect." The meaningfulness of the reported intervention effect – in terms of reducing or slowing the transmission of (pandemic) influenza – could be demonstrated when the NPI was used alone or when used in combination with other interventions.[†] The effect size for each NPI was not reported due to the lack of sufficient data published in the peer-reviewed literature, which is a potential limitation of this assessment of *meaningfulness*.

Characterizing the body of evidence of effectiveness for each NPI as either "strong," "sufficient," or "insufficient" was based on the number of available evidence-based papers, the strength of their study design and execution, and the size and consistency of the reported intervention effects. Finally, the results of Step 3 were synthesized by displaying in a table (see pages 19-20 in Appendix 4) the overall strength of the body of evidence of effectiveness for each NPI. For more details about Step 3 and the definitions of effectiveness and tabular displays, see Appendix 4.

Step 4: Formulate recommendation based on body of evidence of effectiveness for each NPI

Based on the overall strength of the body of evidence of effectiveness from Step 3, a recommendation was formulated for each NPI – "recommended," "recommended against," or "insufficient evidence." A brief rationale statement was drafted to support each NPI recommendation, which summarized the body of evidence of effectiveness, its applicability in terms of settings and populations, and potential barriers to NPI implementation. For more details about Step 4 and the recommendation definitions and supporting rationale statements, see Appendix 4. For more information about the potential barriers to, and harms of,

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[†]Optimal use of NPIs to slow disease transmission requires the application of multiple, partially effective NPIs that are phased-in – or "layered" – over the course of a pandemic, depending on the pandemic's severity and on local transmission patterns. NPIs used in combination can act in complementary ways to "plug holes" that facilitate disease transmission in different circumstances and settings. The combined effect of applying multiple NPIs has been likened to layering slices of Swiss cheese until every hole is covered.

NPI implementation (i.e., the potential secondary consequences), see the *Implementation Issues* for each NPI in Chapter 3 in Technical Report 1.

Step 5: Accept recommendation as is or modify recommendation for each NPI

For each NPI, the CDC CMG Work Group members and SMEs were asked to review the rating scheme process (Steps 2-3), review the recommendation and supporting rationale statement (Step 4), and either accept the recommendation as is or modify it as needed. If they decided to modify the recommendation, they could upgrade, downgrade, or narrow the recommendation. For more details about Step 5 and potential factors influencing the decision to modify a recommendation, see Appendix 4. The CDC NPI recommendations are presented in the MMWR-RR.

Appendix 4. Rating Scheme Methods to Assess Evidence Quality and Develop Recommendations for NPIs: Applying the Community Guide Approach

Before undertaking the NPI rating scheme process, a draft of this methods approach and sample entries were shared with CDC's Office of the Associate Director for Science (Guidelines and Recommendations Activity) and CDC's Community Guide Branch for their review and feedback.

Guiding Review Questions

1) Are NPIs effective in reducing and/or slowing the transmission of (pandemic) influenza within the community?
2) Does the effectiveness of NPIs vary by the presence or absence of additional interventions?

Step 1: Identify NPI evidence-based papers from NPI body of literature

NPI Type	NPI Measure	NPI Body of Literature§ (Number of papers reviewed)		
		Evidence-Based Papers¶	**Background Papers**	
		Effectiveness of NPIs (Papers to be assessed in Step 2)	**NPIs as a Public Health Strategy**	**NPI Implementation Issues**
Personal NPIs	*Personal Protective Measures for Everyday Use*			
	Voluntary home isolation	#	#	#
	Respiratory etiquette	#	#	#
	Hand hygiene	#	#	#
	Personal Protective Measures Reserved for Pandemics			
	Voluntary home quarantine	#	#	#
	Use of facemasks in community settings	#	#	#
	• Ill persons	#	#	#
	• Well persons	#	#	#
Community NPIs	*School Closures/ Dismissals*	#	#	#
	Social Distancing Measures	#	#	#
	General reduction of community social contacts			
	Measures for schools, workplaces, and mass gatherings			
Environmental NPIs	*Environmental Surface Cleaning Measures*	#	#	#
	TOTAL:	#	#	#

§Included English language, peer-reviewed published papers from journals searched dating back to 1990 through September 2016 (see MMWR-RR and Chapter 3 in Technical Report 1 for full list of papers).
¶Included systematic literature reviews/meta-analyses, empirical evidence (actual studies), laboratory evidence (experiments), and modeling evidence (simulations). Individual evidence-based papers for the effectiveness of each NPI were subdivided into these four broad categories of evidence before moving to Step 2.

Step 2: Assess study quality for each NPI: Suitability of study design + Quality of execution

From Step 1 and the corresponding MS Excel spreadsheets, the raters knew the number of evidence-based papers for the effectiveness of each NPI. The raters then:

A. Divided each paper into one of three "Suitability of Study Design" categories – Greatest, Moderate, or Least – as determined by its study design.
B. Divided each paper into one of three "Quality of Execution" categories – Good, Fair, or Limited – as determined by its number of limitations.
C. Synthesized the "Body of Evidence" for each NPI by displaying in a table the distribution of papers by suitability of study design and quality of execution.

Note: Step 2 included empirical evidence (actual studies), laboratory evidence (experiments), and modeling evidence (simulations). Although systematic literature reviews and meta-analyses contributed to the evidence base on the effectiveness of NPIs, they were not included in the suitability of study design and quality of execution assessments or the body of evidence synthesis in Step 2. However, they were included in Step 3 to either help confirm/substantiate/support or refute the findings from assessing individual papers to determine the strength of the body of evidence of effectiveness. They also were included in Step 4 as part of the brief rationale statement to support the NPI recommendation. Individual evidence-based papers that had already been considered as part of a systematic literature review or meta-analysis were excluded from Steps 2-4.

2A. Suitability of Study Design Assessment

NPI Evidence-based Papers 1st Author + Year Published	**Suitability of Study Design Category** Greatest Moderate Least

2B. Quality of Execution Assessment

NPI Evidence-based Papers 1st Author + Year Published	**Descriptions of Study Population/ Intervention**	**Sampling**	**Measurement of Exposure/ Outcome**	**Data Analysis**	**Interpretation of Results**	**Other Issues**	**Total Number of Limitations (#)** 0-1 2-4 >4	**Quality of Execution Category** Good Fair Limited
	(note "L" for limitation)						#	
							#	
							#	

2C. Body of Evidence Synthesis

Quality of Execution	**Suitability of Study Design**		
	Greatest	**Moderate**	**Least**
Good	(note # of papers + individual paper citations)		

Fair			
Limited*			
Total number of papers used to assess effectiveness: # *Papers/studies with *limited* quality of execution were not used to assess effectiveness or support recommendations.			

Definitions

2A. Suitability of Study Design Assessment

- **Greatest:**
    - Randomized, controlled trials (RCTs) with clinical or public health outcomes, prospective cohort studies, or other study designs with concurrent comparison groups.
    - Laboratory/experimental studies that provided direct evidence of NPI effectiveness in reducing or slowing (pandemic) influenza transmission (e.g., testing the use of cleaners/sanitizers/solvents to remove influenza virus from hands or environmental surfaces).
- **Moderate:**
    - Epidemiologic studies (other than RCTs) with clinical or public health outcomes. Examples included non-randomized "trials" (quasi-experimental studies with non-randomized control groups), interrupted time series studies, retrospective cohort studies, case control studies, or modeling studies whose parameters were based on real demographic/public health data sets and assumptions.
    - Laboratory/experimental studies that provided indirect evidence of NPI effectiveness in reducing or slowing (pandemic) influenza transmission (e.g., testing the use of facemasks to prevent escape of viral particles).
- **Least:**
    - Other studies with clinical or public health outcomes. Examples included uncontrolled before/after studies, cross-sectional studies, non-comparative studies (e.g., descriptive epidemiologic studies, case studies, case series, focus groups), or modeling studies whose parameters were based solely on assumptions (e.g., about viral transmission) and did not use real demographic/public health data sets to support the model.

2B. Quality of Execution Assessment

- **Good:** 0-1 limitations
- **Fair:** 2-4 limitations
- **Limited:** >4 limitations

Examples of limitations included:

- Descriptions of Study Population and Intervention (e.g., who, what, when, where, how)
    - The study population was poorly described.
    - The intervention (NPI) was poorly described.
    - The data sets and/or assumptions supporting the model parameters were poorly described (for modeling studies).
- Sampling (e.g., sampling frame, screening criteria, eligibility, allocation to intervention/comparison groups)
    - The selection of the study population was inadequately specified.
- Measurement of Exposure and Outcome (e.g., observation, interview, self-administered questionnaire, laboratory test)
    - Exposure to the intervention (NPI) was not measured.
    - Exposure to the intervention (NPI) was measured, but it was not valid or reliable.
    - The outcome variable was not a valid or reliable measure of the outcome of interest.
- Data Analysis (e.g., conducting and reporting statistical tests, controlling for certain effects/variables)
    - Appropriate data analysis had not been conducted.
    - Sensitivity analysis had not been conducted (for modeling studies).
    - Validation of model details, parameters, and results had not been conducted (for modeling studies).

- Interpretation of Results
    - At least 80% of the enrolled participants did not complete the study.
    - Potential confounding had not been assessed or controlled for (e.g., comparability of units of analyses prior to exposure to the NPI, randomization, matching, stratification).
    - Potential biases were not identified and discussed (e.g., recall bias, sampling bias).
- Other Issues (that limit the ability to interpret the results of the study), for example:
    - The study involved a population whose baseline health status or access to NPI materials (e.g., soap and clean water for hand hygiene) did not reflect conditions in most U.S. communities.
    - The study involved a healthcare setting rather than a community setting.

2C. Body of Evidence Synthesis

- Tabular display of distribution of papers by suitability of study design and quality of execution. Noted total number of papers in each cell and individual papers (1st author + year of publication) in each cell.

Step 3: Assess strength of body of evidence of effectiveness for each NPI: Body of evidence + Demonstration of effectiveness

From Step 2 and the corresponding MS Excel spreadsheets, the raters knew the overall Body of Evidence for each NPI, which included the overall ratings for Suitability of the Study Design, the overall ratings for Quality of the Execution, and the total number of papers/studies used to assess effectiveness. The raters then:

A. Demonstrated the effectiveness of each NPI (across the body of evidence) by:
    - Assessing the consistency of the reported intervention effect in direction and size – Yes [consistent], No [inconsistent], or Not Applicable [NA].
    - Assessing the meaningfulness of the reported intervention effect – Statistically significant positive outcomes, Demonstrates a positive trend (but not significant), or Little or no evidence of effect.

B. Characterized the body of evidence of effectiveness as – Strong, Sufficient, or Insufficient – based on:
    - The number of available papers/studies.
    - The strength of their study design and execution.
    - The size and consistency of reported effects/study results.

Note: Step 3 included empirical evidence (actual studies), laboratory evidence (experiments), and modeling evidence (simulations). Systematic literature reviews and meta-analyses were used in Step 3 to either help confirm/ substantiate/support or refute the findings from assessing individual papers to determine the strength of the body of evidence of effectiveness.

3A & 3B. Strength of Body of Evidence of Effectiveness Translation Table

<table>
<tr><th colspan="3">Body of Evidence</th><th colspan="2">3A. Demonstration of Effectiveness</th><th rowspan="2">3B. Evidence of Effectiveness</th></tr>
<tr><th>Quality of Execution</th><th>Suitability of Study Design</th><th>Number of Papers/Studies</th><th>Consistency of Intervention Effect</th><th>Meaningfulness of Intervention Effect</th></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Good</td><td>Greatest</td><td>2 or more</td><td rowspan="3">Yes [consistent]</td><td rowspan="7">Statistically significant positive outcomes
==========
Demonstrates a positive trend</td><td rowspan="4">STRONG</td></tr>
<tr><td>Good</td><td>Greatest or moderate</td><td>5 or more</td></tr>
<tr><td>Good or fair</td><td>Greatest</td><td>5 or more</td></tr>
<tr><td colspan="4">Meet criteria for Sufficient but not Strong body of evidence</td></tr>
<tr><td colspan="4"></td><td></td></tr>
<tr><td>Good</td><td>Greatest</td><td>1</td><td>Not applicable</td><td rowspan="2">SUFFICIENT</td></tr>
<tr><td>Good or fair</td><td>Greatest or moderate</td><td>3 or more</td><td>Yes [consistent]</td></tr>
</table>

Good or fair	Greatest, moderate, or least	5 or more		(but not statistically significant)	
Inadequate study designs or executions		Too few studies	No [inconsistent]	Little or no evidence of effect	**INSUFFICIENT**

Definitions

3A. Demonstration of Effectiveness (across the body of evidence)

- **Consistency of Intervention Effect**
    - Consistency of the reported intervention effect in direction and size. For example, "most" studies demonstrated an effect in the direction of the intervention (NPI).
        - **Yes** (consistent)
        - **No** (inconsistent)
        - **Not applicable** (NA)
- **Meaningfulness of Intervention Effect**
    - Meaningfulness of the reported intervention effect. For example, the effect demonstrated across the body of evidence was "meaningful" in terms of reducing or slowing the transmission of (pandemic) influenza.
        - **Statistically significant positive outcomes** (in reducing or slowing the transmission of [pandemic] influenza)
            - When the NPI was used alone.
            - When the NPI was used in combination with other interventions.
        - **Demonstrates a positive trend (but not statistically significant)** (in reducing or slowing the transmission of [pandemic] influenza)
            - When the NPI was used alone.
            - When the NPI was used in combination with other interventions.
        - **Little or no evidence of effect** (in reducing or slowing the transmission of [pandemic] influenza)
            - When the NPI was used alone.
            - When the NPI was used in combination with other interventions.

Note: Optimal use of NPIs to slow disease transmission requires the application of multiple, partially effective NPIs that are phased-in – or "layered" – over the course of a pandemic, depending on the pandemic's severity and on local transmission patterns. NPIs used in combination can act in complementary ways to "plug holes" that facilitate disease transmission in different circumstances and settings. The combined effect of applying multiple NPIs has been likened to layering slices of Swiss cheese until every hole is covered.

Step 4: Formulate recommendation based on body of evidence of effectiveness for each NPI

From Step 3, the raters knew the strength of the evidence of effectiveness – Strong, Sufficient, or Insufficient – for each NPI. The raters then:

A. Formulated a recommendation for each NPI based on the evidence of effectiveness
    - **Recommended**
        - Based on strong evidence that the NPI is effective.
        - Based on sufficient evidence that the NPI is effective.
    - **Recommended against**
        - Based on strong evidence that the NPI is harmful or not effective.
        - Based on sufficient evidence that the NPI is harmful or not effective.
    - **Insufficient evidence** (to recommend for or against)
        - Available papers/studies did not provide sufficient evidence to determine if the NPI is, or is not, effective. This does not mean that the NPI does not work. It means that additional research is needed to determine whether or not the NPI is effective.

B. Drafted a brief rationale statement to support the NPI recommendation, which briefly summarized:
  - The body of evidence of effectiveness (the number of available papers/studies, the strength of their study design and execution, and the consistency of reported effects/study results).
  - The findings from systematic literature reviews and meta-analyses that support the NPI recommendation.
  - The applicability of the body of evidence of effectiveness and the resulting recommendation in terms of settings and populations.
  - Any barriers that might impede implementation of the NPI.

Step 5: Accept recommendation as is or modify recommendation for each NPI

To complete Step 5, a modified Delphi approach was undertaken. In July 2014, nine CMG Work Group members and 10 CDC SMEs received three documents to review: 1) a description of the 5-step NPI rating scheme process and methods; 2) a set of ratings, notes, and worksheets for six NPIs (hand hygiene, voluntary home quarantine, use of facemasks in community settings, school dismissals/closures, social distancing measures, and environmental surface cleaning measures); and 3) a Step 5 reviewer rating sheet that included the recommendation and rationale for each of the six NPIs. Everyone was given three weeks to review the documents and complete and return by e-mail their Step 5 reviewer rating sheets. They were asked to accept each NPI recommendation as is or modify it as needed. If they modified the recommendation, they were asked to briefly explain how and why they would modify it. If they decided to modify the NPI recommendation, they could:

- Downgrade the recommendation;
- Narrow the recommendation; or
- Upgrade the recommendation.

Factors that might influence their decision to modify the NPI recommendation included:

- Current/existing CDC or HHS policies related to the NPI.
- Current/accepted practices in healthcare settings (e.g., hand-hygiene practices in doctors' offices, emergency rooms, hospitals, and public health clinics).
- Findings from NPI systematic literature reviews and meta-analyses.
- Serious flaws or inconsistencies in the data.
- Scarcity of high-quality papers in the evidence base.
- Concerns about the link to health outcomes (e.g., little or no link between the NPI and reducing or slowing the transmission of [pandemic] influenza).
- Concerns about the meaningfulness of the intervention effect (e.g., too small to be meaningful).
- Concerns about applicability to U.S. settings and populations.
- Significant barriers to NPI implementation.
- Other concerns about the NPI and/or the evidence base.

Responses were received from three of nine CMG Work Group members and one of 10 CDC SMEs. There was general agreement on four of the six NPI recommendations, but the recommendations for use of facemasks in community settings and social distancing measures required further discussion. Respondents felt the wording of the *facemasks* recommendation should distinguish between *ill* vs. *well* persons using facemasks in community settings; provide some examples of special circumstances; and reflect the standard of care widely practiced in healthcare settings. For the *social distancing* recommendation, respondents felt the wording should emphasize the need to "bundle" and use multiple measures at the same time (i.e., a layered approach); and provide some examples of social distancing.

In March 2015 (prolonged delay due to Ebola response activation), seven CMG Work Group members and six CDC SMEs met (in person or by phone) to discuss these two NPI recommendations. During that meeting, general suggestions were offered for revising the current wording of the recommendations, such as: consult with CDC SMEs on facemasks and infection control; de-clutter the language and make it clearer; and provide examples. For *facemasks*, the group suggested making specific recommendations for *ill* and *well* persons. For *social distancing*, the group suggested a) explaining the combined effect of bundled/layered measures can be potentially large; and b) ensuring the wording reflected the PSAF recommendation for a moderate or severe pandemic. After the meeting, CDC SMEs from the Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases and the National Institute for Occupational Safety and Health were consulted. The proposed revised wording for these two recommendations was circulated by e-mail to everyone for their review and feedback within one week. No additional comments and/or suggested edits to the revised wording were received, thus resulting in group consensus.

Appendix 5. NPI "Body of Evidence" Summary Table

The *NPI Toolbox* in Chapter 3 in Technical Report 1 includes information on NPIs that can help delay the spread and exponential growth of influenza pandemics. The body of literature used to develop the *NPI Toolbox* includes English-language, peer-reviewed published papers from journals searched dating back to 1990 through September 2016.

The evidence-based papers cited in the *NPI Toolbox* are summarized below. They include systematic literature reviews, meta-analyses, and empirical, laboratory, and modeling studies. The papers below are grouped by NPI, and listed by year of publication in alphabetical order. Papers without an asterisk were either systematic literature reviews or meta-analyses themselves, or papers embedded within such reviews/analyses. Their findings are reported here to further support the NPI evidence base. Papers with a single asterisk (*) were reviewed and rated as part of the NPI rating scheme process (see Appendices 3 and 4 for more details). Papers with a double asterisk (**) were reviewed after the NPI rating scheme process was completed.

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
Voluntary Home Isolation and Voluntary Home Quarantine						
CDC recommends **Voluntary Home Isolation** of ill persons (staying home when ill) year-round, and especially during annual influenza seasons and influenza pandemics. CDC might recommend **Voluntary Home Quarantine** of exposed household members as a personal protective measure during severe, very severe, or extreme influenza pandemics, in combination with other personal protective measures such as respiratory etiquette and hand hygiene. If a member of the household is symptomatic with confirmed or probable pandemic influenza, then all members of the household should stay home for up to 3 days (the estimated incubation period for seasonal influenza), starting from their initial contact with the ill person, to monitor for influenza symptoms.						
*Kumar, 2013	9	Assess impact of paid sick days and extra 'flu days' on influenza attack rates at workplaces using agent-based modeling platform	FRED (Framework for Reconstructing Epidemic Dynamics) using synthetic population of Allegheny County, PA (n=1,241,755)	Universal access to paid sick leave reduced workplace attack rates to 10.86% (95% CI = 10.83 - 10.89), a 5.86% decrease. Access to extra paid 'flu days' reduced workplace attack rates to 8.62% (95% CI = 8.59 - 8.64) and to 7.01% (95% CI = 6.98 - 7.04) for 1 and 2 extra days, respectively, a 25.33% and 39.2% decrease for each extra day.	Universal access to paid sick leave and alternative extra 'flu days' aimed at increasing time spent away from work when ill could theoretically reduce infections related to work place transmission between ~6% and 39%.	1. Modeling assumption of complete mixing in given workplace rather than clustering or assortative mixing found in other research 2. Modeling assumption of stay-at-home behavior among workers with access to paid sick days 3. Lack of model validation details and results
**Li, 2013	10	Estimate effectiveness of 60-day mandatory quarantine to provide quantitative information for policy and decision-makers through deterministic SEIR (Susceptible-Exposed-Infectious-Recovered) model	Simulated infectious population (quarantined and not quarantined from mid-May to early July 2009) in Beijing, China	The peak of the 2009 H1N1 pandemic in Beijing would have been 5.6 times higher if mandatory quarantine had not been carried out. Mandatory quarantine served to postpone the spread of the pandemic by one and a half months.	Mandatory quarantine delayed the peak of the pandemic, but when cost was taken into account, mandatory quarantine was not an economically effective intervention against the 2009 H1N1 pandemic.	None mentioned
Tognotti, 2013	4	Contribute to better understanding of applications of quarantine (plague,	40 studies reviewed	Range of disease control measures during historical pandemics around the world included: isolating army soldiers with signs or symptoms; closing schools;	In absence of pharmaceutical interventions, public health control measures (e.g., quarantine) helped contain infection, delayed spread of	None mentioned

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
		cholera, influenza, SARS) and help trace roots of stigma and discrimination through historical review		suspending public gatherings; postponing sporting events; cancelling on-campus public meetings, restricting travel of local populations; closing asylums and nurseries.	disease, averted terror and death, and maintained infrastructure of society.	
*Kumar, 2012	6	Assess social determinants, including access to sick leave and use of public transportation for increasing likelihood of reporting influenza-like illness (ILI) through cross-sectional survey	National representative sample of U.S. population (n=2,042, 56% response rate)	Higher self-reported ILI incidence was related to workplace policies (lack of sick leave - $p < 0.001$) and structural factors (number of children in household - $p < 0.001$). Hispanic ethnicity was associated with higher risk of ILI due to lack of sick leave and children in household ($p < 0.001$), when compared to other ethnicities, and after controlling for income and education.	Social factors (inability to engage in social distancing due to lack of sick leave and household crowding) were related to higher self-reported ILI.	1. Low (56%) completion rates, though consistent with other studies with oversamples of minorities, Spanish language populations, and households with/without access to cell phones 2. Subject to recall bias due to self-reporting 3. Misclassification bias since authors did not specify ILI symptoms in survey
*Miyaki, 2011	5	Evaluate effectiveness of non-vaccine quarantine measure against pandemic influenza A H1N1 in workplaces through quasi-cluster randomized, controlled trial	15,134 workers from two sibling companies of major car industry in Kanagawa Prefecture, Japan	Intervention group had about 20% lower risk of infection than control group; the hazard ratio was 0.799 (95% CI: 0.658-0.970; $p=0.023$); age was also associated with infection risk (younger persons were more easily infected ($p<0.001$)).	Results indicate that the policy of staying at home on full pay reduced the overall risk of influenza A H1N1 infection in the workplace by about 20% in one single influenza season.	1. Participants could not be individually randomized in trial because of characteristics of intervention 2. Some differences in baseline characteristics between 2 groups – higher proportions of current smokers and those under treatment for hypertension and diabetes in Cohort 1 3. Did not confirm number of children of participants in 2 groups (number of family members) 4. Diagnosed influenza A H1N1 using rapid test or clinical symptoms – may have missed large number of true infections 5. Study involves population whose baseline health status or access to health benefits may not reflect conditions in U.S.
*Ferguson, 2006	7	Development of strategies for mitigating severity of new influenza pandemic through epidemic simulation	Simulations in various settings for populations in U.S. (n=300 million) or Britain (n=58.1 million); settings included households, schools, workplaces, and wider community	School closure during the peak of a pandemic can reduce peak attack rates by up to 40% but has little impact on overall attack rates. Case isolation or household quarantine could have a significant impact, if feasible.	Influenza prevention and containment strategies can be considered under the categories of antiviral, vaccine, and NPIs (case isolation, household quarantine, school or workplace closures, or restrictions on travel).	1. Lack of model parameterization data on: - transmission proportion occurring in residential institutions, schools, and workplaces - proportion of infections identified as clinical cases during pandemic - effectiveness of personal protective measures 2. Lack of model validation details and results
*Wu, 2006	8	Understand additional benefits and resource requirements of household-based interventions in reducing average levels of transmission given different levels of	Simulated households of different sizes in Hong Kong	For a basic reproductive number (R_0) of 1.8 and assuming 50% compliance, the (symptomatic) infection attack rate could be reduced from 74% to 49% using only voluntary household quarantine (VHQ); to 43% using VHQ + voluntary individual isolation (VII) of cases outside of the household; and to 40%	For lower transmissibility strains, the combination of voluntary household-based quarantine, isolation of cases outside the household, and targeted prophylactic use of antivirals will be highly effective and likely feasible across a range of plausible transmission scenarios.	1. Lack of model validation details and results

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
		compliance through mathematical model		using VHQ + VII + targeted prophylactic use of antivirals.		
Hand Hygiene						
CDC recommends **Respiratory Etiquette and Hand Hygiene** in all community settings, including homes, child care facilities, schools, workplaces, and other places where people gather, year-round and especially during annual influenza seasons and influenza pandemics.						
**Liu, 2016	24	Test whether risk of influenza transmission associated with self-reported handwashing and unhealthy hygienic habits through case-control study	100 case-patients from Fujian Province, southeastern China	Compared with poorest hand-washing score of 0-3, odds ratios of influenza infection decreased progressively from 0.26 to 0.029 as hand-washing score increased from 4 to the maximum of 9 (P<0.001). Compared with poorest hygienic habits score of 0-2, odds ratios of influenza infection decreased from 0.10 to 0.015 with improving score of hygienic habits (P<0.001).	Regular handwashing and good hygienic habits were associated with reduced risk of influenza infection.	None mentioned
Willmott, 2016	16	Systematic literature review and meta-analysis to establish effectiveness of handwashing in reducing absence and/or spread of respiratory tract and/or gastrointestinal infection	18 studies identified; Children aged 3-11 years, and/or staff working with them in schools and other settings with a formal educational component in any country	Individual study results suggest interventions may reduce children's absence, respiratory tract infection incidence and symptoms, and laboratory-confirmed ILI.	Evidence of effect of hand hygiene interventions on infection incidence in educational settings mostly ambiguous, but may decrease respiratory tract infections among children.	1. Studies were heterogeneous 2. Studies had significant quality issues including small numbers of clusters and participants and inadequate randomization
**Wu, 2016	25	Identify possible hygiene behaviors associated with incidence of ILI through multi-stage sampling, cross-sectional survey of adults using self-administered anonymous questionnaires	Chinese adults (n=13,003) living in households in Beijing	Variables significantly associated with lower likelihood of reporting ILI were regular physical exercise (OR 0.80), optimal hand hygiene (OR 0.87), face mask use when going to hospitals (OR 0.87), and not sharing of towels and handkerchiefs (OR 0.68).	Personal hygiene behaviors were potential preventive factors against the incidence of ILI among adults in Beijing.	1. Respondents had to recall their experience, which may have introduced recall bias in data collection 2. ILI was used to represent infectious diseases, but possible that symptoms were caused by non-infectious diseases in some cases
**Stedman-Smith, 2015	23	Determine effectiveness of office-based, multimodal hand hygiene improvement intervention in reducing self-reported communicable infections and work-related absence through randomized cluster trial	4 office buildings in a U.S. Midwestern government center (n=324 employees)	A 31% relative reduction in self-reported combined acute respiratory infections (ARI), influenza-like illness (ILI), and gastrointestinal infections (GI). A 21% nonsignificant relative reduction in lost work days.	An office-based, multimodal hand hygiene improvement intervention demonstrated a substantive reduction in self-reported combined ARI-ILI/GI infections.	1. CI was wide due to smaller than anticipated enrolled sample 2. Implementation circumstances prevented launch of intervention until late February to early March. As such, study missed peak 2012-2013 seasonal influenza epidemic 3. Not possible to compare demographic characteristics of those who self-selected to enroll from departments that were randomized in cluster trial to those who did not 4. Primary outcome relied on self-reported instead of laboratory or clinical diagnosis 5. Self-report was used as measurement for hand hygiene

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
**Tuladhar, 2015	27	Test efficacy of alcohol-based hand disinfectant against human enteric and respiratory viruses, and compare efficacy of alcohol-based hand disinfectant and handwashing with soap and water against norovirus through carrier tests and finger pad tests	Laboratory experiment: one male and one female participated in finger pad tests	Alcohol-based hand sanitizer (Sterillium and Viruguard) inactivated influenza A virus within 30 seconds.	Alcohol-based hand disinfectants tested were virucidal for influenza A (H1N1) virus.	None mentioned
**Priest, 2014	22	Assess whether hand sanitizer was effective in reducing incidence rate of absence episodes due to any illness through parallel-group cluster, randomized trial	68 primary schools in 3 cities in regions covered by New Zealand Public Health Unit investigators	The rate of absence episodes due to any illness (primary outcome) was similar in the hand sanitizer (1.21 per 100 child-days) and control (1.16 per 100 child-days) groups. The confidence interval for the IRR (IRR 1.06, 95% CI 0.94 to 1.18) excluded a clinically important difference. The rate of absence episodes for any reason and the length of episodes, calculated from absence data collected in the school rolls, did not differ importantly between the intervention and control groups.	The provision of hand sanitizer in addition to usual hand hygiene in primary schools in New Zealand did not prevent any infectious diseases severe enough to warrant school absence.	1. Study was conducted during an influenza pandemic with associated public health messaging about hand hygiene, which may have increased hand hygiene among all children and reduced any additional effectiveness of sanitizer provision 2. Individual participants (follow-up children) were recruited after clusters had been randomized and caregivers knew the allocation of the cluster 3. Use of telephone interviews to collect information on reasons for absence 4. Planned sample size for follow-up children was not achieved
*Godoy, 2012	20	Investigate effectiveness of NPIs in preventing cases of influenza requiring hospitalization through multicenter matched case-control study and structured interviews	36 public hospitals from 7 Spanish regions, with 813 total cases and 2,273 matched controls	Frequency of hand washing 5-10 times (aOR=0.65) and > 10 times (aOR=0.59) and hand washing after contact with contaminated surfaces (aOR=0.65) were protective factors and were dose-responsive ($p<0.001$).	Study demonstrated effectiveness of hand washing and provision of information on influenza prevention in community in preventing hospitalization due to influenza A (H1N1) pdm09.	1. Interviewers not blinded to status of cases and controls when asking questions about use of NPIs 2. Possible misclassification of some controls due to lack of testing, false negative tests, or exclusion of other influenza virus strains 3. Potential selective recall bias as most interviews conducted retrospectively 4. Study population is hospitalized patients – may not be generalizable to community settings
*Lau, 2012	18	Compare absenteeism rates among elementary students given access to hand-hygiene facilities vs. students given both access and short repetitive instruction in use through prospective cohort study	773 students (ages 4-14) from 2 Chicago public elementary schools from grades pre-kindergarten to eighth grade	Both percent total absent days and percent illness-related absent days were significantly lower in the group receiving short instruction during influenza season ($p=0.002$, $P<0.001$, respectively).	Addition of hand-hygiene instructions to existing hand-hygiene practices improved attendance at public elementary schools during the influenza season.	1. Small, convenience-based sample of low-income, older students, resulting in low statistical power 2. No attempt to stop children in intervention group from passing on hand-hygiene instruction to children in control group 3. No data on influenza vaccination rates of children in participating schools 4. Analysis did not correct for clustering at class level 5. Intervention conducted at time of heightened hand-hygiene awareness following H1N1 outbreak, affecting hand hygiene in both intervention and control groups

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*Savolainen-Kopra, 2012	21	Explore whether hand hygiene and transmission-limiting behavior reduce infection and lost work days through open-cluster, randomized trial	683 office workers from 21 office work units in 6 corporations in Helsinki Region, Finland	Soap + water: 6.7% reduction in illness (p=0.04); statistically significant effect (p=0.002) in soap + water arm and control, but not alcohol-rub arm.	Intensified hand hygiene with soap + water reduces self-reported illness in work environment; no effect on sick leave.	1. Subjective self-reporting of disease episodes rather than professional assessment of signs and symptoms of infection 2. No direct measure of adherence to hand-hygiene instructions in different intervention arms 3. National anti-pandemic campaign likely had major role in observed “leakage” of transmission limiting behavior to control arm
Warren-Gash, 2012	15	Systematic literature review of evidence that improving hand hygiene reduces primary and secondary transmission of influenza and acute respiratory tract infections in community settings	16 studies reviewed, which included multiple community settings (residences, childcare centers, schools, workplaces)	Hand hygiene associated with large reduction in influenza and acute respiratory tract infections in institutional settings (schools) and a domestic setting (squatter settlements) in two studies in low- to middle-income countries. In higher-income countries, evidence of small reduction in acute respiratory tract infections in childcare centers, and lower-quality evidence of a protective effect in schools and workplaces. For domestic settings, hand-hygiene intervention alone did not prevent secondary influenza transmission in households with index case.	Greatest effect of hand hygiene was seen in two studies in low- to middle-income settings, which may be partly explained by differences in access to soap and hand-washing equipment. In higher-income settings, smaller effects were seen, which tended to be in institutions such as childcare centers and schools.	None mentioned
Talaat, 2011	19	Evaluate effectiveness of hand-hygiene campaign on reducing absenteeism due to ILI, diarrhea, conjunctivitis, and laboratory-confirmed influenza through randomized, controlled trial	Students from 60 Cairo government elementary schools (20,882 intervention students; 23,569 control students)	Intervention group absences due to ILI reduced by 40%, p<0.0001; diarrhea reduced 30%, p<0.0001; conjunctivitis reduced 67%, p<0.0001; and lab-confirmed influenza reduced 50%, p<0.0001.	Intensive hand-hygiene campaign was effective in reducing absenteeism caused by these illnesses.	1. Schoolchildren and their parents not blinded to intervention, which may have contributed to information bias 2. Differential interest of study teams may have contributed to low rate of testing in students who were absent because of ILI in control schools compared to intervention schools 3. Absence incidence may have been overestimated 4. Relatively short duration of observation (12 weeks) may have led to overestimation of effect 5. Use of rapid tests for diagnosis of laboratory confirmed influenza with known low sensitivity likely resulted in underestimation of illness in each group; this would likely bias the effects towards the null 6. Campaign was not started until end of influenza season; higher baseline prevalence of respiratory and diarrheal diseases during trial period may have led to stronger program effect on disease-specific absenteeism

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Jefferson, 2010	14	Cochrane Review of effectiveness of physical interventions to interrupt or reduce spread of respiratory viruses	61 studies reviewed, which included multiple settings	9 case-control studies suggested that implementing transmission barriers, isolation, and hygienic measures were effective at containing respiratory virus epidemics. Surgical masks or N95 respirators were most consistent and comprehensive supportive measures. N95 respirators were non-inferior to simple surgical masks but more expensive, uncomfortable, and irritating to skin.	Simple and low-cost interventions would be useful for reducing transmission of epidemic respiratory viruses.	None mentioned
*Grayson, 2009	26	Determine effect of hand hygiene on live virus through lab experiment	20 healthcare practitioner volunteers who had undergone vaccination with 2005 influenza vaccine and had demonstrable adequate levels of antibody to influenza A before study began	Air drying: 6/20 had no live virus recovered; All hand-hygiene protocols: 14/14 had no live virus recovered ($p<0.002$); Soap + water statistically superior ($P<0.001$) to all 3 alcohol-based hand rubs.	Soap + water or alcohol rub effective to reduce pH1N1 on hands; soap + water most effective.	1. Small number of participants 2. Did not randomize order in which 4 hand-hygiene regimens were performed 3. Initial reduction in culture-detected H1N1 after simple 2-minute air drying may be due to limitations in detection methods rather than true decrease in virus viability 4. Used high-contaminating concentration of H1N1 to mimic worst-case clinical scenario – may not apply to all clinical situations
Aiello, 2008	12	Meta-analysis to quantify effect of hand hygiene on rates of GI/respiratory illness and identify most effective interventions	30 studies pooled and analyzed from various settings (developed/ developing country, village, school, household)	Hand hygiene reduced respiratory illness by 21% compared with no intervention in control groups.	Hand hygiene effective against respiratory illness.	None mentioned
Rabie, 2006	17	Determine effect of handwashing on risk of respiratory infection through systematic literature review	8 studies included; respiratory outcome related to hand cleansing among healthy general population	All 8 eligible studies reported handwashing lowered risks of respiratory infection, with risk reduction ranging from 6% to 44%.	Handwashing is associated with lowered respiratory infection.	1. Studies were of poor quality 2. No studies related to developing countries, and only one focused on severe disease
Use of Facemasks in Community Settings						
CDC might recommend the **Use of Face Masks by *Ill* Persons** – as a source control measure – during severe, very severe, or extreme influenza pandemics when crowded, community settings cannot be avoided (e.g., when adults and children with influenza symptoms seek medical attention) or when ill persons are in close contact with others (e.g., when symptomatic persons share common spaces with other household members or symptomatic, post-partum women care for and nurse their infants). Some evidence indicates face mask use by ill persons might protect others from infection. CDC does not routinely recommend the **Use of Face Masks by *Well* Persons** in the home or other community settings as a means of avoiding infection during influenza pandemics, except under special, high-risk circumstances (https://www.cdc.gov/flu/professionals/infectioncontrol/maskguidance.htm). For example, during a severe pandemic, pregnant women and other persons at high risk for influenza complications might use face masks if unable to avoid crowded settings, especially if no pandemic vaccine is available. In addition, persons caring for ill family members at home (e.g., a parent of a child exhibiting influenza symptoms) might use face masks to avoid infection when in close contact with a patient, just as health care personnel wear masks in health care settings.						
Barasheed, 2016	46	Systematic literature review to synthesize evidence about uptake	25 studies included; pooled sample size was 12,710 participants	Overall uptake of facemasks ranged from 0.02% to 92.8% with average of about 50%. Only 13 studies examined	Facemask use seems to be beneficial against certain respiratory infections at	1. Heterogeneity in study questions, assessment methods, study designs and quality, and endpoints

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		and effectiveness of facemasks against respiratory infections in mass gatherings (MGs)	from 55 countries aged 11 to 89 years	effectiveness of facemasks, and their pooled estimate revealed significant protectiveness against respiratory infections (RR=0.89).	MGs, but its effectiveness against specific infections remains unproven.	2. Heterogeneity in how frequency and duration of facemask use were assessed may have introduced subjective bias 3. Study designs may have contributed to variability in results 4. Facemask effectiveness also differed depending on study endpoints
MacIntyre, 2015	47	Systematic literature review to examine and summarize available evidence related to efficacy of facemasks and respirators, current practice, and guidelines, as well as highlight gaps in evidence	9 studies identified of facemask use in community settings	Use of facemasks alone and facemasks plus hand hygiene may prevent infection in community settings.	Facemasks and respirators are important but under-studied forms of PPE, which offer protection against respiratory infections.	None mentioned
Wong, 2014	45	Systematic literature review and meta-analysis to evaluate efficacy of hand-hygiene interventions in reducing influenza and possible modifying effects of latitude, temperature, and humidity on hand hygiene efficacy	10 studies reviewed – 9 of which assessed laboratory-confirmed influenza and 10 of which assessed influenza-like illness (ILI)	The combination of hand hygiene with facemasks had statistically significant efficacy against laboratory-confirmed influenza while hand hygiene alone did not.	The findings have implications for interventions that protect against multiple modes of influenza transmission. Additional measures besides hand hygiene also may be important to control influenza.	1. Small number of randomized, controlled trials have been conducted to assess efficacy of hand hygiene to control influenza 2. Limited studies involving the same hand-hygiene interventions prevent providing intervention-specific pooled estimates; thus, efficacy of hand-hygiene interventions cannot be compared 3. Heterogeneity across studies
**Davies, 2013	60	Examine homemade masks (100% cotton t-shirt fabric) as alternative to commercial facemasks through lab experiment; measured total bacterial count when volunteers coughed wearing homemade mask, surgical mask, or no mask	21 healthy volunteers (12 men and 9 women) in United Kingdom	Both homemade and surgical masks significantly reduced number of microorganisms ($p<.001$ and $p=.004$, respectively) expelled by volunteers, although surgical masks were 3 times more effective in blocking transmission than homemade masks.	A protective mask may reduce likelihood of infection, but will not fully eliminate risk. Any mask will have minimal effect if not used in conjunction with other preventative measures.	1. Different materials or materials worn for longer time may show different results 2. If volunteers had any respiratory illness, homemade masks may have shown more significant effect in preventing release of droplets 3. Greater variation of fitting surgical masks among volunteers
*Milton, 2013	48	Describe number of copies of viral RNA in two aerosol size fractions, report culturability of virus in fine-particle fraction, and assess effect of surgical masks through quasi-experimental design	37 volunteers with PCR-confirmed influenza A or B from Lowell, MA; mostly students and staff from University of MA	Surgical masks reduced viral copy numbers in the fine-particle fraction by 2.8-fold (95% CI 1.5 to 5.2) and in the course-particle fraction by 25-fold (95% CI 3.5 to 180); overall, masks produced a 3.4-fold (95% CI 1.8 to 6.3) reduction in viral aerosol shedding.	Surgical masks worn by patients reduce aerosol shedding of virus.	1. Compliance was major limitation, resulting in lower efficacy in real-world practice 2. Recruited patients with certain signs and symptoms or who were positive on rapid test or had fever; data could be biased toward patients with higher viral loads

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*Aiello, 2012	59	Examine if use of facemasks and hand hygiene reduced rates of ILI and lab-confirmed influenza in natural setting through cluster randomized, controlled trial	1,178 students in residence halls at University of Michigan	Largest reduction was observed during week 6 with a 75% reduced ILI rate (adjusted RR= 0.25, [95% CI, 0.07 to 0.87]) among subjects in the facemask and hand-hygiene group in adjusted models.	Facemasks and hand hygiene combined may reduce the rate of ILI and confirmed influenza in community settings.	1. Participants with ILI who tested negative for influenza may have been infected with respiratory viruses other than influenza; ILI cases without laboratory-confirmed influenza positivity may have been influenza cases that were not detected in the laboratory 2. Participants only required to wear masks while in their residence halls; transmission may have occurred outside of residential environment when masks were not worn 3. Reliance on self-reported data, which may be susceptible to reporting and recall bias 4. Generalizability of findings limited to similar environmental settings and populations 5. Participants not blind to study interventions; compliance with interventions must be carefully considered 6. Compliance was observed, but it was not possible to gather observational data on all participants at all times and venues
Bin-Reza, 2012	44	Systematic literature review of masks/ respirators to inform pH1N1 guidance by HPA (United Kingdom)	17 studies reviewed, which included various settings	6 of 8 randomized, controlled trials (RCTs) showed no difference between control and intervention groups; one RCT showed mask coupled with hand hygiene reduced secondary transmission.	No conclusive relationship between mask use and influenza transmission.	None mentioned
*Lai, 2012	50	Measure protection provided by facemasks under various emission scenarios, environmental conditions, and human factors through lab experiment (manikins mimicked virus transmission)	Manikins mimicked human factors in laboratory setting	Facemask protection was 45% against the steady concentration environment and 33-100% against expiratory emissions.	Facemasks protect against ultrafine particles; distance from source of particles was most influential parameter affecting protection.	1. Difficulty with completely mimicking truly normal wearing conditions as surface of human skin is soft; manikins had hard (solid) surface 2. Start of droplet emissions not synchronized with breathing circuit; mode concentration model was adopted to calculate magnitude of protection 3. Leaks could not be guaranteed to be the same for all “normal wearing” scenarios (different types of facemask fits)
*Suess, 2012	57	Investigate efficacy, acceptability, and tolerability of NPIs to prevent influenza transmission in households with influenza index patients through cluster randomized, controlled trial	84 households in Berlin, Germany with influenza positive index cases	Total secondary attack rate (SAR) of laboratory-confirmed influenza was 16%. Total SAR of secondary ILI was 12%. No statistically significant effect of NPIs on secondary infections. When NPIs were implemented within 36 hours after symptom onset of index case, secondary infections in pooled NPI study arms were significantly lower compared to control group. Mask + hand-hygiene participants disinfected their hands 7-8 times per day.	Household transmission of influenza can be reduced by use of NPIs - (surgical) facemasks and intensified hand hygiene (alcohol-based hand rub) - when implemented early and used diligently.	1. Study design resulted in delays between symptom onset of index patients and implementation of intervention 2. Cannot determine whether possible protective effect of wearing facemasks is more attributable to their use by index patients or by household contacts (or both); cannot say whether intensified hand hygiene provides additional protection 3. Laboratory testing of household contacts only conducted for virus subtype with which index patient was infected; could have led to underestimation of secondary cases

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						4. Cannot rule out possibility that behavior of participating households was influenced by monetary incentives and frequent household visits
*Simmerman, 2011	53	Estimate efficacy of hand hygiene vs. hand hygiene coupled with facemasks to decrease influenza transmission in households through cluster, randomized, controlled trial	442 households in Bangkok, Thailand with influenza-positive children and 1,147 household contacts	Secondary attack rate was 21.5% and 56/345 secondary cases were asymptomatic. Odds ratios (ORs) for secondary influenza infection were not significantly different in hand-washing arm (OR: 1.2; 95% CI 0.76–1.88) or in hand washing + facemask arm (OR 1.2; 95% CI 0.74–1.82)	Influenza transmission was not reduced by interventions to promote hand washing and facemask use.	1. Not designed to determine exposure and transmission risk outside household setting (from exposure to ill non-household members) 2. Operation of study was complicated by arrival of H1N1 pandemic in June 2009 and subsequent national hygiene campaign that prompted behavioral changes in control group 3. Delays in implementation of interventions are inherent flaw in study design 4. Study did not assess other potentially important parameters like air flow, air quality, and other environmental factors that may play role in household influenza transmission 5. Poor adherence to interventions, especially among index cases and their younger siblings – as well as shared sleeping arrangements – may have led to underestimation of effects of hand washing or facemask use
Aiello, 2010	58	Examine whether use of facemasks and hand hygiene reduced incidence of ILI through randomized, controlled trial	1,437 students in University of Michigan residence halls	Significant reduction in rate of ILI among the facemask and hand-hygiene group during latter half of the study ranging from 35% to 51% when compared with the control group that did not use facemasks. Discrete-time survival analysis allowed estimation of rate ratio over each week of study: significant reductions observed for mask and hand-hygiene group in weeks 4-6 (p=0.01, 0.01, 0.02) and in facemask only group in weeks 3-5 (p=0.02, 0.01, 0.02) compared with control group. Covariate adjustment: ILI incidence was significantly lower among mask and hand-hygiene group compared with control group in weeks 4-6 (p=0.01, 0.01, 0.02).	Facemasks and hand hygiene may reduce respiratory illnesses in shared living settings.	1. Influenza incidence was low; most ILI cases likely not associated with influenza infection 2. Study underpowered to detect low reductions in rate of ILI and across study arms 3. Small number of clusters, suggesting some potential for inflation of variance estimates 4. Self-reported data may make study susceptible to reporting bias 5. Participants not blind to study interventions 6. Study results cannot be generalized to other non-university aged, community-dwelling populations
**Brienen, 2010	55	Mathematical model to show that mask use at population level can play important role in delaying and containing an influenza pandemic	11 studies included in forming the model	Results suggest that use of facemasks at population level can delay influenza pandemic, decrease infection attack rate, and may reduce transmission sufficiently to contain the pandemic.	Population-wide use of facemasks could make an important contribution in delaying an influenza pandemic. Mask use also reduces R_0, possibly even to levels sufficient for containing an influenza outbreak.	1. Study based on features most commonly expected in influenza – changes in these features can change effect of mask use within population 2. Did not distinguish between different sub-populations or environments

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*Canini, 2010	52	Evaluate effectiveness of surgical facemasks for limiting influenza transmission by large droplets produced during coughing through cluster, randomized trial	105 households in France of size 3 to 8 persons	Difference of ILI attack rate between intervention arm and control arm was 0.40% (95% CI: -10% to 11%, p=1.00); proportion of households with one or more secondary illness in contacts did not differ between arms.	Study did not show any significant difference in ILI proportion among household contacts between intervention arm (facemask group) and control arm.	1. Study was underpowered due to its premature termination 2. No laboratory verification of ILI self-reports; asymptomatic or subclinical infections may have been missed. In addition to including non-influenza events, this limitation may have diminished chance to identify significant effect of facemasks
Cowling, 2010	43	Systematic literature review to investigate evidence supporting effectiveness of facemasks in reducing influenza virus infection under controlled and natural conditions	12 studies reviewed from various settings in U.S., Japan, China, Canada	Studies included in the review provided limited and mixed results on the effectiveness of facemasks.	Review highlights limited evidence base supporting the efficacy or effectiveness of facemasks to reduce influenza virus transmission.	None mentioned
Cowling, 2009	56	Investigate whether hand hygiene and use of facemasks prevents household transmission of influenza through cluster, randomized, controlled trial	259 households in Hong Kong with 407 ILI patients presenting to outpatient clinics who were positive for influenza A or B virus by rapid testing	In 154 households in which interventions were implemented within 36 hours of symptom onset in the index patient, transmission of RT-PCR-confirmed infection seemed reduced, an effect attributable to fewer infections among participants using facemasks plus hand hygiene (adjusted odds ratio, 0.33 [95% CI, 0.13 to 0.87]).	Hand hygiene and facemasks prevent household transmission when implemented ≤ 36 hours of index patient symptom onset.	1. Potential bias from recruiting symptomatic persons 2. Primary outcome measure based on laboratory confirmation of influenza by RT-PCR; may have missed secondary infections that occurred 7 days or more after illness onset in index patient 3. Collection of poor quality specimens or degeneration during transport or freezing could have reduced RT-PCR sensitivity
Johnson, 2009	49	In vivo experiment to assess efficacy of both standard surgical masks and N95 masks to adequately filter influenza virus among patients with laboratory-proven acute influenza A and B to determine which was more appropriate to prevent spread	9 patients >18 years of age with clinical diagnosis of influenza seen in hospital emergency department at Austin Health in Melbourne, Australia.	No influenza could be detected by RT-PCR of the ISP (influenza sample plate) viral transport medium in any of the 9 participants for either mask.	Surgical and N95 masks appear to be equally effective in filtering influenza.	1. Only participants with positive point-of-care assay result participated in mask-assessment protocol 2. Relatively small number of participants recruited 3. No formal demonstration that virus detected in study participants was infectious and could be transmitted to other individuals 4. Method used for detecting influenza during coughing may have been too insensitive to detect small differences in mask filtration efficacy or influenza expelled from around edge of mask 5. Protocol required mask to be worn for only 3–5 minutes; cannot be sure that longer periods of mask use would be associated with same efficacy
Cowling, 2008	54	Study feasibility and efficacy of facemasks and hand hygiene to reduce influenza transmission in households through cluster, randomized, controlled trial	Residents in 128 households in Hong Kong who had ILI and lived with at least two other individuals with no reported influenza-like symptoms	Facemasks: No significant effect on secondary attack rate (AR); Hand hygiene: No significant effect on secondary AR.	No difference in laboratory or clinical secondary AR with facemasks and hand-hygiene interventions.	1. Low adherence 2. Dropout of subjects 3. Potential bias from recruiting symptomatic subjects

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*Li, 2008	51	Test efficacy of facemasks in blocking simulated droplets from breathing pathway through lab experiment	Laboratory experiment performed on 10 adults (5 men and 5 women)	Facemasks A (had exhaust valves) and B (exhaust holes) had ≥ 99% protection efficiency; surgical facemask had 95.5 to 97% protection efficiency.	More distance between breathing pathway and virus contaminated area of facemasks can provide more effective protection.	None mentioned
School Closures and Dismissals						
CDC might recommend the use of pre-emptive, coordinated **School Closures and Dismissals** during severe, very severe, or extreme influenza pandemics. This recommendation is in accord with the conclusions of the U.S. Community Preventive Services Task Force (https://www.thecommunityguide.org/findings/emergency-preparedness-and-response-school-dismissals-reduce-transmission-pandemic-influenza) which makes the following recommendations: • The task force recommends pre-emptive, coordinated school dismissals during a severe influenza pandemic. • The task force found insufficient evidence to recommend for or against pre-emptive, coordinated school dismissals during a mild or moderate influenza pandemic. In these instances, jurisdictions should make decisions that balance local benefits and potential harms.						
**Wong, 2016	90	Develop SEIR compartmental model to simulate pandemic influenza transmission, and to estimate the health and economic effects of different school closure strategies and trigger thresholds during a pandemic	Simulated population based on data from Hong Kong Census and Statistics Department; pandemic influenza transmission and effects of school closures based on data from 2009 H1N1 pandemic in Hong Kong	Individual school closure strategies that used a lower threshold to trigger school closures (3 confirmed cases at a particular school), that involved all types of schools (kindergarten, primary, and secondary), and that closed for 2 weeks performed best, preventing about 830,000 cases and costing about $1,145 (USD) per case prevented.	The most economically viable strategy is to close individual schools based on the number of confirmed [influenza] cases using small thresholds.	1. Ignored school vacations and seasonality within simulation timeframe 2. Assumed school closures would not increase per-contact probabilities of other social contact groups (e.g., family, household, and community) 3. Did not examine the effects of dismissing particular grades or classes (with remainder of the school kept open)
**Ali, 2013	75	Compare H1N1 transmission rates (as quantified by time varying reproduction number [R_t]) during and outside school terms and school holidays, for one year (5/2009-5/2010), through daily laboratory-confirmed reports and simple branching process model of epidemic spread	India as a whole and 3 regions: North-west, South, and Mid-east North-west region had 2 notable waves, with peak of first wave coinciding with start of 4-week holiday in September and peak of second wave with start of year-end vacation in December South region had 2 less clear-cut waves, with peak of first wave coinciding with 2-week holiday in August	Estimating the mean time varying reproduction number (R_t) before and after the start of 3 school holidays: 1) Ganesh Puja and Onam holidays in August, 2) Dashera and Diwali holidays in September, and 3) year-end vacation in December-January. For India as a whole, the August holidays (not observed in North-west region) were associated with a 19% reduction in H1N1 transmission rate (95% CrI: 14-26%); the September holidays with a 21% reduction (95% CrI: 18-20%); and the year-end vacation with a 20% reduction (95% CrI: 24-15%). For the North-west region, the September holidays were associated with a 27% reduction in H1N1 transmission rate (95% CrI: 22-29%); and the year-	School holidays had a significant effect on the epidemiology of the 2009 H1N1 pandemic in India. School holidays reduced the time varying reproduction number (R_t) by 14-27% in different regions of India, relative to levels seen outside holiday periods. These results suggest that contact patterns in school children have a significant impact on disease spread, although people also were encouraged during the pandemic to avoid traditional mass gatherings and travel during vacations.	1. Potential "frailty" of surveillance data due to a) capacity limits on outbreak investigation, sample collection, and laboratory diagnostics (thus, under-reporting and biases in reporting), b) variability in healthcare-seeking behavior among cases, c) lower case detection during vacations, and d) geographic variability in surveillance and laboratory capacity 2. Association between timing of school holidays and reduction in H1N1 transmission rates does not demonstrate causality, or determine precise changes in contact patterns responsible for observed changes in transmission. Supportive data on age distribution of H1N1 cases was not available

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			Mid-east region had too few reported cases for analysis	end vacation with a 25% reduction (95% CrI: 28-19%). For the South region, the September holidays were associated with a 14% reduction in H1N1 transmission rate (95% CrI: 13-16%); and the year-end vacation with an insignificant % as incidence had started to decline substantially by that time.		
Copeland, 2013	71	Compare rates of self-reported acute respiratory illness (ARI) in 2 adjacent school districts through household survey of families with children enrolled in intervention community (IC) and control community (CC)	K-12 students and their households in 2 school districts in Dallas/Fort Worth, TX metropolitan area (n=1,187 IC; n=1,155 CC)	Increase in self-reported ARI rates was 45% lower in IC (0.6% before school closure to 1.2% during) than in CC (0.4% before to 1.5% during) (RRR During/Before = 0.55, P < .001). For households with school-aged children only, IC had even lower increases in adjusted ARI than in CC.	ARI rates and influenza-related emergency department (ED) visits were reduced in "school closure" district (IC) compared with "control" district (CC) during school closure.	1. Outcome measures based on self-reported ARI, not laboratory-confirmed influenza 2. Circulation of influenza may have been different between communities 3. Given low prevalence of ARI reported in community, spike in ED influenza visits seen in late April may have been due to other factors 4. School districts did not match zip codes 5. Relying on school principals to select classrooms within randomly chosen grades could have introduced biases 6. Household survey was distributed 3 weeks following reopening of schools in school district A introducing potential for recall bias 7. Response rates low and differed between IC and CC, raising potential for participation bias 8. Collecting data from field immediately following an outbreak may have resulted in survey data containing biases
Garza, 2013	79	Estimate effectiveness of annual winter public school breaks on incidence of ILI in community through analysis of ILI surveillance using National System for Health Surveillance and school calendars for each province for public primary and secondary schools	Argentina population of all age groups in 2011 (23 provinces and city of Buenos Aires)	Largest decrease in observed ILI cases among 5-14 year olds (33% lower than expected ILI-associated healthcare visits [p<0.05] during 2 weeks of winter school break and 2 weeks after break, including 17% decrease [p=0.008] in first week of winter break.	Winter public school breaks were associated with significant decreases in the number of ILI cases in school-aged children and in community at large.	1. Aggregate data cannot be used to make inferences on causality or effect on individual persons 2. Findings represent data from visits to healthcare provider, and not laboratory-confirmed influenza 3. Surveillance data analyzed obtained primarily from public hospitals and clinics in Argentina – may not be representative of community 4. Data only include dates of winter breaks in public schools 5. Observed reductions might be caused by changes in healthcare-seeking behavior associated with break and might not represent actual disease reductions

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Jackson, 2013	69	Systematic literature review to assess effects of planned or unplanned school closures on transmission and incidence of pandemic and seasonal influenza	79 studies reviewed around school settings	Influenza incidence frequently declined after school closures. Effect sometimes reversed when schools reopened (incidence increased). Benefits associated with school closures greatest among school-aged children (~5- to 20-year olds). Sometimes unclear how much school closures contributed to reductions in influenza incidence as closures often occurred late in outbreaks.	School closures appear to have potential to reduce pandemic and seasonal influenza transmission among school-aged children. There is some evidence that incidence in adults may also be reduced.	None mentioned
*Araz, 2012	88	Mathematical model of influenza transmission to estimate impact of school closures in terms of both epidemiological and cost effectiveness	School-age children and adults. Model conducted with 200 simulations, each based on random sample of R_0. Simulated population size =24,326,974	Cost-effectiveness of strategies highly dependent on severity and on willingness to pay per quality adjusted life-year. For severe pandemics, the preferred strategy couples the earliest closure trigger with longest duration closure considered. For milder pandemics, the preferred strategy also involves the earliest closure trigger, but with shorter duration.	Highlights importance of obtaining early estimates of pandemic severity and providing guidance to public health decision-makers for effectively tailoring school closure strategies in response to a newly emergent influenza pandemic.	1. Lack of sensitivity analysis on contact rate parameters 2. Lack of model validation details and results
CPSTF, 2012	68	Systematic literature review to evaluate overall value of coordinated school dismissals for extended duration to community during influenza pandemic	67 studies reviewed using Community Guide approach	Pre-emptive, coordinated school dismissals during a severe influenza pandemic are recommended based on sufficient evidence of effectiveness in reducing or delaying spread of infection and illness within communities.	Effectiveness of school closures during an influenza pandemic may vary with unique characteristics of the pandemic, and with the abilities of national, state, and local decision-makers, healthcare providers, and the public to quickly implement and sustain a broader set of mitigation responses over an extended period of time (weeks to months).	None mentioned
Earn, 2012	72	Mathematical model to examine correlations between incidence of pandemic H1N1 influenza and school closure and weather changes, and to estimate effects of school closures and weather changes on pH1N1 transmission	Simulated population in cities of Calgary, Edmonton, and province of Alberta in Canada (n=35,510)	Ending and restarting of school terms had major effect in attenuating first wave and starting second wave of pandemic influenza cases. Mathematical models suggested that school closure reduced transmission among school-age children by more than 50% and that this was key factor in interrupting transmission.	School closures seems to be effective strategy for slowing spread of pandemic influenza in countries with social contact networks similar to those in Canada.	1. Data probably represent small sample of all viral infections 2. Mathematical models make simplifying assumptions to make simulations and analysis feasible

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*Uchida, 2012	74	Assess effects of class/ school closure during pandemic on spread of H1N1 infections in Japan through comparative case study	2,141 school children from 2 elementary and 2 junior high schools in Nagano Prefecture, Japan	The cumulative rate of H1N1 infection among these children was 40.9 %. Time-course changes in the epidemic curve showed that school closure reduced the epidemic peak more than class closure. A Poisson regression model showed that a longer duration of closure was significantly related to decreased H1N1 occurrence after the resumption of classes (incidence rate ratio = 0.702; 95 % confidence interval 0.561–0.880, P = 0.002).	School closure more effectively inhibits subsequent epidemic outbreaks than class closure. Longer closures are effective in reducing spread of infection, and should be implemented as early as possible.	1. Small study sample 2. Effects of closure determined without considering weekend effects; lack of child-to-child contact on these days may have influenced their overall rate of H1N1 infection 3. Children monitored by their parents, not by medical specialists – number of patients might have been underestimated 4. Study based on self-reports of patients diagnosed with influenza at hospital or clinic – potential bias 5. Subclinical infections may have altered effects of class/school closures
*Xue, 2012	89	Two models developed (SEIR) to evaluate cost-effectiveness of school closure during potential influenza pandemic and to examine trade-off between costs and health benefits for school closure	Simulated population of all age groups from Oslo, Norway (n=587,000)	Using a case fatality rate (CFR) of 0.1-0.2% and with current cost-effectiveness threshold for Norway, closing secondary school is the only cost-effective strategy, when indirect costs are included. The most cost-effective strategies would be closing secondary schools for 8 weeks if R_0=1.5, 6 weeks if R_0=2.0, and 4 weeks if R_0= 2.5.	School closure has moderate impact on the epidemic's scope, but the resulting disruption to society imposes a potentially greater cost in terms of lost productivity from parents' work absenteeism.	1. Age specific contact rate data adopted from Dutch study, as no Norwegian data on social mixing is currently available. The contact pattern in Norway may differ due to high attendance rates in kindergarten and high employment rate of women. 2. Effect of school closure on contact pattern in population not well documented in literature and is uncertain 3. Lack of model validation details and results 4. Study involves population whose baseline health status or experience with school closure may not reflect conditions in U.S.
*Zhang, 2012	87	Simulation model to answer 3 questions: 1) Do combined interventions always outperform single interventions? 2) How do trigger threshold and duration affect effectiveness of combined interventions? 3) Does implementation sequence in a combined intervention make a difference in its effectiveness?	Simulated population represents 10% of Singapore population with total of 6 types of community structures considered: households, hospitals, schools, workplaces, shopping places, and public transport	Combined interventions do not always outperform individual interventions and are more effective only when the duration is longer than 6 weeks or school closure is triggered at the 5% threshold. Combined interventions may be more effective if school closure starts first when the duration is less than 4 weeks or workforce shift starts first when the duration is longer than 4 weeks.	Exploring correct timing configuration is crucial to achieving optimal or near optimal effect of mitigation for influenza epidemic.	1. Influence of visitors not considered – focused on investigating and comparing effectiveness of individual and combined intervention scenarios 2. Lack of model validation details and results 3. Study involves population whose baseline health status or experience with school closure may not reflect conditions in U.S.

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Chowell, 2011	73	Use influenza surveillance data and transmission model to evaluate effectiveness of mitigation strategies initiated during spring pandemic wave	Workers and their families in Mexico (n=~42.8 million)	Three-wave pandemic profile was identified, with initial wave in April-May (Mexico City area), a second wave in June-July (southeastern states), and geographically widespread third wave in August-December. Estimated 29%-37% reduction in influenza transmission in spring 2009 in the greater Mexico City due to school closures and other social distancing measures.	School closures and other mitigation measures could be useful to mitigate future influenza pandemics.	1. Researchers used ILI and laboratory-confirmed influenza cases reported to Mexican Institute for Social Security Network in 32 states – may be sampling variations between states 2. Reduction in R_0 observed during social distancing period occurred during period of increasing testing rates – overestimation of growth rate in H1N1 cases 3. Researchers cannot rule out impact of other factors on R_0 estimates, including reduction in delay from symptom onset to hospital admission in spring 2009, potentially reducing effective infectious period
Zhang, 2011	82	Evaluate impacts of temporal factors – trigger threshold and duration – on effectiveness of school closure as mitigation policy in influenza pandemic through individual-based simulations on realistic social-contact network model constructed with real-life data	Set up 100,000 households according to Singapore household size distribution, household structure, and age distribution (n=~480,000)	Found upper bound of duration of school closure, where further extension beyond it will not bring additional benefits to suppressing attack rate and peak incidence. For school closure with relatively short duration (<6 weeks), it is more effective to start closure after a relatively longer delay from first day of infection. If duration of school closure is long (>6 weeks), it is better to start it as early as reasonable.	Study reveals critical importance of timing in school closure, especially in cost-cautious situations.	1. Influence of visitors not considered – focused on investigating and comparing effectiveness of individual and combined intervention scenarios 2. Study involves population whose baseline health status or experience with school closure may not reflect conditions in U.S.
Chao, 2010	70	Computer simulation to quantify temporal relationship between opening of U.S. public schools and observed increase of ILI (elevated ILI %)	U.S. population in 2009	Beginning of elevated influenza activity was highly correlated with the median school opening date (Spearman correlation coefficient-0.62, P<1.0x10-5).	Detectable widespread transmission of pandemic H1N1 occurred 2 weeks after schools in a state opened. A delay in opening of schools could delay onset of impending epidemic.	1. Results could be refined with data at finer spatial and temporal resolutions 2. Data aggregated by multi-state region – difficult to determine timing of outbreaks on school district level 3. Regional ILI% baseline values used may not have captured variation in baselines that could exist within a region
Halder, 2010	86	Computer simulation to examine school closure intervention strategies to inform public health authorities as they refine school closure guidelines in light of experience with A/H1N1 2009 pandemic	Schools from real community of Albany, Australia (population size n=30,000)	Illness attack rate was reduced from 33% to 19% (14% reduction in overall attack rate) by 8-week school closure activating at 30 daily diagnosed cases in the community for an influenza pandemic with R_0 = 1.5.	Results indicate that the particular school closure strategy to be adopted depends both on the disease severity, which will determine duration of school closure deemed acceptable, and its transmissibility.	1. Model based on population in developed country – outcomes may not be applicable to populations in developing country 2. Focused on reduction in number of daily symptomatic cases and cumulative illness attack rate rather than on influenza-related adverse events such as hospitalizations and deaths 3. Did not account for possible antiviral drug resistance

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Lee, 2010	83	Agent-based computer simulation to assess impact of school closure as mitigation strategy during influenza pandemic	Population of Allegheny County, PA; representing individual households, schools, and workplaces (n=1,242,755)	Entire school system closures were not more effective than individual school closures. Any type of school closure may need to be maintained throughout most of the epidemic (at least 8 weeks) to have any significant effect on overall serologic attack rate.	School closure alone may not be able to quell an epidemic but, when maintained for at least 8 weeks, could delay the epidemic peak for up to a week, providing additional time to implement a second more effective intervention such as vaccination.	1. Influenza pandemic and resulting circumstances may not necessarily conform to data and assumptions that model drew from referenced sources or previously published models 2. Simulation did not include mortality as epidemic parameter which could vary with influenza viruses 3. Did not model effects of hand-hygiene measures because their quantitative effects on influenza transmission have not been established
Morimoto, 2010	85	Assess intervention strategies against novel influenza epidemic through simulations of various scenarios in Sapporo City, Hokkaido, Japan	Residents of Sapporo City, Japan in households, playgroups, schools, colleges, and workplaces (n=1,880,863)	Both targeted antiviral prophylaxis (TAP) and school-age targeted antiviral prophylaxis (STAP) interventions were highly effective in suppressing spread of infection during the early period of an outbreak, but STAP was inferior to TAP in terms of the ripple effect of administration of anti-virus drugs. School closure and restraint brought about a delay in the peak of infection.	Based on simulation results, recommend implementing TAP together with both school closure and restraint as strategies against a future novel influenza outbreak.	1. Effectiveness of school closure may be over-estimated, as it is difficult to implement closure for such a long period as was assumed in the model
Wheeler, 2010	80	Analyze effect of annual 2-week closure of schools during winter holidays on incidence of influenza among school-age children through analysis of Arizona passive surveillance data	Influenza cases in Arizona stratified by age: exposed to social distancing provided by school closure (5-17 years old) and not exposed (those < 4 and > 18 years old)	From "before" to "during" school closure: rates among school-age children did not significantly increase compared to non-school age children and adults. From "during" to "after" school closure: rates in school-age children increased significantly.	Community-wide school closures during an influenza pandemic may significantly reduce the incidence of influenza among school-age children.	1. No information on behaviors of influenza cases 2. No data on specific school attended by each school-age case to identify with certainty individual school closure periods 3. Assumed that small deviations in closure periods resulted in non-differential misclassification of influenza cases – results most likely underestimate true effects 4. Holiday break generally occurs early in influenza season – future studies may consider doing similar analyses on extended school closures taken later in the year
Heymann, 2009	77	Analyze effect of nationwide closure of public elementary schools in Israel (due to teachers' strike) in 2000 on spread of upper respiratory tract diseases, including influenza through observational study	21,932,000 physician visits recorded between 1998-2002 in Israel's Maccabi Healthcare Services	Strike variable significantly decreased ILI "peak" ratio (to non-respiratory) for school-aged children in strike year in 2000 (p=0.007), compared to other years. Smaller decrease seen for adults with no school-aged children in 1999 (p=0.037). Chanukah holiday had negative impact on ratio for school-aged children in 1998, 1999, and 2001 (p=0.008, 0.006, and 0.045, respectively) and was significant for both adult groups in 1999 and adults with no school-aged children in 2001.	This "natural experiment" study provides evidence of significant effect of school closure on reducing ratio of number of physician visits due to ILI to those with non-respiratory illness for school-aged children.	1. Use of non-specific outcomes to define influenza – school closure effective for seasonal respiratory viral spread in community, but cannot assume same for influenza 2. Design does not predict magnitude of preventive effect of school closure 3. Patients may have sought care in ER and diagnostic data limited to clinic visits (bias) 4. Did not include children ages >6 years old as many continued to attend preschool – presence in families with school-aged children may have weakened beneficial effect of school strike 5. Due to high percentage of population that are children, results may not apply to Western countries with lower proportion of children

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Sypsa, 2009	84	Explore effectiveness of various intervention strategies in European region using individual-based stochastic simulation model	Simulated community of approximately 2,000 people to match age distribution, household size, and number and size of schools of Greek population	With 100% school closure, total number of symptomatic cases is predicted to decrease by 89.3%, as compared to the non-intervention scenario. When school closure is coupled with treatment and home isolation of symptomatic cases and a 50% reduction of social contacts, a 94.8% decline in the cumulative attack rate is predicted along with much shorter duration of influenza A(H1N1)v transmission.	Active surveillance that will ensure timely treatment and home isolation of symptomatic cases in combination with school closure seem to form an efficient strategy to control the spread of influenza A(H1N1)v.	1. Uncertainty remains concerning key epidemiological parameters of influenza A(H1N1)v 2. Simulation model applied to community of 2,000 people – results concerning anticipated duration and peak of outbreak do not apply for an epidemic in whole country 3. Assumptions of small community model is that after initially infected persons have been seeded into the community, then that population remains isolated 4. Model did not consider workplaces as mixing groups but rather used higher transmission probabilities for contacts
Caley, 2008	92	Investigate hypothesis that multiple epidemic waves caused by people avoiding potentially infectious contacts through modeling	Total population size of Sydney, Australia (n=810,700)	Approximately 22% of population spared from clinical infection, and estimated 260 per 100,000 lives saved. Estimate, on average, people reduced their infectious contact rate by as much as 38% during 1st wave and 24% during 2nd wave.	Social distancing interventions could play major role in mitigating public health impact of future influenza pandemics.	1. Smaller changes in degree of social distancing would explain epidemic waves. R_0 cannot be reduced much below 1.6 before it becomes impossible to achieve an attack rate of 36.6% in an epidemic with two waves of similar magnitude. 2. Longer serial interval would have produced higher estimates of R_0 3. Other interventions such as closing schools and quarantining infected persons probably did not contribute to changes in R(t)
Cauchemez, 2008	78	Computer simulation/ analysis of disease surveillance data to quantify role of schools in influenza epidemics and predict effect of school closure during pandemic	Data on sentinel population and simulated population match structure of French population	Holidays lead to 20%-29% reduction in rate at which influenza is transmitted to children. Holidays prevent 16%-18% of seasonal influenza cases (18%-21% in children). Prolonged school closure during pandemic might reduce cumulative number of cases by 13%-17% (18%-23% in children) and peak attack rates by up to 39%-45% (47%-52% in children).	Use of school closure in a severe pandemic is not ruled out, but expectations of the scale of reduction in overall illness and mortality achievable through this measure alone should be tempered.	1. Extrapolations to pandemic contexts rest on relatively strong assumption that people will behave during a pandemic as they do during seasonal outbreaks 2. Extrapolation to developing countries is more difficult because of lack of independent data
Yasuda, 2008	81	Analyze 3 measures against spread of influenza: prohibition of traffic, school closure, and vaccination of school children in Greater Tokyo through individual-based simulation model	Simulated population of Tokyo, Japan	For school closure starting 1, 2, 3, and 4 weeks after the beginning of the epidemic, the averages of total number of newly infected were 2,756, 2,895, 2,820, and 2,696, respectively. Peaks of the number of infected in 3 towns coalesced about 6 weeks after the beginning of the spread of influenza. School closure within 3 weeks delayed the peak of the epidemic more than 2 weeks.	School closure delayed the epidemic and reduced peak of disease, but was not as effective in decreasing the number of infected people.	None mentioned

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Heymann, 2004	76	Evaluate effect of school closure on occurrence of acute respiratory tract infection among children ages 6-12 years and impact on healthcare services utilization through retrospective cohort study	186,094 children (ages 6-12 years old) cared for by Maccabi Healthcare Services in Israel	Significant decreases in diagnoses of respiratory tract infections (42%), visits to physicians (28%) and emergency departments (28%), and medication purchases (35%) during school closure compared with before and after closure.	School closure was temporally associated with decreased morbidity from respiratory tract infections, consequent decrease in visits to physicians and emergency departments, and reduction in purchases of medications.	1. Results may not be applicable to Western countries with lower percentage of children and differences in parental attitudes toward respiratory illness symptoms in other cultures 2. Limited availability of over-the-counter medications
*Langmuir, 1958	91	Historical account of 1957 Asian influenza pandemic surveillance	Multiple surveillance reports reviewed	Readily apparent that an outbreak was related to the opening of summer school sessions in a rural area of Louisiana where children were required to work at the harvest later in the season. Spread from school children to other members of families was clearly demonstrated. In early September when schools and colleges began to open, number of influenza outbreaks increased greatly.	Consistent pattern of initial involvement of high school children, followed by spread to elementary school children and adult populations; reopening of schools increased outbreaks.	None mentioned
Social Distancing Measures for Schools, Workplaces, and Mass Gatherings						
Even though the evidence base for the effectiveness of some of these measures is limited, CDC might recommend the simultaneous use of multiple **Social Distancing Measures** to help reduce the spread of influenza in community settings (e.g., schools, workplaces, and mass gatherings) during severe, very severe, or extreme pandemics while minimizing the secondary consequences of the measures. Social distancing measures include the following: • Increasing the distance to at least 3 feet between people whenever possible might reduce person-to-person transmission. This applies to apparently healthy persons without symptoms. In the event of a very severe or extreme pandemic, this recommended minimal distance between people might be increased. • Persons in community settings who show symptoms consistent with influenza and who might be infected with (probable) pandemic influenza should be separated from well persons as soon as practical, be sent home, and practice voluntary home isolation.						
Rashid, 2014	122	Systematic literature review to assess impact of school- and workplace-based interventions, case-based distancing (self-isolation, quarantine), and restriction of mobility and mass gatherings against pandemic influenza. For each intervention, review assessed: 1) evidence of effectiveness, 2) secondary effects, and 3) practicalities and expectations	80 studies reviewed with emphasis on papers published in or after 2008	Results of the "evidence of effectiveness" component of the review: • Proactive school closures can reduce influenza transmission from 1%-50% and delay peak of the epidemic by a week or two; reactive school closures may reduce transmission by 7%-15%, rarely up to 90%-100%. • Modeling studies suggest that 10% workplace closure has only modest impact while 33% workplace closure lessens attack rate to less than 5%, and delays peak by 1 week. • Home-working (teleworking) is moderately effective in reducing influenza transmission by about 20% - 30%.	Overall, social distancing measures appear modestly effective. Many are likely to be acceptable in the short-term, but there is a lack of strong evidence. • School closures are moderately effective and acceptable in reducing disease transmission and delaying the peak of an epidemic, but associated with high secondary costs. • Voluntary home isolation and quarantine are effective and acceptable, but associated with increased risk of intra-household transmission. • Workplace-related interventions (work closures and teleworking) are	1. Dearth of high-quality studies and controlled trials of social distancing measures. Quality of evidence is weak and based primarily on observational or simulated (modeling) data 2. Need systematic reviews to evaluate interactions between social distancing measures and other interventions, such as use of facemasks, vaccines, and antivirals 3. Use of arbitrary scales for effectiveness and economic impact

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				• Data on voluntary home isolation are limited. Overall effectiveness of the measure is moderate; may delay peak of influenza when combined with other measures. • Modeling studies indicate that home quarantine decreases peak case load and attack rate and delays peak. • Effectiveness of cancellation of mass gatherings is not proven but modeling studies suggest some benefit if cancelled around peak of the epidemic. • Modeling studies suggest that high internal mobility (travel) restriction (50%) delays peak of influenza. A minimal travel restriction is not helpful.	modestly effective and acceptable, but likely to be economically disruptive. • Mass gatherings occurring within 10 days before the epidemic peak are likely to increase the risk of influenza transmission. • Internal mobility (travel) restrictions are effective only if implemented at prohibitively high rates (50% of travel).	
*Bolton, 2012	132	Assess benefit of interventions under consideration for use in Mongolia during future influenza pandemics through stochastic, compartmental patch model	Mongolian population	In a moderate pandemic scenario, early social distancing measures decreased the mean attack rate from around 10% to 7–8%. In a severe pandemic scenario, such measures cut the mean attack rate from approximately 23% to 21%. In both moderate and severe pandemic scenarios, a suite of NPIs proved as effective as the targeted use of antivirals.	To be successful, interventions to prevent influenza transmission must be triggered when the first cases are detected in border regions. If social distancing measures are introduced at this stage and implemented over several weeks, they may have a notable mitigating impact.	1. Fail to consider all interventions used 2. Neglect seasonal and other secondary effects (age dependency in immune response, population mixing) 3. No allowance made for virus transmission at household level – benefits of social distancing and quarantine may be overestimated 4. Results based on data from Mongolia – may not be applicable to U.S. community settings
*Herrera-Valdez, 2011	131	Investigate ”drivers” of 2009 pandemic spread in Mexico in relation to transportation/population movement, social distancing measures, and population density through qualitative analysis and modeling exercise	Mexican population	Models support that the three ”waves” observed in Mexico were a result of synergistic interactions of 1) regional movement patterns, 2) impact and effectiveness of strict social distancing measures, and 3) summer recess for school children.	Social distancing measures and school closures can have delaying effect in spread of pandemic influenza.	1. No mention of conducting sensitivity analyses 2. Lack of model validation details and results 3. Bias in interpreting results due to estimations in fitting rate of change in sample data 4. Results based on data from Mexico – may not be applicable to U.S. community settings
Ishola, 2011	121	Systematic literature review to identify evidence related to NPI use and effectiveness at mass gatherings to inform policy statements during a pandemic	24 studies reviewed, covering mass gatherings of varying sizes and settings	Mass gatherings may be associated with increased risk of influenza transmission, but association is highly variable; most likely to occur at large, multiple day, open-air events. Type of mass gathering can increase risk; key factors include degree of crowdedness, event duration, and either indoor/outdoor venue (such as outdoor tents, etc.).	Limited data to support that mass gatherings are associated with influenza transmission, but some evidence indicates restricting mass gatherings together with other NPIs may help reduce transmission.	None mentioned

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*Yang, 2011	129	Assess effectiveness of NPIs including: 1) refraining from social activities, 2) school closures, and 3) household quarantine through Individual Space-Time Activity-based Model (ISTAM)	General population of Eemnes, Netherlands (n=8,382)	Among the set of NPIs tested, refraining from social activities with various compliance levels was relatively ineffective. Household quarantine was very effective, especially for the peak number of cases and total number of cases, with large differences between compliance levels. When coupling NPIs, household quarantine with school closure was the most effective strategy.	Simulated results showed that household quarantine was the most effective control measure, while school closure and household quarantine implemented together achieved the greatest benefit.	1. Unable to validate model directly due to lack of historical data on impact of NPIs on disease outbreaks in Eemnes, Netherlands 2. Results based on data from Netherlands – may not be applicable to U.S. community settings
**Lee, 2010	124	Validate effectiveness of public health interventions in reducing influenza spread during 2009 H1N1 pandemic through prospective observational cohort study	Singapore military personnel (n=1,015)	Seroconversion among essential units and healthcare workers was significantly lower than that in normal units ($P<0.001$). Symptomatic illness attributable to influenza was lower in essential units and healthcare workers than in normal units ($P=.06$).	Public health measures are effective in limiting influenza transmission in closed environments.	1. Relatively few groups for comparison and study's inability to separate the incremental impact of each individual intervention 2. Did not monitor participants after epidemic to determine if cumulative case numbers trended toward parity over time for the different groups
Lim, 2010	123	Describe steps taken and lessons learned to mitigate influenza A H1N1 during Asian Youth Games in 2009	~2,000 participants (athletes and officials) of Asian Youth Games in Singapore	WHO declared a pandemic 1 week before start of the games; through planning, flexibility, and communication of the containment and mitigation measures, the games were implemented as scheduled. 66 suspected cases were identified; 6 were confirmed positive for H1N1.	It is possible to prevent outbreaks of influenza within a large, international mass gathering with the use of good planning, early case detection, and appropriate mitigation measures (including rigorous disease containment measures).	None mentioned
*Kelso, 2009	127	Predict effectiveness of intervention strategies in a pandemic, and determine their magnitude and timing of activation that would be necessary to arrest a future pandemic through individual-based model	Urban community in Albany, Australia (n=30,000)	With R_o of 1.5, a combination of 4 social distancing measures could reduce the final attack rate from 33% to below 10 % if introduced within 6 weeks from the introduction of the first case. With R_o of 2.5, these measures must be introduced within 2 weeks of the first case to achieve a similar reduction. With R_o of 3.5, the combination of all 4 measures could reduce the final attack rate from 73% to 16% when introduced without delay. With a higher R_o, no single measure has a significant impact on attack rates.	The results suggest critical role of social distancing in the potential control of a pandemic, indicating that such interventions are capable of arresting influenza epidemic development, but only if they are used in combination, activated without delay, and maintained for a relatively long period.	1. No mention of conducting sensitivity analyses 2. Lack of model validation details and results 3. Results based on data from Western Australia – may not be applicable to U.S. community settings – may not be applicable to developing countries with lower population mobility and/or higher population densities

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*Halloran, 2008	130	Simulate effectiveness of set of potentially feasible intervention strategies and examine robustness of results of model assumptions through stochastic simulation models	Chicago population (n=8.6 million)	At lowest R_o, in all 3 models, all 5 baseline intervention scenarios are effective at reducing the illness attack rates. Both UW/LANL and Imperial/Pitt models show an increasing effectiveness in reducing attack rates as community social and workplace distancing increased from 0% to 50%.	At the expected transmissibility of a pandemic strain, timely implementation of a combination of targeted household antiviral prophylaxis and social distancing measures could substantially lower illness attack rate before highly efficacious vaccine is available.	1. Lack of model validation details and results
*Milne, 2008	128	Compare modeled results of final attack rates in absence of any interventions and effect of school closure as single intervention with other published individual-based models of pandemic influenza in developed world through individual-based, stochastic simulation model	Urban community in Albany, Australia (n=30,000)	Multiple social distancing measures applied early and continuously can be effective in interrupting transmission of the pandemic virus for R_0 values up to 2.5. Different conclusions reached on the simulated benefit of school closure in published models appear to result from differences in assumptions about the timing and duration of school closure and flow of effects on other social contacts resulting from school closure.	Results suggest NPIs have key role in slowing rate of growth of the pandemic until vaccination or antiviral drugs become available. Many countries may not have access to pandemic vaccine or to antiviral drugs, further highlighting the importance of NPIs. Models of the spread and control of pandemic influenza have the potential to assist policy makers with decisions about which control strategies to adopt.	1. Lack of model validation details and results 2. Results based on data from Western Australia – may not be applicable to U.S. community settings – may not be applicable to developing countries with lower population mobility and/or higher population densities
Hatchett, 2007	125	Test whether 19 classes of NPIs implemented early in 1918 pandemic were associated with reduced influenza transmission through retrospective cohort study	17 large U.S. cities impacted by 1918 pandemic with complete historical account of public health response to pandemic	Early implementation of 4 or more NPIs (before cumulative excess pneumonia/ influenza deaths > 20/100,00: 3-6% population infected) 1) was statistically associated with a lower peak excess mortality (Spearman = -0.49 to -0.68, P=0.002-0.047); 2) were similar for normalized peak death rates (and possible cutoffs for excess deaths); and 3) had a fewer total excess deaths during study period (405 vs. 551 per 100,000 population, P=0.03).	Rapid implementation of multiple community NPIs can reduce influenza transmission, but relaxation of interventions can result in renewed spread.	1. Use of observed weekly excess fatality rates as proxy for weekly community morbidity rates 2. Varying patterns of bacterial colonization or other identified factors could contribute to variation 3. Potential systemic error due to differences in case fatality proportions between cities 4. Source materials may not have captured full range of interventions used or reflect true timing of implementation

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
Markel, 2007	126	Determine whether city-to-city variation in excess death rates was associated with timing, duration, or combination of NPIs through retrospective cohort study	43 large U.S. cities with complete archival and mortality data	Combining school closures and cancellation of mass gatherings were the most common combination and were significantly associated with reductions in weekly excess death rate. Early NPI implementation had greater delays in reaching peak mortality (spearman r = -0.74, p < 0.001), lower peak mortality rates (spearman = r=0.31, p=0.02), and lower total mortality (spearman r=0.37, p=0.008). Increased duration of NPIs was statistically associated with reductions in total mortality burden (spearman r=-0.39, p=.005).	Early, sustained, and layered application of NPIs appeared to have mitigated the impact of the 1918 influenza pandemic in many cities. Timing alone was not as important as the choice and combination of NPIs implemented.	1. Difficulties in interpreting 90-year-old historical data
Environmental Surface Cleaning Measures						
CDC recommends **Environmental Surface Cleaning Measures** in all settings, including homes, schools, and workplaces, to remove influenza viruses from frequently touched surfaces and objects. Use of these measures might help prevent transmission of various infectious agents, including seasonal and pandemic influenza (https://www.cdc.gov/nonpharmaceutical-interventions/environmental/index.html; https://www.cdc.gov/oralhealth/infectioncontrol/questions/cleaning-disinfecting-environmental-surfaces.html).						
**Pillet, 2016	151	Evaluate presence of viral RNA from epidemic viruses (e.g., influenza virus) through behavioral questionnaire and sampling mobile phones (MPs)	114 healthcare workers (HCWs) from University Hospital in Saint-Etienne, France	Viral RNA was detected on 38.5% collected MPs; presence of viral RNA was significantly associated with MPs from pediatric HCWs (p<0.001).	Findings raise possible role of MPs in cross-transmission of epidemic viruses in hospitals, with the transfer from nonporous fomites to fingers and from fingers to fomites including MPs.	1. Only viral RNA was detected on MPs, without presumption of the possible infectious potential of the different viruses 2. Concerns of absence of virus load determination on MPs by RT-qPCR 3. Not able to show correlation between contamination of MPs and frequency of hand hygiene
Otter, 2016	148	Non-systematic review of studies evaluating influenza and human coronavirus survival on dry surfaces	Of 254 studies identified, 198 focused on influenza in terms of survival on surfaces, fomite transmission, surface contamination, and disinfection; 13 focused on survival of influenza viruses on dry surfaces	Influenza can survive for extended periods on dry surfaces, sometimes up to months.	Viruses with pandemic potential including influenza, MERS-CoV, and SARS-CoV can survive for extended periods on dry surfaces, cause contamination in field settings, and may require enhanced cleaning and disinfection to assure effective infection prevention and control.	None mentioned
**Goyal, 2014	156	Evaluate efficacy of condensing hydrogen peroxide vapor (HPV) system in inactivation of viruses dried on stainless-steel discs through laboratory experiment	Laboratory experiment to test following viruses: avian influenza virus, swine influenza virus, human adenovirus, feline calicivirus (norovirus surrogate), and SARS coronavirus surrogate	No viable viruses were identified on stainless steel discs after HPV exposure at any of the vaporized volumes of hydrogen peroxide tested (25, 27, and 33 mL).	HPV is virucidal for viruses (including influenza virus) dried on surfaces. HPV may be considered for the disinfection of virus-contaminated surfaces in many settings (e.g., healthcare, veterinary, and public settings).	1. Study tests use of HPV on cleaned surfaces; need additional studies to confirm that HPV also works on soiled surfaces 2. Study involves viruses dried on stainless-steel discs, mimicking only one type of surface; need additional studies to confirm that HPV can inactivate viruses on a range of materials

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
**Oxford, 2014	147	Investigate survival of influenza A H1N1 virus on common household surfaces through laboratory experiment. Contaminated each surface with infective dose of H1N1, and rinsed viral samples off at 7 time points (0, 1, 8, 24, 48, 60, and 72 hours) and inoculated into cell culture. After 3 days, determined titer of recovered virus by hemagglutination assay	Laboratory experiment involving viruses on wood, stainless steel, plastic, or cloth surfaces	Infectious particles of influenza H1N1 survived on: • Wooden surfaces for 48 hours; • Stainless steel and plastic surfaces for 24 hours; and • Cloth surfaces for 8 hours.	Influenza A H1N1 can survive on common household surfaces for extended periods of time. This finding suggests that good hand hygiene and regular cleaning and disinfection of commonly touched surfaces can help reduce disease transmission during influenza seasons.	1. Short survival time on cloth might be due to technique used to elute the virus from the cloth or to presence of inhibitory substances in the cloth fibers 2. A report of shorter (4 hour) survival times on wood from a different research group (Greatorex et al, 2011) could be due to use of different types of wood or to different experimental procedures
**Zietler, 2014	157	Evaluate efficacy of glucoprotamin-containing surface disinfectant (previously shown to have high virucidal activity against viruses in solution) against viruses dried on surfaces through laboratory experiment. Exposed vacuum-dried viruses (influenza A or vaccinia virus) to 0.25%, 0.5%, and 1% disinfectant for 5 min, 15 min, and 30 min without agitation. Determined residual infectivity by endpoint dilution titration in cell culture	Laboratory experiment involving viruses dried on stainless steel, glass, and polyvinyl chloride (PVC) carriers	For complete inactivation of influenza viruses: • In suspension: Required 5 minutes exposure to 0.25% solution of disinfectant • Dried on stainless steel or glass: Required either 15 minutes exposure to 0.25% solution of disinfectant or 5 minutes exposure to 1% solution • Dried on PVC: Required 30 minutes exposure to 0.50% solution of disinfectant • Dried on all surfaces: Required 15 minutes exposure to 1% solution of disinfectant	Viruses in a dried state (especially on PVC surfaces) are less susceptible to glucoprotamin-containing disinfectants than viruses in suspension. Mechanical action (rubbing or wiping) may be needed to bring attached viruses into contact with virucidal compounds; simple exposure to the disinfectant may not be sufficient. This may be especially important when disinfecting medical devices or equipment for surgical applications.	None mentioned
*Jeong, 2010	153	Assess efficacy of different disinfection methods typically used in healthcare settings on inactivation of influenza A virus (H1N1) through experimental laboratory study	Laboratory experiment	H1N1 completely inactivated to undetectable levels in 1 minute using 0.1 mol/L NaOH, 70% ethanol, 70% 1-propanol, and solvent/detergent treatments in surface and suspension tests. H1N1 inactivated to undetectable levels within 5 minutes, 2.5 minutes, and 1 minute of heat treatment at 70, 80, and 90 degrees C, respectively, in suspension tests. H1N1 completely inactivated by ethylene oxide treatment in surface tests.	H1N1 nosocomial transmission can be prevented by disinfection and cleaning of medical equipment, surgical instruments, and hospital environmental surfaces using common disinfectants and physical treatments.	None mentioned

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
*Simmerman, 2010	150	Measure prevalence of influenza surface contamination, effect of hand washing, and potential association of absolute humidity and indoor air temperature with surface contamination through study nested within larger prospective household cohort study - Household Influenza Study [HITS]	90 urban households in Bangkok, Thailand with children ages <=15 years with lab-confirmed influenza	16 (17.8%) of 90 households had at least 1 influenza A positive surface, but viruses were not viable. Control compared to intervention households had higher prevalence of surface contamination (24.4% vs 11.1%). Index patients in control group reported mean of 2.8 hand-washing episodes per day compared with 3.8 per day in intervention group. In households with secondary infections, effect of lower absolute humidity on surface contamination was detected (p=-.07).	Influenza virus RNA can be detected from common household surfaces and fingertips of ill children. Lower absolute humidity also favored contamination.	1. Study design limits ability to arrive at conclusions about contribution of contaminated surfaces to influenza transmission 2. Human and lab resource constraints prevented collection of surface swab samples from day-1 and day-7 home visits 3. Isolating viruses from household surface samples difficult because they are subject to rapid degradation 4. Small numbers limited statistical analysis 5. Secondary exposures of interest not randomized, which increases potential for confounding 6. Swabbing only on day 3 means authors cannot know whether secondary infections that were detected were result or cause of surface contamination
*Rudnick, 2009	155	Assess efficacy of hydrogen peroxide (HP) and triethylene glycol (TEG) at low vapor concentrations as surface disinfectants through experimental laboratory study	Laboratory experiment	Exposure to 10-ppm of HP for 2.5 minutes resulted in 99% inactivation of influenza viruses (detectable titer levels). For air saturated with TEG at ambient temperatures (25 to 29 degrees C), disinfection rate was ~1.3 log10 reductions per hour, 16 times faster than natural inactivation under normal, non-treated ambient conditions. TEG had a slower disinfection rate compared to HP, even at higher ppm concentrations.	Vapor concentrations of 10 ppm of HP or 2 ppm of TEG can provide effective surface disinfection. These concentrations will not impact airplane mechanical components or avionics.	None mentioned
*Patnayak, 2008	154	Assess virucidal efficacy of 9 disinfectants at different concentrations and time durations on AIV, aMPV, and NDV, and virucidal efficacy of 3 different hand sanitizers on aMPV and NDV through laboratory study	Laboratory study to test 9 different disinfectants on contaminated stainless-steel discs	Phenolic compounds and glutaraldehyde were found to be most effective against all 3 viruses. Quaternary ammonium compounds were effective against aMPV but not against the other 2 viruses. All 3 hand sanitizers were effective against aMPV and NDV within 1 minute of application on fingers (not tested against AIV).	There are many available disinfectants that are efficacious against common viruses in the poultry industry and should be used to slow transmission of these viruses among poultry and humans.	None mentioned
*Thomas, 2008	152	Assess survival and duration of infectiousness of human influenza viruses on banknotes through laboratory experiment	Laboratory experiment	Influenza A viruses from banknotes survived (per cell culture) 3 days when inoculated at high concentrations; increased to 17 days in presence of respiratory mucus. Influenza B virus still infectious > 1 day when mixed with respiratory mucus. When using nasopharyngeal secretions from naturally-infected children to inoculate banknotes, influenza virus survived at least 48 hours in 1/3 of case-patients.	Human influenza viruses survive and maintain their infectiousness for several days when deposited on banknotes.	1. Some factors not considered in the experiment, including: type of surface, type of virus used, viral concentration, temperature, humidity, light and UV conditions, and pH

Author, Year	Ch. 3 Ref #	Study Goals and Design	Setting, Population, and Sample Size	Key Results	Conclusions	Limitations
*Boone, 2005	149	Evaluate prevalence of influenza A virus on surfaces in daycare and private home settings and assess potential role of fomites in transmission of influenza through sampling/testing of fomites	310 fomites in 14 day care centers and 8 homes in Tucson, AZ	Influenza A detected on 23% of daycare fomites in fall and 53% during spring - most often on kitchen dishcloths and diaper changing areas. No influenza virus was detected at home during summer, but 59% of fomites tested in March were positive - most often on phone receivers.	Influenza A virus can be detected on (hard, non-porous) indoor surfaces - at daycare centers and home settings. Differences in detection rates could be influenced by frequency at which surfaces/objects are cleaned or disinfected.	1. Infectivity of detected influenza viruses not tested
*Bean, 1982	11	Assess survival of laboratory grown influenza A (H1N1) and B viruses on surfaces; investigate transmission of influenza viruses via hands and environmental surfaces through laboratory experiment	Laboratory experiment	Both influenza A and B survived on hard, non-porous surfaces (metal/plastic) for 24-48 hours, but less than 8-12 hours on cloth/tissue/paper. Persons shedding heavy virus could transmit disease for 2-8 hours via stainless-steel surfaces and for a few minutes via paper tissues.	Hand contact with contaminated environmental surfaces and subsequent self-inoculation may result in transmission of influenza virus.	None mentioned

Appendix 6. List of Individual Studies Included in 14 NPI Systematic Literature Reviews and Meta-analyses

The evidence-based papers cited in the *NPI Toolbox* in Chapter 3 in Technical Report 1 include 14 systematic literature reviews and meta-analyses composed of ~475 individual studies (listed below) that were reviewed and analyzed by their respective authors. CDC CI-ICU staff did not re-review them. The studies contribute to the overall body of literature on NPIs, and help support the evidence base on the effectiveness of NPIs.

Personal Protective Measures for Everyday Use

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Appendix 7. Tools and Resources for Pandemic Influenza Planning and Preparedness

Tools and resources developed by non-governmental public health partners to help states and localities in pre-pandemic planning for NPI implementation and to facilitate community engagement include:

- **American Academy of Pediatrics (AAP)**
  (http://www.healthychildcare.org/PDF/InfDiseases/AR_PanFlup.pdf)

- **American Journal of Bioethics (AJB)**
  - An AJB article published during the 2009 H1N1 pandemic entitled "*Listen to the people": public deliberation about social distancing measures in a pandemic* (Baum NM, Jacobson, PD, Goold SD. Am J Bioeth. 2009 Nov; 9(11):4-14) generated a number of comments and responses from bioethics experts (see pages 15-25 in this issue).

- **American Journal of Public Health (AJPH)**
  AJPH issued a special supplement on influenza preparedness and response in October 2009 (Volume 99, Issue S2; http://ajph.aphapublications.org/toc/ajph/99/S2) that included:
  - Marshall H, Ryan P, Roberton D, Street J, Watson M. Pandemic Influenza and Community Preparedness (http://ajph.aphapublications.org/doi/full/10.2105/AJPH.2008.153056)

- **Association of State and Territorial Health Officials (ASTHO)**
  - At-risk Populations and Pandemic Influenza: Planning Guidance for State, Territorial, Tribal, and Local Health Departments (http://www.astho.org/Infectious-Disease/At-Risk-Populations/At-Risk-Populations-and-Pandemic-Influenza-Planning-Guidance/)
  - Public Health and Faith Community Partnerships: Model Practices to Increase Influenza Prevention Among Hard to Reach Populations (http://ihpemory.org/ihp-programs/public-health-and-faith-community-partnerships/)

- **Contra Costa Health Services, County Health Department, Costa County, California**
  - A paper issued by CCHS entitled *Community Engagement in Public Health* (http://cchealth.org/public-health/pdf/community_engagement_in_ph.pdf) draws on local experiences in Costa County, California, to illustrate a range of approaches for engaging communities to help address traditional and emerging public health issues.
  - A Pandemic Action Kit for Schools (http://cchealth.org/pandemic-flu/school-action-kit/)

- **Institute of Medicine (IOM)**
  - The IOM Forum on Medical and Public Health Preparedness for Catastrophic Events convened a series of workshops ("community conversations") to explore public perceptions of potential alternative strategies for facilitating access to antiviral medications and treatment advice during a pandemic – *Public Engagement on Facilitating Access to Antiviral Medications and Information in an Influenza Pandemic: Workshop Series Summary*. Washington (DC): National Academies Press (US); 2012. (http://www.nap.edu/catalog.php?record_id=13404)

- **Keystone Center**
  - *Public Engagement Project on the H1N1 Pandemic Influenza Vaccination Program* Keystone Center, in partnership with CDC, the University of Nebraska Policy Center, and WestEd (https://www.keystone.org/wp-content/uploads/2015/08/final-h1n1-report-sept-30-2009.pdf)

- **National Association of Child Care Resource and Referral Agencies (NACCRRA)** (http://www.naccrra.org/publications/naccrra-publications/2011/12/emergency-preparedness-for-child-care-a-how-to-guide)

- **National Association of County and City Health Officials (NACCHO)**
  - Advanced Practice Centers (http://apc.naccho.org/Pages/default.aspx)
  - Project Public Health Ready (www.naccho.org/topics/emergency/PPHR)

- **Trust for America's Health (TFAH)**
  - TFAH has issued position statements and letters that outline recommendations for policymakers on ways to better prepare the country for a pandemic (http://healthyamericans.org/policy/emerging-infectious-diseases/), and a series of brochures for families, medical providers, businesses, and community leaders who want to learn more about how to prepare for a possible pandemic (http://healthyamericans.org/reports/flu/brochures/).

- **University of Pittsburgh Medical Center (UPMC), Center for Health Security** (http://www.upmchealthsecurity.org/) Articles on community engagement issued by the Center for Health Security include:
  - Schoch-Spana M. *Community Resilience: Beyond Wishful Thinking* (http://www.upmchealthsecurity.org/our-work/publications/community-resilience-beyond-wishful-thinking)
  - *Resilient American Communities: Progress in Practice and in Policy* (http://www.upmchealthsecurity.org/our-work/events/2009_resilient_american_communities/pdf/Conference%20Summary%20Report.pdf)
  - Schoch-Spana M, Franco C, Nuzzo JB, Usenza C, on behalf of the Working Group on Community Engagement in Health Emergency Planning. *Community Engagement: Leadership Tool for Catastrophic Health Events.* Biosecur Bioterror 2007; 5(1) (http://www.ncbi.nlm.nih.gov/pubmed/17437348)

- **World Health Organization (WHO)** (http://www.who.int/csr/resources/publications/mass_gathering/en/index.html; http://www.who.int/influenza/en/index.html)

Tools and resources developed by U.S. government agencies to help states and localities in pre-pandemic planning for NPI implementation and communication and to facilitate community engagement include:

- **U.S. Department of Agriculture**
  - Information for state and local planners on USDA Food and Nutrition Service programs that provide eligible school children with meals during emergencies (http://www.fns.usda.gov/disaster/disaster-assistance) (http://www.fns.usda.gov/disasters/pandemic/default.htm) (http://www.fns.usda.gov/sfsp/summer-food-service-program-sfsp)

- **U.S. Department of Education**
  - Guidance for K-12 schools and IHEs on emergency planning, readiness, and management (http://rems.ed.gov/GuideK12.aspx) (http://rems.ed.gov/GuideDevelopingHighQualityEmergency.aspx)

- Guidance for schools on continuity of operations planning (http://rems.ed.gov/trainings/CourseCOOP.aspx)

- **U.S. Department of Health and Human Services**
  - Office of the Assistant Secretary for Preparedness and Response (ASPR)
    - Technical Resources, Assistance Center, and Information Exchange (TRACIE) (https://asprtracie.hhs.gov/)
    - Tools for the media and public health communicators (https://www.phe.gov/emergency/communication/Pages/default.aspx)
    - *Community-and-Faith-based Organizations and Pandemic Preparedness* (https://www.cdc.gov/flu/pandemic-resources/archived/community-planning.html)
  - Centers for Disease Control and Prevention (CDC)
    - Web-based pandemic influenza preparedness tools for state and local planners (https://www.cdc.gov/flu/pandemic-resources/)
    - Web-based communication and education materials to promote the use of NPIs for pandemic influenza prevention at home, school, work, and a gathering (https://www.cdc.gov/nonpharmaceutical-interventions/tools-resources/educational-materials.html)
    - A training course for public health officials on risk communications during a pandemic (https://emergency.cdc.gov/cerc/training/index.asp)
    - A training course for public health professionals on implementation of NPIs before, during, and after a pandemic (https://www.train.org/cdctrain/course/1051645/)
    - *Legal Preparedness for School Closures in Response to Pandemic Influenza and Other Emergencies* (April 2008); a review and report submitted to CDC by the Center for Law & the Public's Health at Georgetown and Johns Hopkins Universities (http://www.myfcph.org/panflu/pdfs/schoolclosures.pdf)
    - *Public Health Preparedness Capabilities: National Standards for State and Local Planning* (March 2011); see Capability #1: Community Preparedness and Capability #11: Non-Pharmaceutical Interventions (https://www.cdc.gov/phpr/capabilities/DSLR_capabilities_July.pdf)
    - *Principles of Community Engagement* (https://www.atsdr.cdc.gov/communityengagement/)
    - CDC-sponsored *Social Distancing Law Assessment Project* (https://www.cdc.gov/phlp/publications/social_distancing.html)

- **U.S. Department of Homeland Security**
  - Federal Emergency Management Agency (FEMA)
    - Guidance for state and local leaders on disaster emergency communications (https://www.fema.gov/disaster-emergency-communications)
    - Guidance for state and local leaders on pandemic influenza infrastructure and resources (https://www.ready.gov/document/pandemic-influenza-guide-critical-infrastructure-and-key-resources)
    - A list of Emergency Management Institute (EMI) Virtual Table Top Exercises (VTTX), including pandemic influenza (https://training.fema.gov/programs/emivttx.aspx)
    - *A Whole Community Approach to Emergency Management: Principles, Themes, and Pathways for Action* (http://www.fema.gov/library/viewRecord.do?id=4941)
    - *Promising Examples of FEMA's Whole Community Approach to Emergency Management* (http://www.cdcfoundation.org/whole-community-promising-examples). These examples were selected by the CDC Foundation and the CDC Office of Public Health Preparedness

and Response to showcase community efforts that reflect and embody FEMA's Whole Community approach to emergency management.

- **U.S. Department of Labor**
  - Occupational Safety and Health Administration (OSHA)
    - Guidance on preparing workplaces for an influenza pandemic (https://www.osha.gov/Publications/influenza_pandemic.html)
    - Guidance for employers on protecting workers from pandemic influenza (https://www.osha.gov/Publications/employers-protect-workers-flu-factsheet.html)
    - Safety and health topics: Pandemic influenza (https://www.osha.gov/SLTC/pandemicinfluenza/index.html)

- **U.S. Department of Veterans Affairs**
  - *Infection: Don't Pass It On (IDPIO)* – an ongoing public health campaign that develops and distributes education and communication materials for the VA community to prevent the transmission of infection (http://www.publichealth.va.gov/infectiondontpassiton/index.asp)

Tools and resources under development to facilitate NPI implementation and monitoring include:

- **Social Media Tools for Communication and Monitoring NPI Implementation**
  CDC and partners are working to develop social media tools that can facilitate two-way communication with individuals – especially young adults and teenagers – during public health emergencies. Examples of interactive social media platforms include on-line surveys, Facebook messages, Twitter messages, text messages, and blogs. During a pandemic, social media tools might be used to:
  - Engage the community in pandemic planning in ways that are meaningful and sustainable
  - Provide individuals with information on how to implement NPIs in their community
  - Compare an individual's perception of the pandemic with their behaviors and actions
  - Gauge public perception of pandemic risks and the acceptability of school closures
  - Monitor NPI coverage, acceptance, and effectiveness
  - Provide answers from public health experts to questions from social media users that address the needs of local health departments, respond to areas of concern, refute false/inaccurate information, or meet the needs of non-English speaking populations
  - Place pre-established videos that provide information such as proper usage of NPIs, accurate information about spread of disease, or updates to news information

- **Additional Tools for Monitoring NPI Implementation**
  CDC and partners also are developing improved surveillance methods and metrics that:
  - Schools can use to monitor school absenteeism due to ILI
  - Businesses can use to monitor workplace absenteeism due to ILI
  - Communities can use to monitor continued use of NPIs
  - State and local health departments can use to monitor:
    - School closures, including closures recommended by public health authorities and closures implemented when many students and staff stay home due to illness and regular school functions cannot be maintained
    - Workplace closures due to worker absenteeism or lack of patronage during a severe pandemic