EDITORIAL

Public Health Interventions for COVID-19
Emerging Evidence and Implications for an Evolving Public Health Crisis

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Related article

For decades, leading scientists and influential professional societies have warned of the dangers of emerging infections and the specter of a global pandemic.[1,2] The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its subsequent spread has lived up to and surpassed many of the warnings and has caused an evolving global public health and economic crisis. Significantly, no pharmaceutical agents are known to be safe and effective at preventing or treating coronavirus disease 2019 (COVID-19), the resulting illness.[3] This leaves the medical and public health community with only nonpharmaceutical interventions (NPIs) to rely on for reducing the burden of COVID-19. These measures aim to reduce disease transmission both locally and globally and include bans on public gatherings, compulsory stay-at-home policies, mandating closures of schools and nonessential businesses, face mask ordinances, quarantine and *cordon sanitaire* (ie, a defined quarantine area from which those inside are not allowed to leave), among others. The effectiveness of NPIs has been studied theoretically,[4] especially within the context of pandemic influenza, and also through analysis of historical observational data.[5-7] A common finding of these studies is that implementing NPIs, especially when done rapidly after initial detection of a new contagious pathogen, can reduce transmission.

In a study published in *JAMA*, Pan et al[8] examined the epidemiologic outcomes following implementation of NPIs during the COVID-19 outbreak in Wuhan, China, shortly after the disease was identified. From a cohort of 32 583 patients with laboratory-confirmed SARS-CoV-2 infection in Wuhan, the authors computed standardized number of infections per day per million people, effective reproduction numbers, and the proportion of severe disease in cases spanning the period December 2019 through early March 2020. Importantly, this time span was separated into 5 distinct periods, each characterized by different combinations and applications of public health measures: before January 10 (no intervention), January 10 to 22 (movement of large numbers of people for the Chinese New Year holiday), January 23 to February 1 (city lockdown with traffic restriction, home quarantine, *cordons sanitaire*), February 2 to 16 (intensified social distancing measures, centralized quarantine and treatment), and February 17 to March 8 (door-to-door and individual-to-individual community screening for symptoms in all residents).

Based on their sophisticated evaluation, Pan et al suggest that this series of multifaceted NPIs was associated with improved control of the COVID-19 outbreak in Wuhan. The daily confirmed case rate per million people increased from 2.0 before January 10, to 45.9 between January 10 and 22, and to 162.6 between January 23 and February 1. The rate then decreased to 77.9 between February 2 and 16 and to 17.2 after February 16. In addition, the proportion of severe or critical cases decreased gradually over time: 53.1%, 35.1%, 23.5%, 15.9%, and 10.3%, respectively, for the 5 periods.

The study is remarkable in several ways. Pan et al applied surveillance data to quantify the time evolution of COVID-19 transmission intensity through the different periods in their study. In doing so, they recognize the implicit goal of any contagious disease intervention: interrupt the chain of transmission by reducing the average number of cases caused by each infected individual over their infectious period, the effective reproduction number, R_t, to less than 1.0. The authors' estimation of R_t throughout the study illustrates a striking association between NPIs employed in Wuhan, especially during the third period of their study when the city was under *cordons sanitaire*, automobile traffic was suspended, and quarantine of confirmed and presumptive cases and their close contacts were enforced. Given the delays the authors observed between symptom onset and laboratory confirmation and an incubation period of roughly 5 days,[9] it is difficult to assert that additional interventions in periods 4 and 5 were necessary in driving R_t below 1.0, although transmission did continue to decline further as additional measures were implemented. Thus, it appears that strict travel restrictions and home quarantine were the dominant factors associated with reducing R_t to less than 1.0 in the early days of the Wuhan outbreak.

Pan et al[8] also present new epidemiological data on COVID-19, stratified by age group and sex, and illustrate substantially elevated risk among health care workers who cared for patients with COVID-19 during the early days of the outbreak. Increased testing throughout their study period revealed higher rates of infection among younger persons in Wuhan than has been previously reported. Perhaps most concerning was the high infection rate among those younger than 1 year (13.4 per million), which was found to fall between those observed for persons aged 20 through 39 years (12.7 per million) and 40 to 59 years (19.4 per million). This may have important implications for ongoing and potential future nonpharmaceutical bundles in the US and other nations with respect to daycare for children in this age group. Pan et al also observed that males were at higher risk than females for severe disease, with females in this study having a 10% lower risk of severe or critical infection, a finding consistent with other recent observations.[10]

An important question unresolved in the absence of population immunological surveys concerns the role that immunity may have had in the observed decreased rates of infection and R_t. Until the extent and persistence of SARS-CoV-2 immunity is understood, however, there is an acute need to better understand the roles that quarantine, *cordons sanitaire*, and the suspension of within- and between-city travel restrictions have in the control of COVID-19. The work of Pan et al suggests that *cordons sanitaire,* suspension of automobile traffic, and quarantine of all confirmed and potential cases and exposed persons was sufficient to reduce R_t to less than 1.0. Thus, it will be important to determine which of these components is necessary to break the chain of transmission because implementation of some of these measures may encounter legal and ethical challenges if applied elsewhere.[11] Analysis of current public health responses to intense transmission of SARS-CoV-2 across the globe will soon reveal if variably applied "shelter-at-home" policies can effectively replace mass quarantine of cities. Beyond the current phase of the pandemic, it may be necessary to mass quarantine geographic "hot spots" to limit spreading to other regions in potential future waves of COVID-19.[12] Such decisions will depend on many factors, including the availability of rapid testing and serological surveys to accurately measure population immunity.

Taken as a whole, the study by Pan et al[8] hints at a tantalizing possibility: the accessibility of data to support the real-time formative evaluation of public health interventions in an ongoing pandemic. Monitoring infection rates and effective reproduction numbers continuously may effectively allow for quality improvement methods to be used to evaluate public health policies, provided data can be drawn continuously from different sources. Regardless, for the time being, NPIs are the only tool in the armamentarium for controlling COVID-19, and this report in *JAMA* serves to quantify important metrics suggesting their potential effectiveness. As it appears that the US and other nations will be living with NPIs to varying degrees during the immediate future,[13,14] the suggestion that their application can quickly reduce COVID-19 transmission if applied effectively is reassuring.

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