Comparing Alternative Approaches to Debriefing in a Tool to Support Peer-led Simulation-based Training

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Abstract. This poster describes an early-stage project. It introduces MedDbriefer, a tablet-based tool that allows small groups of paramedic students to practice realistic prehospital emergency care scenarios. While two or more students collaborate as members of an emergency medical service (EMS) team, a peer uses the tablet's checklists to record the team's actions. The system then analyzes the event log to provide an automated debriefing on the team's performance. Although debriefing is purported to be one of simulation-based training's most critical components, there is little research to guide human and automated debriefing. We are implementing two approaches to automated debriefing and will compare their effectiveness in an upcoming randomized controlled trial.

Keywords: Simulation-based Training, Debriefing, Healthcare Training

1 Project Goals

The coronavirus pandemic highlighted the dire consequences of an international shortage of paramedics and other emergency medical service (EMS) providers [1-2]. This poster introduces MedDbriefer, a tablet-based tool that allows small groups of EMS students to engage in simulated prehospital emergency care scenarios and participate in an automated debriefing on their performance.

Across the healthcare professions, students who struggle to acquire clinical reasoning and psychomotor skills can rarely get the supplemental simulation-based training (SBT) they need to pass certification exams. Instructors who are trained to facilitate simulated scenarios during course labs are in short supply [3-4]. Many instructors are themselves active healthcare providers, which limits the time that they can devote to teaching. If successful, MedDbriefer could help to reduce the shortage of EMS providers and, ultimately, other healthcare professionals.

Even if instructors were plentiful, little is known about how to guide them in conducting an effective debriefing [5-6], which is often deemed to be simulation-based training's most critical component [5, 7-9]. Our research goal is to extend the knowledge base on debriefing. Toward that end, we are implementing two approaches to automated debriefings in MedDbriefer. One approach mirrors that taken in state of the art computer-based healthcare systems: a step-by-step narrative of students' actions during the scenario, coupled with color-coded (red-green-yellow) textual feedback [10]. The second, experimental approach adapts one of several debriefing protocols developed to help human SBT instructors to structure their debriefings [5, 11-12]. These protocols actively engage students in the process of reflecting on and critiquing their performance, more so than do narrative system-led debriefings. However, there is no empirical evidence that a protocol-based approach to automated debriefing would be more beneficial for learning than a narrative walkthrough of students' actions. An upcoming randomized controlled trial will examine this question.

2 MedDbriefer

As in most healthcare professions, becoming a paramedic requires mastery over a circumscribed body of domain knowledge, clinical reasoning skills, team coordination skills, and numerous psychomotor skills (e.g., intubating a patient's airway) [13-14]. MedDbriefer focuses on developing clinical reasoning and decision-making skills. It is a web-based application designed to run on a tablet, so that it ultimately can be used for scenario-based practice just about anywhere: in a simulation lab, breakout room, dorm room, etc., without the need for simulation equipment or a human instructor.

MedDbriefer's scenarios are adapted from those included in standard EMS training curricula, such as the *Prehospital Trauma Life Support* scenario bank. They exercise clinical reasoning skills by requiring students to: (1) perform a rapid but thorough patient assessment in order to gather clinical findings and other pertinent information (e.g., vital signs such as heart rate and blood pressure; the events leading up to an injury or illness); (2) interpret these findings to identify life-threats requiring immediate attention and less serious problems to address if time permits (e.g., minor wounds); and (3) determine what interventions to perform and how to perform them.

For example, one scenario involves a patient who experienced a lawnmower rollover accident. He presents with an amputated foot; severe blood loss; low blood pressure; pale, cool, diaphoretic skin; decreasing consciousness; and numerous bruises and lacerations. These findings indicate that the patient is in hypovolemic shock, a serious condition that should be managed immediately by applying a tourniquet to stop blood loss, intubating the patient's airway, administering high flow oxygen and intravenous (IV) fluids, and keeping the patient warm. Various decisions govern effective execution of these interventions, such as: the need for sedation prior to intubation, type and size of airway adjunct, type and dosage of fluids to administer intravenously.

Simulation-based training during live, instructor guided labs that use practice scenarios such as this one typically assigns one student to play the role of team leader while one or more peers serve as team member(s)—for example, an emergency medical technician (EMT) who assists the lead paramedic. The scenario can be conducted in various ways, depending on the focus of instruction. If the instructor wants students to practice psychomotor skills as well as non-technical skills (e.g., team coordination; clinical reasoning and decision making), the instructor will direct the EMS team to fully assess

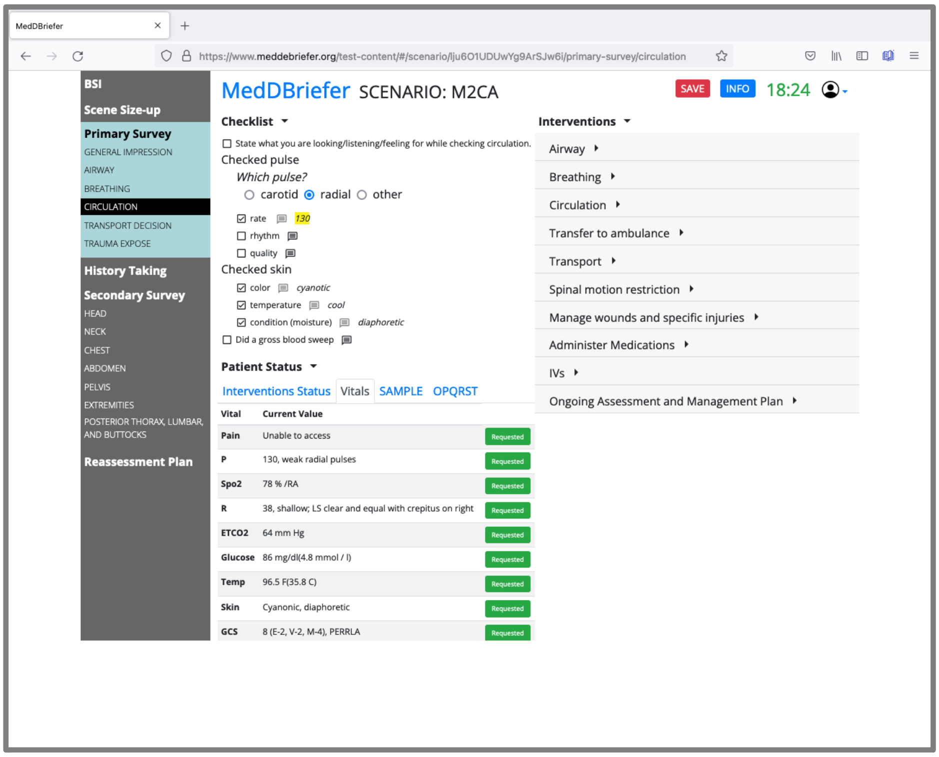

Figure 1: MedDbriefer's observer interface. Assessment checklists and findings at left; intervention checklists at right. Prompts for further detail in italics; current callout highlighted in yellow.

and treat the simulated patient (e.g., a manikin or peer), using lab equipment and supplies. However, if the focus is on non-technical skills, the instructor might opt to have students “voice treat” the simulated patient. Voice treating entails verbalizing the assessment and treatment actions the team leader would perform, how he would perform them, which actions he would delegate to a team member, etc. In addition to its role in training, voice treating is used for assessment (e.g., on part of the National Registry of Emergency Medical Technicians Paramedic certification exam). Although students often mime actions using readily available equipment (e.g., a stethoscope), voice treating obviates the need for students to perform interventions, thereby allowing them to focus on clinical reasoning and decision-making skills instead of psychomotor skills.

MedDbriefer is being developed to support this approach to scenario-based practice that focuses on non-technical skills, with one exception: students will be able to use the system on their own, without an instructor. A student who is not part of the EMS team (the session “Observer”) will use MedDbriefer’s checklists to record the team’s stated actions. As shown in Figure 1, MedDbriefer’s observer interface presents two main checklists: one to record the team’s (stated) assessment actions, the other to record their (stated) interventions. Interspersed throughout these menus are prompts for the Observer to issue to the EMS team if they fail to provide sufficient detail while voice treating the “patient”: a peer, manikin (if available), doll, or other tangible object. For example, the Circulation menu includes a prompt to the team leader to specify which pulse he is checking (carotid pulse, radial pulse, etc).

MedDbriefer analyzes the event logs that the peer Observer produces, to provide feedback during and after the scenario. During the scenario, the system provides feedback on the team's actions: initial findings and updated findings that result from treatment interventions. For example, when the team leader states that he is checking the patient's pulse and the Observer checks this action, MedDbriefer displays a callout for the Observer to issue (e.g., 130 beats per minute, highlighted in yellow; Figure 1). A limited simulation feature determines when patient findings should change from the "initial" values pre-specified in the scenario description to their "good" or "bad" values. This decision requires a representation of the interventions, or lack thereof, that would improve or downgrade patient findings, respectively. For example, if the EMS team "performs" interventions necessary to manage shock and then requests a pulse reading to determine if the patient's condition is improving, MedDbriefer will display a callout of the "good" (or improved) pulse rate specified in the scenario description. Otherwise, MedDbriefer will display the scenario's "bad" (unchanged or worsened) pulse rate.

After the EMS team completes a scenario, MedDbriefer analyzes the event log to generate an automated debriefing. At this stage of the project, we represent a correct solution for each clinical problem that the simulated patient presents (e.g., hypovolemic shock, an obstructed airway), to enable the system to assess which actions are correct and incorrect in the recorded event log. Each solution is represented as a set of findings that should suggest to the EMS team that the problem needs to be addressed, appropriate interventions to address that problem, interventions that would be contra-indicated according to state EMS protocols, and explanations about why this is the case. Relevant findings, along with partial ordering constraints, suggest when events (both assessment actions and treatment interventions) should take place relative to each other. For example, the team needs to have discovered certain patient findings before they can recognize that a clinical problem exists and begin to manage it. Overall, this analysis executes a limited form of plan recognition. In a later stage of the project, we will add rules to generate solutions automatically.

MedDbriefer uses this analysis to generate appropriate debriefing feedback. For example, if the team leader failed to state that he would ventilate the "patient" using a bag valve mask attached to high flow oxygen, the debriefing will state findings that indicated the need to ventilate and oxygenate the patient, such as slow respiratory rate. If the team leader failed to assess the patient's respiratory rate, this missed assessment will be included in the feedback.

3 Two approaches to automated debriefings

We are implementing and will compare the effectiveness of two approaches to automated debriefing in a randomized controlled study whose aim is to address the question: *Is it more effective to structure a debriefing by having students step through a chronological narrative of their actions during the scenario, with embedded feedback, or by* *following a standardized debriefing protocol?* The former approach is commonly implemented in computer based SBT systems, such as the American Heart Association's *HeartCode BLS* [10]. Although several simulation researchers and practitioners have advocated the use of protocols to structure human instructor-led debriefings—for example, Gather-Analyze-Summarize (GAS) [15], TeamGAINS [16], and DEBRIEF [11-12]—there is little empirical evidence to support this practice [5, 11-12].

As a step towards addressing this gap in simulation-based training research, we will conduct a study to compare a version of MedDbriefer that implements a system-led, narrative approach to automated debriefing with one that implements an adaptation of the DEBRIEF protocol, which stands for: **D**efine the debriefing rules; **E**xplain the learning objectives; specify the performance **B**enchmarks; **R**eview what was supposed to happen; **I**dentify what actually happened; **E**xamine why; and **F**ormalize the "take home" points [11-12].

The chief difference between these approaches to debriefing lies in the extent to which they engage students in active reflection on, and critiquing of, their performance. In the narrative approach, a human instructor or tutoring system critiques each step of a student's (or student team's) solution, as in HeartCode BLS [10]. In contrast, when human facilitators implement protocol-based debriefings—which have not yet been automated—they encourage students to play a more active role. This approach is illustrated by the US military's implementation of the DEBRIEF protocol for battlefield training [11] and a proposed adaptation of DEBRIEF for simulation-based training in healthcare [12]. Specifically, students are prompted to assess whether their solution met a set of performance standards ("benchmarks"), and then consider why it fell short of meeting certain standards. As such, DEBRIEF affords a more active and interactive approach to post-practice debriefings than does the narrative approach.

We are adapting DEBRIEF for inclusion in MedDbriefer and, ultimately, other healthcare SBT systems. Abundant research demonstrates the superiority of active and interactive approaches to learning and instruction over more passive approaches [17]. This research therefore suggests that the DEBRIEF protocol-based version of MedDbriefer will predict higher learning gains than the narrative version.

The DEBRIEF protocol does not uniformly engage students in active and interactive learning, neither in live implementations of this protocol nor as implemented in MedDbriefer. Its first three components are didactic and realized in MedDbriefer using canned text. During "D", MedDbriefer states the goals of the **d**ebriefing and outlines what students will do to achieve these goals. During the first "E", the system lists the main learning objectives ("**e**xpectations") that the scenario was designed to achieve—for example, to provide practice with recognizing and managing hypovolemic shock. During "B", MedDbriefer specifies performance **b**enchmarks for each objective. For example, effective shock management entails administering oxygen at a flow rate of 15 liters per minute, administering the correct dosage of fluids intravenously (commensurate with the patient's weight), and performing several other interventions to spec.

These DEBRIEF components set up a framework for the more active and interactive components that follow. During "R", MedDbriefer presents a summary of a sample expert solution, which **r**eviews the clinical problems that the EMS team should have discovered and the interventions they should have performed to manage these problems. Selected terms and phrases contain hyperlinks that allow students to request additional information. For example, selecting the link in, "The team lead recognizes that this patient is in hypovolemic shock", would display findings that indicate shock.

The next two components ("I" and "E") lie at the core of student-system interaction and leverage the same analysis of event logs that drive the system's critique in the narrative version. During "I", MedDbriefer focuses on each clinical problem that a scenario provides practice with diagnosing and managing, and prompts students to **i**dentify which performance benchmarks they met or failed to meet. MedDbriefer compares students' self-critique with its assessment of the scenario event log, to identify benchmarks that students incorrectly rated as achieved (i.e., "false positives") and the reverse (i.e., "false negatives"). It then provides feedback to address (truly) missed benchmarks. This feedback is similar in content to that provided on the same errors in the narrative version's debriefings. During the second "E", MedDbriefer prompts students to **e**xamine and explain why they missed selected priority benchmarks, in their own words. To scaffold this reflective process, MedDbriefer suggests a few likely causes. For example, if students failed to perform any interventions that would indicate they recognized the need to manage shock, the system will suggest: "I forgot to do assessment actions that would have indicated shock" and "I misinterpreted (an) assessment finding(s)." Finally, during "F", MedDbriefer prompts students to state (**f**ormalize) a few lessons learned from the debriefing, also in their own words.

Currently, the observer interface is operational and narrative debriefings are generated. Implementation of the adapted DEBRIEF protocol is partially completed. In an upcoming study to compare these two approaches to automated debriefing in MedDbriefer, students enrolled in the EMS program at the University of Pittsburgh will be randomly assigned to a debriefing condition. Each participant will complete a scenario-based and written pretest and then voice treat the patient presented in four intervention scenarios. These scenarios require identification and management of several clinical problems. For logistical and control purposes, an EMS instructor or expert (not a student) will play the role of Observer, using MedDbriefer to record participants' stated actions, issue callouts, prompt for further detail, etc. Participants will engage in an automated debriefing after each scenario, structured according to their assigned condition. They will then take a written and scenario-based posttest that is similar in content to the pretest. The pre- and post-tests target the clinical reasoning and decision-making skills exercised in the intervention scenarios.

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