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Original Contribution

Inattentional blindness in anesthesiology: A simulation study☆

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ABSTRACT

Study objectives: Inattentional blindness is the psychological phenomenon of inability to see the unexpected even if it is in plain view. We hypothesized that anesthesiologists may overlook unexpected intraoperative events whereas medical students, lacking in intraoperative monitoring experience and knowledge, may be more likely to notice such events.
Design: A simulation study using a video of a simulated septic patient undergoing abdominal surgery.
Setting: A large academic center.
Participants: 31 certified anesthesiologists and 46 upper-year medical students.
Interventions: None. Participants watched a video of a simulated surgery and scored the abnormalities they saw.
Measurements: These abnormalities included abnormal physiologic parameters consistent with the condition of the simulated septic patient, and two unexpected but plausible events: head movement and a leaky central line catheter.
Main results: Students were significantly more likely than anesthesiologists to notice head movement ($p < 0.001$).

"The real problem isn't how to stop bad doctors from harming, even killing, their patients. It's how to prevent good doctors from doing so."

[Atul Gawande 1999]

1. Introduction

In 2005, a woman in shock had a femoral venous line sited using the Seldinger technique. Over the following several days, multiple chest X-rays were taken, and CT scan showed pulmonary embolism. On the 5th day, during placement of an IVC filter, it was discovered that the guidewire from the femoral line placement was still inside the patient. A review of all the radiographs revealed that the guidewire was visible in every one of them [1]. In 2013, the heart from a donor of a different blood group was transplanted into another patient in a highly respected transplant center, in spite of multiple checks by the transplant team [2].

Vigilance is a theme on the coat of arms of several colleges of anesthesiologists. Unfortunately, failing to notice problems in a timely manner happens to us all. When that happens, we may be accused of not being vigilant, as clinicians in the above examples might have been accused of also. However, there may be other complex and critical human factors at play that might explain those situation awareness (SA) failures. Understanding them is important. One of those human factors is inattentional blindness (IB).

Simplistically, IB is failing to notice an unexpected yet salient visual event while undertaking a different task [3–6]. We are constantly distracted and bombarded with myriads of sensory inputs. Outside of our conscious awareness, our brain automatically selects and processes relevant inputs, filtering out unimportant ones, so we can interact intelligently and efficiently with our surroundings [3–5]. Sometimes, however, important inputs can be mistakenly blocked out. IB is innate and hard to eliminate and may be worse if an event/input/object is unexpected, inconspicous, when there is concommitant distractions/task interferences/mental overload, and/or when one is stressed, intoxicated, unwell, and tired [6]. To experience IB, readers may watch a famous video of two teams of players passing basketballs amongst themselves [7]. Sometimes, again in the name of efficiency, the brain may see

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something familiar and automatically fills in the blanks and forms a preconceived picture that does not exist [3–5]. An example is picking up an ampule of drug B misplaced in a bin for a similarly looking drug A, "reading" the label, and administering it still thinking it is drug A [6,8].

We simulated and recorded a video of a major abdominal surgery in which some common and/or expected events occurred. Inserted into the video were two unexpected events – both plausible but rare – in plain sight. We then showed the video to unsuspecting anesthesiologists and medical students. The hypothesis was that anesthesiologists would focus their attention on the monitors, searching for "expected" (e.g., hypotension, tachycardia, etc.) events and perhaps contemplating treatment options, whereas students without intraoperative monitoring experience and with less clinical experience, would have a less selective brain "screener" of visual inputs and, therefore, would be more likely to perceive events that may be unexpected to anesthesiologists but not necessarily to the same degree to students. By highlighting the phenomenon of IB, we wish to improve our discourse on safety, OR and monitor design, non-technical skills training, SA, curriculum planning, and legal arguments about vigilance and liability.

2. Methods

2.1. The scenario

A simulation was set up using a METI simulator (CAE Healthcare, Saint-Laurent, QC, Canada) in the Department of Anaesthesia and Intensive Care of the Prince of Wales Hospital, Hong Kong. The simulated septic "patient" was lying on the OR table, with the end of an endotracheal tube taped to his mouth and a central line to the right side of his neck facing the camera. The "patient" was undergoing bowel resection, and being given intravenous and inhalational anesthetics and norepinephrine. A video consisting of five 1-min segments (with 10-s gaps between them outlining medical interventions that were being consecutively carried out) of the anesthetic machine with the monitors and the "patient" was recorded. The "surgeon", "scrub nurse" and "anesthesiologist" were not shown in the simulated scene to maximize the sizes of the "patient" and the monitors on the screen. The monitors showed multiple physiologic parameters that are consistent with sepsis and abdominal surgery. During the 3rd 1-min segment, the "patient" turned his head once from a neutral position through an angle of 45° away from the camera and back to a neutral position over 10 s. This was repeated in the 4th and 5th 1-min segments. His central line oozed "blood", made with red dye, because of a poorly fitted connector throughout the 3rd-5th min. Table 1 lists the abnormalities shown in the video.

2.2. The experiment

Ethics approval was obtained from the New Territories Eastern Cluster, Hong Kong, to play this video to participants, who were told that the exercise was voluntary and anonymous, to see whether they could identify *any* abnormalities/derangements in the video. Each signed informed consent. A convenience sample of 31 certified anesthesiologists and 46 3rd-5th-year medical students were asked to watch the video on a Saturday morning before an unrelated lecture in an auditorium with a theater sized screen. Before the video, the scenario describing a septic adult on norepinephrine infusion undergoing bowel resection, the absence of OR personnel in the video was explained. A still frame of the opening scene of the video was presented and the monitors and parameters displayed were shown (Fig. 1 without the bloody CVP line) on screen for several minutes. Participants were given a sheet containing the "normal" ranges of the cardiorespiratory parameters, and a score sheet containing five headings: Min 1, Min 2, …, Min 5, and were asked to record all the abnormalities as they occurred every min of the 5 min-video shown. Apart from the headings, the score sheet was blank and there were no score cards containing items to check. They were also asked not to communicate amongst themselves or make noise or gesture. There were no other instructions. The abnormalities that the participants recorded were classified as correct as long as they were within the same area of concerns as the list shown in Table 1. For example, if a participant writes "blood pressure", it was viewed as identification of "hypotension".

The percentage of participants noticing each abnormality at each minute was reported separately for the students and anesthesiologists. χ^2 test was used to compare the proportion of anesthesiologists to the proportion of students who noticed a given abnormality during the video.

The answer sheets were collected at the end of the video and the scheduled lecture for that morning began as planned. There was no follow up debriefing or survey after the answer sheets were collected.

3. Results

A total of 77 people participated in the study, of which 31 were anesthesiologists (26 male and 5 female) and 46 were students (17 male and 29 female). The anesthesiologists' years of experience post-anesthesia certification ranged from 3 years to 39 years (mean: 18). The

Table 1
Noticed Abnormalities by Anesthesiologists (Anesth; $n = 31$) and Students (Stu; $n = 46$). NA (not applicable) means the parameter was within the normal range during that minute. PVC = premature ventricular complex; HR = heart rate; SpO_2 = oxygen saturation; CVP = central venous pressure; PAP = pulmonary artery pressure; $EtCO_2$ = end-tidal CO_2; CVC = central venous catheter.

Minute	PVC			HR			SpO_2			High CVP			High PAP		
	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p
1	0%	0%	1.000	29%	57%	0.008	100%	100%	1.000	NA	NA	NA	17%	28%	0.217
2	29%	41%	0.272	19%	39%	0.066	87%	96%	0.170	NA	NA	NA	26%	24%	0.850
3	58%	87%	0.004	32%	52%	0.086	81%	93%	0.086	68%	65%	0.818	39%	28%	0.337
4	65%	83%	0.071	45%	63%	0.121	90%	96%	0.352	84%	83%	0.885	45%	22%	0.030
5	42%	70%	0.016	55%	61%	0.598	84%	96%	0.078	81%	76%	0.636	35%	33%	0.794
Ever	77%	98%	0.004	61%	89%	0.004	100%	100%	1.000	90%	91%	0.883	52%	54%	0.814

Minute	Hypotension			Fever			Low $EtCO_2$			Head Movement			Leaky CVC		
	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p	Anesth	Stu	p
1	NA	NA	NA	16%	59%	<0.001	68%	89%	0.020	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	16%	59%	<0.001	39%	78%	<0.001	NA	NA	NA	NA	NA	NA
3	81%	93%	0.086	16%	61%	<0.001	NA	NA	NA	29%	63%	0.003	0%	2%	0.409
4	74%	93%	0.018	16%	59%	<0.001	NA	NA	NA	29%	65%	0.002	6%	26%	0.028
5	71%	91%	0.019	23%	63%	<0.001	NA	NA	NA	26%	70%	<0.001	19%	33%	0.200
Ever	90%	100%	0.031	35%	80%	<0.001	74%	98%	0.002	42%	83%	<0.001	23%	39%	0.128