Prototype Design of Real Time Vital Signs Monitor System for Critical Care Air Transport Team(CCATT)

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Background Military critical care air transportation teams (CCATT) have demonstrated reliable capability to evacuate critically injured patients from deployed hospitals. However, these compact medical teams constantly face challenges regarding in-flight assessments that are required to rapidly render appropriate clinical support. Clinical decision-making is further confounded by an aeromedical environment characterized by confined space, noise, vibration, and limited visibility. An automated physiological data-organizing and information-summary system could present aggregated information from multiple data sources, provide at-a-glance summaries of clinical data and assist with prioritizing care for multiple patients. We designed and implemented a prototype vital sign (VS) viewer specifically designed for this unique and hostile environment, and tested its capacity for data throughput and stability.

Method: All bedside monitors are connected in a local network. A data server collects VS reported from each monitor with bed number and timestamp. To organize data from multiple sources, and to ease the information acquiring burden, the CCATT viewer displays multiple monitored patients as a group, using their VS trajectories. It uses highly distinguishable colors (green, yellow and red) to code normal, warning, and alert values. With a set of pre-defined and adjustable thresholds, abnormal VS above/below warning or alert thresholds are filled with yellow and red blocks to help rapidly identify patients who need attention. With longer VS trajectories (up to 72 hours) physiological patterns can be observed at a glance. With interactive design, patient data can be selected for detailed display. All operations can be performed on a touchscreen.

Result: In a level 1 shock trauma center, the viewer displays 230 beds (grouped into 14 clinical units) for up to 72 hour continuous VS data with 1-minute temporal resolution. It shows up to 9 VSs in complete trajectories: Shock index (SI), heart-rate, systolic blood pressure, oxygen saturation, intracranial pressure, etc., that are routinely monitored for patients with shock, burns, trauma, traumatic brain injury, or respiratory failure. Each minute, approximately 9 million data points are streamed to the viewer and rapidly converted to a display: for a typical 16-bed unit, the viewer takes less than 200 milliseconds to render all data. The system has high reliability—with asynchronous communication, it can tolerate temporary network failure. In our preliminary evaluation, the system has been in continuous operation for more than 3 months, and is now routinely used by the intensive care physicians in our trauma center.

Conclusion: In a noisy, busy and confined transport aircraft, loosely-organized physiological data, over-saturated information delivery, and limited visual assessment may reduce the capability of a small clinical team to recognize changes in physiologic status and prioritize care. The CCATT viewer prototype demonstrates a method to assemble large quantities of data from multiple sources, and represent trends in each patient's condition with simple color codes, greatly improving situational awareness. We are currently conducting a prospective study in the intensive care unit to evaluate the usablity and the effect of the viewer on diagnostic efficiency for prioritizing care.