Using EventFlow to Analyze Task Performance During Trauma Resuscitation

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Introduction and Background

The Advanced Trauma Life Support (ATLS) protocol provides trauma teams with a framework for the initial evaluation and treatment of injured patients.[1] Trauma teams with higher compliance with the ATLS protocol commit fewer errors and have better patient outcomes.[2,3,4] Despite this evidence, deviations from the proper sequence of ATLS primary and secondary survey components are common.[5,6] The objective of this study was to analyze patterns of ATLS task performance among trauma resuscitation teams.

Methods

Each trauma bay at Children's National Medical Center is equipped with two ceiling-mounted cameras that record high-resolution video streams. The video and audio streams for 215 trauma resuscitations over a 4 month period (May-August 2012) were reviewed for completeness and timing of ATLS primary and secondary survey tasks. The first phase of ATLS, the primary survey, is a rapid evaluation to identify life-threatening injuries. The steps include **A** (Airway), evaluation and treatment of airway injuries; **B** (Breathing), evaluation of respiratory function; **C** (Circulation), evaluation of the patient's hemodynamic status; and **D** (Disability), assessment of neurological function. The primary survey is followed by the secondary survey—a head-to-toe physical examination that identifies other injuries. The secondary survey should not be initiated until the primary survey is complete and the patient is stable.

Data from video review were uploaded into EventFlow, a data visualization tool developed by the University of Maryland Human Computer Interaction Lab.[7] EventFlow is an interactive program consisting of a framework of simple operators (align, rank, group by, and filter).[8,9] Alignment forces every record to be ordered by a certain feature (in this case, start of secondary survey) so the events that occur before and after the feature can be easily compared. Each primary survey task is presented as a point estimate representing its start time, and the secondary survey is presented as the interval of time from the first secondary survey task to the last.

Results

The EventFlow display allowed for manipulation of all 215 records simultaneously, presenting an overview of the relative temporal relationships of ATLS task performance. Color coding (A=red; B=yellow; C=green; D=blue; SS=gray) allowed for rapid interpretation of the data and ability to recognize outlying patterns (Figure). About 50% of the resuscitations (n=111; 51.6%) did not follow the ATLS protocol. The most common error was assessment of patient disability after the beginning of the secondary survey. Aligning all events by the start of the secondary survey showed this error pattern in more detail. The scrollable right-hand panel was useful for the identification of individual records that deviated from protocol.

Discussion and Conclusion

EventFlow was useful for analyzing our dataset that contained multiple time-stamped variables and interval data. Deviations from ATLS protocol were easy to detect and the align function allowed for quick identification of various types of protocol violations. Previous analyses of these data using multivariate statistical techniques did not allow for this type of focused analysis of the order and timing of specific tasks.[10] Composite outcomes consisting of multiple tasks were created in order to avoid multiple comparison issues when analyzing each ATLS primary and secondary survey task separately. While this approach identified the patient and resuscitation factors affecting the timing and completion of ATLS tasks, it did not provide detail about what specific deviations were occurring.

Our work was a case study for the currently emerging EventFlow features, enabling unique analyses of clinical data, while providing guidance for the developers to add and refine features and validating the efficacy of their novel tool. Existing tools would not have been appropriate for the kinds of analyses we wanted to perform. In the future, we plan to collect additional data on patient outcomes and medical errors during trauma resuscitation and use EventFlow for providing direct feedback on team performance. The data will be sorted and viewed by different attributes to determine which protocol deviations are associated with medical errors and adverse effects.

Keywords: data visualization, EventFlow, pediatric trauma resuscitation, Advanced Trauma Life Support

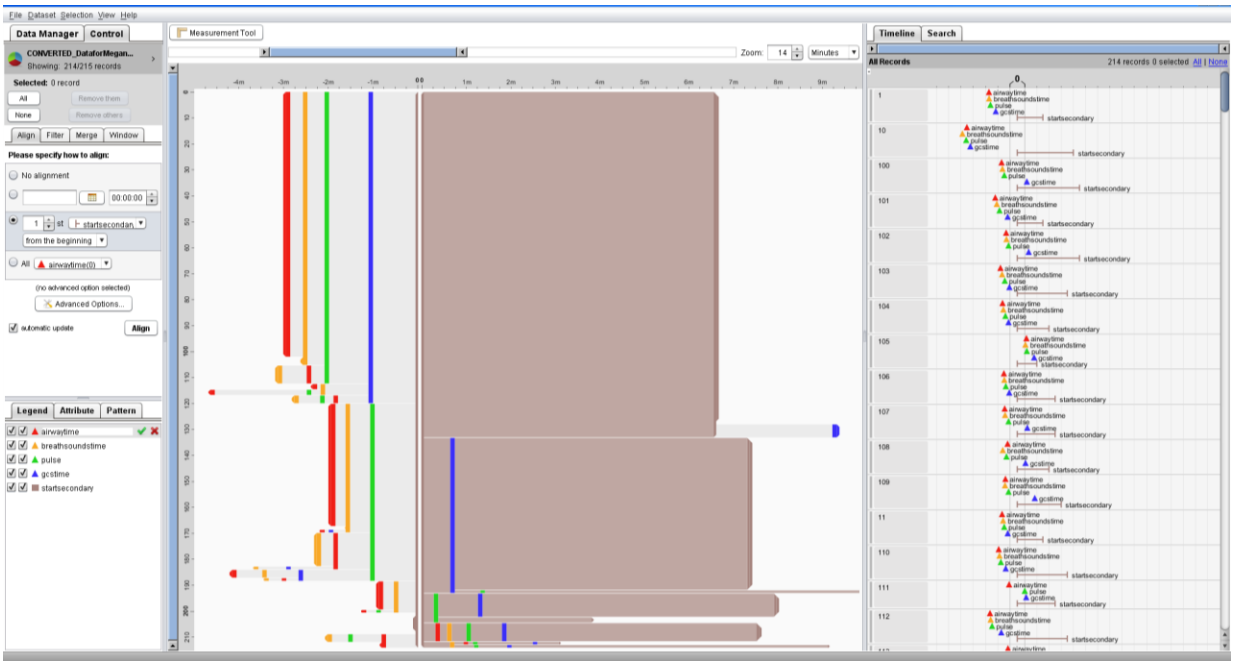

Figure: The EventFlow interactive data visualization tool with a dataset of 215 trauma resuscitations. The control panel is on the left, the middle panel contains the overview of all sequence patterns, and the panel on the right is a scrollable timeline browser of individual records. The records are aligned by the start of the secondary survey. The top sequence in the overview (red=Airway, orange=Breath sounds; green=Circulation; blue=Disability; beige=Secondary Survey) follows the proper Advanced Trauma Life Support protocol, with all ABCD tasks being completed before the secondary survey begins.

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