Pre-Deployment Assessment of NETCCN COVID-19 Tele Critical Care Technologies in a Laboratory Environment

Presenting Author: Julian M. Goldman, MD
Co-Authors: David Arney, PhD, Yi Zhang, PhD, David Guffrey, MS, MSM, and team leads of The Geneva Foundation NETCCN DISTRESS team: Tracy Rausch, Steven Dain, MD (DocBox), Sanjay Subramanian, MD (Omnicure), Christopher Colombo, MD (Geneva Team P.I.)

The COVID-19 pandemic has led to an increased interest in using telemedicine and tele-critical care (TCC). Solutions typically comprise multiple components, such as patient monitoring and reporting, clinician communication, and administrative coordination. This complexity and urgency necessitate testing prior to clinical deployment. The Medical Device Plug-and-Play Interoperability and Cybersecurity lab at Massachusetts General Hospital (MD PnP) contains an environment to facilitate the rapid evaluation of new medical devices and systems, including engineering development of prototypes and improvised setups that may have not yet been cleared for clinical use. We used the MD PnP lab to evaluate a novel combination of technologies, developed by the DISTRESS team, intended for tele critical care of COVID-19 patients in the TATRC National Emergency Tele Critical Care Network* [https://www.tatrc.org/www/resources/covid-19.html].

Our approach included configuration of the system to reflect simultaneous care of 3 patients by local and remote providers. Connected medical devices included three patient monitors and two ventilators. Two of the patient monitors were physical devices (Philips MX800 and MP70) and one was virtual - simulated in software. One ventilator was a physical device (PB 980 or GE Engstrom) and one was virtual. The mix of physical and virtual devices permits testing of data connectivity from real medical devices while enabling scalability with virtual devices to simulate numerous patients. Patients were represented by 2 Fluke ProSim 8 patient simulators, a Michigan Instruments test lung, and pre-recorded time series of vital signs, integrated into a test harness which included modifications to the ProSim8 to allow for long-term remote operation through the OpenICE platform (openice.info). Additional patients were simulated by custom software. The medical devices were connected to three DocBox systems (docboxmed.com), which captured data from the bedside medical devices, translated communications into a standards-based nomenclature and time-base, provided an interface for bedside visualization and notation, and transmitted data to cloud servers.

Medical device data and other patient information was retrieved from these servers and presented to remote clinicians using the Omnicure app (omnicuremd.com). Omnicure provided the ability for clinicians to manage multiple patients and create alerts and notifications based on the medical device data. Omnicure also integrates with text, voice, and video chat capabilities to allow remote clinicians to assist the local providers.

The aim of the project was to demonstrate, test, and evaluate this end-to-end system to assess its suitability to support remote consultation and care of COVID-19 patients, as well as develop generalizable test methods. We tested the ability of Omnicure to receive data from medical devices accurately and in a timely manner. This was done by creating clinical scenarios, modeling typical COVID-19 progression, and using these to drive patient simulators. Then the data could be observed as it was recorded in the server database and the Omnicure app to evaluate performance. These tests were done repeatedly while introducing network perturbations through varying available bandwidth and overall latency between the lab) and servers. These parameter adjustments represented varying qualities of network connection at

care facilities as well as enabled characterizing minimum network quality needed to support reliable system communications.

System issues were identified by iterative functional and usability testing which enabled resolution prior to clinical deployment. The approach to creating test scenarios, scripts, and developing patient simulators to create realistic vital sign progressions, and evaluation of system performance under varying network conditions is broadly applicable to telemedicine applications and especially to the development of Smart and Autonomous Medical Systems (SaAMS).

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