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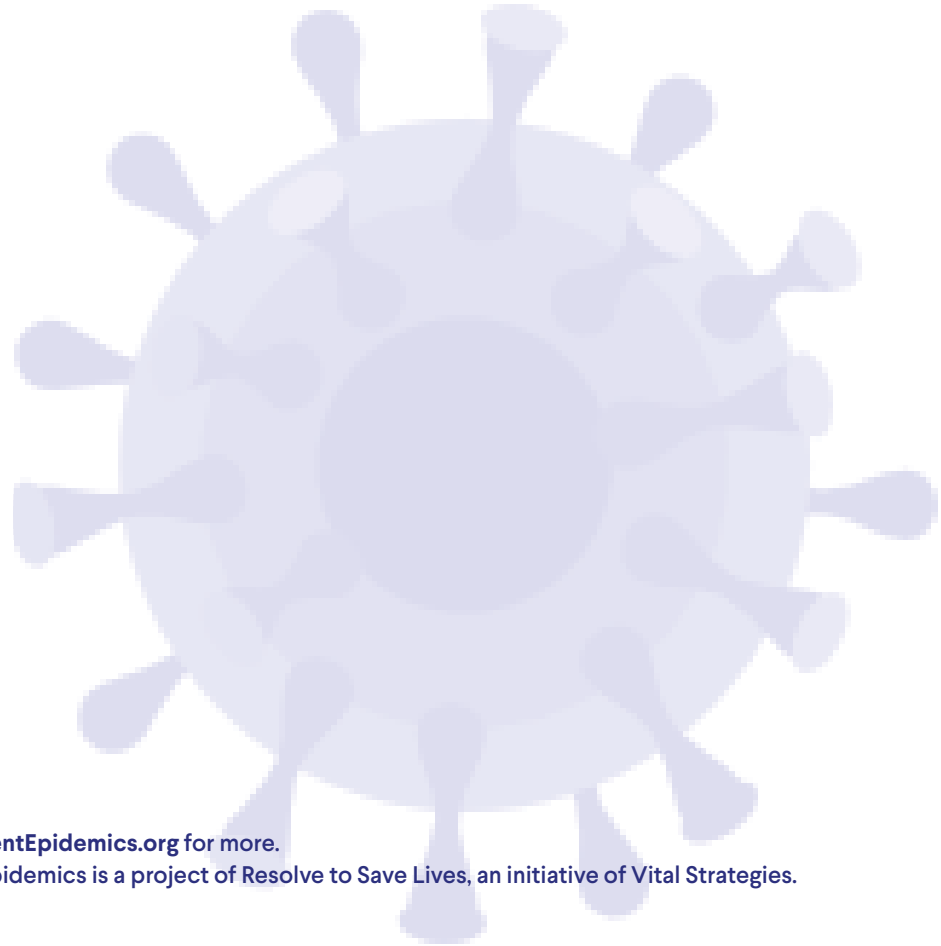
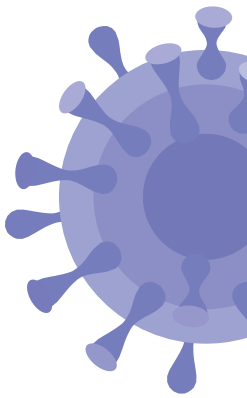
CORONAVIRUS — APRIL 2020

IMPLEMENTATION OF NON-PHARMACEUTICAL INTERVENTIONS

EVIDENCE BASE AND APPLICATION TO THE AFRICAN CONTEXT





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SUMMARY TABLE

Best Practice Measures and Considerations for COVID-19 Response in the African Setting

	Transmission Scenario*					
Measure	**1**	**2**	**3**	**4**	**5**	**Considerations**
Rapid identification, testing, and isolation of cases	✔	✔	✔**	✔**	✔	Symptomatic people in isolation should be given proper medical care and facilities. Their privacy should be protected as much as possible, while allowing for contact tracing. Isolation of cases in crowded households can result in household transmission, which can be either mitigated by identifying areas within the household (e.g., separate room), house-swapping, or assuming all household members are contacts and voluntary quarantine of the household. Testing and contact tracing capacity will be exceeded at the peak; when community transmission is widespread, ill persons should be advised to self-identify symptoms, isolate at home, and seek medical care if severely ill. Before transmission begins to decline, contact tracing capacity can be improved by hiring, training, organizing, and equipping teams of contract tracers so they are ready to deploy as soon as needed again.
Voluntary quarantine of contacts	✔	✔	✔	✔	✔	Voluntary rather than mandatory quarantine should be used. Meaningful and sustained community engagement through local leaders and timely and accurate information from central credible sources will be needed to promote adherence. Food, livelihood support, employment protections, childcare, medical and psychosocial support will be needed for sustained and effective implementation. Undue securitization or quarantine of communities should be avoided. If mandatory quarantine must be enforced, complaint and redress mechanisms should be put in place and publicized
Relevant, accurate, and timely risk communication tailored to communities	✔	✔	✔	✔	✔	Risk communication at each transmission phase should be tailored to ensure public understanding and acceptance of, and adherence to, the NPIs being implemented. Such efforts, which include meaningful and sustained community engagement, can build trust in the implemented measures, address informational gaps, and motivate adherence. Communications should use plain language, age appropriate (also targeting children) and be available in multiple languages, including for those with low or no literacy, or belonging to minority groups.

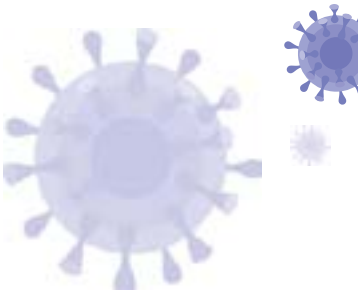
Hand and respiratory hygiene	✔	✔	✔	✔	✔	Hand hygiene education likely improves effectiveness, particularly in combination with other mea-sures. There is evolving evidence to support the use of face masks among the general public to prevention infection, but surgical masks (rather than N95 masks) are likely sufficient to reduce trans-mission from persons who are already ill. If surgical masks are sufficiently available for public use, they should be considered when community transmission is widespread. Subsidized access to water and soap or hand sanitizers might be required. Price gouging and hoarding should be prohibited. Provision of hand-washing stations at central points, outside of business and schools can improve adherence and act as a reminder of risk.
Infection Control and Prevention and Protecting Health Workers	✔	✔	✔	✔	✔	Strategies including dedicated COVID-19 treatment units, analogous to ETUs and implement adminis-trative controls at existing health facilities to minimize spread may be effective when lacking minimal resources for appropriate infection prevention and control measures. Such measures will be critical to prevent disruption of essential health services, which can result in non-COVID-19 specific deaths.
Shielding vulnerable populations most at risk	✔	✔	✔	✔	✔	While there is a limited evidence base for a "shielding" strategy, certain at-risk groups for severe out-comes (ICU admission, death) for COVID-19. Increased precautions and prolonged social distancing measures for these populations, in combination with appropriate livelihood, food, and medical sup-port, may allow for the phased lifting of other social distancing measures while protecting vulnerable populations until a safe and effective vaccine is available.
Cancellation or adaptation of mass gatherings		✔	✔	✔		Conduct within a week of local transmission detection and sustain throughout the pandemic response. Discouraging mass gatherings may slow spread and prevent superspreader events. Rules should be broadly communicated with clear and consistent thresholds for maximum attendance or density (e.g., one person per 3sq meter), and reasonable exemptions for essential service. Engage with community and religious leaders to articulate value-based decisions and encourage local adoption. Adaptation of existing events, including outdoor services or services in shifts, may be help-ful in localities where cancellation of gatherings is not practical. Special care should be taken to main-tain continuity of government functions (legislature, judiciary, elections) and other essential services.
School closures			✔	✔		While proactive school closures and other mass gatherings of children before a case in the com-munity is identified might be more effective in reducing transmission, reactive implementation in response to an identified case in the community can mitigate the household and livelihood impacts. Community acceptance may be stronger if alternative services for childcare and student learning and provision of nutrition are established.

Work closures				✔		Voluntary work adjustments such as teleworking, variable shift scheduling, and desk spacing may be encouraged as soon as community spread is identified. If restrictions on mass gatherings, isolation, and quarantine fail to sufficiently slow spread, further work closures of non-essential businesses may be considered, conscious of undue financial hardship.
International travel restrictions and entry screening	✔***					International travel restrictions might delay importation but cannot prevent importation; island states might achieve the greatest benefit. Entry screening is not effective to identify cases, although incoming travelers should be provided disease and contact information for testing and isolation if needed. Entry screening might have greater benefit if rapid point of care testing becomes available. Targeted limitations on incoming travel from transmission hotspots might delay importation, but will be of minimal benefit after importation has occurred. If implemented, international travel restrictions can only be imposed by law, for a legitimate purpose, and when the restrictions are proportionate, including in considering their impact.
Internal travel restrictions or *Cordon Sanitaire*		✔***			✔***	Consider during initial containment stage, in conjunction with NPIs, to reduce the peak of the pandemic and to "buy time" for preparedness in other jurisdictions; however there is no evidence of long-term benefit of internal travel restrictions or cordon sanitare, unless other social distancing measures are put in place. There is a high risk of discriminatory impact and other human rights violations for the targeted community, which can further erode trust in public health officials. If community quarantine is enacted, substantial services and provisions to provide for livelihoods, access to food, and psychosocial supports will be required.66 Internal travel restrictions can only be imposed by law, for a legitimate purpose, and when the restrictions are proportionate, including in considering their impact.

* 1 = no cases; 2 = sporadic cases or clusters of cases; 3 = local community transmission; 4 = widespread community transmission; 5 = declining transmission

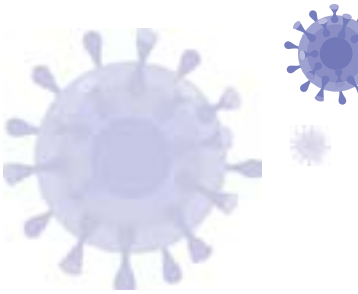
** Continue where possible, but testing capacity and contact tracing capacity will likely be exceeded during widespread community transmission.
Testing efforts should be then be directed towards sentinel sites and detecting new areas of transmission where a containment strategy might prevent further spread.

*** Inconsistent evidence for the recommendation; initial modeling studies suggest effectiveness to limit spread for Covid-192,[3]



Abstract

The 2019 novel coronavirus (COVID-19) pandemic has passed the point of global containment. In the absence of safe and effective antiviral therapeutics and vaccines, non-pharmaceutical interventions (NPIs) are the only measures available to reduce transmission, mitigate the impact of COVID-19 on healthcare facilities including intensive care units, and prevent excess mortality. Here we review the evidence for NPIs over the last century, with a focus on implementation, legal, and ethical considerations in the African context. We provide best practices for the adaptive implementation of NPIs, including considerations to mitigate their impacts on livelihoods and economies. Domestic and international travel restrictions and traveler screening are unlikely to and have not prevented the widespread transmission of the causative virus, SARS-CoV-2. Aggressive and timely implementation of containment measures (rapid identification of cases, isolation, and voluntary and supported quarantine of contacts) in addition to respiratory and hand hygiene and facility-based infection prevention and control practices can delay but not halt transmission. Implementation of social distancing measures, including cancellation of mass gatherings and school closures, should be implemented in a phased approach that responds to local epidemiology.

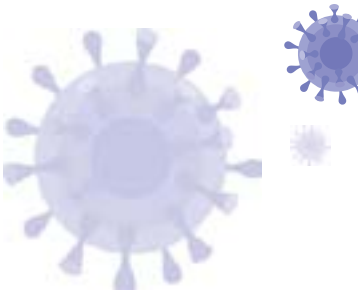


Introduction

The current novel coronavirus (COVID-19) pandemic has resulted in transmission of the causative virus (SARS-CoV-2) in all continents except for Antarctica.[1] In the absence of effective antiviral medications or vaccines, non-pharmaceutical interventions (NPIs) are the only line of defense against this pandemic threat. NPIs aim to reduce the probability of transmission and prevent overwhelming hospitals and intensive care units. Nations with high levels of transmission have implemented measures unlike any seen since the 1918 "Spanish" influenza A(H1N1) pandemic, but often only after community transmission has become widespread.

NPIs vary in resource-intensity and resulting social and economic disruption. Chinese authorities implemented a 4-phase control strategy including: 1) detection and preliminary control (December 20, 2019-January 22, 2020); 2) cancellation of mass gatherings, exit screening, and public health response in 31 provinces (January 23-29, 2020); 3) larger-scale cancellation of mass gatherings, construction of hospitals, improvement in diagnosis and treatment, and spontaneous household quarantine (January 30-February 11, 2020); and 4) scale-up of online teaching, clinical diagnosis, and resumption of work (February 12-20, 2020). A modeling study of these interventions suggested that rigorous control policies resulted in decreased transmission (reproductive number R_0), and highlighted the critical importance of early detection and isolation of cases and adequate medical support.[2] However, travel quarantine in Wuhan may have had only a mild impact on epidemic progression (delay of 3-5 days) and travel restrictions to and from mainland China likely only had modest benefit.[3]

This paper seeks to describe what is known about the effectiveness of NPIs from previous epidemics and pandemics, including the 1918 Spanish influenza pandemic, 2003 Severe Acute Respiratory Syndrome (SARS) epidemic, the 2009 influenza A(H1N1) pandemic, and the 2014-2016 West Africa Ebola Virus Disease epidemic. We later describe ethical and legal considerations for the implementation of quarantine measures and provide best practices for the adaptation and implementation of NPIs in the African context.



What is Known About NPIs from Previous Pandemic Threats?

1918 SPANISH FLU

The 1918-1919 H1N1 influenza pandemic was unprecedented in scale, resulting in an estimated 50-100 million deaths, with a case fatality ratio of ›2.5%.[4] Large-scale non-pharmaceutical interventions were implemented globally, the effectiveness of which varied over time and location.

Preventing entry by community quarantine: Island states were unable to isolate themselves completely from introduction of pandemic influenza with maritime quarantines, although they appear to have delayed introduction. Maritime quarantines in Australia and Madagascar appeared to have delayed introduction by at least 3 months (reviewed by WHO).[5] Conversely, implementation of land quarantine in Canadian provinces and Australian states by way of road and rail interruptions and police checkpoints did not appear to delay transmission.[5] Furthermore, measures to isolate individuals or entire families in Canada did not prevent spread of the disease.[6]

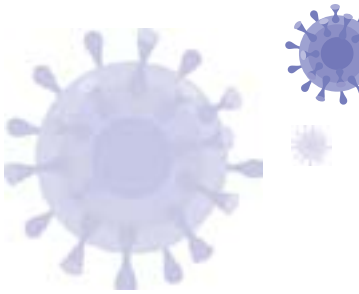
Implementation of multiple measures: Studies of interventions enacted in the United States in response to the Spanish flu suggest that early implementation of multiple measures (≥4 measures versus ≤3 measures) had less-steep epidemic curves, presumably reducing the stress on hospitals and health systems and resulting in lower peak mortality (50%) and lower cumulative excess mortality (20%).[7] Such interventions included the closure of schools, churches, and theatres, although no single intervention was independently sufficient to reduce transmission or death rates. St. Louis had notably low rates of cumulative excess mortality (347/100,000 versus Philadelphia, 719/100,000)[7] and has been heralded as a "model city" for its response to the Spanish flu pandemic.[8] Within a week of identifying the first cluster of cases, St. Louis declared a public health emergency requiring doctors to report cases or face stiff fines. In consultation with the United States Public Health Service, American Red Cross, local business leaders, schools, and the medical community, the St. Louis Health Commissioner issued edicts to close all public houses, movie theatres, and ban public gatherings within the first week; staggered shift work was encouraged to reduce the risk of transmission.[9] A separate analysis of U.S. interventions found that early implementation of measures had significant reductions in overall mortality.[10]

Releasing interventions: In the absence of available vaccine, the timing of release of NPIs is uncertain, as the virus can continue to circulate in susceptible populations. In a study of 17 U.S. cities, those that relaxed interventions within 2-8 weeks experienced second waves of infection after NPIs were suspended.[7] Peak weekly death rates tended to be inversely associated between the first and second waves; cities with more effective initial suppression (and presumably a larger susceptible population after the first wave) had larger second waves. Hatchett et al. postulate that "a mitigated two-phase epidemic may result in a cumulative burden of morbidity and mortality less than that observed in a single unchecked pandemic because of reduced epidemic overshoot."[7]

2003 SARS EPIDEMIC

The 2003 epidemic of Severe Acute Respiratory Syndrome (SARS) sickened 8,096 persons and resulted in 774 deaths (case fatality ratio 9.6%), and cost between U.S. $30-50 billion.[11,12] In response to the epidemic in a globalized setting, countries enacted large scale NPIs including entry and exit screening procedures and community-wide social distancing practices, particularly in China and Hong Kong Special Administrative Region (Hong Kong).

Isolation and Quarantine of Cases and Contacts: Timely identification of disease among the ill with isolation, and monitoring and quarantine among their contacts, was credited with reducing the outbreak timeline and decreasing transmission rates.[13-15] Approximately 30,000 out of 3 million people living in Toronto were quarantined, 1,282 out of 7 million in Hong Kong SAR, and 4,090 out of 18 million in Shanghai.[16] In Hong Kong and China, quarantine led to both psychosocial and financial distress among persons and families, and workforce staffing issues among businesses and governments.[13] Widespread application of quarantine during SARS raised challenging ethical and legal dilemmas; however, in the absence of effective pharmaceutical countermeasures, there were few other options and legal appeals were rare.[13,17] To mitigate the effects of quarantine, Shanghai passed a law prohibiting migration construction workers from being fired and providing them with full salaries while unable to work. In Hong Kong, the city reimbursed employers for salaries of employees that missed work during quarantine, and "work quarantine" was imposed for health workers who continued to work by providing housing and subsidies.[16] Following the SARS epidemic, a telephone survey in Toronto found that there was strong support for the use of quarantine if needed, contingent on the presence of legal safeguards to prevent misuse and the provision of psychological support to affected



persons.[18] In a 2006 poll of approximately 500 respondents each in the United States, Hong Kong, Taiwan, and Singapore, the majority of respondents favored quarantining contacts of known cases (ranging from 76% acceptance in the U.S. and 95% in Taiwan).[19]

Entry and Exit Screening of Travelers: After the diagnosis of the index case in Toronto on March 13, 2003, Health Canada implemented entry and departure screening for SARS, which included a symptom screening questionnaire and later enhanced by infrared thermal scanning machines to detect temperatures ›38°C in selected airports.[20] The cost of screening of ›1 million passengers was estimated to be CDN $7.55 million and detected zero cases. The authors concluded that the positive predictive value of screening in a low prevalence situation was essentially zero, and that health facilities rather than airports should be points of entry into the healthcare system and should be the focus of investments.[20] A pooled analysis of entry screening in China, Canada, and Hong Kong found that no cases of SARS were detected by thermal scanning of ›35 million travelers at points of entry.[13] Similarly, exit screening by thermal scanning of ›7 million travelers did not detect any new cases.[13] Similar to the 1918 pandemic and entry screening, thermal scanning of intercity travelers did not efficiently detect cases.[6] The World Health Organization (WHO) recommends consideration of exit screening in countries with known transmission during pandemic phases 4-6, despite the lack of clear evidence, as a better use of resources.[5]

Social Distancing Measures: Public campaigns during the SARS epidemic were credited as successful by WHO, including encouraging self-recognition and isolation among those who were ill, call centers and hotlines providing medical advice, and appropriate triage and isolation in health facilities.[6] Combined implementation of enhanced contact tracing and social distancing measures, including canceling mass gatherings and closing schools and other public places, were temporally associated with declines in SARS cases.[13] The rapid identification of disease and spread of information during a public health emergency are critical to ensure prompt and effective response measures not only at the central governmental level, but also at the collective and individual levels.[21]

Use of Face Masks: In Hong Kong, NPI implementation was complemented by the widespread use of masks in public as a result of edict (mandated use of masks for persons using public transport, working in restaurants, or entering hospitals) and by voluntary use outside the home (76% of the public reported wearing masks).[13,22] A case-control study conducted among 94 probable SARS patients and 281 community-based controls in Beijing found that use of masks was highly protective in a dose-response fashion; in a

multivariable analysis, persons who wore masks all of the time were 70% less likely than those who did not to be diagnosed with clinical SARS.[23] A similar study in Hong Kong found that wearing a face mask in public resulted in significantly lower odds (OR 0.36) of infection.[24]

Infection Prevention and Control in Health Facilities: During the SARS epidemic, 1,706 of 8,096 (21%) total cases were among healthcare workers.[12] Superspreading events (SSEs) in health facilities served as loci for outbreak clusters and facilitated propagation of the epidemic.[25] Stringent implementation of infection control practices, including the rapid isolation of highly infectious patients, might outperform population-wide interventions.[26] Ultimately, a combination of facility-based and community-based interventions controlled the SARS epidemic.[15,27]

2009 AVIAN (H1N1) INFLUENZA

The 2009 influenza A H1N1 pandemic resulted in a WHO official count of 18,449 laboratory confirmed deaths,[28] although modeled estimates were ~10-fold higher.[29] Individual case reporting of A(H1N1) was discontinued in July 2009 by both WHO and the U.S. Centers for Disease Control and Prevention (CDC), however the overall disease burden was modeled to be substantially higher than official case counts; for each case of disease reported to CDC, 79 had likely occurred.[30,31]

Paid Sick Leave: Voluntary home isolation was applied in many settings during the 2009 pandemic. A Japanese study comparing two sibling companies, one control and one company which asked workers with family members with influenza-like illness symptoms to stay home on paid leave, found that the intervention could reduce influenza A(H1N1) risk by 20%.[32] Conversely, a path analysis conducted found that the absence of workplace policies conferred a population attributable risk of 5 million additional influenza-like illness cases in the U.S. population.[33] Two other studies from the United States concluded that paid sick leave can reduce transmission in workplaces, resulting in lower influenza-related absenteeism overall.[34,35]

School Closure: The 2009 A(H1N1) pandemic disproportionately affected children. In the United States, the 0-4 year-old age group had greater than twice the hospitalization rate (per 100,000) as other age groups, although deaths were highest among those 50-64 years old.[30] Observational studies of school closures during the pandemic found that school re-opening could result in a surge of cases in the U.S.,[36] and that school closure could have

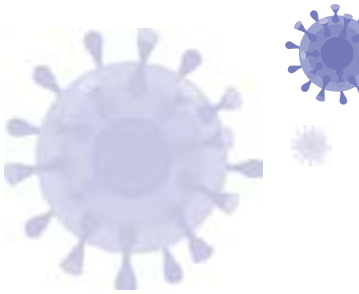
substantially reduced H1N1 transmission in both Mexico and Canada (between 29% and 50% reduction).[37,38] A cost-effectiveness analysis in Hong Kong found that a lower trigger for school closure resulted in the best performance (80%) reduction, and the cost per case prevented was U.S. $1,145.[39]

Lessons from Other Epidemics

Modeling, systematic reviews, and meta-analyses of NPI implementation from various epidemics allow for pooling of data, and for some inferences to be made about the efficacy of interventions based on features of the pathogen, including severity and transmissibility.

Effectiveness of Quarantine: Although isolation of ill patients and quarantine of their contacts has been widely used and adopted in pandemics, the effectiveness of the interventions depend on the quality and rapidity of implementation as well as characteristics of the disease. In a probabilistic modeling experiment, three main requirements were identified for quarantine practices to be most effective if: (1) there remains a large disease reproductive number in the presence of isolation for symptomatic cases alone; (2) a large proportion of infections generated by an individual can be prevented through quarantine; and (3) a high probability that a contact can be placed into quarantine before symptoms develop.[40] In an agent-based branching model comparing the effectiveness of symptom monitoring and quarantine, quarantine was found to have additional benefit specifically for fast-course disease (relatively short duration of infectious period and latent period compared to incubation period), when a high proportion of contacts can be traced, or when there is a long delay between symptom onset and isolation.[41] Similarly, results from another simulation concluded that a combination of case isolation, quarantine, and targeted prophylaxis of exposed individuals could substantially reduce the cumulative attack rate; contact tracing would enhance these efforts but is largely impractical to implement at a pandemic scale.[42] Taken together, these studies suggest that quarantine is most effective for a highly transmissible disease with a fast course, assuming that isolation is effectively implemented and contact tracing is possible to continue when the pandemic becomes large; the benefit of large-scale quarantine in the absence of these provisos is not known.

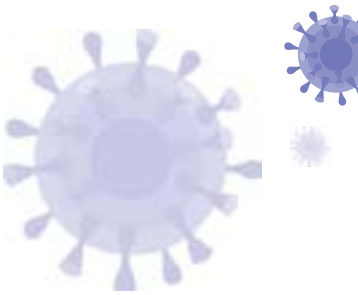
Communication: Communication can play a critical role in enhancing the effectiveness of NPI implementation. During an outbreak, people may respond in ways that that



exacerbate disease transmission – for example, either by not heeding the cautions or by panicking. Social and behavior change communication is key to ensuring adaptive behaviors in the population at risk. A 2009 modeling study found that locally spreading awareness, even among communities where the disease is not yet present, can lower the size of outbreaks.[21] However, as extensive reviews in the risk communication literature have found, for the communication to be effective it must fulfill certain core principles.[43-45] Effective risk communication is a dynamic two-way process between the communicator and the audience that is tailored to its changing informational needs. Trust in and the credibility of the communicator is key, and in the communication of outbreaks, it is crucial that the information be perceived as truthful – even if it concedes to uncertainty or incompleteness. Effective risk communication addresses risk perceptions such that it motivates a desire to act, and does so by recommending actions that people believe is in their power to take to protect themselves and their communities.

Hand and Respiratory Hygiene: Hand hygiene, either using soap and water or alcohol-based disinfectants, can effectively reduce transmission of respiratory illnesses, including influenza viruses.[46,47] A meta-analysis of six case-control studies suggested that hand-washing more than 10 times daily could significantly decrease the spread of SARS, but combined measures of physical interventions (hand-washing, gloves, gowns, and masks) were most effective for reducing both SARS transmission and influenza trans-mission among households.[48] There are conflicting data about the effectiveness of face masks for respiratory protection; in the above study, N95 respirators conferred greater protection than surgical masks; both showed benefit, although their confidence intervals overlapped.[48] Experimental volunteer studies with confirmed influenza A or B infection found that N95 and surgical masks were equally effective in preventing growth of virus on petri dishes when coughed on by the test subjects, indicating a hypothetical benefit for use of masks by ill persons.[49] Study results of use of masks among healthy persons in com-munity settings were less consistent, although only when done in combination with hand hygiene.[49] There are no data to strongly recommend the use of masks in the community to prevent becoming ill, and WHO recommends that mask use be based on setting and risk.[6]

Comparing NPIs: Using transmission in households, schools, workplaces, and commu-nities in the United States and Great Britain as examples, Ferguson and colleagues tested simulations of NPI implementation to determine their effectiveness to stem transmis-sion.[50] In this model, after a novel influenza A virus with a reproductive number similar to



those observed in previous pandemics begins to circulate, instituting travel restrictions (reducing number of importations of cases into the country) only delays the arrival of the virus by a matter of days, and internal travel restrictions are unlikely to contain virus spread (these models are specific to COVID-19, a pathogen with demonstrated pandemic poten-tial, and not more general models of infectious disease[51] where internal travel restrictions might have benefit on reduced transmission). Rapid case isolation and household quar-antine of contacts can substantially reduce cumulative attack rates, assuming they are implemented effectively, ideally with a form of viral prophylaxis if available. Last, school closures can substantially reduce peak attack rates (by as much as to 40%), although they are less likely to substantially reduce cumulative attack rates. However, such a decrease in peak attack rates can reduce the stress on the healthcare systems. Workplace closures could enhance the effect of school closures, albeit at higher economic cost.

A 2007 evaluation of the existing evidence base found that there were few robust stud-ies demonstrating the efficacy or effectiveness of NPIs (having identified 9 systematic reviews of relevant material and 3 randomized clinical trials) and relied instead on expert consultation.[52] Experts recommended hand hygiene and respiratory etiquette (at all phases), human surveillance and case reporting (at all phases), rapid viral diagnosis (at all phases until testing capacity is strained), patient and provider user of masks and other protective equipment (when an outbreak begins), and voluntary isolation of the sick (at all phases). The experts recommended against the widespread use of face masks and other protective equipment among the general public in the early phase of a pandemic, although could not provide recommendations for later stages. They also recommended against restrictions on travel or entry screening in the advanced phases of a pandemic. The experts noted inconsistent evidence for the effectiveness of school closures and recommended against implementation in the early phase.

How Has This Played out in Africa Before?

2014-2016 WEST AFRICAN EBOLA EPIDEMIC

The largest epidemic of Ebola Virus Disease (EVD) occurred in 2014-2016. Guinea, Liberia, and Sierra Leone had widespread transmission, while Italy, Mali, Senegal, Nigeria, Spain, the United Kingdom, and the United States had imported cases or small clusters. The total number of suspected, probable and confirmed cases was 28,652, with 11,325 deaths[53] and an estimated projected loss of U.S. $2.8-32.6 billion of gross domestic product (GDP)[54-56].

Containing the EVD epidemic required the widespread implementation of NPIs, the scale of which had not previously been seen in the African context. While containment of the epidemic was finally reached, social science and epidemiologic research have identified several lessons that can be applied to NPI implementation in the current context.

TABLE 1

Implementation of Emergency Measures for Ebola

Measure	Guinea	Liberia	Nigeria	Sierra Leone
Emergency Declaration	**8/3/2014**	**8/6/2014**	**8/8/2014**	**7/30/2014**
Screening	✔	✔	✔	✔
Surveillance and Testing	✔	✔	✔	✔
Travel Restrictions	✔	✔	✔	✔
Isolation of Cases	✔	✔	✔	✔
Quarantine of Contacts	✔	✔	✔	✔
Cordon Sanitaire	✔	✔		✔
Lockdown				✔
Closures of Borders, Schools, and Markets	✔	✔	✔	✔
Closures of Schools and Higher Education Institutions	✔	✔	✔	✔
Closures of Markets and Workplaces	✔	✔	✔	✔
Curfews		✔		
Disinfection and Improved Sanitation		✔		

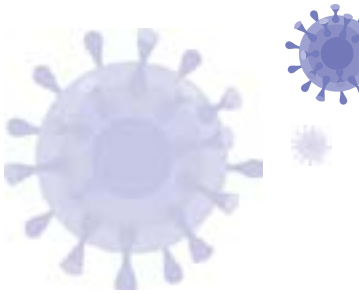
Adapted from[57]

Affected African countries implemented a broad range of NPIs, which are summarized in Table 1.[57] All countries implemented disease control strategies including screening, surveillance, testing, treatment, and isolation of cases and quarantine of contacts. The 3 countries with widespread transmission implemented *cordon sanitaire*, resulting in the quarantine of entire communities with transmission, including known cases, their contacts, and otherwise healthy persons. An agent-based model estimated the effectiveness of NPIs and found decreased incidence attributable to safe burial practices, the provision of

household protection kits, and the increasing availability of Ebola treatment units (ETUs), which could reduce transmission in other hospitals.[58] A CDC analysis found that the availability of ETUs and isolation of cases at home would be critical to control the response.[59]

Cordon Sanitaire: Some form of *Cordon sanitaire* was imposed in all countries with widespread community transmission, often resorting to coercion or militarization of response efforts.[60] Sierra Leone's army blockaded rural areas with Ebola transmission, regardless of health status of travelers, and Liberian armed forces were reportedly ordered to shoot on sight any unlawful border crossers from neighboring Sierra Leone.[57] The securitization (and in some cases politicization) of the response led to episodes of violence in Guinea,[61] Sierra Leone,[62] and Liberia.[63] On August 24, 2014, a *cordon sanitaire* was imposed on the West Point township of Monrovia, Liberia, without sufficient public consultation, engagement, or supportive services in place. Instead, razor wire was erected, and police fired live bullets into the community, resulting in the death of a teenager.[63] The *cordon sanitaire* ended after only 10 days, after which President and Nobel laureate Eleanor Sirleaf Johnson admitted, "We went into a security approach … people's ownership, community participation, works better in a case like this."[64]

Mitigation of Impact: In addition to the militarization of the response, implementation of household and community quarantines resulted in high degree of social insecurity and substantial livelihood disruption, including access to food.[57,65] Community engagement was critical for the successful quarantine in Fuamah[66] District Task Force members worked with Mawah leaders to provide education and secure cooperation. Innovative measures were taken to allow regulated river crossing for access to fields to continue agricultural production, psychosocial support for affected families, and provision of rations by the World Food Programme[66,67] Experiences from Senegal indicate that perception and acceptance of contact monitoring can evolve over time, even during a 21-day[60]Although most contacts were initially agreeable, acceptance later on was contingent on economic and social supports, including the fulfillment of basic needs. Psychosocial supports and minimizing the stigma of monitoring were also found to be important enablers of adherence, as many contacts reported anxiety-related insomnia and experiences of discrimination or physical threats when seen as having "contaminated" their communities. Quarantine and contact tracing measures can be feasible in the West African context, but provision of timely and accurate information, income allowances, food assistance, and psychosocial supports will be critical to maintain adherence.



Community Perceptions and Micro-Social Responses: Local social networks play a substantial role in controlling infectious disease outbreaks.[21,44] In Sierra Leone, inter-personal relations were found to be more trustworthy than institutions beyond the local level; communications considerations should include not only engaging with religious and community leaders, but providing practical advice for households that are the locus for implementation of measures.[68] A Liberian study conducted in September 2014 using a grounded-theory approach identified community-based responses at the micro-social level for containing EVD in the setting of limited support from national and international institutions.[69] Survey responses showed that community leaders did not feel that they needed general information about Ebola, but rather training methods to adapt public health messages and make them practical rather than just raise fear. Community leaders identified need for support for community-based care, which included prevention (training and awareness, hygiene, infrastructure, surveillance, restricting mobility), response and treatment (referrals, quarantine management, care provision, burial and disposal of bodies), and aftermath (orphans, survivors, memorialization). They were able to identify practical steps to take when someone in the community became ill, how to help sick relatives, and how to manage household hygiene. In order to implement these measures, they would require resources to improve sanitation and distribute protective equipment (including raincoats, rainboots, and plastic bags) for those caring for the ill, rather than reserve these measures for medical providers alone. Although ethnographic evidence suggests that communities can engage in surveillance, management, and triage, there were few material resources available for them to effectively implement them during the EVD epidemic.[69]

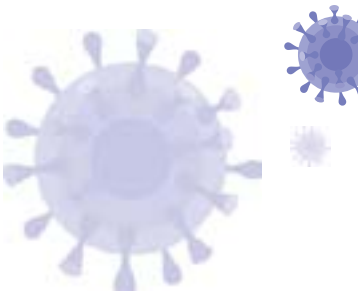
Maintaining Essential Services and Access to Care: In addition to the direct health and economic costs of EVD, an estimated additional U.S. $18.8 billion loss was attributed to deaths from non-Ebola causes as a result of disruption to health systems.[56] These impacts were a result of reduction of healthcare workers, diversion of resources, and reduced access to essential care. A modeling study in Sierra Leone estimated that 3,600 additional maternal, neonatal, and stillborn deaths resulted from decreased health utilization, a figure similar to the 3,956 EVD deaths reported in Sierra Leone during the same period.[53,70] A Liberian survey found that 67% of urban respondents and 46% of rural respondents found it very difficult or impossible to access care during the epidemic.[71] The West African EVD epidemic also demonstrated that, despite the absence different biological vulnerabilities to EVD, women and children's health was particularly impacted

during the outbreak.[72] In March 2020, the United Nations High Commissioner for Human Rights reaffirmed that effectively combating the COVID-19 outbreak requires that everyone has access to treatment and is not denied health care on the basis of stigma or financial hardship.[73]

What Ethical and Legal Dimensions Should be Considered?

The EVD epidemic raised important questions about the ethics and legal authorities of states to restrict individual rights in times of public health emergencies, as coercive measures can be abused by governments and erode trust in communities.[74] Even without the explicit abuse of human rights, public health measures implemented without reciprocity or transparency have resulted in poor outcomes from both disease control and societal perspectives.[43] Community resistance against the often forceful measures implemented during the EVD epidemic should be viewed in the context of histories of structural violence and inequalities in Africa, compounded by the presence of foreign aid groups perceived to be working in support of national authorities.[75] The application of quarantine and the suspension of personal freedoms highlights the tension between the concepts of utilitarianism (the public good) and libertarianism (individual freedoms).[63] Ethical principles to determine whether public health objectives warrant suspension of personal freedoms were proposed by Upshur: Before an intervention is enacted, public health officials should determine that: (a) the intervention is likely to be effective, (b) the action is proportional to the threat of the disease, (c) the intervention is necessary for effective control of the disease, (d) it is implemented so as to have the least infringement on individual liberties, and (e) officials publicly justify the measures, especially to the affected community.[76]

The International Health Regulations (IHR) (2005) require countries to apply health measures in a transparent and non-discriminatory manner and respect the dignity, human rights, and fundamental freedoms of persons (Art. 3 and 42).[77] Although international human rights law instruments including the International Covenant on Civil and Political Rights (ICCPR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR) allow for some limitations and derogations in response to public health emergencies, the liberty-restricting measures should meet criteria as defined under the United Nations (UN) principles. The UN Human Rights Committee provides authoritative



guidance on government responses that restrict human rights for reasons of public health or national emergency, which are also laid out by the Siracusa principles that such restrictions should be:[78]

1. provided for and carried out in accordance with the law;
2. in the interests of a legitimate objective of general interest;
3. strictly necessary in a democratic society to achieve the objective;
4. the least intrusive and restrictive means available to achieve the objective;
5. based on scientific evidence not drafted or imposed arbitrarily, i.e., in an unreasonable or otherwise discriminatory manner[61,78]

Rothstein additionally suggests that such restrictions be of limited duration and subject to the possibility of challenge to and remedy against its abusive application.[79]

During the EVD epidemic, adherence to these principles was inconsistent. In the United States, courts have typically upheld orders by states in the name of public health, with the notable exception of a racially-motivated San Francisco policy (Jew Ho vs. Williamson, 1900). Isolation and quarantine can be permissible only when there exists compelling evidence that the measures are the least restrictive to achieve the objective, and governments must meet daily needs including health care, medication, and food when persons are detained.[63,80]

While the constitutions of Sierra Leone, Guinea, and Liberia allow for a range of emergency measures to protect public health during emergencies, the scope of the powers vary.[57] Guinea's Constitution specifically notes that human rights cannot be suspended during emergencies, whereas limitations in freedoms of assembly are constitutionally permitted in Nigeria and Sierra Leone.[57] For non-state actors, Calain and Poncin warn that aid groups have "no role or legitimacy in enforcing public-health measures. They are bound to respect national laws, but they cannot possibly be held accountable for the enforcement of public-health law."[61] Based on observations from the EVD epidemic, they provide practical recommendations to respect the autonomy and ease tension among communities based on trustworthiness, reciprocity, proportionality, and least infringement. Quarantine places a burden on individuals for the collective benefit; reciprocity requires society to provide support for those burdened by the quarantine. Silva and Maxwell argue that reciprocity requires diminishing the burden imposed on individuals by restrictive measures.

The authors maintain that "if a society does not discharge its reciprocal duties to support those burdened by restrictive measures, then those measures are deemed illegitimate and unethical."[81]

Considering the ethical and legal principles discussed above, the application of quarantine should be the least burdensome possible to affect the required public health objective, should be narrowly targeted with clear inclusion criteria, and instituted in the context of sufficient provisions for daily needs, including food, medical, and psychosocial support. The application should be transparent, with accountability and protection of civil liberties.[82] Martin Cetron, Director of CDC's Division of Global Migration and Quarantine, notes that the response must be adaptive; while individual quarantine of contacts might be effective when transmission of a novel influenza is still limited, community-based social distancing measures including school closing, cancellation of mass gatherings, and encouraging non-essential workers to stay home should be implemented before resorting to community-wide quarantine.[83] Encouraging voluntary measures may have the same health impact as mandatory measures without the risk to community trust and burden on legal system.[16] NPI have the most impact and generate the least friction when they respect and rely on individual autonomy, and appeal to civic duty and community care.

Conclusions

The COVID-19 pandemic is unprecedented in modern times. While awaiting the develop-ment of safe and effective antiviral therapeutics and vaccines, implementation of NPIs are the only mechanism to suppress transmission, buffer hospital and intensive care unit capacity, and prevent excess mortality. Based on historical patterns of influenza pandem-ics and the specifics of transmission dynamics of SARS-CoV-2, aggressive case identifica-tion, isolation, and quarantine of contacts will be required for containment, mitigation, and suppression strategies.[84] Implementation of NPIs should be done rapidly (within 1 week of initial case identification) and adaptively to respond to the changing epidemiology and reduce societal and economic disruption (Table 2). In the absence of vaccinations to confer widespread population immunity, second waves of infection are likely to occur with magnitude proportional to the effectiveness of the initial NPIs implemented. Further modeling and observational data from China and other settings that achieved suppres-sion are required to inform policy guidance for NPI implementation after diminution of the first wave.

TABLE 2

Best Practice Measures and Considerations for COVID-19 Response in the African Setting

	Transmission Scenario*					
Measure	**1**	**2**	**3**	**4**	**5**	**Considerations**
Rapid identification, testing, and isolation of cases	✔	✔	✔**	✔**	✔	Symptomatic people in isolation should be given proper medical care and facilities. Their privacy should be protected as much as possible, while allowing for contact tracing. Isolation of cases in crowded households can result in household transmission, which can be either mitigated by identifying areas within the household (e.g., separate room), house-swapping, or assuming all household members are contacts and voluntary quarantine of the household. Testing and contact tracing capacity will be exceeded at the peak; when community transmission is widespread, ill persons should be advised to self-identify symptoms, isolate at home, and seek medical care if severely ill. Before transmission begins to decline, contact tracing capacity can be improved by hiring, training, organizing, and equipping teams of contract tracers so they are ready to deploy as soon as needed again.
Voluntary quarantine of contacts	✔	✔	✔	✔	✔	Voluntary rather than mandatory quarantine should be used. Meaningful and sustained community engagement through local leaders and timely and accurate information from central credible sources will be needed to promote adherence. Food, livelihood support, employment protections, childcare, medical and psychosocial support will be needed for sustained and effective implementation. Undue securitization or quarantine of communities should be avoided. If mandatory quarantine must be enforced, complaint and redress mechanisms should be put in place and publicized
Relevant, accurate, and timely risk communication tailored to communities	✔	✔	✔	✔	✔	Risk communication at each transmission phase should be tailored to ensure public understanding and acceptance of, and adherence to, the NPIs being implemented. Such efforts, which include meaningful and sustained community engagement, can build trust in the implemented measures, address informational gaps, and motivate adherence. Communications should use plain language, age appropriate (also targeting children) and be available in multiple languages, including for those with low or no literacy, or belonging to minority groups.

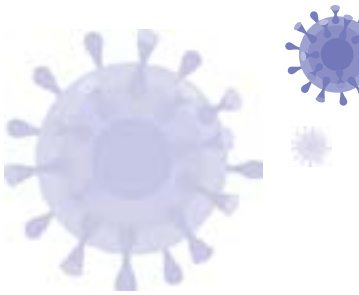
Hand and respiratory hygiene	✔	✔	✔	✔	✔	Hand hygiene education likely improves effectiveness, particularly in combination with other mea-sures. There is evolving evidence to support the use of face masks among the general public to prevention infection, but surgical masks (rather than N95 masks) are likely sufficient to reduce trans-mission from persons who are already ill. If surgical masks are sufficiently available for public use, they should be considered when community transmission is widespread. Subsidized access to water and soap or hand sanitizers might be required. Price gouging and hoarding should be prohibited. Provision of hand-washing stations at central points, outside of business and schools can improve adherence and act as a reminder of risk.
Infection Control and Prevention and Protecting Health Workers	✔	✔	✔	✔	✔	Strategies including dedicated COVID-19 treatment units, analogous to ETUs and implement adminis-trative controls at existing health facilities to minimize spread may be effective when lacking minimal resources for appropriate infection prevention and control measures. Such measures will be critical to prevent disruption of essential health services, which can result in non-COVID-19 specific deaths.
Shielding vulnerable populations most at risk	✔	✔	✔	✔	✔	While there is a limited evidence base for a "shielding" strategy, certain at-risk groups for severe out-comes (ICU admission, death) for COVID-19. Increased precautions and prolonged social distancing measures for these populations, in combination with appropriate livelihood, food, and medical sup-port, may allow for the phased lifting of other social distancing measures while protecting vulnerable populations until a safe and effective vaccine is available.
Cancellation or adaptation of mass gatherings		✔	✔	✔		Conduct within a week of local transmission detection and sustain throughout the pandemic response. Discouraging mass gatherings may slow spread and prevent superspreader events. Rules should be broadly communicated with clear and consistent thresholds for maximum attendance or density (e.g., one person per 3sq meter), and reasonable exemptions for essential service. Engage with community and religious leaders to articulate value-based decisions and encourage local adoption. Adaptation of existing events, including outdoor services or services in shifts, may be help-ful in localities where cancellation of gatherings is not practical. Special care should be taken to main-tain continuity of government functions (legislature, judiciary, elections) and other essential services.
School closures			✔	✔		While proactive school closures and other mass gatherings of children before a case in the com-munity is identified might be more effective in reducing transmission, reactive implementation in response to an identified case in the community can mitigate the household and livelihood impacts. Community acceptance may be stronger if alternative services for childcare and student learning and provision of nutrition are established.

Work closures				✔		Voluntary work adjustments such as teleworking, variable shift scheduling, and desk spacing may be encouraged as soon as community spread is identified. If restrictions on mass gatherings, isolation, and quarantine fail to sufficiently slow spread, further work closures of non-essential businesses may be considered, conscious of undue financial hardship.
International travel restrictions and entry screening	✔***					International travel restrictions might delay importation but cannot prevent importation; island states might achieve the greatest benefit. Entry screening is not effective to identify cases, although incoming travelers should be provided disease and contact information for testing and isolation if needed. Entry screening might have greater benefit if rapid point of care testing becomes available. Targeted limitations on incoming travel from transmission hotspots might delay importation, but will be of minimal benefit after importation has occurred. If implemented, international travel restrictions can only be imposed by law, for a legitimate purpose, and when the restrictions are proportionate, including in considering their impact.
Internal travel restrictions or *Cordon Sanitaire*		✔***			✔***	Consider during initial containment stage, in conjunction with NPIs, to reduce the peak of the pandemic and to "buy time" for preparedness in other jurisdictions; however there is no evidence of long-term benefit of internal travel restrictions or cordon sanitare, unless other social distancing measures are put in place. There is a high risk of discriminatory impact and other human rights violations for the targeted community, which can further erode trust in public health officials. If community quarantine is enacted, substantial services and provisions to provide for livelihoods, access to food, and psychosocial supports will be required.66 Internal travel restrictions can only be imposed by law, for a legitimate purpose, and when the restrictions are proportionate, including in considering their impact.

* 1 = no cases; 2 = sporadic cases or clusters of cases; 3 = local community transmission; 4 = widespread community transmission; 5 = declining transmission

** Continue where possible, but testing capacity and contact tracing capacity will likely be exceeded during widespread community transmission.
Testing efforts should be then be directed towards sentinel sites and detecting new areas of transmission where a containment strategy might prevent further spread.

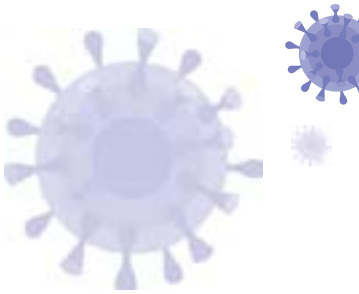
*** Inconsistent evidence for the recommendation; initial modeling studies suggest effectiveness to limit spread for COVID-192,[3]



In the initial phase of the pandemic, aggressive containment measures should be enacted including public communication, rapid case detection and isolation, contact tracing and voluntary quarantine of contacts, respiratory and hand hygiene measures, and appropriate triage and infection prevention and control in healthcare facilities to reduce the possibility of superspreading events.[25] Mask use among the general population to prevent infection is of unclear benefit in the absence of effective hand hygiene measures, which should be prioritized. Among infected persons, surgical masks are likely as effective as N95 masks in preventing transmission to healthy contacts.

Human rights considerations are of paramount importance during the implementation of social distancing measures. Forced isolation and quarantine are impractical and likely violate Siracusa principles. Measures restricting personal freedoms should be implemented only if they are in accordance with the law, minimally intrusive and proportional to the public health threat, are evidence-based and likely to be effective, and are sustained only as long as needed to be effective. These principles are guided not only by human rights instruments and ethical principles, but as demonstrated during the West Africa EVD epidemic, are pragmatic concerns that can mitigate the risk of social unrest, undue strain on families and communities, and enable adherence. Household or community quarantine should only be implemented after meaningful consultation with those people communities consider as their leaders, the establishment and publicization of complaint and redress mechanisms, and arrangements for food, medical, and psychosocial supports to be delivered to affected persons.

International and internal travel restrictions may play a modest role in delaying introduction, but these measures in addition to traveler entry screening have been historically ineffective and have not succeeded in controlling national or international spread of COVID-19. That said, nonessential travel should be deferred. Under IHR (2005), measures implemented "shall not be more restrictive of international traffic and not more invasive or intrusive to persons than reasonably available alternatives that would achieve the appropriate level of health protection" (Art 43[1]).[77] Examples from contemporary epidemics indicate limited support for the use of travel bans in minimizing the spread of infectious diseases; such restrictions can hamper the response as delivery of supplies, equipment, and humanitarian aid to affected areas becomes difficult.[85,86] As such, countries would need to demonstrate that international travel restrictions are not unlawfully or unproportionally infringing on individuals' freedom of movement, and in particular the



right of everyone to enter their own country. Countries should also ensure that measures implemented are not causing individuals to be returned to where they face persecution or torture.

When local transmission begins, aggressive and phased implementation of social distancing measures should be enacted, including cancellation of mass gatherings. Practical measures to reduce impacts on communities can include limiting attendance of mass gatherings by conducting church, mosque, and funerary services in shifts or remotely via video, and holding such events in open air environments where the risk of transmission is lower. School closures should be considered in areas where community transmission occurs, although there are limited data supporting work closures (assuming other NPIs are fully implemented), which should be limited to settings with widespread community transmission.

Social distancing measures call upon citizens to make dramatic shifts to their regular social relationships and behaviors. These shifts may be called upon in a relatively short span of time, as has been the case with COVID-19. In order to achieve these population shifts effectively and safely, it is critical that people's baseline knowledge of the outbreak, their fears, and informational needs be addressed. Open and engaging communication is key to building public trust in the recommended health measures. The communication must be truthful, sensitive to cultural contexts and practices, and delivered by locally trusted authorities. Even as it enables people to perceive their personal risk of illness, it must build confidence that the recommended public health measures are feasible and will ultimately protect their own and others' health. As noted above, sharing information during a public health emergency is a crucial factor.

This commitment to transparency and access to critical information is also rooted in international human rights law, as the right of health entails the obligation "to provide education and access to information concerning the main health problems in the community, including methods of preventing and controlling them."[87] When implementing distancing measures, countries should consider their direct and indirect impacts on other rights, including the right to education, or the principle of non-discrimination. As of March 20, 2020, UNESCO estimated that › 1.2 billion students are affected by 124 country-wide school closures.[88] Such closures may jeopardize efforts to increase school enrollments or leave children in low-income families without subsidized meals.

Based on previous pandemic experiences, including the 1918 influenza A(H1N1) pandemic, lifting of social distancing measures will likely result in subsequent waves of transmission, in the absence of population immunity. However, maintaining social distancing measures for any period of time is logistically challenging and can cause substantial financial hardship and strain on families and communities. Cohort studies from China suggest that risk factors for severe outcomes, including acute respiratory distress syndrome and mortality, include older age and comorbid chronic medical conditions.[89,90] Although not evidence-based as an intervention, Dahab and colleagues suggest a range of interventions to "shield" vulnerable populations including household-level measures (demarcated spaces for high-risk household members), street or extended family shielding (including 'house swap' to place high-risk members in dedicated houses or shelters), and neighborhood shielding (assigning sections of settlements to high-risk, uninfected persons).[91] These measures are likely practical and easier to sustain in both low- and high-resource settings. Although not sufficient for suppression or reversal of the pandemic, simulations by Imperial College predict that shielding the elderly (60% reduction in social contacts) could reduce mortality burden by half.[92]

Worldwide spread of SARS-CoV-2 is inevitable, and failure of containment is not a failure of the public health system. The early and effective response to COVID-19, aligned with human rights and ethical principles, is an indicator of government strength and public trust.

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