CAPTURING VITAL SIGNS FOR RESEARCH IN A MULTI-BED MONITORING ENVIRONMENT

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Background: Capturing vital signs for research activities, such as measuring heart rate variability [1], obtaining data to design, or testing novel medical displays [2] or alarm algorithms [3] is traditionally done by directly connecting a data capture device to the patient monitor. A novel method and device that allow researchers to retrospectively analyze data for all patients admitted to an intensive care unit (ICU) is presented.

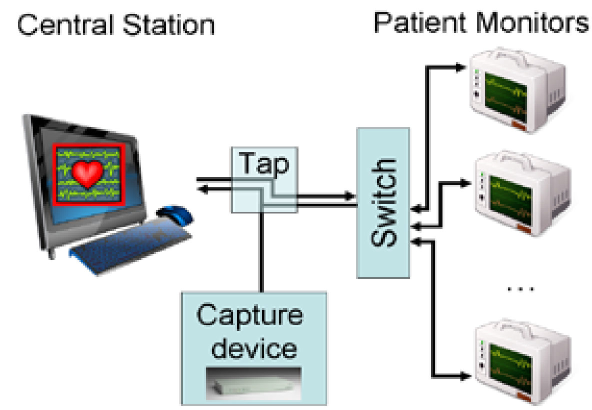

Figure 1: Overview of the patient monitoring network with the data tap and capture device.

Method: A passive tap was installed between the central monitoring station and the switch connecting patient monitors. The tap allowed unobtrusive capture of the entire data stream sent to the central station [4]. A dedicated embedded platform (net5501, Soekris Engineering Inc, Santa Cruz, CA) running a minimal OpenBSD operating system was permanently connected to the data tap. This reduced the risk of connecting and removing a device from the network, interfering with data collected by the central station. The device captured the raw data transmitted to the central station in a compressed packet capture (PCAP) format, partitioned into 1 hr segments, and stored it on an internal hard disk. Arbitrary segments of the recorded data could be extracted to a flash drive at any time from the live system. This data extraction was automatically driven by a spreadsheet table containing a batch list of monitor IDs, start times/dates and durations. To prevent unauthorized extraction of protected health information, the capture box transferred data only to authenticated drives and provided an audit trail by logging all data transfer requests. The researcher used a universal parser to convert the extracted data segments into numeric trends and waveforms in CSV format for further investigation. The parser could decode data from Phillips Intellivue and GE Datex-Ohmeda central networks, although support for other Ethernet-based monitor networks can be added. This will potentially provide a single interoperable patient data access point for incompatible vendor implementations.

Discussion: A simple and safe method of allowing researchers access to previously captured vital sign information in an ICU is presented. Advantages of this solution are 1) low cost and low maintenance, 2) access to comprehensive past data, which allows analysis of rare events, 3) secure access to captured data without the need to connect research equipment to the live monitoring network, 4) modification of the offline parser is possible due to raw data storage e.g. parameters not originally requested by the researcher can be added, 5) the capture box works with any Ethernet based monitor network, and 6) boxes can be chained for simultaneous and redundant storage of data from multiple locations, such as the ICU and operating rooms. Disadvantages of the method are: 1) a special parser is needed to extract information from the captured network packages, 2) using a flash drive is a cumbersome method to extract large chunks of data due to limited transfer speed, and 3) data extraction to the flash drive is delayed from the real-time feed by up to one hour due to the internal data partitioning. Real-time access to the data is possible from a secondary network interface on the capture box, but requires real-time parsing.

Conclusion: The described capture device provides an easy method to access vital sign information for ICU patients. It requires minimal training for the user and reduces the workload for the research group that is providing the device. Finally, it can easily be expanded to operating rooms and wards with telemetry monitoring.

References:

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