Community Mitigation Strategies: A Review of the Evidence

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Decision Making for Using Community Mitigation Measures
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Mitigating the Impact of an Influenza Pandemic

- **Vaccination is the primary recommended strategy to prevent and control influenza transmission**

- **Community mitigation may also be an important strategy, especially when vaccines and antiviral medications are unavailable[1]**
  - Mitigate transmission
  - Decrease surge in healthcare system
  - Delay peak of infection rate
  - Some of these measures can be costly and disruptive

1 CDC, 2007

Categories of Community Mitigation Strategies

- **Personal Protective Behaviors & Equipment**
  - Hand washing
  - Covering coughs and sneezes
- **Social Distancing**
  - Staying home when sick
  - School closures
  - Cancellation of events
  - Limiting public transportation
- **Environmental Provisions**
  - Surface cleaning
  - Availability of supplies (personal hygiene and cleaning)
- **Community Preparedness**
  - Continuity planning (e.g., schools, workplaces)
  - Policy changes (e.g., leave , absenteeism)

When Should Nonpharmaceutical Interventions (NPIs) be Implemented?

	Seasonal Influenza	During Pandemic
Personal Protective Behaviors	✓	✓
Environmental Provisions	✓	✓
Community Preparedness	✓	✓
Social Distancing	✗ (encourage staying home when ill)	Depending on: Severity and Transmissibility

Preparedness Considerations For Severe Outbreaks and Pandemics

- **Social distancing measures (e.g., school closures)**
  - Reduce medical care surge
  - Minimize secondary effects of overwhelmed healthcare system
- **Require local input and tailoring**
  - Timing and duration
  - Geographic extent
  - Feasibility
  - Avoiding untoward consequences
    - Loss of school meals
    - Additional household costs
    - Job losses

Outline: Community Mitigation Strategies

- Hand washing
- Covering coughs and sneezes
- Use of masks
- School closures
- Discussion

Personal Protective Behaviors and Equipment

HAND WASHING

Only One Hand-Washing Study Has Used Confirmed Influenza As An Outcome[1]

- **Egypt: 12-week randomized controlled trial (RCT)**
  - 60 schools randomly assigned to intervention or control groups
  - Intensive hand hygiene intervention:
    - Children required to wash hands twice during school day
    - Health messages through entertainment activities
    - Soap provided by schools and parents
- **Absence and illness data collected by teachers/nurses**
  - Reduction in absences due to ILI: 40%
  - Reduction in lab-confirmed influenza: 47%
  - OR of multiple cases of influenza: 2.8

1 Talaat, Afifi, et al, ICEID 2010

Studies of Association Between Hand-Hygiene Interventions and Respiratory Illness[1]

Intervention	# Studies	Reduction in RI	95% CI
Overall effect	16	**21%**	5%–34%
Education vs. Control	4	14%	0%–27%
Nonantibacterial soap + education vs. control	1	51%	39%–60%
Antibacterial soap + education vs. control	1	50%	39%–60%
Antibacterial soap vs. nonantibacterial soap	2	0%	-19%–16%
Alcohol-based hand sanitizer vs. control	0	-	-
Alcohol-based hand sanitizer + education vs. control	6	7%	-3%–16%
Benzalkonium chloride-based hand sanitizer vs. control	2	40%	19%–55%

NOTES: All studies took place in a community setting; of the 16 studies, 13 were RCTs; none of these studies had influenza as a specific outcome; ***bold*** *typeface indicates statistically significant risk ratios (95% confidence)*

[1] Meta-analysis of 16 studies by Aiello, Coulborn, et al, Am J Pub Hlth 2008

Other Findings On Hand Hygiene And Respiratory Illness[1]

- **Likely larger benefit of hand-hygiene interventions in developing countries vs. developed countries**
  - Developed countries: 15% (95pct CI: 0%–29%)
  - Developing countries: 37% (95pct CI: 13%–55%)

- **No difference in benefit of interventions between different target age groups**
  - Ages 5 or less: 20% (95pct CI: -1%–37%)
  - Ages older than 5: 22% (95pct CI: -5%–42%)

[1] Meta-analysis of 16 studies by Aiello, Coulborn, et al, Am J Pub Hlth 2008

Adherence to Hand Hygiene Recommendations Can Vary Significantly in Community Settings

- **U.S., education intervention in 5 schools, ages 5–10:[1]**
  - Statistically significant increases in hand washing or sanitizing in intervention group during flu season
  - Effect of intervention was observed across all grades
- **Bangladesh, observational study of hygienic practices in two communities at baseline[2]**
  - In 2,248 episodes of sneezing/coughing in households or schools, hand washing was never observed following the episode
- **Mexico, household survey during 2009 pandemic[3]**
  - Respondents reported increased hand washing (>75%) and use of hand sanitizer (>25%) as behaviors adopted to avoid becoming infected

[1] Stebbins, Downs, and Vukotich, J Pub Hlth Mgm Pr 2010 and 2011
[2] Nasreen, Azziz-Baumgartner et al, Trop Med & Int Hlth 2010
[3] Aburto Pevzner et al, Am J Prev Med 2010

Personal Protective Behaviors & Equipment

COVER COUGHS AND SNEEZES

Respiratory Etiquette: No Direct Evidence—Widely Recommended

- Cough and sneeze recommendations have been made more on the basis of *"plausible effectiveness"* than on documented evidence[1]
- Although the relative contribution of different modes of flu transmission is not known, recommendations arise from belief that large droplets play an important role
- Despite lack of direct evidence, respiratory etiquette is widely supported in the literature and recommended by experts[2]

1 WHO, 2006
2 Aledort , Lurie et al, BMC Pub Hlth 2007

Adherence and Attitudes Towards Guidelines Vary with Setting and Situation

- **Bangladesh observational study[1]**
  - In 81% of observed events, participants did not cover their mouths when coughing or sneezing
  - In 11% of observed events, they coughed/sneezed into their hands
- **Mexico household survey during 2009 pandemic[2]**
  - 14% to 22% of participants (depending on city) reported increased covering of their coughs/sneezes with tissue or elbow
- **Argentina household survey during 2009 pandemic[3]**
  - More than 89% of respondents believed covering their mouth when sneezing was important to be protected against influenza

1 Nasreen, Azziz-Baumgartner et al, Trop Med & Int Hlth 2010
2 Aburto, Pevzner et al, Am J Prev Med 2010
3 Basurto-Davila, Garza et al, 2010

Personal Protective Behaviors & Equipment

USE OF FACE MASKS AND RESPIRATORS

Limited Evidence Supporting Mask Use in Community Settings

- **Three RCTs found significant effects of mask use under certain circumstances[1]**
  - Lower infection OR in HHs with mask use and hand hygiene when implemented within 36 hrs of index case illness onset (IC)
  - Lower ILI incidence among HH contacts who adhered to correct use of masks and N95 respirators (C)
  - Lower ILI incidence among university students randomized to mask use and hand hygiene in weeks 4–6 of influenza season (6-week study)
- **One RCT found no evidence of effectiveness of mask use in the household (IC)[1]**
- **Survey of experts in 2007:[2]**
  - No support for use by general public of masks or respirators **in early stages** of pandemic influenza
  - Divided opinion on their use in **advanced** pandemic stage

[1] Studies reviewed by Cowling, Zhou et al, Epi & Inf 2010
[2] Aledort, Lurie et al, BMC Pub Hlth 2007

(IC) Masks worn by index case and HH contacts
(C) Masks worn only by HH contacts

Not Enough Evidence on Other Issues Related to the Use of Masks

- **Are N95 respirators more effective than surgical masks?**
  - One RCT and one observational study found no significant differences between them[1,2]
  - Evidence of aerosol transmission is still controversial[3-5]
- **Should the infected wear masks?**
  - One study found that use of surgical masks by infected may be able to reduce infectiousness[5]
- **Compliance with recommended use of face masks**
  - Some studies have reported lower compliance with use of face masks compared to hand hygiene and other NPIs[6,7]

[1] Loeb, Dafoe et al, JAMA 2009
[2] Ang, Poh et al, Clin Inf Dis 2010
[3] Tellier, J Roy Soc Int 2009
[4] Han, Zhu et al, Em Inf Dis 2009
[5] Brankston, Gitterman et al, Lancet 2007
[6] Johnson, Druce et al, Clin Inf Dis 2009
[7] Cowling, Zhou et al, Epi & Inf 2010
[8] Aiello, Coulborn et al, Am J Inf Ctrl 2010

Social Distancing

SCHOOL CLOSURES

Implementation of School Closures (SC) Has Been Recommended During Severe Pandemics

- **Rationale for intervention[1,2]**
  - Children are important vectors of influenza transmission
  - They may shed virus for longer period than adults
  - High contact rates in schools
- **Expected benefits[2]**
  - Reduction in total number of cases
  - Slow epidemic to give time for vaccine production/distribution
  - Reduction in incidence of cases at peak time of virus circulation
  - Reduce peak in burden on healthcare system

1 WHO, 2006
2 Cauchemez, Ferguson et al, Lancet 2009

Direct Evidence on Effectiveness of SCs

- **Israel 2-week nationwide teacher strike, 2000[1]**
  - Children physician visit rates decreased by 28% (95 pct CI: 26, 30)
  - Respiratory tract and viral infections fell by 42% (95 pct CI: 41, 43)
  - Respiratory illness visits increased after strike ended
- **U.S. and Australian cities, 1918 pandemic[2-5]**
  - Overall mortality reduction of 10 to 30% (U.S.)
  - Peak mortality reduction of up to 50% (U.S.)
  - Cumulative attack rate reduction of up to 38% (Australia)
- **United States school closure, 2009 pandemic[6]**
  - SC in a school district while schools in nearby area remained open
  - Reductions in respiratory illness from 52% to 74%

1 Heymann, Chodick et al, Ped Inf Dis J 2004
2 Markel, Lipman et al, JAMA 2009
3 Bootsma and Ferguson, PNAS 2007
4 Hatchett, Mecher et al, PNAS 2007
5 Caley, Philp et al, J R Soc Int 2008
6 Copeland, Basurto-Davila et al, 2010

Indirect Evidence of Effectiveness of SCs

- **France school holidays, 1984–2006[1]**
  - Three zones with different holiday timings
  - School holidays prevent 16–18% increase in total cases
  - Prediction for a pandemic:
    - 13–17% reduction in total cases
    - 38–45% reduction in peak attack rates

- **Argentina school holidays, 2005–2008[2]**
  - School holiday timing varies across years and across provinces
  - Estimated 17–37% reduction in ILI rates
  - Larger effect on school-age children than on younger children or adults

1 Cauchemez, Valleron et al, Nature 2008
2 Garza, Basurto-Davila et al, 2010

More Evidence is Needed on Other Issues Related to School Closures

- **Triggers for closing and reopening schools**
  - Use of school absenteeism as trigger signal: likely late closure[1]
  - Sensitive triggers (lab-confirmed cases) might be the most reliable, but may also lead to long closures[1]
  - Modeling studies:
    - Maximum effect if SCs occur before 1% of population is infected[2]
    - Short closures (<2weeks) may result in 2 peaks and even increase AR[3]
- **School-level, local, or nationwide closures?**
  - Broader closures: Larger impact → Higher social cost
  - Adequate plans need to be in place before closures
    - Minimize economic and other costs to families
    - Maintain communication with parents and teachers
    - Continue education during closures

1 Cauchemez, Ferguson et al, Lancet 2009
2 Halloran, Ferguson et al, Proc Nat Ac Sci 2008
3 Lee, Brown et al, J Pub H Mgt Pract 2010

Costs of School Closures Can be Significant

- **Economic costs:**
  - Societal loss of productivity from working parents and teachers
  - Household costs due to lost income and additional expenses
  - Concerns about job security
- **Estimates of costs of closures:**
  - Modeling study for the UK[1] estimated cost of 12-week closure equal to **0.2–1.0% of GDP**
  - Modeling study for the US[2] estimated a 26-week closure would result in societal costs of **6% of GDP**
  - Study of closures in 3 schools in Argentina[3] found that household costs due to SCs were higher among low-SES households when compared to high-SES households

1 Sadique, Adams et al, BMC Pub H 2008
2 Sander, Nizam et al, Val in Hlth2009
3 Basurto-Davila, Garza et al, 2010

Community Mitigation Strategies

SUMMARY AND DISCUSSION

Summary of Documented Evidence

- **More conclusive evidence for effectiveness of hand washing against respiratory illness**
- **Not much evidence for covering coughs and sneezes, but widely recommended by literature and experts**
- **Use of facemasks and/or respirators by general public is more controversial**
- **Evidence exists for effectiveness of school closures, but much remains to be understood**
  - More information needed on when to start and when to stop
  - How to minimize negative secondary effects
  - Cost-effective?

Some Issues Are Relevant to Several or All Community Mitigation Measures

- **Communication channels during outbreaks/pandemics**
  - TV and radio were the highest reported sources of information by studies in Mexico[1] and Argentina[2] during 2009 pandemic
  - Internet and government toll-free numbers were not as important
  - Relative importance of information sources is likely to vary across countries
- **Barriers to adoption of community strategies[1,2,3]**
  - Costs of soap, hand sanitizer, and masks
  - Inadequate compliance due to confusion about preventive measures, particularly among low-SES populations

1 Aburto, Pevzner et al, Am J Prev Med 2010
2 Basurto-Davila, Garza et al, 2010
3 Blendon, Koonin et al, Em Inf Dis 2008

New Studies May Provide Needed Evidence on Effectiveness of Community Mitigation Strategies

- **Weaknesses in literature[1,2]**
  - Significant risk of bias and confounding in existing studies
  - Laboratory-confirmed outcomes needed for more robust evidence
  - Little data on knowledge and attitudes towards NPIs among different populations
  - Extent of barriers to implementation of NPIs
- **Relative importance of different modes of transmission is still a controversial topic[3,4]**
  - Studies in different locations during different times of the year could help elucidate role of temperature and humidity in mediating modes of transmission

1 Jefferson, Del Mar et al, Coch Sys Rev 2010
2 Aiello, Coulborn et al, Am J Inf Ctrl 2010
3 Cowling and Leung, Ev Bas Med 2010
4 Cowling, Zhou et al, Epi & Inf 2010

Conclusion: Community Mitigation Strategies

- **Universally available**
  - Self-empowering for individuals and communities
  - Complement other interventions
  - Select NPIs can be promoted as best practices/social norms
- **Key considerations for implementation**
  - Preparedness: Effectiveness & Feasibility
  - Response: Local decisions
  - Communication strategy critical for all levels
- **Important gaps in knowledge remain**

BIBLIOGRAPHY

List of References (1)

- Aburto, N. J., Pevzner, E., Lopez-Ridaura, R., Rojas, R., Lopez-Gatell, H., Lazcano, E., et al. (2010). Knowledge and Adoption of Community Mitigation Efforts in Mexico During the 2009 H1N1 Pandemic. American Journal of Preventive Medicine, 39(5), 395-402.
- Aiello, A.E., Couborn, R.M., Aragon, T. J., Baker, M.G., Burrus, B.B., et al (2010). Research Findings from Nonpharmaceutical Intervention Studies for Pandemic Influenza and Current Gaps in the Research, American Journal of Infection Control, 38(4), 251-258.
- Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. (2008). Effect of hand hygiene on infectious disease risk in the community setting: A meta-analysis. American Journal of Public Health, 98(8), 1372-1381.
- Aledort, J. E., Lurie, N., Wasserman, J., & Bozzette, S. A. (2007). Non-pharmaceutical public health interventions for pandemic influenza: an evaluation of the evidence base. BMC Public Health, 7.
- Ang, B., Poh, B. F., Win, M. K., & Chow, A. (2010). Surgical Masks for Protection of Health Care Personnel against Pandemic Novel Swine-Origin Influenza A (H1N1)-2009: Results from an Observational Study. Clinical Infectious Diseases, 50(7), 1011-1014.
- Basurto-Dávila, R., Garza, R., Meltzer, M. I., Carlino, O. L., Albalak, R., Uez, O., et al. (2010). School Closures and the Pandemic H1N1 Influenza Virus in Two Cities in Argentina: Household Economic Impact, Attitudes, and Compliance. Presented at Options for the Control of Influenza VII, Hong Kong..
- Bell, D., Nicoll, A., Fukuda, K., Horby, P., Monto, A., & World Hlth Org Writing, G. (2006). Nonpharmaceutical interventions for pandemic influenza, national and community measures. Emerging Infectious Diseases, 12(1), 88-94.
- Blendon, R. J., Koonin, L. M., Benson, J. M., Cetron, M. S., Pollard, W. E., Mitchell, E. W., et al. (2008). Public response to community mitigation measures for pandemic influenza. Emerging Infectious Diseases, 14(5), 778-786.
- Bootsma, Ferguson NM. (2007) The effect of public health measures on the 1918 influenza pandemic in US cities. Proceedings of the National Academy of Sciences, 104, 7588-7593.
- Brankston G, Gitterman L, Hirji Z, Lemieux C, Gardam, M (2007). Transmission of influenza A in human beings, The Lancet, 7, 257-65.
- Caley P., Philp DJ, McCracken K. (2008). Quantifying social distancing arising from pandemic influenza. Journal of the Royal Society Interface, 5, 631-39.
- Cauchemez, S., Ferguson, N. M., Wachtel, C., Tegnell, A., Saour, G., Duncan, B., et al. (2009). Closure of schools during an influenza pandemic. The Lancet, 9(8), 473-481.

List of References (2)

- Cauchemez, S., Valleron, A.-J., Boëlle, P.-Y., Flahault, A., & Ferguson, N. M. (2008). Estimating the impact of school closure on influenza transmission from Sentinel data. Nature, 452(10), 750-754.
- Centers for Disease Control and Prevention. (2007) Interim Pre-Pandemic Planning Guidance: Community Strategy for Pandemic Influenza Mitigation in the United States.
- Copeland, D., Basurto-Davila, R., Chung, W., Kurian, A., Fishbein, D., Szymanowski, P., et al. (2010). Effectiveness of a school district closure for pandemic influenza A (H1N1) on respiratory infections in the community: a natural experiment. Presented at Options for the Control of Influenza VII, Hong Kong.
- Cowling, B. J., & Leung, G. M. (2010). Simple physical interventions such as hand washing and wearing masks can reduce spread of respiratory viruses. Evid Based Med, 15(1), 3.
- Cowling, B. J., Zhou, Y., Ip, D. K. M., Leung, G. M., & Aiello, A. E. (2010). Face masks to prevent transmission of influenza virus: a systematic review. Epidemiology and Infection, 138(4), 449-456.
- Garza, R., Basurto-Dávila, R., Carlino, L. O., Meltzer, M., Widdowson, M.-A., Albalak, R., et al. (2010). The Impact of winter holidays on the Incidence of Influenza-like Illness in Argentina, 2005-2008. . Presented at Options for the Control of Influenza VII, Hong Kong.
- Halloran, M. E., Ferguson, N. M., Eubank, S., Longini, I. M., Cummings, D. A. T., Lewis, B., et al. (2008). Modeling targeted layered containment of an influenza pandemic in the United States. Proceedings of the National Academy of Sciences of the United States of America, 105(12), 4639-4644.
- Han K, Zhu X, He F, Lunguang L, Zhang L, et al (2009). Lack of airborne transmission during outbreak of pandemic (H1N1) 2009 among tour group members, China, June 2009, Emerging Infectious Diseases, 15(10), 1578-81.
- Hatchett RJ, Mecher CE, Lipsitch M. (2007). Public health interventions and epidemic intensity during the 1918 influenza pandemic, Proceedings of the National Academy of Sciences, 104, 7582-87.
- Heymann A, Chodick G, REichman B, Kokia E, Laufer J. (2004). Influence of school closure on the incidence of viral respiratory diseases among children and on health care utilization, Pediatric Infectious Diseases Journal, 23, 675-77
- Jefferson, T., Del Mar, C., Dooley, L., Ferroni, E., Al-Ansary, L. A., Bawazeer, G. A., et al. (2010). Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database of Systematic Reviews.

List of References (3)

- Johnson DF, Druce JD, Birch C, & Grayson ML (2009). A Quantitative assessment of the efficacy of surgical and N95 masks to filter influenza virus in patients with acute influenza infection, Clinical Infectious Diseases, 49, 275-277.
- Lee BY, Brown ST, Cooley P, Potter MA, Wheaton WD, et al. (2010). Simulating school closure strategies to mitigate an influenza epidemic. Journal of Public Health Management and Practice, 16(3), 252-261.
- Loeb, M., Dafoe, N., Mahony, J., John, M., Sarabia, A., Glavin, V., et al. (2009). Surgical Mask vs N95 Respirator for Preventing Influenza Among Health Care Workers A Randomized Trial. Jama-Journal of the American Medical Association, 302(17), 1865-1871.
- Markel H, Lipman HB, Navarro JA, et al (2007) Nonpharmaceutical interventions implemented by US cities during the 1918-1919 influenza pandemic, JAMA, 298, 644-54.
- Nasreen S., Azziz-Baumgartner E, Gurley ES, Winch PJ, Unicomb L, Sharker MAY, et al. (2010). Prevalent high-risk respiratory hygiene practices in urban and rural Bangladesh. Tropical Medicine & International Health, 15(6), 762-771.
- Sadique, M. Z., Adams, E. J., & Edmunds, W. J. (2008). Estimating the costs of school closure for mitigating an influenza pandemic. BMC Public Health, 8.
- Sander B, Nizam A, Garrison LP, Postma MJ, Halloran ME, & Longini IM (2009). Economic Evaluation of Influenza Pandemic Mitigation Strategies in the United States Using a Stochastic Microsimulation Transmission Model. Value in Health, 12(2), 226-233.
- Stebbins, S., Downs, J. S., & Vukotich, C. J. (2011). The effect of grade on compliance using non-pharmaceutical interventions to reduce influenza in an urban elementary school setting. J Public Health Manag Pract, 17(1), 65-71.
- Stebbins, S., Stark, J. H., & Vukotich, C. J. (2010). Compliance With a Multilayered Nonpharmaceutical Intervention in an Urban Elementary School Setting. Journal of Public Health Management and Practice, 16(4), 316-324.
- Talaat M, Afifi S, Dueger E, El-Ashry N, Marfin A, et al. (2010) Impact of intensive hand hygiene campaigns on the incidence of laboratory-confirmed influenza and absenteeism in school children in Cairo Governorate: a randomized control trial, International Conference on Emerging Infectious Diseases, Atlanta,
- Tellier, R. (2009). Aerosol transmission of influenza A virus: a review of new studies. Journal of the Royal Society Interface, 6, S783-S790.
- World Health Organization Writing Group (2006). Nonpharmaceutical interventions for pandemic influenza, national and community measures. Emerging Infectious Diseases, 12(1), 88-94.