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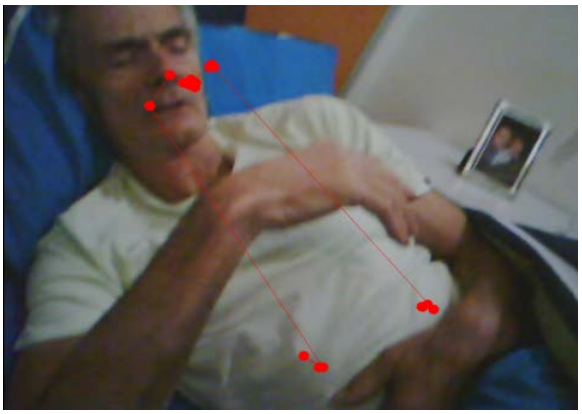
Can eye-tracking technology improve situational awareness and student feedback during simulation?

Final Report 2014



Partner institutions, team members and report authors:

Monash University
Simon Cooper (project leader), Mark Browning, Linda Ross, Louise Sparkes, Brett Williams

LaTrobe University
Graham Munro, Peter O'Meara

The University of Queensland
Barbara Black, Fiona Bogossian

http://emergencyeyetracking.com/

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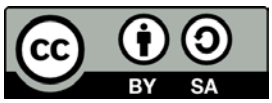

Requests and inquiries concerning these rights should be addressed to:
Office for Learning and Teaching
Department of Education
GPO Box 9880,
Location code N255EL10
Sydney NSW 2001

learningandteaching@education.gov.au

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Our thanks to the students who willingly gave up their time to participate in this project.

Executive summary

This seed project aimed to evaluate the effectiveness of eye-tracking technology for improving feedback and situation awareness in nursing and paramedic students. The management of deteriorating patients is known to be poor and is well documented in the 'failure to rescue' literature. Non-technical skills such as decision making and situation awareness are essential for patient safety, but are rarely taught in undergraduate curricula. In a simulated setting, this project used an innovative combination of techniques: namely video recording and eye tracking in order to understand and inform participants' responses to an acutely deteriorating patient. Educational and technological guidance on the use of these educational approaches are available at the project website: http://emergencyeyetracking.com/

Project approach

Undergraduate nursing and paramedic students were invited to attend a two-hour individual training program where they completed initial paper-based questionnaires about demographic information and knowledge and confidence ratings prior to attending three scenarios. Scenarios were conducted using a simulated patient (actor) with an acutely deteriorating medical condition. Eye-tracking glasses were worn by the student throughout each scenario, video recording the scene and tracking the student's eye movements. On completion of each scenario, participants were questioned about their level of situation awareness and debriefing feedback was provided using the eye-tracking video records. Post-course knowledge, confidence and evaluations surveys were completed.

Outcomes

- thirty-nine final year students (20 nurses and 19 paramedics) participated in the project from three Australian universities;
- participants' clinical skills improved significantly between the start and the end of the program *(p* = <0.001);
- situation awareness also improved significantly (*p* = 0.02), as did participants' post-course ratings of their skills, competence and confidence (*p* <0.001*)*;
- course evaluations and satisfaction levels showed strong approval and most indicated that the 'eye-tracking' component had improved learning and aided feedback;
- participants placed a high value on the video debriefing (and attention focus component) as it created an opportunity to reflect on aspects of their practice; and
- participants reported a greater insight into their performance and the possible positive impacts on practice.

Recommendations

Outcomes were predominantly positive but should be balanced against the feasibility of the approach. The program was resource intensive and would require adaptation for those

working with large cohorts in the undergraduate sector. Therefore, in order to translate these findings into feasible practice for educators, we recommend:

1. That eye-tracking or point-of-view cameras are incorporated into clinical training (and potentially, also clinical practice). Point-of-view cameras are significantly cheaper but do not provide eye-tracking data which may be of particular value to the educator or student.
2. Inclusion of point-of-view cameras in educational programs that make use of team-based scenarios, thereby increasing student throughput and enhancing teamwork.
3. Consideration for less resource intensive debriefing approaches such as student self-review (providing DVDs of performance for students).

In addition, we recommend the need for repetitive and frequent high-fidelity simulation in order to reduce the time it takes for students to reach competency. Our findings indicate significant performance deficits that can only be addressed by realistic simulated practice.

Further research is required to understand and learn from experienced practitioners, especially to ascertain where their area of interest is focussed in emergency settings. Such work will further inform and develop educational programs. Explorations of (simulated) patient views and the impact of empathetic communication on their care will also be of significant benefit, creating insight into 'best strategies' and key priorities when caring for the acutely ill.

In summary, eye-tracking and point-of-view video recording techniques are feasible and, with applicable debriefing techniques, can benefit clinical and situated performance.

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1. Introduction

Situational awareness (SA) is a cognitive process that involves perceiving and comprehending critical elements of information during a certain task[1]. It is simply 'having an idea of what's going on around you'. A level of SA is crucial for nursing and paramedic undergraduates as they will need to make potentially life-threatening decisions in complex, unpredictable and demanding situations. Immersive simulation and debriefing (enacted through mannequins, actors or role play) are a common educational strategy that enables the development of SA[2]. Recent evidence also indicates that practising in a safe simulated setting has an impact on patient safety[3, 4]. The theoretical underpinning for a simulation-based educational approach is the belief that the non-technical skills necessary for practice are best acquired through a situated learning experience, an approach supported by Experiential Learning Theory[5], and the notion of concrete experience and abstract conceptualisation—in all, a process that is achieved through activity or reflective observation. In addition, modalities of learning such as visual, visual/verbal, physical (or kinaesthetic), and auditory have been described[6] as demanding a variety of teaching approaches to meet students' needs. Models of assessment *for* and *as* learning are also beneficial and are often delivered as Objective Structured Clinical Examinations (OSCEs)[7].

While OSCEs and simulation techniques are the main assessment approaches used to measure non-technical skills such as SA, a number of issues currently exist. First, feedback is often limited as video-recorded debriefings of OSCEs are time consuming and fail to capture and accurately isolate levels of SA. Secondly, it is well established that effective feedback is integral to student learning, yet students frequently report dissatisfaction with the feedback they receive during simulation[2]. This project addresses these challenges using eye-tracking recordings to improve the quality of feedback and to enhance SA.

Rationale

Central and unique to this study is the use of eye-tracking technology: a point-of-view camera and eye-tracking technology attached to a pair of glasses (see Figure 1.1).

Figure 1.1. Tobii Eye-tracking glasses: Including a video camera and overlays of the movement of the right eye

Originally developed for the marketing and aviation industries, this technology is used to identify an individual's area of interest, gaze fixation/duration, and scan path (e.g. a focus on particular supermarket shelves or a television advertisement). This enables analysis of where individuals are looking when a decision is made[8]. Based upon the *'eye mind hypothesis'* the assumption is that gaze fixation is normally the focus of thought[8]. Eye-tracking measurements therefore enrich our understanding of behaviour and will enable a deeper understanding of emergency performance and SA and will inform developmental feedback with the capacity to improve student learning. This technology therefore enabled us to elicit decision strategies of students through a structured debrief that also informed their level of SA and clinical performance.

To our knowledge eye-tracking devices have never been used in the emergency setting and it is likely that this simulation-based program will not only inform education and practice but have the potential to be translated into clinical practice. Given the ongoing importance of SA and debriefing among the healthcare professions, these techniques will benefit education and have the potential to impact on patient safety.

Project aim

Through collaboration with three university partners (Monash University, La Trobe University and the University of Queensland (UQ)), the overall aim of this project was to enhance nursing and paramedic students' SA through improved debriefing techniques. Feedback is an essential component of student learning as it is '*informative and supportive and facilitates a positive attitude to future learning'*[9]. Thus, this project aimed to improve learning experiences by developing strategies that enable educators and students to '*progressively take responsibility for assessment and feedback processes'* [9]*.*

The specific aims of the project were to:

1. evaluate the effectiveness of eye-tracking technology for improving feedback and situation awareness for nursing and paramedic undergraduate students;
2. develop preliminary guidelines and resources for best practice in the use of this new technology in undergraduate teaching and learning; and
3. disseminate the outcomes to key partners in the sector.

2. Approach and methods

Final-year nursing and paramedic students from three universities in two states of Australia were recruited to participate in three simulation exercises. Owing to the preliminary nature of the study and to finite resources, the sample was limited to one of convenience comprising 40 students: 20 at Monash, and 10 each at La Trobe and UQ. Using trained actors (simulated patients), each student completed a set of three 8-minute simulations with debriefing after each session. The medical conditions depicted were an acute cardiac condition, shock, and an acute respiratory condition. On completion of each scenario, each participant was asked a series of SA questions (using the Situation Awareness Global Assessment Technique –SAGAT)[10, 11] which enabled a quantitative rating of SA and SA improvements across the three scenarios. Participation formed part of students' normal weekly simulation practice, thereby not disrupting or adding to the students' workload.

Participants were fitted with eye-tracking glasses that were calibrated to the individual. Participants' focus of attention was then tracked throughout each of the simulation exercises. Eye-tracking glasses track eye movement and focus of attention through a reflective light technique and record all data in a belt-mounted data pack. Data was then uploaded to a computer for a visual replay with emphasis on participants' focus (or over-focus) of attention. This process enabled participants to reflect upon their performance and for facilitators to provide instantaneous and informed feedback through photo elicitation (video reflective review). When drawn together in a feedback session the eye-tracking technology, SAGAT measures and photo elicitation were intended to assist students to reflect upon and thereby improve their performance (Figure 2.1).

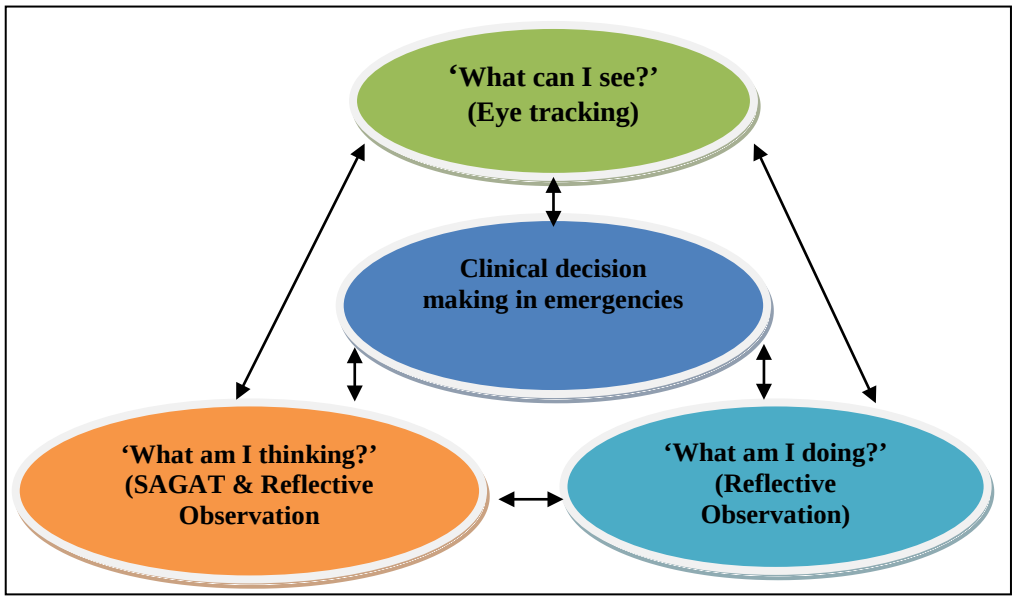


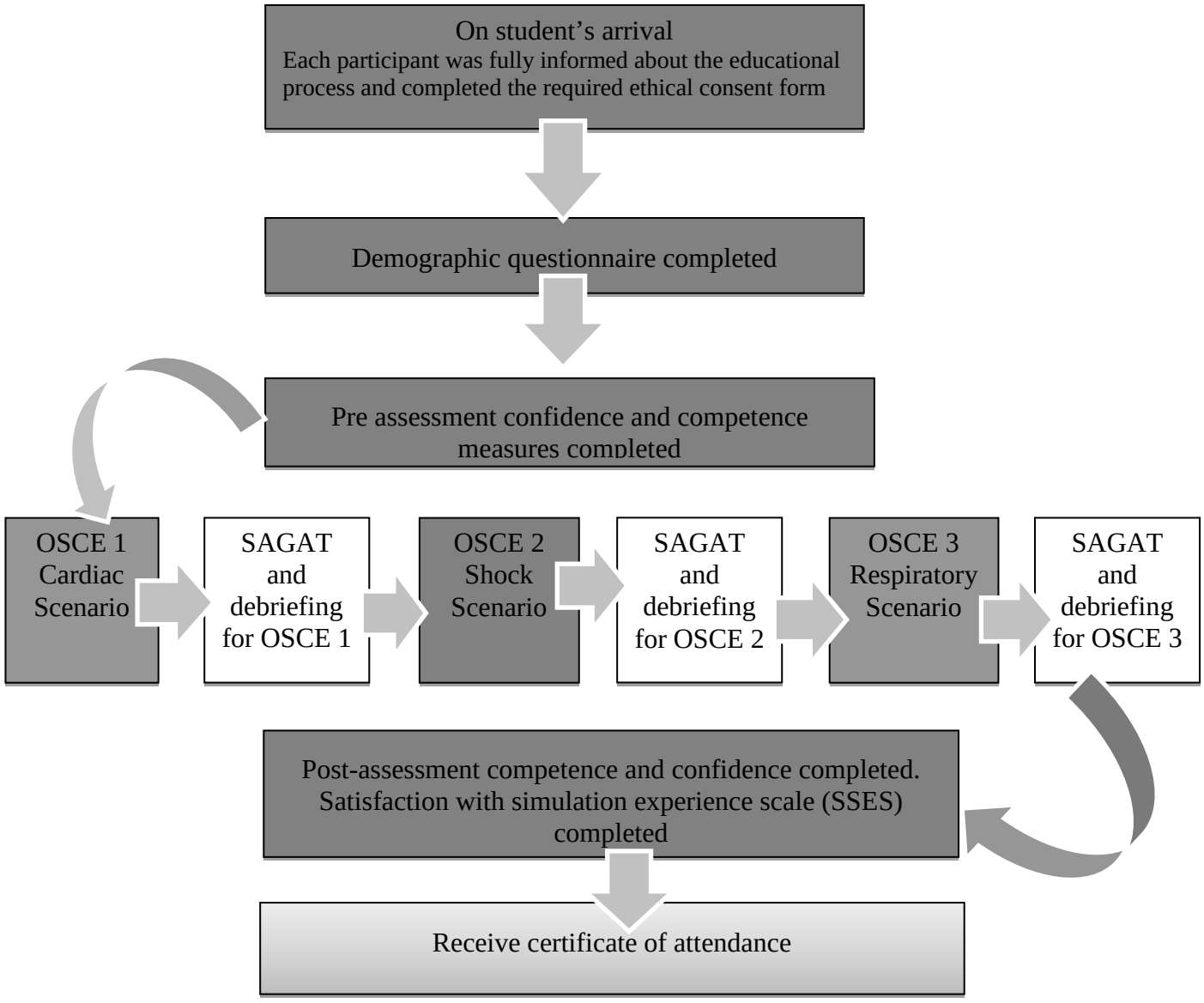
Figure 2.1. Understanding situation awareness and clinical decisions in emergencies—a model for analysis

Learning outcomes were evaluated using Kirkpatrick's[12] and Clark's[13] models for educational evaluation. Both models describe the need to evaluate programs across the spectrum from personal impact on participants to the impact on society or, in this case, the likely clinical impact. Moreover, the technology had the capacity to not only *'feedback'* but also *'feed-forward'* in changing thinking habits and behaviours. The project reference group also provided critical feedback on methods and approaches used in the project and provided insight into the evaluation questions and the intended project logic. This was developed at the commencement of the project, enabling the project team to clarify its approach.

Project evaluation

The study was designed as a quasi-experimental before-and-after study. Details of the design with regard to the teaching intervention (the participants' journey) are shown in Figure 2.2.

Figure 2.2. Flow chart of student participants' journey



Data collection, management and analysis: Statistical software (IBM-SPSS Vs 20) was used for data storage and tabulation of quantitative data. Summary participant demographic information was reported and a repeated measures design employed to evaluate the effect of the eye-tracking technology and intervention on student performance and feedback. Non-parametric statistics were used for bivariate analyses where a non-normal data distribution was identified. All tests were two tailed with the results considered statistically significant if the *p* value was <0.05. Effect sizes were also calculated for quantifying the differences between mean scores using Cohen's *d* (interpreted as small = .2-.4, medium =.5-.7, large = ≥.8)[14].

Ethical considerations: The study received human ethics committee approval from each respective university: Monash University CF13/652 – 2013000282, LaTrobe University 13/059R; UQ 2013000405.

Resource development

A web-based, evidence-based preliminary set of educator guidelines was developed during the project and subsequently published on an open source webpage. The resource provides tertiary sector educators with a contemporary resource that is also accessible to other disciplines and to peak professional bodies. The package includes rationale; supporting theory and evidence; outcomes; exemplars drawn from video records and debriefing techniques; and guidance on eye-tracking technology and point-of-view cameras.

Outcomes and deliverables <emergencyeyetracking.com/>

The tangible outcomes from the project are:

1) A preliminary evaluation report on the effectiveness of eye-tracking technology for improving student feedback and SA in simulated emergency situations.
2) In line with resource development (*above*) a web-based, evidence-based preliminary set of guidelines incorporating examples of innovative simulation approaches to guide educators.

Timeline

The project was completed over a 12-month period in 2013, as shown in Appendix A.

3. Results

Participant demographics

Thirty-nine final-year students (20 nursing and 19 paramedics) participated in the project. They were enrolled at three universities:

- 10 nursing students and 10 paramedicine students at university A;
- 10 nursing students at university B; and
- 9 paramedicine students at university C.

The nursing students were all enrolled in a three-year degree leading to a Bachelor of Nursing. Paramedicine students were enrolled in either a three-year Bachelor of Emergency Health or four-year double degree: Bachelor of Health Science/Master Paramedic Practice. This latter group were in the fourth year of their course while the remainder were in the third year which met the inclusion criteria of '*near completion*' students. All but three students spoke the English language at home and all were domestic as opposed to international students.

Three-quarters of all students (74%) were female and the overall median age was 21 years with a range 19 to 53 years (mean: 26.5, SD 9 years). There was no significant difference in age between the nursing and paramedicine groups.

Students were asked about their experience of the healthcare environment. Most students had experience of several clinical placements, the majority of which were in general wards, mental health, aged care, community or ambulance services. Around one-third reported prior employment in nursing or a healthcare-related field, such as assistant in nursing, Enrolled Nurse or other role. Two-thirds reported witnessing a patient deteriorating but none reported having an active role in the management of the patient.

Project outcomes

Participants' performance improved as the scenarios (OSCEs) progressed and the program received positive appraisals. Table 3.1. summarises the outcomes, which are described in detail in the following sections of this report.

Table 3.1. Summary of project outcomes: Whether data measures showed improvement over the simulation training period

Domain	**Data collection technique**	**Significant improvement**	**Outcome /Effect size**
MEASURES OF STUDENT PERFORMANCE			
Knowledge/skill/competence/ confidence	Prospective pre-post self-completed survey using five-point rating scale	Yes	Medium
Clinical simulation performance (OSCEs)	Prospective ratings in three consecutive OSCEs using valid Yes/No checklist	Yes	Medium
Situation Awareness (SAGAT)	Ratings in consecutive post-simulation assessments (3) using valid Yes/No checklist SAGAT[10]	Yes	Small
STUDENTS' EVALUATIVE FEEDBACK			
Satisfaction survey (SSES)[15] ratings	18-item validated survey using five-point rating scale	Positive feedback	Positive: 96% satisfaction
Student feedback: Ratings in course evaluation survey	seven-item survey using a five-point rating scale	Positive feedback	Positive: 94% approval
Student feedback: three open-text questions about learning from the program	Focused open-text questions in post-test survey	Positive feedback	Positive reports
Ratings of impact of use of eye-tracking equipment	Three focused questions using five-point rating scale	Positive feedback	Positive impact overall (73%); and 97% benefited

Participants' performance: Objective assessments

Eye-tracking process during simulation events

While attending to the patient during simulation events, each student wore video-recording eye-tracking glasses to record their field of view and to the track the movement of their right eye (seen as a moving dot on the video screen - Figure 3.1). This technology enabled the teaching team to replay the video recording to each participant immediately after each scenario. This allowed participants to reflect on their performance with particular reference to their focus of attention (known as their 'Area of Interest': AoI).

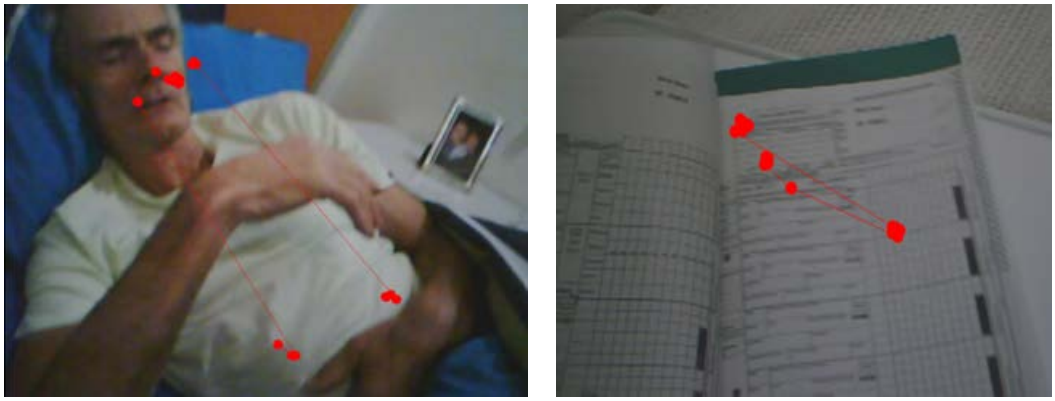


Figure 3.1. Eye-tracking movements—the larger the red dot, the longer the time spent looking at the area

Software provided with the glasses also produced output from this AoI data, such as 'gaze patterns' (Figure 3.1 above) and 'heat maps' (Figure 3.2 below). In addition, the researchers were able to designate the students' AoI, for example looking at 'the patient' or 'the monitor', in order that the time spent looking at each area could be compared within and between groups in relation to overall clinical performance.

Figure 3.2. Example of a heat map showing a paramedic's focus of attention in the first five seconds of entering a room i.e. direct eye contact with the patient

Measurement of the AoI data was performed by technicians at Tobii's China office with data provided on an Excel spread-sheet for later analyses. Detailed analyses of this data will be reported at a later date.

Clinical performance

Each student participated in three clinical scenarios, with performances rated by a trained observer using a valid checklist. The scenarios were: Cardiac (rated out of a possible 25 points); Shock (out of 23 points) and Respiratory (out of 20 points). To enable a direct comparison between these, average percentage scores were calculated for the whole sample. Paramedic and nursing students averaged 49% in the Cardiac scenario, 50% in the Shock scenario and 66% in the Respiratory scenario.

There was a significant improvement in performance in the related samples between the first (Cardiac) scenario and the last scenario (Respiratory) (t = -8.77; df 38; CI -20.18 -13.67 p = <0.001 [Mean difference [Md] 3.25]). The effect size was moderate, as indicated by Cohens' d (d = 1.66; r = 0.64).

> **Key result:** OSCE performance improved between the first and third scenarios with a moderate effect size.

Situation Awareness

A key aim of this project was to evaluate the effectiveness of eye-tracking technology for improving feedback and students' Situation Awareness (SA); for example whether SA would improve with each subsequent clinical simulation (Cardiac-Shock-Respiratory). Hence, immediately after each scenario, each student's level of SA was measured using the SAGAT[10, 11] —a verbal question-and-answer survey using a Yes/No response checklist, each list with an identical number of items. The SA scores were moderate overall, with an average score of 52% (5.8/11). Overall Cardiac SA was 50%; Shock SA was 51%; and Respiratory SA was 56%.

Improvement by third scenario: There was an improvement trend (non-significant) between each scenario and a significant improvement between the first (Cardiac scenario) and the last scenario (Respiratory scenario) (t = -2.08; df 38; CI -1.21 - 0.02; p = 0.04 (Md 0.59)). The effect size was small, as indicated by Cohens' d (d = 0.40; r = 0.20).

> **Key result:** Improvement in SA scores between the first and third scenarios showed a small effect size.

Improvement in knowledge and skill

On arrival each participant was asked to rate their skills and knowledge (five items) and the same survey was repeated immediately after the teaching intervention. Overall results showed significant improvement in ratings for all items (p <0.001*)* although there was some variation between discipline groups.

In the pre-test survey, paramedic participants rated their skill levels significantly higher (Mean total: 16.32; SD 2.21) than the nursing students (Mean total: 13.85; SD 2.68) (p = 0.014). While both disciplines rated their skills as improved in the post-test, there was no significant difference in the post-test ratings total by discipline (Mean total: PM 18.21; SD 2.64; BN 18.55; SD 2.26; p = 0.67). This indicates that nursing students rated their overall improvement more strongly than the paramedic group.

> **Key result:** Skills, competence and confidence were rated significantly higher after the intervention with relatively greater improvement in nursing students' ratings.

Course evaluation feedback

Course evaluation survey

The seven-item course evaluation survey returned a median score of five out of a possible five in every item, indicating strong approval of the experience. Students' responses showed 94% overall approval (Mean 33 of a possible 35 points).

> **Key result:** A course feedback survey showed strong approval of the course.

Satisfaction with simulation experience

The students also expressed strong satisfaction with the program in the SSES feedback survey, giving highly positive feedback. Each of 18 items was rated ≥4.51 of five points, with an overall score of 96% (Mean 86 of a possible 90 points).

> **Key result:** A satisfaction survey showed strong approval for the course and the learning environment from nearly all participants.

The most positively rated items were: 'The facilitator made me feel comfortable and at ease during the debriefing' (M 4.97); 'I had the opportunity to reflect on and discuss my performance during the debriefing (M 4.90); and 'Reflecting on and discussing the simulation enhanced my learning' (M 4.90).

Impact of eye tracking

Participants were asked to rate whether the use of eye-tracking equipment *aided feedback* (on a five-point scale from (1) 'not at all' to (5) 'to a large extent'). Participants agreed that eye tracking assisted feedback with 35 participants (90%) rating this highly (4 or 5; M 4.46; SD 0.76). None of the participants reported that eye tracking had no influence and there was no significant difference between nursing and paramedic students' views.

Participants were asked to rate whether eye-tracking equipment *improved their learning* (on the same five-point scale). Participants agreed that eye tracking assisted their learning, with 34 students rating this highly (4 or 5; M 4.38; SD 0.78). None of the participants reported that eye tracking had no influence on learning and there was no significant difference between nursing and paramedics' views.

When asked whether they 'benefited from using the eye-tracking equipment?' (yes/no) all but one participant agreed. Nearly all students provided comments in response to the open-ended question about how they benefited. These findings are summarised below.

Key result: Nearly all participants reported that 'eye-tracking' improved learning and aided feedback.

Qualitative feedback

Students reported that they benefited from video and audio playback, but not necessarily from the eye-tracking component, for example:

> 'Benefitted primarily from video and audio playback, eye tracking not to as great an extent. But overall helpful in recognising where your attention is focused.' (PM student)
>
> 'Watching the feedback was really helpful.' (BN student)

Key result: Participants placed a high value on video debriefing with opportunity to reflect on aspects of practice.

Comments from both nursing and paramedic groups emphasised their increased awareness of the attention focus, providing indirect support for the eye-tracking component of the study:

> 'It helped in [knowing] where I was focused on, that I really just focused on the immediate scenario not very observant to surroundings initially.' (BN student)
>
> '[it] Raised my awareness of the areas I need to focus on. Seeing what was being focused on, and what to put more emphasis on.' (BN student)
>
> 'Made more aware of considering my surroundings. Could see when I was unaware of what to do next and started looking around room rapidly. Thanks.' (PM student)

Key result: Participants described how visual review of their focus of attention during debriefing added a feedback dimension.

In addition, students perceived the opportunity to revisit, view and review the details of their videoed performance, as having educational benefits.

> 'Immediate reflection on my clinical reasoning assessment and treatment of the patient and what should be done better next [helped]. To reflect straight after was

perfect.' (PM student)

'Having the ability to reflect on how I handled the scenarios without it being real life [helped].' (BN student)

There were no negative comments and no specific comments about whether the wearing of the eye-tracking glasses impeded their performance.

Reported learning outcomes

The majority of students reported that eye tracking improved their learning (34/39 'largely' or 'to a large extent') in the evaluation survey. Students were also asked to provide open textual comments about the key outcomes, with the responses being centred around:

- a need to further develop situation awareness;
- the opportunity to identify weaknesses in clinical performance;
- the need to pay more attention to their surroundings to benefit patient care;
- perceptions of their communication ability—or lack of;
- an understanding of time management and prioritisation ;
- the need for a systematic approach to patient assessment (ABCDE); and
- an increase in confidence especially for those that performed well.

While it is acknowledged that traditional face-to-face debriefing (using verbal review alone) may facilitate positive outcomes, there appears to be an added dimension provided by the visual field review. For example, a better understanding of where they looked (and did not look), and how long they focused on any particular area. As one nursing student stated:

'I learnt to scan my environment and to stick with my basics of obs and DRABCD'.

Key result: Following the course, participants reported a greater insight into their performance and the possible positive impacts on practice.

Suggested program improvements

Participants were asked *'How could the program be improved?'* Comments from 19 of 39 participants were related to:

- An improved orientation to the scenarios and environment, for example:
  - 'A run through without feedback initially'
  - 'A short intro to the room and what equipment is available and where'
- Preference for working with a partner:
  - '… do the study with a partner to see how much you look at them for answers'
  - 'two sets of (eye-tracking) glasses to make team set-up'
  - '… using two students, mimicking real life practice in crew'
- Longer scenarios:
  - 'felt a little rushed'
  - 'longer scenarios'.

4 Outcomes and recommendations

Outcomes

In line with the objectives of this project, there were strong indications that the 'eye-tracking' component had improved learning and aided feedback. Participants placed a high value on the video debriefing (and attention focus component) as it created an opportunity to reflect on aspects of their practice. Participants also reported a greater insight into their performance and the possible positive impacts on practice. Program evaluations and satisfaction levels were high, and participants' clinical skills improved significantly between the start and the end of the program. Situation awareness also improved significantly whilst participants' self-ratings of their skills, competence and confidence improved significantly from pre-course levels.

While these outcomes are predominantly positive they must be balanced against the feasibility of the approach and the potential cost benefits. The program was resource intensive, requiring a minimum of three to four academics and one simulated patient to 'train' five students per day. As a stand-alone training program this is unlikely to be feasible for most providers unless, like us, they were interested in exploring performance and education outcomes to inform education and clinical practice. In this study we have been able to demonstrate the feasibility and benefits of eye-tracking technology and how debriefing benefits clinical and simulated performance.

In order to translate these findings into feasible practice for educators (as opposed to educational researchers) we would therefore recommend:

1. That eye-tracking or point-of-view cameras are incorporated into clinical training (and potentially into clinical practice). Point-of-view cameras are significantly cheaper but do not provide eye-tracking data which may be of particular value to the educator or student.
2. The use of eye tracking in educational programs that make use of team-based scenarios, thereby increasing student throughput and enhancing teamwork.
3. Consideration for less resource-intensive debriefing approaches such as students' self-review (e.g. providing DVDs of performance for students to watch at a later date).

In addition, we recommend the need for repetitive and frequent high-fidelity simulation in order to reduce the time it takes for students to reach competency. Our findings indicate significant performance deficits that can only be addressed by realistic simulated practice.

Further research is required to understand and learn from experienced practitioners, especially to ascertain where their area of interest is focussed in emergency settings. Such work will further inform and develop educational programs. Explorations of (simulated) patient views and the impact of empathetic communication on their care will also be of significant benefit, creating insight into 'best strategies' and key priorities when caring for the acutely ill.

Guidance on the use of Tobii eye-tracking technology is listed in Figure 4.1.

Figure 4.1. Guidance on the use of Tobii eye-tracking technology

Guidance on the use of Tobii eye-tracking technology

Instrumentation: Tobii eye-tracking glasses software need to be calibrated before each participant can be eye-tracked, a process that takes around one minute to complete. The accuracy of calibration is dependent on a number of factors, which, from our experience, include the shape of the participant's face (fuller-faced individuals with smaller eyes were more difficult to calibrate) while blue eyes were notably easier to calibrate than dark eyes.

Visual field: In addition, participants were encouraged to look directly through the glasses to improve the percentage of time that eye movement was recorded (for AoI analyses Tobii recommend greater than 40%). Our records ranged from 15% to 79% which meant that some data was excluded from AoI analyses. In the dynamic situations we were working in, participants were often working up close with a patient, for example, reading an ECG or making notes. This caused them to drop their eyes and look under the glasses with loss of eye tracking.

Full guidance on this technology is available at: <http://www.tobii.com/>

Dissemination

The planned program of dissemination for this program is ongoing, with core members of the reference group advising and assisting in the dissemination strategy (e.g. Professors Scholes). Final outcomes and the educational toolkit are available on the open access website including background information, links to key papers and websites, advice on eye-tracking technology and video exemplars of practice.

The publicity program includes publication in applicable peer-review journals—two to date (Table 4.1)—and an ongoing series of papers planned by the research team (Table 4.2).

Table 4.1. Journal publications to date

Journal publications:
1. Cooper S, Porter J, Peach L. Measuring situation awareness in emergency setting: a systematic review of tools and outcomes. Open Access Emergency Medicine. In Press – accepted 1 November 2013.
2. Williams B, Quested A, Cooper S. (2013) Can eye-tracking technology improve situational awareness in paramedic clinical education? Open Access Emergency Medicine. 5; 23-28.

Table 4.2. Publications planned

Planned publications:
1. A summary paper on participant quantitative performance. Leads: Fiona Bogossian and Louise Sparkes.
2. Video debriefing outcomes based on eye-tracking and evaluation data.

Leads: Brett Williams and Linda Ross.

3. Situation awareness development using data from SA ratings, eye-tracking and debriefing techniques. Leads: Graham Munro and Peter O'Meara.

4. Area of interest analysis-based. Leads: Simon Cooper and Mark Browning.

This final report is available at Monash University library depository and direct representation is being made to the 39 schools of nursing and 12 paramedic schools across Australia. International conference presentations to date (and planned) are listed in Table 4.3.

Table 4.3. Project dissemination via conferences

Conference presentations		
Conference details	**Speaker**	**Content of presentation**
Paramedics Australasia Conference Canberra, 19 October 2013.	Linda Ross	Can eye-tracking technology improve situational awareness in paramedic clinical education? (20 minute presentation) (50 attendees)
The University of Hong Kong 2013: 12-13 September, Hong Kong.	Simon Cooper	2-day workshop, First2ActWeb™ and eye-tracking presentations (30 attendees).
University of Brighton (UK) 2013: 29 October, United Kingdom.	Simon Cooper	2-hour workshop on First2ActWeb™ and eye-tracking presentations (10 attendees)
3rd Australian Catholic University Simulation in Health Education Showcase (VIC). 2013. 25 November. ACU Melbourne.	Simon Cooper	Two 40-minute presentations: First2ActWeb™ and eye-tracking presentation (200 attendees).
Planned conference presentations		
The 1st global conference on Emergency Nursing and Trauma care. Dublin Ireland. 18-21 September 2014	Louise Sparkes	Eye-tracking study—differences between nursing and paramedic students? (to be submitted: 20-minute presentation)
NET NEP 2014, The Netherlands	Fiona Bogossian	Standardised patient actors' perceptions, experiences and evaluation of nursing care in high-fidelity simulation scenarios (submitted).
NET NEP 2014, The Netherlands	Fiona Bogossian	Can eye-tracking technology improve situational awareness in undergraduate nursing students? (submitted).

References

1. Saus E, Johnsen B, Eid J, Riisem P, Andersen R, Thayer J. The effect of brief situational awareness training in a police shooter simulator: An experimental study. Military Psychology 2010;18:S3--S21.
2. Cant R, Cooper, SJ. The benefits of debriefing as formative feedback in nurse education. Australian Journal of Advanced Nursing 2011;29:37-47. Open access At: http://www.ajan.com.au/Vol29/-1_Cant.pdf.
3. Cant R, Cooper S. Simulation-based learning in nurse education: Systematic review. Journal of Advanced Nursing 2009;66(1):3-15.
4. Waldner MH, Olson JK. Taking the patient to the classroom: Applying theoretical frameworks to simulation in nursing education. International Journal of Nursing Education Scholarship 2007;4(1).
5. Lisko S, O'Dell V. Integration of theory and practice: Experiential learning theory and Nursing education. Nursing Education Perspectives 2010;31(2):106-108.
6. Kolb AY, Kolb DA. Learning styles and learning spaces: enhancing experiential learning in higher education. Academy of Management Learning & Education 2005;4(2):193-212.
7. Tiwari A, Lam D, Yuen KH, Chan R, Fung T, Chan S. Student learning in clinical nursing education: perceptions of the relationship between assessment and learning. Nurse Education Today 2005;25(4):299-308.
8. Duchowski AT. Eye Tracking Methodology: Theory and Practice. Springer-Verlag ; 2007.
9. Boud D. Assessment 2020: Seven propositions for assessment reform in higher education. [report] Sydney: Australian Learning and Teaching Council, 2010.
10. SA Technologies. Super SAGAT: Situational Awareness Global Assessment Technique. At: <www.Satechnologies.Com> Accessed 12/10/10.
11. Endsley R. Situation awareness global assessment technique (SAGAT). National Aerospace and Electronics Conference (NAECON): New York IEEE; 1988.
12. Kirkpatrick DI. Evaluation of training. In: CR. Bittel [ed]. Training Development Handbook. London: McGraw Hill; 1967.
13. Clarke D. Instructional System Development – Evaluation Phase. At: <www.nwlink.com/~donclrk/hrd/sat6.html>; 1995.
14. Pallant J. SPSS Survival Manual; a step by step guide to data analysis using SPSS. (5th Ed). Sydney: Allen and Unwin; 2013.
15. Levett-Jones T, McCoy M, Lapkin S, et al. The development and psychometric testing of the Satisfaction with Simulation Experience Scale. Nurse Education Today 2011;31(7):705-710.

Appendix A: Project timeline

Table A.1. Project plan by month in 2013

January – March 2013	Recruit project assistant Complete literature review Submit ethics proposal First project group meetings.
April 2013	Design self-report survey for participant feedback Design database Recruit participants Additional project group meetings
May – August 2013	Educational interventions and data collection Data entry of quantitative survey data Additional project group meetings Publication of two peer reviewed papers (literature reviews)
September – December 2013	Analysis/write-up of project findings Submission of project report to funding body Dissemination of results through conference abstract submissions Generation of four journal manuscripts for submission to refereed journals Finalisation and publication of website Preparation for large OLT grant submission (EoI) to build on the Seed Grant.

Appendix B: Data collection instruments

(please also see website for additional resources: <emergencyeyetracking.com/)

Participant No.:	Date:	Study Centre: Monash / UQ /LaTrobe

Participant demographic form			
Your sex? (please tick one)	☐ **Female** ☐ **Male**		
Your age?	**……..Years**		
Do you speak a language other than English at home?	☐ **No, English only** ☐ **Yes, Italian** ☐ **Yes, Greek** ☐ **Yes, Cantonese** ☐ **Yes, Arabic** ☐ **Yes, Vietnamese** ☐ **Other (please name):**_____		
Your course of university of study? (Please tick one)	☐ **Bachelor of Nursing** ☐ **Bachelor of Emergency Health** ☐ **Bachelor of Nursing/Bachelor of Emergency Health** ☐ **Other (please name):** **……**		
Are you enrolled as an international or domestic student?	☐ **International** ☐ **Domestic**		
What year of your course are you currently studying?	☐ **Year 3** ☐ **Year 4**	**In which semester or trimester are you currently enrolled? (please tick one)**	☐ **Semester 1** ☐ **Semester 2** ☐ **Trimester 1** ☐ **Trimester 2** ☐ **Trimester 3**
Have you ever worked as an employee in a nursing or healthcare related field (e.g., Enrolled Nurse, Personal Care Assistant, first responder etc)	☐ **No** ☐ **Yes – <u>If yes</u>, what was your role and how many years did you work in that role?** **…….** **……..**		

<table>
<tr><td rowspan="7">Where have your clinical placements been during your nursing or paramedic education? (please tick any)</td><td>Aged care</td><td></td><td>General wards</td><td></td></tr>
<tr><td>Community</td><td></td><td>Mental Health</td><td></td></tr>
<tr><td>Critical / intensive care</td><td></td><td>Operating Theatre</td><td></td></tr>
<tr><td>Emergency</td><td></td><td>Rehabilitation</td><td></td></tr>
<tr><td>Non-emergency ambulance</td><td></td><td>Emergency ambulance</td><td></td></tr>
<tr><td>Other (please specify)

……</td><td colspan="3"></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Have you ever cared for a patient whose condition suddenly deteriorated such that a medical emergency or Medical Emergency Team (MET) or MICA backup was called?</td><td colspan="4">☐ No
☐ Yes –If yes, what was your role?
☐ Observer ☐ Recorder/scribe
☐ First responder ☐ Calling MET
☐ Airway ☐ external cardiac compressions
Comments ……</td></tr>
<tr><td></td><td colspan="4"></td></tr>
</table>

Participant No.: ..... Date: ..... Study Centre: Monash / UQ /LaTrobe

Tracking Situation Awareness Study

Form 2: Pre-assessment of confidence and competence

Please rate your abilities **by choosing a number to respond to each statement below between 1 (Not at all) and 5 (To a large extent).**

My perceived ability to:	Before this session				
	Not at all				To a large extent
Recognise a deteriorating patient	**1**	**2**	**3**	**4**	**5**
Manage emergency priorities	**1**	**2**	**3**	**4**	**5**
Perform emergency tasks	**1**	**2**	**3**	**4**	**5**
My overall:	Before this session				
Confidence level:	**1**	**2**	**3**	**4**	**5**
Competence level:	**1**	**2**	**3**	**4**	**5**

Cardiovascular System Scenario

Research staff:

- Participants should be asked to arrive dressed as they would for clinical placement. That is, in uniform, hair and jewellery appropriate, note pad, pen, watch, stethoscope, etc.
- Ask participant not to discuss the scenarios with their colleagues until study is complete.
- Ensure pre-assessment forms are complete.
- Ensure eye tracking is working.
- Ask SA questions at the end of the scenario.
- Check equipment is available and correct for the scenario.
- Run through scenario with participants and ask them to repeat it back.
- Emphasise the need to record observations regularly and verbalise thoughts and actions

Briefing notes

Nursing student: You are just starting your shift as a district nurse and you are visiting your first patient of the day at his home. As your 'patient' is an actor you are required to take observations as per normal but results will be revealed by the researcher. The patient is alone in their bedroom.

Paramedic student: You are just starting your shift as a primary response paramedic in a response car and have been called to a patient at home. As your 'patient' is an actor you are required to take observations as per normal but results will be revealed by the researcher. The patient is alone in their bedroom.

The patient: John is 65 years of age and is being treated by the district nurse for cellulitis of his leg, for which a course of oral antibiotics has been completed. On arrival he tells you he has chest pain and points to the centre of his chest. You are the first to respond.

The scenario will be run in 'real time'. There will therefore be gaps in activity, *(this does not mean you are doing anything wrong).* You have an observation chart to document vital signs. Talk out loud about what you are thinking and doing. You can ask for the patient's status at any point and you can expose him down to his underwear.

At the end of the simulation you will be stopped and asked about specific aspects of the situation, as you perceive them, at that time. The questions should be answered as rapidly as possible – it is OK to use your instinct.

Researcher
DO NOT PROMPT at any point. Give information as requested after an applicable action, i.e. only indicate the BP or HR after it has been taken. Please rate performance on the following scale during or immediately after each scenario.

Patient scenario:

You are Mr John Edwards a 65-year-old retired accountant**.**

Moulage – Cyanosis – i.e. pale/sweaty lips

Presenting condition (if asked)
You are being treated at home by the district nurses for cellulitis of the leg and are taking oral antibiotics. About 20 minutes ago you got severe chest pain and rang 000. (*If this is a nurse led scenario indicate to the nurse that they had arrived just in time as you had just called 000).*

- Chest pains and breathlessness.
- The pain came on gradually and is currently approx 5/10.
- The onset of pain was AT REST. You did not have indigestion.
- The pain was across the front of your chest. It did not radiate anywhere else.
- The pain was accompanied by you feeling generally unwell and breathless. You still feel your breathing is 'a bit tight'.
- You have had this pain in the past. It does feel similar to your angina pain.
- Usually you need to use your GTN approx. once every month or so and you have not seen your GP about your angina for the last 8–9 months.

You are anxious and agitated but not aggressive. Your wife is out shopping with her sister and you have been unable to contact them so far.

Past medical history

- You are known to have high BP for which you take medication.
- You had a blood test to check your cholesterol last year which was 5.4.
- You have had angina for the last three years.

Drug history

- Metoprolol 50mg twice a day (for your BP and angina – you think).
- Aspirin 100mg daily.
- Pravastatin 40mg at night (for your high cholesterol).
- GTN spray prn (for your angina when you need it).

Social history

- You drink 4 glasses of red wine per day.
- You eat 'healthily'.
- You smoked 20 cigarettes per day for 25 years but have recently given up.
- You have gained about 6kg in weight over the last six months.
- Married to Grace, also retired, with four adult children.
- You don't exercise specifically but you take your dog for a walk twice a day.

Family history

- Your father died aged 48 years of a heart attack which is adding to your concerns.

Decline at 4 minutes (halfway point of scenario)

- Rapid increase in chest pains (9/10) and breathlessness (rapid shallow breaths).
- The pain is crushing central chest pain right across the front of your chest. It did not radiate anywhere else.
- You are anxious, agitated and very frightened.

Objective Structured Clinical Examination – Cardiac

Participant No.: ..... Date: ..... Study Centre: MU / UQ / LaTrobe				
CVS Chest Pain (Scenario 1)				
Approx time (mins)	Observations	Action	Correct/ incorrect	*Points at debrief*
On arrival 1–4		**Obtain immediate history**	**Y/N**	
	5/10	**Pain assessment**	**Y/N**	**PQRST (Provoke/Palliation, Quality, Radiates, Severity, Time)**
		Record/request obs		
	BP 150/95		**Y/N**	
	HR 110 *(if palpated)*		**Y/N**	
	RR 20		**Y/N**	
	CRT – 2 secs		**Y/N**	
	O^2 Sats 95%		**Y/N**	
	Temp 36.8		**Y/N**	
		Investigate current medication usage	**Y/N**	**Prescription, over counter, recreational**
		Identify other symptoms	**Y/N**	**Dyspnoea, nausea, diaphoresis, neck vein extension**
		Consider non-cardiac causes of chest pain	**Y/N**	**Aortic aneurysm, oesophageal reflux, pneumothorax, musculoskeletal**
		Aspirin (sub-lingual)	**Y/N**	
		Commence ECG monitoring	**Y/N**	**[Paramedic students only]**

(continued)

Patient rapidly deteriorates **Rapid increase in chest pains (9/10) and breathlessness (rapid shallow breaths)**				
4–8 mins	**9/10** **BP 170/95** **HR 140** **RR 32** **CRT – 2 secs** **O^2 Sats 89%** ***(despite O^2 if on)***	**Pain assessment** **Nitrates** **Record/request Obs.**	**Y/N** **Y/N** **Y/N** **Y/N** **Y/N** **Y/N** **Y/N**	**Emphasise systematic ABCs. Time critical**
		Call for applicable emergency assistance **Position appropriately** **Administer 0^2 (non-rebreath)** **Ensure IV cannulation** **Morphine**	**Y/N** **Y/N** **Y/N** **Y/N** **Y/N**	**Upright or Semi-recumbent.** MONA **– M**orphine, O**xygen, N**itrates, A**sprin** **[Paramedics only]**
7.5–8 mins?	**BP 140/80** **HR 120** **RR 25** **CRT – 2 secs** **O2 Sats 93%**	Instructor note**:** **Where requested – unless majority of above have been missed – indicate these observations and initial stabilisation in last 30 secs of scenario**		**Stabilisation may be temporary**
End scenario with SA questions **Give feedback with attached rubric**				

Situation awareness (SA)

Process for development of SA questions

(Wright et al. 2004: Objective measures of SA in a simulated medical environment)

Goal Task Analysis (Cardiac)

Key goal
Resuscitation

Sub goal
Primary Stabilisation/Resuscitation (first 8 minutes)

Key decisions
What is the patients' status (observations)?
Is assistance required?
What is the differential diagnosis?
What equipment is required?
What responses are required to the observations?
How should the patient be stabilised?

SA requirements
Visual assessment (e.g. RR & LOC)?
Physiological monitoring (BP, HR, Temp, CRT, $SpO^{2,}$)?
Awareness of the need for assistance?
Observation/indicators of pain?
Awareness of heart rythm?
Awareness of equipment requirements?
Awareness of applicable actions (e3.g. analgesia)?
Awareness of requirements for patient stabilisation (e.g. MONA)?

SAGAT Queries

Physiological perception
What is the BP at the moment?
What is the HR at the moment?
What is the RR at the moment?

Global situation perception
Is suction available?
What's on the patient's wrist?
What was on the wall near the patient?

Comprehension
Is the patient adequately oxygenated?
What is wrong with this patient?

Projection
If condition does not improve, what will happen to the HR?
If condition does not improve, what will happen to the BP?
What investigations may be required?
What medications may be required?

Situation Awareness Checklist

Cardiac Scenario

Question	Answer	Right	Wrong
What medications may be required?	**2 of- Morphine, Nitrates, Asprin**		
What is the HR at the moment?	**140 or 120**		
Is the patient adequately oxygenated/sats?	**NO- 89%- 93%**		
What is on the patient's wrist?	**A friendship band**		
What investigations may be required?	**2 of -12 lead ECG, Bloods (cardiac enzymes), CXR**		
What was on the wall near the patient?	**Childs drawing**		
If condition does not improve, what will happen to the HR initially?	**Increase**		
What is wrong with the patient	**MI**		
What is the BP at the moment?	**170/95 or 140/80**		
What is the respiratory rate at the moment?	**32 or 25**		
Is suction available?	**Yes**		
If condition does not improve, what will happen to the BP initially?	**Increase then decrease**		

Rating: correct = 1; incorrect = 0

Photo elicitation schedule

Key points for feedback following photo elicitation

Use beefburger technique:

- Good points – points for improvement – finish with good points
- You will have 15 minutes only for the feedback (please do not overrun)

As you work through the scenario with the student (photo – elicitation) make notes on a spare rating form. You will see that this form has key points for feedback:

In cardiac scenario these are:

- PQRST – pain assessment
- Current medication usage
- Key symptoms
- Non-cardiac causes of chest pain
- Patient positioning
- MONA

In the respiratory scenario these are:

- Discuss summarise 'blue bloater'
- Current medication usage
- Key symptoms
- Patient positioning
- Drugs required
- O_2 levels – hypoxic drive issues – aim for 90% sats – but GIVE lots lots of o_2 in this emergency

In the hypovolemic scenario these are:

- Importance of ongoing assessment of circulation – Central and peripheral
- Fluid resuscitation - IV access (2 large bore cannula)
- Key symptoms
- Patient positioning

<u>General take-home points:</u>

- Highlight the need to watch trends
- Need to record respiratory rates (the missed observation)
- Call for help early
- Increase frequency of observations when necessary
- Importance of vital signs being attended overnight
- Check urine outputs, blood sugar, level of consciousness, pain scores.
- Importance of taking Vital Signs overnight

Participant No.: ..... Date: ..... Study Centre: Monash / UQ /LaTrobe

Course evaluation (**Immediately post simulations)**

Form 3: Post assessment of confidence and competence

Please rate your abilities **by choosing a number to respond to each statement below between 1 (Not at all) and 5 (To a large extent).**

My perceived ability to:	After this session				
	Not at all				To a large extent
Recognise a deteriorating patient	**1**	**2**	**3**	**4**	**5**
Manage emergency priorities	**1**	**2**	**3**	**4**	**5**
Perform emergency tasks	**1**	**2**	**3**	**4**	**5**
My overall:	After this session				
Confidence level:	**1**	**2**	**3**	**4**	**5**
Competence level:	**1**	**2**	**3**	**4**	**5**

Course evaluation

Participant No.: ..... Date: ..... Study Centre: Monash / UQ/ LaTrobe

This simulation course:	**Not at all**				**To a large extent**
Was relevant to my needs	**1**	**2**	**3**	**4**	**5**
Was appropriate to my level of training	**1**	**2**	**3**	**4**	**5**
Provided effective feedback	**1**	**2**	**3**	**4**	**5**
Was challenging without being threatening	**1**	**2**	**3**	**4**	**5**
Enabled me to integrate theory into practice	**1**	**2**	**3**	**4**	**5**
Stimulated my interest in the topic	**1**	**2**	**3**	**4**	**5**
Encouraged me to think through a clinical problem	**1**	**2**	**3**	**4**	**5**

Please circle the applicable rating:

Please add any other comments or suggestions
For example - what were the key things you learnt from this program? **How could the program be improved?**

Participant No.: ..... Date: .....Study Centre: Monash / UQ /LaTrobe

SSES

Please indicate your level of agreement/disagreement with each statement by circling one option related to the following scale *(Levett-Jones et al 2011):*

		Strongly agree	Agree	Unsure	Disagree	Strongly disagree
1.	**The facilitator provided constructive criticism during the debriefing**	5	4	3	2	1
2.	**The facilitator summarised important issues during the debriefing**	5	4	3	2	1
3.	**I had the opportunity to reflect on and discuss my performance during the debriefing**	5	4	3	2	1
4.	**The debriefing provided an opportunity to ask questions**	5	4	3	2	1
5.	**The facilitator provided feedback that helped me to develop my clinical reasoning skills**	5	4	3	2	1
6.	**Reflecting on and discussing the simulation enhanced my learning**	5	4	3	2	1
7.	**The facilitator's questions helped me to learn**	5	4	3	2	1
8.	**I received feedback during the debriefing that helped me to learn**	5	4	3	2	1
9.	**The facilitator made me feel comfortable and at ease during the debriefing**	5	4	3		1
10.	**The simulation developed my clinical reasoning skills**	5	4	3	2	1
11.	**The simulation developed my clinical decision making ability**	5	4	3	2	1
12.	**The simulation enabled me to demonstrate my clinical reasoning skills**	5	4	3	2	1

(continued)

13.	**The simulation helped me to recognise patient deterioration early**	5	4	3	2	1
14.	**This was a valuable learning experience**	5	4	3	2	1
15.	**The simulation caused me to reflect on my clinical ability**	5	4	3	2	1
16.	**The simulation tested my clinical ability**	5	4	3	2	1
17.	**The simulation helped me to apply what I learned from the case study**	5	4	3	2	1
18.	**The simulation helped me to recognise my clinical strengths and weaknesses**	5	4	3	2	1