Analysis of eye-tracking behaviours in a pediatric trauma simulation

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ABSTRACT

Eye-tracking devices are able to capture eye movements, which are further characterized by fixations. The application of eye tracking in a trauma setting has not been explored. Visual fixation can be utilized as a surrogate measure of attention during the management of a trauma patient. We aimed to determine the feasibility of using eye tracking and to characterize eye tracking behaviours of pediatric emergency medicine physicians during management of a simulated pediatric trauma patient. Each participant was equipped with a head-mounted eye-tracking device during a standardized simulated pediatric trauma scenario. Each session was video recorded, with visual fixations defined as >0.2 seconds, and characterized by start time, duration, and the area of interest. Data from seven videos were analysed; 35% of eye fixations were directed towards the mannequin, 16% towards the monitor, and 13% towards the bedside doctor. Visual eye tracking in a trauma simulation is feasible. Frequency of fixations tends to be highest towards the patient. Eye tracking within trauma simulation may provide new insights into quality improvement and inform advancements in pediatric trauma.

RÉSUMÉ

Les dispositifs de monitorage oculaire, ou oculomètres, peuvent détecter les mouvements des yeux, phénomène qui se caractérise aussi par des fixations. L'application du monitorage oculaire dans les contextes de trauma n'a pas encore été étudiée. Par ailleurs, les fixations visuelles peuvent servir de mesures de substitution de l'attention pendant le traitement des patients ayant subi un trauma. Aussi l'étude visait-elle à déterminer la faisabilité de l'utilisation du monitorage oculaire et à caractériser, à l'aide de celui-ci, le comportement des médecins en pédiatrie d'urgence durant la prise en charge d'une simulation de trauma chez un enfant. Chaque participant portait un oculomètre sur la tête et faisait l'objet de suivi durant une simulation uniformisée de prise en charge d'un cas de trauma chez un enfant. Chaque séance a été enregistrée par vidéo, et les fixations visuelles, définies comme des pauses d'une durée >0,2 s, ont été caractérisées par le début et la durée ainsi que le champ d'intérêt. Ont été analysées des données de 7 vidéos; 35 % des fixations visuelles étaient dirigées vers le mannequin; 16 %, vers le moniteur et 13 %, vers le médecin traitant. Le monitorage oculaire dans les simulations de trauma s'avère donc possible. C'est sur le patient que les fixations visuelles tendent le plus à se porter. Le monitorage oculaire dans les simulations de trauma pourrait jeter un éclairage nouveau sur l'amélioration de la qualité et guider des changements dans la prise en charge des traumas chez les enfants.

Keywords: eye tracking, gaze preference, pediatric trauma, simulation, situational awareness

BACKGROUND

By mapping movements of the eye in various clinical settings, eye tracking can be used as a tool to characterize the visual fixation of healthcare providers.[1,2] Characterization of visual fixation in various clinical environments helps build on our understanding of behaviours that promote best practices.[1] Although eye tracking has been used in various clinical settings, it has not been applied to pediatric trauma resuscitation. In this study, we used simulation as a tool to study eye tracking behaviours in pediatric trauma resuscitation.

Each year, thousands of children are hospitalized due to trauma-related incidents.[3] The burden of pediatric trauma can be lessened with effective and efficient emergency care.[3] Effective management requires multiple healthcare providers working together with a shared understanding of goals for patient care. To achieve this, situational awareness is key.[4] *Situational awareness* is the ability of an individual to process information about her or his environment.[4] This concept consists of three levels: Level 1 – acquisition of relevant information; Level 2 – integration of information leading to understanding; and Level 3 – prediction of future states.[4] Eye-tracking technology permits the collection of data regarding Level 1 of situational awareness via a video analysis. Eye-tracking data collected during pediatric trauma may build our understanding of situational awareness amongst trauma team members, which can be used to guide the development of future educational interventions.[4–6]

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PURPOSE

We sought to determine the feasibility of using eye tracking in pediatric trauma simulation and to characterize the eye-tracking behaviours amongst physicians during the management of a simulated pediatric trauma patient. We hypothesized that eye-tracking technology is feasible and visual fixation would be focused on the patient.

DESCRIPTION OF INNOVATION

Methods

This study was an observational, non-blinded, simulation-based study. Research ethics board approval was obtained from The University of Calgary Behavioural Research Ethics Board. Nine pediatric emergency medicine (PEM) physicians (years in practice: 1 to 15 years) were recruited to participate as a trauma team leader (TTL) in a simulated pediatric trauma scenario (blunt trauma with hypovolemic shock) with nurses, respiratory therapists, paramedics, and a bedside doctor filling out the roles of the other trauma team members. TTLs were fitted with a head-mounted Mobile Eye XG™ eye-tracking device. All sessions were video recorded through the eye camera and scene camera. As means of standardization, the first 5 minutes[7] of each session were manually analysed by watching the video using Noldus Observe XT™ software. A coding matrix was used to identify and mark areas of interest (AOIs), or instances where the visual gaze remained fixated on a specific area for > 0.2 seconds. For each fixation, the start time of fixation, duration, and end-time of fixation were documented. Pre-defined AOIs were identified a priori by consensus via discussion amongst research team, and included the patient, bedside doctor, paramedic, monitor, recording nurse, medication nurse, procedure nurse, fluids, oxygen, checklist, and respiratory therapist.

RESULTS

Nine video sessions were recorded, seven analysed, and two excluded due to loss of calibration mid-simulation. While cumbersome at times, eye-tracking devices were well tolerated by participants and did not impede their ability to make decisions or perform tasks as a TTL; 35% of eye fixations were directed towards the mannequin, 16% towards the monitor, and 13% towards the bedside doctor (Table 1 and Figure 1).

Table 1. Descriptive summary of average number of fixations, total time spent per fixation, average fixation time, and average proportion of fixations as a percentage across all AOIs

	Average number of fixations (n)	Average total time of fixations (s)	Average fixation time (s)	Average proportion of fixation time (%)
Patient	43	74.71	0.90	34.99
Bedside doctor	26	26.59	0.50	12.97
Medication nurse	10	10.90	0.49	5.15
Procedure nurse	9	13.87	0.86	6.60
Recording nurse	2	2.06	0.48	0.99
RT	19	19.85	0.51	9.39
EMT	3	10.71	3.51	6.13
Monitor	26	34.93	0.58	16.14
Medications	2	1.78	0.40	0.85
Fluids	5	4.90	0.41	2.29
Oxygen	5	3.86	0.33	1.89
Checklist	4	5.33	0.57	2.60

EMT = emergency medical technician; RT = respiratory therapist.

DISCUSSION

Our study suggests that use of eye tracking for simulated pediatric trauma is feasible, and that TTLs primarily fixate on the patient during resuscitation. Exploring patterns of visual fixation amongst TTLs shed light on one key element of situational awareness (i.e., Level 1), verifying that amongst PEM physicians, patient assessment serves as a key source of information during trauma. The AOIs that we studied include both "human" (i.e., including simulated patient) and non-human elements. Social norms dictate some degree of visual fixation when another human being is speaking compared to the observation of a piece of equipment. Likewise, a patient who is speaking may get even more fixation than one who is obtunded. These social norms are balanced against the importance of data/information offered by objects in the clinical environment – all variables that likely contributed to patterns of visual fixation amongst TTLs.

Our study adds to existing knowledge of the application of eye tracking in medical education, but is the first of its

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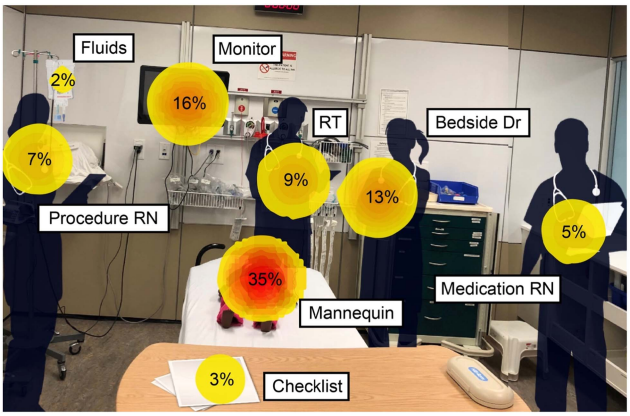

Figure 1. Heat map representing gaze preference towards pre-defined AOIs from most commonly viewed to least commonly viewed. This is depicted by the percentage, size of circle as well as colour. A darker core within the circle relates to an increased proportion of fixations during the simulation. RT = respiratory therapist; RN = registered nurse; Dr = doctor.

kind in pediatric trauma.[5–7] In neonatal resuscitation, gaze preference amongst six expert consultants was focused primarily towards the monitor rather than the neonate.[8] In a simulated pediatric intensive care unit (PICU) environment, expert consultants focused their gaze predominantly on the chest and airway of the patient, whereas novice clinicians had visual preference directed towards the defibrillator.[9] Both studies elucidate an important difference in visual fixation during resuscitation, with the PICU study indicating a role for eye tracking in characterizing expert behaviours.

The small size and descriptive nature of this study is a limitation. Because this was a simulation-based study, we cannot confirm whether our results are generalizable to the real clinical environment. Our study was not designed to determine whether focusing visual fixation on the patient leads to a more effective resuscitation. Mis-calibration (movement of the camera off of its pivot) of the eye-tracking unit was a challenge and resulted in two videos being removed from analysis. We don't foresee this as a feasibility issue moving forward because new eye-tracking devices have improved calibration functionality. Apart from this, no other technical malfunctions were encountered with the eye-tracking units. Some participants reported the unit as being cumbersome at times, but all felt that this did not subjectively affect their ability to lead the resuscitation. In fact, most participants described not noticing the eye-tracking device after only a couple of minutes.

Our study provides data supporting the use and feasibility of eye tracking in pediatric trauma. In the future, we hope to compare and contrast eye-tracking behaviours in trainees versus attending physicians.[7] Assuming that experts have a better sense of what is important to focus on, contrasting this to trainee's visual fixation may identify opportunities for behaviour change.[10] Secondly, we hope to study visual eye tracking in other high-stakes clinical contexts (e.g., cardiac arrest) and during technical skills (e.g., intubation). We believe that the use of eye technology can enhance our understanding of situational awareness in various clinical contexts, thus providing a source of data to inform positive change in clinical practice.

Competing interests: None declared.

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