ROUNDTABLE REPORT – LEVERAGING DIGITAL HEALTH TECHNOLOGIES DURING LARGE-SCALE EPIDEMICS

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<u>**Introduction**</u>

The capabilities required to manage a large-scale epidemic are multifaceted, complex and range across a number of critical domains – the ability to detect and recognize the presence of disease in the community; the capacity to design, manufacture and deliver life-saving medical countermeasures, including therapeutics and vaccine; and the process by which healthcare services can be delivered to the population-in-need in a scalable fashion that maintains the highest possible standard of care.

<u>**Background**</u>

In-Q-Tel/B.Next convened a Roundtable meeting, held on December 5, 2019 in Arlington, VA to explore the role digital health technologies can play to support the response to large infectious disease outbreaks. Roundtable participants included experts drawn from several United States (U.S.) Government agencies, academia, private-sector technology companies and members of the In-Q-Tel and B.Next team. The discussion took place over a single day. There were two invited presentations, and the meeting was conducted on a not-for-attribution basis.

This Roundtable discussion was the first of a series of meetings which intend to explore how digital health technologies might be applied to epidemic management. This meeting was focused expressly on two broad themes -- the role enabling technologies can play in allowing the population to initiate self-triage, and how such technologies might aid in preserving the integrity of hospital services over the course of an extended outbreak event. Subsequent Roundtable discussions in this series will explore the potential of these technological platforms to help provide appropriate medical treatment in an austere environment where resources are scarce. We will also examine how digital health technologies might enable the collection, analysis and coordination of data in order to provide essential situational awareness, thereby facilitating the creation of a "learning healthcare system" in the midst of an epidemic crisis.

<u>**Overview of Topic:**</u> *Digital Health tools will be critical to managing epidemic events.*

The potential roles that digital health technologies might serve during an epidemic requires an understanding of the likely adoption rate, capabilities, and limitations of such technologies. The rationale for this approach is based upon three key points. The first is that healthcare service delivery is currently undergoing a fundamental shift toward the increasing adoption of digital health tools. Changes in the marketplace are driving rapid changes in healthcare service delivery. These forces include the need to reduce costs and respond to patient demands for more efficient access to care. The second is that the platforms that support digital health tools – namely the adoption of the smartphone with its consumer facing applications, along with the extension of broadband internet connectivity – are widely available in the U.S. This facilitates the ability to exchange meaningful and timely health-related

information to a population in need. To serve these needs, hundreds of start-up companies and large, established corporations are pursuing telehealth applications. The third, and perhaps the most important, element relates to the characteristics of an emerging infectious disease public health emergency that distinguish it from other disaster events. Conventional sudden-onset disasters (e.g. the 2001 attacks on the World Trade Center and Pentagon; catastrophic earthquake, nuclear detonation) generate large numbers of casualties simultaneously. An injured population suffering traumatic injuries will require stabilization and expedited hospital-based medical management. In contrast, an emerging outbreak event will likely build in size and intensity over time and will simultaneously affect numerous geographical regions of the U.S. (and the rest of the world). There may also be a spectrum of illness severity in an infectious disease outbreak, with some victims not requiring hospital care. This presents an opportunity to filter patients based on their presenting symptoms and state of physical and physiologic status, thus preserving hospital services for those patients most likely in need, and most likely to benefit from such care. Moreover, it is a fundamental premise that hospital services must be maintained for fundamental treatments that address the health security of the population (obstetric services, emergency services, chronic disease management, etc.). Preventing the collapse of the healthcare system – rationing scarce resources under "crisis care" conditions and limiting or slowing the transition away from "conventional care" – should be considered a fundamental national security imperative in the context of a large-scale epidemic event.

Summary of Discussion

"Digital health" has been defined as "the convergence of healthcare and the internet." The Roundtable adopted this as the umbrella term incorporating various instances of digital health including telehealth, telemedicine, digital medicine, distributed health, and direct to consumer healthcare applications focused on symptom presentation. Each of these approaches to digital healthcare delivery was defined and explored to varying degrees over the course of the day. The overarching commonality amongst this diverse tool set is its capacity to serve as a force multiplier for healthcare providers who will be in short supply during a large-scale epidemic, but essential to caring for the population over the (likely prolonged) course of the crisis.

The day's discussion was organized around three topic focus areas:

(1)   What role could digital health tools play in helping the population self-triage?
(2)   What is the current and future business and technical landscape of digital health?
(3)   How could digital healthcare technologies help protect the healthcare system from collapse during an epidemic?

A digital health technology capabilities framework was introduced based upon the existing B.Next Technology Architecture that frames the IQT approach to epidemic identification, characterization and management. We suggest that digital health technologies can support the response to large scale disaster events, specifically epidemics, based upon the quadruple value that such digital technologies provide. Ideally, digital health technologies could be used for the following: symptom reporting and clinical evaluation, support for a rapid response by providing early warning of an outbreak, support of clinical trials, and as a means to deliver and amplify core public health messaging. The digital health

capabilities framework (see Figure 1), based on these key requirements, is comprised of five core capabilities:

- Self-sorting: Enable individuals to determine their own health status, and to assist in gathering data relevant to population health.
- Remote patient management: Provide healthy patients with information about what they need to do to remain healthy and provide a process for ongoing evaluation of patients who are not yet ill (or ill enough) to warrant formal clinical care.
- Healthcare workforce protection: Provide monitoring to ensure healthcare workforce safety.
- Maintain critical healthcare system capabilities: Ensure that there is capacity and capability within the healthcare system to treat epidemic victims requiring hospitalized care; preserve tertiary care service delivery; and facilitate medical care oversight.
- Seeing, sharing and using data: Track patient interactions in order to assess the overarching health of the population so as to describe the epidemiologic characteristics of the epidemic.
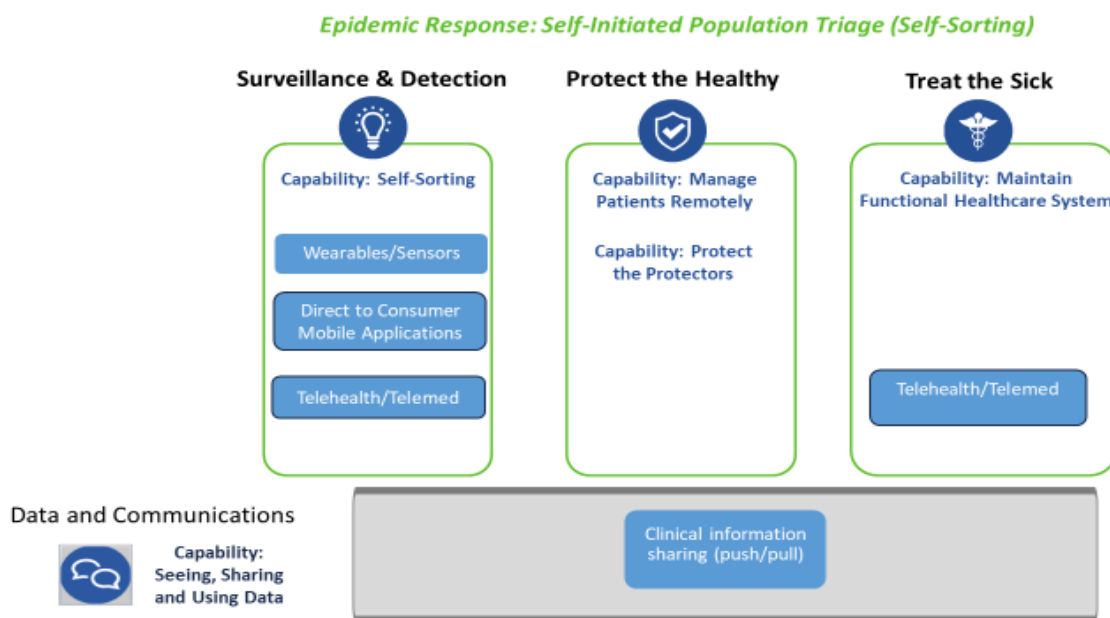

Figure 1. Digital healthcare technology capabilities framework, B.Next/In-Q-Tel

The day's discussion primarily centered around two of the five core capabilities – the ability to self-sort, and the ability to maintain a functional healthcare system. The Roundtable also included two invited presentations. Dr. Robert Walker, Chief, Health Innovation, Office of the Army Surgeon General, focused his remarks on how the Department of Defense plans to use digital health technologies as they "fight the future fight". Dr. Eric Toner, Senior Scholar, Johns Hopkins Center for Health Security discussed the elements necessary to protect the healthcare system from collapse during response to an epidemic.

Key Findings

The Roundtable discussion yielded five key findings summarized below:

(1) The ability to scale information communication platforms (data, SMS, voice, video and combinations thereof) in a large sustained epidemic event requires further exploration and delineation.

(2) Successful patient triage and delivery of medical services during a large-scale epidemic will be significantly enhanced by application of artificial intelligence and machine learning to support both patient and clinician decision-making.

(3) Fear, uncertainty and confusion are expected hallmarks of an epidemic outbreak. Individuals' willingness to use and trust digital health tools during an epidemic is essential. These issues must be proactively addressed and continuously evaluated, preferably before a crisis occurs.

(4) Market and demographic factors are already driving the utilization of digital health tools in the field of healthcare service delivery.

(5) The U.S. government is unlikely to develop the technologies required to support the full range of digital health capabilities that could support epidemic management, but state and federal government can promote these capabilities through incentives and funding designed to accomplish their adoption and implementation.

Ability to scale requires further exploration: Gaps in our knowledge base and understanding of the capacity for digital communications platforms to manage sudden and sustained utilization of services were highlighted over the course of the day's discussion. Bandwidth requirements will increase with the increasing complexity of the communications service utilized (data>>SMS>>voice>>video). However, further clarification is needed to determine what digital health tools can accomplish during a sustained event. What is the communications load possible for current systems to support, in what modality, and over what period of time? The current communications infrastructure, especially access to wireless bandwidth, was described as "*fragile*" and the wireless spectrum presently in place was referred to as a "*scarce resource*." Information propagates through a communications network based upon the principle of demand access – with the recognition that "*the more the demand, the less the access*". This led to a discussion about the role that dedicated systems, in addition to the existing demand access systems might play in crisis response. Spike surges in access may limit access to timely information flow, but the consensus of the group was that such spike surges would be less likely to occur in a sustained event, like an epidemic. The greater risk to prolonged disruptions would be physical loss of the cell towers, also deemed to be less likely in an infectious disease outbreak.

The advent of 5G networks was also discussed, focusing specifically on 5G networks' promise to deliver "enhanced mobile broadband," "ultra-reliable low latency communications," and support for connectivity to the "Internet of Things". We discussed the need to proactively consider security protections in the development and distribution of 5G networks. In addition, we noted that recruiting subscribers onto these new networks will be a near-term business challenge, one that might affect the pace and scope of access to 5G improvements. There are also several technical hurdles 5G network operators must address. Solutions will require research, development, capital investment and policy changes geared to facilitating the deployment of secure 5G infrastructure.

Role of artificial intelligence/machine learning (AI/ML): In a large-scale epidemic, there will not be a sufficient number of healthcare practitioners available to address the queries of the potentially exposed population. Even under conventional conditions, the U.S. healthcare system is overwhelmed. One participant described this dilemma as the "*too much disease, not enough healthcare*" problem. We recognized that episodic consultations would not be effective in a dynamic event that stresses the healthcare systems ability to provide services. "*Healthcare practitioners will eventually get tired, but computers never do.*" Too much data will likely overwhelm clinicians. As a result, much discussion centered on automated solutions that could assist patients in decisions regarding their own healthcare choices during an epidemic. The accuracy of such systems was noted to be a key characteristic for consumer-facing applications to be deemed trustworthy. We discussed the role of "checklists" and their limitations were explored. One key issue identified was described as the "*variability*" of patients. "*People have different presentations of the same disease*". The distinction between "overtriage" (sending too many patients to the hospital) and "undertriage" (missing those patients who actually need to go to the hospital) was explored. AI/ML supported symptom analysis based upon individual patient interactions might serve to limit the fluctuations in over/undertriage.

Importance of trust: Fear, uncertainty and confusion, compounded by variations in language, culture and existing medical knowledge, will all be key factors that influence how the population will make decisions about their own healthcare choices during an epidemic. A recurring theme of the day's discussion circled back to the importance of "*trustworthiness*" and "*authority*" with regards to digital health tools being used for population self-triage. Protocols based upon trusted sources such as medical professional societies for the Centers for Disease Control and Prevention will be important, thereby assuring that "*accuracy*" in the decision-making process is an inherent feature. Much of this trust needs to be developed prior to the onset of an epidemic event.

Market and demographic factors will influence adoption: There is currently no dominant "*tech ecosystem*" or platform in the U.S. used by the entire population. A combination of market forces and demographics will influence the broad adoption of digital health tools in the coming years. Rather than expecting these capabilities to usher in complete disruption in healthcare service delivery, we should anticipate a shallower path towards utilization of digital health tools. Numerous market analysis firms point to the steady trend of increasing utilization of telehealth and telemedicine services, the rapid adoption of wearable sensors, and corporate entrance into the healthcare marketplace (e.g. Best Buy Healthcare, Amazon, Walmart, Apple).

Cellphone utilization in the U.S. is ubiquitous. Most people use smartphones, 9 in 10 Americans access the internet regularly, and three-quarters of Americans have access to broadband services in their home. Extensive access to digital technology platforms, plus the dual demographic trends of "digital natives" entering the marketplace (bringing expectations of usability, access and value-based care to their interactions in the healthcare space) and a transition of "digital immigrants" towards retirement will propel the adoption of digital health tools. However, application of digital health technologies in a large-scale epidemic will require broad penetration and familiarity with their use. We cannot expect the population to access these tools during an epidemic if they are not comfortable with using them for routine health and medical concerns.

Need for U.S. government role in supporting adoption: A recurrent theme of discussion over the course of the day was the role that government should play in supporting the adoption of digital health tools for use in a large-scale epidemic. The group pointed towards the clear recognition that private sector entities will move faster with technological innovation in this space than the government. Yet, government funding and incentives will be critically important to drive these capabilities forward. The technological platform that can be used for digital health response in an epidemic is the very same platform as that used in delivery of conventional healthcare services. However, there is a significant difference in the use case between "*conventional digital health*" and "*disaster digital health*". The government will need to support the adoption and implementation of disaster digital health tools because regular market incentives are not in place to fund it presently (this is true of the economics of emergency preparedness and response in total – underfunded, until it is required).

Next Steps: Pursuant to the key findings outlined in this report several ongoing initiatives are planned in order to better understand the role that digital health technologies can play in mitigating and responding to a large-scale epidemic. The In-Q-Tel/B.Next team will continue to investigate the capabilities that current and future telecommunications platforms provide to support large scale utilization of digital health tools, how they can scale, and at what point they become saturated or incapable of supporting timely information exchange. This will include conduct of further discussions with representatives from industry regarding the capabilities of their respective platforms, as well as exploration of other efforts in the start-up community that might be reasonably expected to be able to support these mission requirements. The team will engage in continued dialogue with key influencers and decision-makers across multiple agencies of the U.S. government. We will explore opportunities to further develop the thesis that digital health tools should be explored for use in a large-scale epidemic, both to initiate population self-triage, as well as to protect the functionality of hospitals and the healthcare system. And as noted in the course of the day's proceedings, we plan to conduct two additional Roundtable meetings. The next Roundtable will explore the role that digital health platforms can provide to improve remote patient monitoring and patient care delivery under austere conditions. The third Roundtable will address the role that data gathered from the use of digital health tools can play to support the development of a "learning" healthcare system in the midst of a crisis event.

We wish to express our appreciation to the individuals who participated in this IQT Roundtable and to those whom we consulted for their time, expertise and willingness to consider the issues of epidemic management.

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