Short Communication

Cost and benefit of military quarantine policies

Andrew Hall [a,b,*], Iram Qureshi [c], Jacob Glaser [c], Paul Auchincloss [a], Ramey Wilson [a,d]

[a] Special Operations Command Africa, Unit 30401, APO AE 09107, B96 Medical Group, 307 Boatner Rd., Eglin AFB, FL 32542, USA
[b] 96 Medical Group, 307 Boatner Rd. Eglin AFB, FL 32542, USA
[c] Naval Medical Research Unit San Antonio, Department of Surgery, 3698 Chambers Rd., San Antonio, TX 78234, USA
[d] Uniformed Services University, Department of Medicine, 4301 James Creek Road, Bethesda, MD 20814, USA

ARTICLE INFO

ABSTRACT

The initial response to COVID-19 included quarantine policies. This study aims to determine the infection containment proportions and cost of two variations of quarantine policies based on geographic travel and close contact with infected individuals within deployed US military populations.

Special Operations Command Africa (SOCAF) records of individuals quarantined between March 1, 2020 and June 1, 2020 were examined. The infection containment proportion and cost in containment hours were compared between types of quarantine and between geographic areas. Geographic quarantine contained 2 cases out of 63 quarantined individuals in West Africa (3.2%) compared to 0 out of 221 in East Africa ($p = 0.0486$). Close contact quarantine contained 3 cases out of 31 quarantined individuals in West Africa compared to 4 out of 55 in East Africa (7.3%, $p = 0.6989$). Total confinement was 42,048 h for each contained infection using geographic quarantine compared to 4076 h using close contact quarantine.

In the US military population deployed to Africa for COVID-19, quarantining based on geographic movement is an order of magnitude more costly in terms of time for each contained infection then quarantining based on close contact with infected individuals. There is not a statistical difference between East and West Africa. The associated costs of quarantine must be carefully weighed against the risk of disease spread.

1. Introduction

The COVID-19 pandemic was a shock to the world. Many health systems instituted quarantine and isolation measures to contain the disease and keep their populations safe. Many decisions were made with limited information in the best interests of entire communities, including the use of quarantine (Wynants et al., 2020; Quarantine and Isolation, n.d.). In locations where the U.S. military often deploys forces in support of training and advising missions, expeditionary medical forces are often required to deploy in order to provide combat casualty care in the event of casualties from conflict or accidents. These locations, such as the ones in Africa, are often austere and remote, increasing the evacuation times and medical risks associated with operating in countries with different expectations of care. While the US expeditionary medical system does well in support trauma casualties, the system had to contend with the COVID-19 pandemic and the likelihood of providing critical care and evacuation capabilities to unstable infectious patients. As with most diseases, prevention of the uncontrolled spread of the virus was preferred in order to prevent overwhelming available medical

resources and, like other health systems, quarantining was used aggressively as a primary strategy. This paper aims to determine the infection containment proportion and costs of quarantine policies for deployed military populations by analyzing the results within Special Operations Command Africa (SOCAF).

2. Materials and methods

Within the AFRICOM area of responsibility (AOR) a quarantine policy was implemented requiring asymptomatic travelers coming from countries outside an area to be placed into quarantine for a planned 14 days upon arrival to their new location (geographic quarantine). These travelers included individuals moving between countries in Africa, forces traveling from Europe and forces rotating into the theater from the United States. Asymptomatic individuals judged by medical authorities to have been in close contact with an infected individual were placed into a planned 14-day quarantine (close contact quarantine). All individuals diagnosed with COVID-19 either clinically or via testing were placed in isolation and removed from quarantine.

The study was conducted after declassification of data and approval by the 59th Medical Wing IRB. Quarantine records of individuals entering quarantine between March 1 to June 1, 2020 maintained by SOCAF were analyzed. Data for comparison were start and end date of quarantine, reason for quarantine (geographic or close contact), any detection of disease while in quarantine, and location of the individuals (East or West Africa). The geographic areas of East or West Africa were purposely left broad due to ongoing military operations but was defined as being east or west of the 20° east meridian. Partial or incomplete data entries were excluded from statistical comparisons. Quarantine costs were defined as the confinement hours of those placed into quarantine. Additional costs of confinement are food, security, housing, sanitization, etc. and the labor required to supply each to the quarantined was not calculated due to regional and installation variations.

The infection containment proportions of each quarantine policy, defined as the number of contained cases out of the total number of individuals quarantined, within geographic areas were compared using Fisher's Exact Tests. The use of laboratory testing was compared using a Chi-square test. All analysis was completed using SAS version 9.4, and statistical significance was set at alpha = 0.05.

3. Results

A total of 436 US personnel entered quarantine during this period. Sixty-six individuals were excluded due to missing required data. A total of 370 individuals were quarantined in both West and East Africa. The geographic and close contact policy contained infections per number quarantined proportions within each region were compared (Table 1). There was a statistical difference between the proportion of contained infections out of the total number of quarantined individuals among the geographic quarantine in West Africa versus East Africa (0.0% vs 3.2%, $p = 0.0486$). There was no statistical difference between the proportion of infections contained between East and West Africa in the close contact quarantine.

The total confinement cost in both regions per individual in geographic quarantine was 296.1 ± 79.0 h, and 331.8 ± 47.5 h per individual in close contact quarantine. The total number of cases of COVID-19 that were contained within the entire SOCAF study population through geographic quarantine was two (0.7%) with a total cost of 84,096 h. The cost in confinement hours for each case contained was 42,048 h. The total cases contained through quarantine of close personal contacts was seven (8.1%), with a total cost of 28,537 h. The cost was 4077 h for each case contained using close contact quarantine.

Laboratory testing occurred in East Africa 202 out of 276 quarantines (73.2%) while in West Africa it was 45 out of 94 (47.9%, $p < 0.0001$). All quarantined individuals in West Africa that were determined to be positive were diagnosed clinically. All quarantined individuals in East Africa that were determined to be positive were diagnosed through laboratory testing.

Table 1
Comparison between West and East Africa geographic and close contact quarantine programs managed by AFRICOM. Each geographic area could declare an individual positive for disease either clinically or through laboratory testing.

West Africa		East Africa		p
Geographic quarantine		Geographic quarantine		
Number	63	Number	221	
Mean days of quarantine	13.3	Mean days of quarantine	12.1	
Infections contained	2	Infections contained	0	p = 0.0486
Close contact quarantine		Close contact quarantine		
Number	31	Number	55	
Mean days of quarantine	13.5	Mean days of quarantine	14.0	
Infections contained	3	Infections contained	4	p = 0.6989

4. Discussion

A cornerstone of epidemic response in the past has been quarantine and isolation or cohorting of infected individuals (Rosenberger et al., 2012). Unfortunately, quarantine can be a draconian measure with a negative impact on quarantined individuals and populations due to the prolonged confinement (Brooks et al., 2020). Not only are the quarantined populations affected, but time and resources of the non-quarantined must be spent to support those quarantined. Consequently, the benefits of quarantine have to be carefully weighed against costs. These data support that the cost for quarantining people based on geographic movement is an order of magnitude greater then quarantining based on close personal contact when examining the infection containment proportions. Geographic quarantine may best be used in populations that are truly isolated without ongoing community spread of disease or in the early stages of a novel disease.

The different quarantine policies have differing success rates at isolating and identifying disease carrying individuals. Within the US deployed populations in Africa, geographic quarantine had a low proportion of detected and contained infected individuals at a very substantial human cost. The number contained infections could potentially have been zero if the positive cases that were clinically diagnosed had been other pathogens. The costs of food, facilities, etc. and the labor required to provide it have costs beyond the human capital expense of isolating individuals. This was not tallied due to the variation between regions, but have to be contemplated for any population contemplating strict quarantine practices. These costs can be substantial, especially for military units with restricted facilities, manpower, and supply chains. When the disease is in almost every corner of the world, geographic quarantine loses utility as populations are still interacting with the disease in the local environment. In this scenario, a strategy that quarantines close contacts of those determined to be positive is demonstrated to be much more likely to contain infected individuals. Both methods will contain infections, but with the COVID-19, the human costs of geographic quarantine may be unreasonable for many communities.

The cost of quarantine must be balanced with the risk of infection spread. For many current and likely future diseases, social distancing and rigid hygiene practices may be as effective as quarantine (Ahmed et al., 2018). Future diseases may have differing periods between infection and cessation of communicability then COVID-19. Once a disease's course and consequences are understood, then it becomes important to determine the cost and benefit of actions. For COVID-19, the initial morbidity and mortality figures were concerning, but it became quickly apparent that older age and comorbidities are the primary risk factors for morbidity and death (Weiss and Murdoch, 2020; Onder et al., 2020). For predominantly healthy populations like military personnel, isolation for the most at risk individuals may have been the better option for COVID-19. The deployed military population is often different then civilian populations in that living quarters are often communal, strict public hygiene measures are more easily enforced, and the option for evacuation to higher levels of care may be limited due to extreme distances. If quarantine policies are required, modifications based on data should be rapid and flexible enough to minimize the negative impact. The best foreseeable changes are those that eliminate the need for quarantine through testing that can accurately certify disease presence or absence. For small populations, like deployed military populations, the ability to expand small and austere footprints to provide facilities and manpower to accommodate quarantine populations is limited (Hall et al., 2020). This burden can be the same for civilian populations and governments. The faster quarantine can be safely but also reasonably ended, the better.

Future diseases may have longer and shorter periods between infection and cessation of communicability. Quarantine will contain infections if strictly enforced but the productivity and well-being of the individual will be negatively affected, and they will have to be cared for by the community. The authors believe a geographic quarantine is an

ideal option for confronting an unknown infection or possibly to protect isolated populations. As soon as the disease is in the community or information makes the possibility of further exposure more acceptable, geographic quarantine should be abandoned and close contact quarantine utilized if necessary.

The main weakness of this study is the possible variance in application and recording of quarantine policy and data. This variance is exemplified by the non-uniform quarantine lengths and data exclusions. The data were derived from records meant to primarily keep track of manpower availability and not to precisely account for medical status. Better precision would be possible through a prospective medical study prepared in the event of the next global pandemic.

5. Conclusion

Quarantining US personnel deployed to Africa for COVID-19 based on geographic movement contained relatively few infections at a high cost to individuals. Quarantining based on close contacts has many more contained infections at a lower cost per contained infection. We recommend geographic quarantine be used solely to prevent the introduction of the disease into isolated populations or during the period of time where the disease characteristics are unknown.

Funding source

Credit authorship contribution statement

Andrew Hall: provided conceptualization, methodology, investigation, formal analysis, writing – original draft, and supervision. **Iraq Qureshi**: provided formal analysis and writing – original draft. **Jacob Glaser**: provided writing – review and editing. **Paul Auchincloss**: provided investigation. **Ramey Wilson**: provided writing – review and editing and investigation.

Acknowledgments

References

Ahmed, F., Zviedrite, N., Uzicanin, A., 2018. Effectiveness of workplace social distancing measures in reducing influenza transmission: a systematic review. BMC Public Health 18 (1), 518.

Brooks, S., Webster, R., Smith, L., et al., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet. 395, 912–920.

Hall, A., Morrow, L., Monsaert, K., Wilson, R., Dixon, M., 2020. Converting a small surgical team into a pandemic response team for an isolated population. J. Am. Coll. Surg. 230 (6), e27–e30.

Onder, G., Rezza, G., Brusaferro, S., 2020. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA. 328 (18), 1775–1776.

Quarantine & Isolation. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine-isolation.html (Accessed: June 20, 2020).

Rosenberger, L., Riccio, L., Campbell, K., Politano, A., Sawyer, R., 2012. Quarantine, isolation, and cohorting: from cholera to Klebsiella. Surg. Infect. 13 (2), 69–73.

Weiss, P., Murdoch, D., 2020. Clinical course and mortality risk of severe COVID-19. Lancet. 395, 1014–1015.

Wynants, L., Calster, B., Collins, G., et al., 2020. Prediction models for diagnosis and prognosis of covid-19: systematic review and critical appraisal. BMJ 369, m1328.