Fever Screening – Public Health Protection or Security Theater?

Dan Hanfling, MD

Thermal imaging devices to detect travelers who have elevated temperatures and hence might be harboring a contagious disease, have been deployed during several infectious disease outbreaks. It is being deployed again at US borders and elsewhere in attempts to contain the spread of the coronavirus emanating from Wuhan, China. Screening potentially exposed individuals in order to limit disease spread is a fundamental pillar of public health response to outbreaks. The focus on fever detection at borders is more theater than protection, however. Data collected in past outbreaks demonstrate that thermal screening is of limited effectiveness while requiring a tremendous amount of resources. Public health authorities in numerous countries employed such measures during the SARS (2003), H1N1 (2009) and West Africa Ebola (2014/15) outbreaks to evaluate the movement of potentially infected patients across borders, continents and oceans. The fundamental concept of screening is sound – detect those travelers who may be potentially infected at the border, upon either entry or exit, before they have the chance to transmit a respiratory infection to those not yet exposed.

Examples from previous outbreaks demonstrate the limited efficacy of fever screening. During the SARS epidemic in 2003, 1.8 million inbound passengers were screened at Australian airports, 794 travelers were detained, and none of them were found to have the virus[i]. In Singapore, nearly half a million people were screened[ii] and in Toronto, Canada, 350,000 passengers were screened[iii]. In both instances, no patients were deemed to be infected with the SARS coronavirus. The yield with thermal scanning during the H1N1 global pandemic in 2009 was only very slightly better. 465,000 passengers were screened upon entry in Auckland, New Zealand; four were found to be positive for the novel influenza strain[iv]. 625,000 were screened on arrival in Sydney, Australia; 5,845 were detained awaiting confirmatory testing, and only 3 passengers were found to be infected with H1N1[v]. The single highest yield was recorded by officials in Tokyo, Japan who screened 471,000 passengers, further evaluated over 800 of them, and confirmed diagnosis in 15[vi].

Why do these efforts demonstrate limited success? The answers lie in a combination of viral characteristics, human behavior, and technological limits. Viral infections in the human host present with different lengths of incubation. Coronaviruses tend to have greater variability in their incubation period than do influenza viruses, and the epidemiological characteristics of this novel coronavirus are yet to be determined. Thus, it is possible that infected individuals do not yet exhibit fever but are already transmitting virus. Preliminary evaluation of a cluster of cases transmitted within a single family in Wuhan suggests the possibility of asymptomatic transmission[vii]. In addition, human behavior is such that evasive answers on official questionnaires regarding risk of exposure, and/or incomplete or misleading descriptions of clinical symptoms are common. So, too, is the use of medications such as acetaminophen and ibruprofen which lower fever and can mask any symptoms at the time of border crossing[viii].

Finally, there is the available technology. The most advanced thermal screening devices utilize non-invasive infrared thermal detection systems, which detect a difference between the subject being evaluated and the ambient temperature from a stand-off distance. While the accuracy of such systems, including correlation with the measurement of confirmatory oral temperatures, demonstrates that they can identify febrile subjects, the utility of such an approach as part of a comprehensive public health screening strategy remains limited. If we are to truly achieve public health protection by deploying mass screening efforts, we will need to augment current capabilities[ix].

The most useful approach to screening would be to have point-of-care diagnostic test that could rapidly and specifically identify people who are infected with the novel coronavirus. While high throughput, remote monitoring and rapid capture of potential infections among a very mobile population remains the aspirational gold standard, there are other solutions that can be employed now. Ideally, screening tools should be sensitive enough to detect everyone infected with the novel coronavirus but not mistakenly select others with fevers due to more mundane causes, like the common cold. One approach would be to utilize digital health platforms, especially smartphone or computer based chatbots and telehealth consultations, for patients arriving to the U.S. for whom there is concern with potential infection. The US requires development of a national system that utilizes AI-driven triage assessment tools that can query patient symptoms and determine the likelihood of infection. Like the use of conventional 'health questionnaire' forms required by some immigration policies, completion of basic medical and demographic information on such a platform could be considered a requirement for cross-border entry. This would provide a tracking mechanism, useful for disease surveillance. It would simultaneously offer immediate telehealth connectivity for persons seeking additional medical consultations, either based on general concerns or perhaps in response to a change in their health status. And it would provide the platform upon which public health authorities could continue to deliver their important risk communications messaging regarding what to do in the setting of an evolving outbreak.

Population based screening remains an important component of the response to outbreak events. However, the utility of stand-off fever screening efforts is so limited as to significantly call in to question the financial costs and investment of public health resources associated with such efforts. The fever screening tools, the deployment of public health personnel and the tremendous disruption that these efforts cause, to travelers and responders alike, suggests the time has come to explore other means of careful, thoughtful evaluation of passengers during an epidemic outbreak. Adoption of digital health solutions should be the next step in the evolution of border disease screening efforts.

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[viii] Bindman P, Chinese tourist says she evaded coronavirus checks to fly to France, *The Guardian*, January 23, 2020, available at https://www.theguardian.com/science/2020/jan/23/chinese-tourist-says-she-evaded-coronavirus-checks-fly-france

[ix] There are newer technologies that allow for remote measurement of fundamental physiologic parameters – heart rate and blood pressure [Liu J, et. al. 2018. Transdermal optical imaging revealed different spatiotemporal patterns of facial cardiovascular activites. Scientific Reports 8(10588): 1-10.] which, in combination with thermal imaging, might demonstrate better results, albeit likely at higher costs. And very preliminary experimentation with laser-pulsed transdermal analysis of blood flow has shown promising results with the potential to detect transdermal optical excitation and acoustic detection of vapor nanobubbles related to intraparasite hemozoin, a finding in malaria infections that occurs when the malaria parasite travel through the bloodstream [Lukianova-Hieb, et. al. 2015. Transdermal Diagnosis of Malaria Using Vapor Nanobubbles, *Emerging Infectious Diseases*, 21(7): 1122-1127.]. Could such conceptual efforts eventually lead to the identification of signals or markers for other infectious agents?