

Large-Scale Quarantine Following Biological Terrorism in the United States

Scientific Examination, Logistic and Legal Limits, and Possible Consequences

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DURING THE PAST FEW YEARS, the US government has grown increasingly concerned about the threat that biological terrorism poses to the civilian population.¹⁻³ A number of events have occurred that have raised awareness about the potential threat of bioterrorism. These include the suspected attempt to disseminate anthrax by Aum Shinrikyo in Japan,⁴ widespread occurrence of bioterrorist hoaxes,⁵ and revelations about the bio-weapons programs in the former Soviet Union⁶ and Iraq.⁷ Most recently, the anthrax-related deaths, illnesses, and exposures in Florida and the New York City and Washington, DC, areas have generated even more concern.^{8,9} It is now generally acknowledged that a large-scale bioterrorist attack is plausible and could conceivably generate large numbers of seriously ill exposed individuals, potentially overwhelming local or regional health care systems.¹⁰⁻¹² In the event of a large bioterrorist attack with a communicable disease, the potential for person-to-

person transmission of the disease would create serious health care and emergency management problems at the local and federal levels. Throughout history, medical and public health personnel have contended with epidemics and, in the process, evolved procedures to lessen morbidity and mortality. Historically, quarantine was a recognized public health tool used to manage some infectious disease outbreaks, from the

Concern for potential bioterrorist attacks causing mass casualties has increased recently. Particular attention has been paid to scenarios in which a biological agent capable of person-to-person transmission, such as smallpox, is intentionally released among civilians. Multiple public health interventions are possible to effect disease containment in this context. One disease control measure that has been regularly proposed in various settings is the imposition of large-scale or geographic quarantine on the potentially exposed population. Although large-scale quarantine has not been implemented in recent US history, it has been used on a small scale in biological hoaxes, and it has been invoked in federally sponsored bioterrorism exercises. This article reviews the scientific principles that are relevant to the likely effectiveness of quarantine, the logistic barriers to its implementation, legal issues that a large-scale quarantine raises, and possible adverse consequences that might result from quarantine action. Imposition of large-scale quarantine—compulsory sequestration of groups of possibly exposed persons or human confinement within certain geographic areas to prevent spread of contagious disease—should not be considered a primary public health strategy in most imaginable circumstances. In the majority of contexts, other less extreme public health actions are likely to be more effective and create fewer unintended adverse consequences than quarantine. Actions and areas for future research, policy development, and response planning efforts are provided.

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plague epidemic in the 13th century to the influenza epidemics of the 20th century. During the past century in the United States, professional medical and public health familiarity with the practice of quarantine has faded. A review of the medical literature found no large-scale human quarantine implemented within US borders during the past 8 decades.¹³ Despite this lack of modern operational experience, local, state, and federal incident managers commonly propose or have called for quarantine in the early or advanced stages of bioterrorism exercises.¹⁴ Management of some incidents that later proved to be hoaxes included the quarantine of large numbers of people for periods of hours while the purported biological weapon was analyzed.^{4,15} A striking example of the inclination to resort to quarantine was demonstrated during a recent federally sponsored national terrorism exercise, TOPOFF 2000.^{16,17} During the biological terrorism component of this drill, a national, large-scale geographic quarantine was imposed in response to a growing pneumonic plague epidemic caused by the intentional release of aerosolized *Yersinia pestis*, the bacteria that causes plague. An array of significant political, practical, and ethical problems became apparent when quarantine was imposed.

Given the rising concerns about the threat of bioterrorism and the concomitant renewed consideration of quarantine as a possible public health response to epidemics, it is important that the implications of quarantine in the modern context be carefully analyzed.

QUARANTINE VS ISOLATION

One of the first challenges to address is the lack of a precise definition of *quarantine*. In the historical context, quarantine was defined as detention and enforced segregation of persons suspected to be carrying a contagious disease. Travelers or voyagers were sometimes subjected to quarantine before they were permitted to enter a country or town and mix with inhabitants. The term *quarantine* is derived from the Italian *quarante*, which refers to the 40-

day sequestration imposed on arriving merchant ships during plague outbreaks of the 13th century.¹⁸

In the modern era, the meaning of the term *quarantine* has become less clear. The *Oxford English Dictionary* defines *quarantine* as “a period of isolation imposed on a person, animal or thing that might otherwise spread a contagious disease.”¹⁹ Unfortunately, during modern bioterrorism response exercises, this term has been used broadly and confusingly to include a variety of public health disease containment measures, including travel limitations, restrictions on public gatherings, and isolation of sick individuals to prevent disease spread. The authors believe it is most appropriate to use *quarantine* to refer to compulsory physical separation, including restriction of movement, of populations or groups of healthy people who have been potentially exposed to a contagious disease, or to efforts to segregate these persons within specified geographic areas. For clarity in this article, this action is termed *large-scale quarantine* to differentiate it from incidents of exposure by only a few persons. To avoid confusion, we do not use the terms *quarantine* and *isolation* interchangeably. We use the term *isolation* to denote the separation and confinement of individuals known or suspected (via signs, symptoms, or laboratory criteria) to be infected with a contagious disease to prevent them from transmitting disease to others.^{20,21} It is operationally important that medical and public health emergency managers use accurate terminology.

LEGISLATIVE FRAMEWORK FOR DISEASE CONTAINMENT

The moral authority for human quarantine is historically based on the concept of the public health contract.²² Under the public health contract, individuals agree to forgo certain rights and liberties, if necessary, to prevent a significant risk to other persons. Civil rights and liberties are subject to limitation because each person gains the benefits of living in a healthier and safer society.²³

The statutory authority for the imposition of quarantine in the United States originated at a local level during the colonial period. Massachusetts established state quarantine powers in the first comprehensive state public health statute in 1797.²⁴(pp238-239).²⁵ At approximately the same time (1796), a federal statute authorized the president to assist in state quarantines.²⁶ The act was later replaced by a federal inspection system for maritime quarantines.²⁷ Thereafter, the federal government became more active in regulating the practice of quarantine, and a 19th-century conflict between federal and state quarantine powers resulted. In the ensuing federalism debate, the states maintained that they had authority pursuant to police power.²⁸⁻³⁰ The federal government maintained that its preeminent authority was derived from regulatory powers over interstate commerce. Today, states are primarily responsible for the exercise of public health powers. However, if the exercise of quarantine clearly would affect interstate commerce, the federal government may claim that its authority is supreme.^{31,32} Following is a brief summary of which institutions or levels of government have statutory authority to apply quarantine in distinct contexts.

Local Outbreaks in the United States

When an infectious disease is confined to a specific locale, the authority for quarantine usually rests with local or state public health officials. The authority is generally relinquished to the state when the event affects more than a single community or has the potential to spread across jurisdictional boundaries within the state. The individuality of each state authority has led to a widely divergent group of regulations providing for the use of quarantine.³³ Few local and state jurisdictions, however, have established specific policies and procedures to assist officials in deciding whether an individual event merits imposition of quarantine.³⁴

Interstate and National Outbreaks

The federal government has the authority to enact quarantine when presented with the risk of transmission of infectious disease across state lines.³⁵ Legislation stipulates that this is an executive decision to be made by the president. Once the decision has been made, the Centers for Disease Control and Prevention (CDC) is the federal agency authorized to manage federal quarantine actions.³⁶ The implementation apparatus for such an order could involve federal assets from other agencies, such as the Department of Defense or the Federal Emergency Management Agency, deploying in support of federal, state, or local authorities.³⁷ The federal government may also assert supremacy in managing specific intrastate incidents if so requested by that state's authorities or if it is believed that local efforts are inadequate.^{35,38} Other legal venues for federal action may exist but have not been well delineated.³⁹

Foreign Outbreaks and US Border Control

For travelers seeking to enter the United States, the CDC has the authority to enact quarantine. At the turn of the 20th century, the Marine Hospital Service (forerunner to the modern US Public Health Service) established this federal power.⁴⁰ The authority was later delegated to the CDC's Division of Global Migration and Quarantine, currently consisting of 43 employees in the field and 30 at department headquarters in Atlanta, Ga.⁴¹ In areas where Division of Global Migration and Quarantine personnel are not stationed, Immigration and Naturalization Service and US Customs Service personnel are trained to recognize travelers with potential illness of public health significance. While rarely used, detention of arriving individuals, including US citizens, is authorized to prevent the entry of specified communicable diseases into the United States. Using definitions delineated in this article, the detention of arriving passengers with visible signs of illness would be termed *isolation*.⁴²

Currently, federal law authorizes cooperative efforts between the federal government and the states related to planning, training, and prevention of disease epidemics and other health emergencies.⁴³ Despite this, lines of authority between federal and state/local jurisdictions have not been sufficiently tested to ensure that all essential parties have clear understanding of the boundaries and interface between these potentially conflicting authorities. In a large-scale or rapidly evolving natural or deliberate biological incident, confusion and conflict in this public health authority may result. This issue was demonstrated in the TOPOFF exercise.^{16,17}

Extensive reviews of the legal basis for quarantine actions have been published elsewhere and will not be reviewed in detail here.^{21,44,45} Perhaps the most important understanding that can be extracted from these reviews is that though legal powers exist to quarantine in many contexts, the imposition of quarantine would likely be challenged in the courts using modern interpretations of civil liberties provided by the US Constitution. Additionally, courts have suggested that, in the event of a quarantine, detainees would have to be provided with reasonable amenities to reduce harm (eg, adequate shelter and medical care). Ultimately, extensive quarantines would likely cause the judicial system to become a slow and deliberate arbitrator between the conflicting ideals of public health and individual civil liberties. The CDC and many states are currently in the process of reexamining the legal authority for public health actions, including quarantine.^{46,47}

HISTORICAL ILLUSTRATIONS OF ADVERSE CONSEQUENCES OF QUARANTINE

United States history has demonstrated that quarantine actions themselves may cause harm. Large-scale quarantine today can be expected to create similar problems, perhaps to a greater degree. Three historical events in the United States provide examples

of the unintended consequences of quarantine implementation.

Increased Risk of Disease Transmission in the Quarantined Population

One of the most controversial US quarantines was imposed by the New York City Port Authority in 1892 on ships traveling from Europe, where a cholera outbreak had occurred.⁴⁸ Cholera had been detected among immigrants, and the subsequent public health response included quarantining passengers aboard arriving vessels. Passengers of lower socioeconomic standing were clearly subjected to separate, more severe conditions than wealthy passengers. Authorities sequestered these impoverished immigrants below deck without sanitary provisions during the confinement. Cholera spread disproportionately among the poor on board the vessels and resulted in at least 58 deaths on one ship alone.⁴⁸

Mistrust in Government Recommendations Led to Violence

The municipality of Muncie, Indiana, was confronted with an outbreak of smallpox in 1893.⁴⁹ Public health officials had great difficulty convincing citizens that intrusive public health actions were necessary, in part because the diagnosis of smallpox was repeatedly challenged. Many infected citizens were isolated under home detention and their presumably uninfected family members were quarantined with them. Entire neighborhoods were quarantined by patrolling armed guards; violators were incarcerated. Mandatory vaccination was instituted. Violence broke out as some civilians resisted the public health impositions, and several public officials were shot. Public health officials ultimately concluded that their quarantine actions had been "an utter failure" as the public had repeatedly defied their quarantine efforts.⁴⁹

Ethnic Bias Adversely Altered Public Health Decision Making

A quarantine was instituted in the Chinese neighborhood of San Francisco,

California, in 1900, after plague was diagnosed in several inhabitants.⁵⁰ The boundaries for the quarantine were arbitrarily established such that only Chinese households and businesses were included. This resulted in severe economic damage to the once-thriving Chinese business community. A federal court found the quarantine unconstitutional on grounds that it was unfair—health authorities acted with an “evil eye and an unequal hand.”⁵¹

KEY CONSIDERATIONS IN QUARANTINE DECISIONS

In most infectious disease outbreak scenarios, there are alternatives to large-scale quarantine that may be more medically defensible, more likely to effectively contain the spread of disease, less challenging to implement, and less likely to generate unintended adverse consequences. Decisions to invoke quarantine, therefore, should be made only after careful consideration of 3 major questions examined within the specific context of a particular outbreak: (1) Do public health and medical analyses warrant the imposition of large-scale quarantine? (2) Are the implementation and maintenance of large-scale quarantine feasible? and (3) Do the potential benefits of large-scale quarantine outweigh the possible adverse consequences?

1. Do Public Health and Medical Analyses Warrant the Imposition of Large-Scale Quarantine?

Decision makers must consider whether large-scale quarantine implementation at the time of discovery of disease outbreak has a reasonable scientific chance of substantially diminishing the spread of disease. There is no valid public health or scientific justification for any type of quarantine in the setting of disease outbreaks with low or no person-to-person transmission, such as anthrax. Despite this, quarantine has been invoked in anthrax bioterrorism hoaxes in recent years.^{4,15} Among the many diseases that are termed contagious (ie, capable of being spread by contact with sick persons), only a limited number

could pose a serious risk of widespread person-to-person transmission. Of these contagious diseases with potential for widespread person-to-person transmission, only a limited number confer sufficient risk of serious illness or death to justify consideration of the sequestration of large groups or geographic areas. In addition to the agent characteristics, available treatment and prophylaxis options also create the context for the decision process. Public health responses must be accurately tailored to meet the specific risks and resource needs imposed by individual agents.

There are imaginable contexts in which a large-scale smallpox outbreak would generate reasonable considerations for quarantine. But even in the setting of a bioterrorist attack with smallpox, the long incubation period (10-17 days) almost ensures that some persons who were infected in the attack will have traveled great distances from the site of exposure before the disease is recognized or quarantine could be implemented. Subsequent issues with quarantine will remain problematic.

2. Are the Implementation and Maintenance of Large-Scale Quarantine Feasible?

If medical and public health principles lead to a judgment that quarantine is an effective and necessary action to stop the spread of a dangerous disease outbreak, the next set of issues that should be considered involves the logistics of actually establishing the large-scale quarantine. These issues are applicable to local, state, and federal decision makers.

Is There a Plausible Way to Determine Who Should Be Quarantined? Are there practically available criteria for defining and identifying a group or a geographic area that is at higher risk of transmitting a dangerous disease? As noted, depending on the disease-specific incubation period and due to the mobility of modern society, it is probable that a population exposed to a biological weapon will have dis-

persed well beyond any easily definable geographic boundaries before the infection becomes manifest and any disease containment measures can be initiated. Even within a specific locale, it will be initially impossible to clearly define persons who have been exposed and, therefore, at risk of spreading the disease. A quarantine of a neighborhood would potentially miss exposed individuals, but a large-scale quarantine of a municipality could include many with no significant risk of disease. Currently proposed or functional health surveillance systems have not yet demonstrated adequate proficiency in rapid disease distribution analysis.^{52,53}

Are Resources Available to Enforce the Confinement? The human and material resources that would be required to enforce the confinement of large groups of persons, perhaps against their will, would likely be substantial, even in a modest-sized quarantine action. The behavioral reaction of law enforcement or military personnel charged with enforcing quarantine should also be considered. It is possible that fear of personal exposure or public reaction to enforcement actions may compromise police willingness to enforce compliance.

Can the Quarantined Group Be Confined for the Duration During Which They Could Transmit the Disease? Quarantine will not be over quickly. The period during which confined persons could develop disease might be days or weeks, depending on the specific infectious agent. Development of illness among detainees could prolong the confinement of those remaining healthy. Resources and political resolve must be sufficient to sustain a quarantine of at least days, and probably weeks. Furthermore, the multiple needs of detainees must be addressed in a systematic and competent fashion. During previous events, the courts have required that those quarantined be detained in safe and hygienic locations.⁴⁴ Adequate food and other necessities must be provided. Competent medical care for those de-

tained is an ethical and possibly constitutional requirement.²¹ Transferring supplies across quarantine lines can be difficult, as can recruiting qualified medical personnel to enter quarantined areas. The shortage of trained medical persons to adequately care for quarantine detainees should be anticipated and was clearly demonstrated during the influenza epidemic of 1918.^{13,54}

Given the presumption that biological terrorism would impose multiple competing demands for human and material resources within the affected region, decision makers must weigh the costs and benefits of devoting available assets to the maintenance of quarantine.

3. Do the Potential Benefits of Large-Scale Quarantine Outweigh the Possible Adverse Consequences?

If valid public health and medical principles lead to a judgment that quarantine is an effective and necessary action to stop the spread of a dangerous disease outbreak, and it is established that a quarantine could logistically be put into place, the possible unintended adverse consequences of a quarantine action must then be carefully considered.

What Are the Health Risks to Those Quarantined? As noted herein, there are US historical examples in which persons with clear evidence of infection with a contagious disease have been quarantined together with persons with no evidence of infection.^{48,49} It is now beyond dispute that such measures would be unethical today, but a recent event illustrates that this ethical principle might still be disregarded or misunderstood.⁵⁵ A passenger returning to the United States was noted to be ill and vomiting on an airline flight, and the passenger's consequent subconjunctival hemorrhages were initially mistaken to be a sign of a coagulopathic infection. On arrival at a major US airport, the plane was diverted and quarantined by airport authorities with all passengers on board, including the poten-

tial index case. They were released after an hour-long period of investigation, when public health authorities arrived and concluded that there was no dangerous contagion. Had this been an actual contagious disease, quarantined passengers may have been subjected to an increased risk by continued confinement on the parked aircraft with the ill person. At a minimum, passengers should have been allowed to disembark and remain in an area separate from the index case while this person was being evaluated.

What Are the Consequences if the Public Declines to Obey Quarantine Orders? It is not clear how those quarantined would react to being subjected to compulsory confinement. Civilian noncompliance with these public health efforts could compromise the action and even become violent. Historical quarantine incidents have generated organized civil disobedience and wholesale disregard for authority. Such conditions led to riots in Montreal, Quebec, during a smallpox epidemic in 1885.²⁴ (pp285-286) Some might lose confidence in government authorities and stop complying with other advised public health actions (eg, vaccination, antibiotic treatment) as well. The possibility also exists for development of civilian vigilantism to enforce quarantine, as occurred in New York City in 1892.⁴⁸ The rules of engagement that police are expected to follow in enforcing quarantine must be explicitly determined and communicated in advance. Protection of police personnel and their families against infection would be essential to police cooperation.

What Are the Consequences of Restricting Commerce and Transportation to and From the Quarantine Area? Halting commercial transactions and the movement of goods to and from quarantined areas will have significant economic effects that may be profound and long-term and reach well beyond the quarantined area. Much modern business practice relies on just-in-time supply chains. Shortages of food, fuel, medicines and medical supplies, essential personnel, and social ser-

vices (sanitation) should be anticipated and provisions must be in place to deal with such issues. Postquarantine stigmatization of the geographic location and of the population quarantined should be anticipated.

CONCLUSIONS AND RECOMMENDATIONS

Public Health Disease Containment Measures Must Be Based on Scientific, Disease-Specific Analysis

The essential first step in developing any disease containment strategy is to determine if the disease at issue is communicable. If not, then no consideration of quarantine should be pursued. If the disease of concern is contagious, then the specific mechanism of disease transmission must drive the disease containment strategy (eg, spread by cough at close distances or possibly over longer range, as has occurred in smallpox outbreaks; infrequent spread by cough at close distance, as in some plague outbreaks; or spread through person-to-person contact, as in Ebola outbreaks). Some progress in delineating disease containment strategies for bioterrorism-induced outbreaks has already occurred in the form of consensus public health and medical recommendations,⁵⁶⁻⁵⁸ though more diseases must be addressed and public health actions examined. Political leaders in particular need to understand that a single strategy for limiting the spread of all contagious diseases is not appropriate and will not work. The political consequences of public health actions such as large-scale quarantine must also be carefully examined and understood. Modern US disaster response has consistently focused on assistance to those directly affected; in the case of bioterrorism, response will focus on both those potentially infected and those actually infected. With implementation of quarantine, the perception may be that those potentially and actually infected have instead been secondarily harmed by response actions.

In an outbreak of a contagious disease, disease containment may be more

effectively achieved using methods that do not attempt to contain large groups of people. As noted, persons with clinical or laboratory evidence demonstrating infection with a contagious disease should be isolated, separate from those who do not have clinical or laboratory evidence of that contagious disease. Depending on the illness, this isolation may be primarily respiratory, body fluid, or skin contact isolation rather than full physical separation from all healthy people.

Additional, population-based public health intervention strategies should also be considered. Depending on the context, rapid vaccination or treatment programs, widespread use of disposable masks (with instructions), short-term voluntary home curfew, restrictions on assembly of groups (eg, schools, entertainment sites), or closure of mass public transportation (buses, airliners, trains, and subway systems) are disease containment steps that may have more scientific credibility and may be more likely to result in diminished disease spread, more practically achievable, and associated with less adverse consequences. For clarity, these alternative disease control measures should not be termed *quarantine* or *quarantine actions*.

Invest in New Information Tools and Emergency Management Systems That Would Improve Situational Awareness During Disease Outbreaks

During large-scale contagious disease outbreaks, decision makers would be critically dependent on the availability of timely, accurate information about what is happening and what interventions are desirable and feasible. Emergency management and public health officials will need real-time case data and the analytic capacity to determine the epidemiological parameters of the outbreak to make the most appropriate disease containment decisions. Clinicians will seek information about the natural history and clinical management of the illness and ongoing analyses of the efficacy of treatment strate-

gies. Rapid communication between the medical and public health communities may be especially important and in most locales is currently not conveyed by electronic means or through routine, well-exercised channels.

Provide Incentives to Foster Specific Public Actions

Positive incentives may help to persuade the public to take actions that promote disease containment. The ready provision of adequate medical expertise, appropriate vaccines or antibiotics, or distribution of disposable face masks to the public in specific circumstances are examples of incentives that may positively influence population behavior to promote disease containment. Allowing family members to voluntarily place themselves at some defined, calculated risk of infection to care for their sick loved ones might encourage participation in a community's overall disease containment strategy. Assisting family members in these efforts by offering them some forms of protection against the disease could be a valuable aspect of an integrated disease containment strategy. For example, distribution of barrier personal protective equipment and education aimed at discouraging potentially dangerous burial rituals were successful interventions in controlling viral hemorrhagic fever in Africa.⁵⁹

Devote Resources to Developing Robust Public Communication Strategy Commensurate With the Critical Importance of This Action

The development of strategies for communicating with the public throughout a disease outbreak is of paramount importance. Objectives of this strategy would include informing the public through multiple appropriate channels of the nature of the infectious disease and the scope of the outbreak, providing behavioral guidelines to help minimize spread of illness, and conveying details about how to get prompt access to effective treatment. Ideally, such messages would be conveyed by informed, widely recognized

health experts such as the state health commissioner or US surgeon general. In a bioterrorist attack, the media's appetite for information will be limitless and health authorities must be prepared to provide accurate and useful information on a nearly continuous basis.⁶⁰ Advanced planning and preparation for such a media storm is essential. Once public credibility is lost, it will be difficult or impossible to recover. A well-informed public that perceives health officials as knowledgeable and reliable is more likely to voluntarily comply with actions recommended to diminish the spread of the disease. Effective information dissemination would work to suppress rumors and anxiety and enlist community support.

It is clear that public health strategies for the control of potential epidemics need to be carefully reevaluated. This process should ensure that civil rights and liberties are kept at the forefront of all discussions, as recently proposed by the congressionally created Gilmore Commission.³ Further delineation of the authority to impose quarantine is required, and the political and psychological implications must be addressed. Given the complex multidisciplinary nature of this problem, further analysis of possible disease containment strategies would ideally include experts from the fields of medicine, public health, mental health, emergency management, law, ethics, and public communication. The process should specifically examine the various alternatives to quarantine that may be more effective and more feasible in addressing the containment of an infectious outbreak. Strict definition of terms such as *quarantine* must be maintained. With modern, in-depth understanding of specific diseases, more specific and medically valid response is appropriate than that used in the era of poor scientific understanding that established the practice of quarantine. The resulting work from this effort could provide a more comprehensive systems approach to disease containment in general.

Disclaimer: The opinions and findings in this article are those of the authors and should not be construed as official policies or positions of the US Public Health Service or the New York City Department of Health.

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