Research

An educational programme for error awareness in acute trauma for junior doctors

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Background. In resource-poor environments of the developing world, young and inexperienced interns and community service doctors are often responsible for treating trauma patients without sufficient supervision. Time and experience are required for competency to develop, but in the understaffed environment of many hospitals time is often a constraint. Educational interventions are needed to accelerate competency development of the novice doctor.

Method. The researchers designed an intervention using real cases and error theory to expand young doctors' experiences of common trauma errors made in our setting. We analysed cases at the regular morbidity and mortality meetings and selected cases where error contributed to the condition of the patient. Using error theory, these cases were presented to doctors with the objective to increase error awareness. To assess the success of this intervention, three doctors who were exposed to the intervention and three who were not exposed to it were included in the study using a structured interview.

Results. This study demonstrated that interns who had been exposed to the intervention had a broader understanding of how errors can compound a patient's pathology and are often the result of systematic rather than individual failure.

Conclusion. The researchers focused on the rationale for and the development of an intervention for novice doctors to expose them to trauma experiences in the framework of understanding error. The immediate success of the intervention is illustrated in the structured interviews. Further development of this intervention and more formal research into its pedagogical value are planned after formalisation of the intervention into a teaching curriculum for trauma doctors. This educational initiative will have to be part of a comprehensive multifaceted quality-improvement programme if it hopes to be successful.

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Trauma is a ubiquitous reality in South Africa and severely injured patients may present to a range of institutions.[1-6] Junior staff may be required to care for these patients in settings where they are not well supervised. Many courses have been designed with the following educational outcome in mind: the improvement of the knowledge and skills of junior staff in the resuscitation and management of a trauma patient.

The best-known such course is the Advanced Trauma Life Support (ATLS) course of the American College of Surgeons, which was famously inspired by an incident over three decades ago when an orthopaedic surgeon and his family were involved in a plane accident in rural Nebraska and received poor trauma care at the local hospital.[2,3] Since then, the ATLS course has been propagated worldwide and has come to be regarded as the gold standard in terms of trauma education.[2,3] The ATLS course focuses on techniques and not on what could go awry in the trauma setting.

Since the turn of the millennium, there has been a growing awareness that error in healthcare is a significant cause of morbidity and mortality.[1-4] International and local research has demonstrated that human error is problematic in trauma care at dedicated high-volume centres and even more so in smaller centres where severely injured patients are occasionally seen by less experienced doctors. Error theory suggests that the making of mistakes is not random, but follows specific patterns. If teaching staff are aware of possible errors, it may contribute towards reducing error incidence and impact.[3-6] Educational programmes on error prevention and reduction make staff aware of errors.

In light of this, the researchers applied the understanding of error prevention and reduction to trauma care education. Cases where error contributed to an adverse outcome were documented and examined in detail using a taxonomy of error. This allowed educators the opportunity to convert individual cases into structured interactive teaching interventions. Examples of four such cases are included in Appendix 1. This study reports on the development and use of these anonymous case studies of human error as interactive teaching interventions for small groups of junior staff. To gauge the effectiveness of this intervention, we interviewed three interns who were exposed and three who were not exposed to the intervention about their understanding of human error.

The intervention consisted of a seminar where junior doctors were given a brief overview of error theory followed by a detailed discussion of cases selected from morbidity and mortality meetings. This error training was mandatory for all junior doctors working in surgery. They were asked to analyse and discuss the cases in terms of Chang's taxonomy of error,[2] and to discuss the cases with senior clinicians.

Chang's taxonomy classifies error into the following five complementary nodes, which equate to the general descriptive terms in brackets:

- Impact (how bad was the error?). This refers to degree of harm experienced as a result of the error.
- Type (what went wrong?). This refers to the failed processes of care, which we divided into broad categories, i.e. errors of resuscitation, errors of assessment, operative or technical errors and logistical failure. A patient may experience any number of a combination of failed processes.
- Domain (where did it go wrong?).
- Cause (why did it go wrong?). The researchers divided the causes into:
  - errors of planning
  - errors of execution
  - protocol violations
  - errors of omission
  - errors of commission.
- Prevention (what are we going to do about it?). All error reduction programmes need to develop interventions to reduce the incidence of error and limit its effect.

Four typical cases of error used in these seminars are provided in Appendix 1.

Methods

Development of the intervention

The researchers identified and analysed cases of error at the structured morbidity and mortality meetings, using a standard modern taxonomy of human error. The senior staff of the Pietermaritzburg Metropolitan Trauma Service were present at these weekly meetings. They provided a quorum of experienced trauma surgeons who identified appropriate cases, which were recorded for future use. They also identified human and systems errors in these cases by noting a number of sentinel events, which the researchers identified as indicators of error. These events included an unexpected readmission to the operating theatre, readmission to the ICU, surgical site sepsis and delay in definitive treatment. An adverse event was defined as an unintentional, definable injury because of medical management, while an error was defined as failure to complete a planned action as intended, or use of an incorrect plan to achieve an objective.

On review of the data from the morbidity and mortality meetings, we established that assessment failure is the major source of error and that junior staff tend to apply their observations to their preconceived view of reality, which more experienced staff are less likely to do. This phenomenon is referred to as cognitive dissonance. Decision-making is a complex process and one tends to make a superficial assessment, especially in unfamiliar or stressful situations, and then resist prompts that should make one reconsider one's initial assessment. Furthermore, less experienced staff are more inclined to err by failing to act than by acting, and errors of omission far outweigh errors of commission.[3,4] We designed a trauma education intervention plan by working backwards from the known deficits towards a targeted learning programme that teaches the concept of error awareness.

Assessing the efficacy of the intervention

A structured interview was designed to assess the efficacy of this intervention before implementing it as part of a formal curriculum for interns rotating through trauma surgery. Interns (n=3) who had been exposed to the intervention >2 months before the interview, and those (n=3) who had not been exposed to it, were interviewed. The interview was conducted by an educationalist who had not been present at any of the seminars. After establishing whether the doctor had been exposed to the intervention or was familiar with the test case (Case 1 (Appendix 1)), it was presented to them. The following questions were asked:

Question A. Mention the problems that occurred in the management of the child in Case 1.

Question B. Who, in your view, should be held accountable for the mistakes made in the treatment of this child? Explain your response.

Question C. Would you say that any of the problems were caused by lack of knowledge or semi-automatic behaviour? Explain your response.

Question D. Which mistakes were preventable? Explain your response.

Results

Question A. Both groups identified a range of problems that occurred in the management of the patient, lack of consultation with senior staff and various other issues concerning management of the patient. There was no qualitative difference between the responses of the exposed and the non-exposed groups.

Question B. The exposed group named several people who could be accountable, including the admitting doctor, doctors who continued with the treatment and nursing staff, whereas the non-exposed group mentioned only the admitting doctor. One response from a non-exposed doctor was as follows: 'The admitting doctor who did the initial patient assessment is at fault. They should have asked for CVP insertion from someone else. There was poor communication with the Burns Unit. They did not follow protocols.'

The response from a doctor who was exposed read: 'Firstly, the admitting doctor …', followed by an explanation. 'Secondly, the follow-up doctor …', followed by an explanation. 'Thirdly, the nursing staff …', followed by further explanation.

Question C. There was no qualitative difference between the responses of exposed and non-exposed groups. Both groups cited semi-automatic behaviour because of work burden as the source of the problem as opposed to lack of knowledge.

Question D. When asked which mistakes were preventable and for an explanation, all the respondents said that all the errors were preventable, but the exposed group gave more comprehensive answers. To illustrate, a response from a non-exposed doctor stated: 'All were completely preventable. The doctor did not follow the guidelines.' A doctor in the exposed group gave the following response: 'All errors were preventable. There should have been senior cover to ensure proper all-round care of this child. The nursing staff should have had enough basic knowledge of treatment of an injured child and ensured that proper treatment was given. There should have been a handover responsibility between interns and nurses and a senior in terms of wound treatment, fluid management and feeding.'

The three doctors who had been exposed to the intervention responded positively to the following questions:

- Did you find value in understanding error in trauma?
- Does your awareness of error in trauma affect the way you work?
- Do you view the morbidity and mortality meetings differently since you have been made aware of error in trauma?

Discussion

Any course aimed at training with regard to reduction in error or bias in trauma settings and care, especially as part of ongoing professional

development, needs to be informed by learning theories that take account of the complex and dynamic nature of such situations, the range of choices medical staff can make and how they make them. Because these relate not only to knowledge but also to professional practice, there is an emphasis on situated, experiential learning. Case studies provide the means to do this. Key theories that focus on learning in unstructured, multifaceted practical contexts relate to judgement and decision-making and the differences between novice and expert engagement in professional situations. These theories should inform training interventions, which need to be experiential, encourage interactive and collaborative learning and foster reflective practice if they are to ensure optimal learning.

Bleetman *et al.*[7] noted that 'Humans make errors in predictable and patterned ways. Novices make errors due to incomplete knowledge, while experts make errors due to the intrinsic hazards of semi-automated behaviour.' They identified four triggers of error, i.e. disturbance or interruption, disruption of normal sequencing, unexpected new tasks, or need for multitasking. Cases incorporating these and the taxonomy of error can increase practitioner awareness and understanding. Attempts to use such intuition in teaching or to raise awareness of these processes, require materials focused on improving metacognitive function through practice and reflection. Therefore, the use of simulations and case studies provides useful methods to involve students actively in context-rich activities, providing a means to accumulate further experience through intensive practice and reflection in safe environments within a relatively short period.

The interactive nature allows for feedback, which can contribute to improved reasoning processes and pattern recognition and create awareness of intuitive decision-making through reflection. Cases may require participants to move rapidly through a process of recognition, decision and action, which Fadde[8] terms reaction skills compared with deliberate and controlled actions. He indicates that it may take up to 10 years of practice and reflection to become an expert, and thus the role of instructional design is important in speeding up parts of the process. Learners must move rapidly from surface features of a context which focuses on technical aspects to a more non-analytical pattern recognition process in order to generate early hypotheses, such as those of experts during stressful situations. He claims that scenario-based case studies aid transfer of learning because cases reflect authentic task design in a holistic fashion. In this study, drawing on these theories and using Kolb's reflective cycle, which moves participants from a concrete experience through reflective observation and abstract conceptualisation to active experimentation, the participants were able to reflect on various points of error.[9]

In high-pressure situations novices ask questions about general things and work from more abstract principles, while experts ask more focused questions in the context of their hypotheses.[10-14] Exposure to simulations, case studies and vignettes may be used to develop appropriate questioning processes, which provide the possibility to repeat practices regularly. Importantly, simulations allow the introduction of various unexpected situations so that participants can respond to different cues. By using cases of error as teaching tools the researchers created a mechanism to introduce junior doctors to the unspoken issue of decision-making and priority setting in high-pressure situations where the information was incomplete.

At least two months after their exposure to the intervention, the relevant doctors already showed a broader reasoning regarding error in trauma care. They perceived that errors can compound and accumulate and that the patient is also the responsibility of the healthcare system. The doctors who received training acknowledged experiential learning as an important outcome. Trauma education and assessment have evolved significantly over the past three decades. Several trauma courses for primary healthcare professionals have been developed, aiming towards a standardised approach to the acute care of the trauma patient. However, a major problem with acute trauma care in our environment is failure of assessment, which revolves around the inability of junior staff to associate potential pathology with a mechanism of injury. Developing an intervention that teaches junior staff to be aware of error may assist with this problem.

It is acknowledged that this assessment was carried out only once using a qualitative research approach that included three participants who were exposed to the intervention and three who were not exposed to it. Further research into the didactic and pedagogical approach of the intervention and the long-term learning effects should still be done.

Conclusion

Incorporating cases of error and the formal discussion of error theory into clinical meetings assist junior doctors to become aware of the problem. As an isolated intervention, it is unlikely to reduce the incidence of the impact of human error and as such needs to be part of a multifaceted programme aimed at improving the quality of care.

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Appendix 1. Error cases

Case 1

A 10-month-old baby sustained hot water burns to the face. The protocol at our institution states that all such patients must be admitted to the high-care unit, have intravenous access secured, and be discussed with the burns unit consultant on call for the night. Although the extent of the burn was small, the distribution on the face and the baby's age made this a potentially much more severe injury than a similar burn on another part of the body. Because of a technical difficulty, an intravenous line was not inserted; therefore the baby was admitted with instructions for oral feeds. The baby was admitted to the general ward, as the admitting staff thought it was a relatively minor burn. He did not feed well owing to facial swelling and became dehydrated. As the baby was in the general ward, he was overlooked during the weekend ward round. He was finally reviewed 48 hours after admission, was profoundly dehydrated and required urgent fluid resuscitation. He made an uneventful recovery and was discharged well 10 days later.

Case 2

A 28-year-old man was set alight during a domestic dispute. He sustained 60% mixed full-thickness burns. He was admitted to the nearest hospital (Hospital 1), which discussed his care with the major burns centre (Hospital 2). The latter hospital accepted him as they had an intensive care unit (ICU) bed available. As the original receiving hospital did not have any ICU facilities, he was transferred to a holding hospital in the metropolitan complex (Hospital 3), which did have temporary ICU facilities. He would be kept there pending transfer to Hospital 2. He arrived at Hospital 3 being ventilated. At this point Hospital 2 was contacted again, but it did not, as previously thought, have an ICU bed available. The patient could therefore not be transferred. In light of the fact that there was no definitive ICU bed available at the temporary hospital and the burn was more extensive than previously thought, the therapeutic plan had to be altered to a palliative plan.

Case 3

A 31-year-old man was admitted to our institution within 30 minutes of being stabbed in the precordium. He had a massive left haemothorax, which was drained empirically with an intercostal chest drain. At insertion of the drain, he was noted to have palpable central pulses. He was transported to the operating room and underwent an emergency thoracotomy, which revealed an injury to his left ventricle. This was repaired, but the patient died an hour after the procedure. His peri-operative arterial blood gas revealed that he had been profoundly acidotic (Table 1). On review of the case, it became apparent that the patient had spent at least 20 minutes in the Emergency Department prior to the surgical team being informed. At that point the patient could potentially have survived (Table 2). During the time in the Emergency Department the staff had attempted to insert a central venous catheter, but this was abandoned when the patient deteriorated. It is likely that this delay converted a potentially salvageable injury into a fatal one.

Case 4

This patient arrived at 13h35 on a Friday afternoon. She was a 29-year-old woman with a painful submandibular swelling of about 2 weeks' duration secondary to a painful tooth. The nursing staff recorded a blood pressure of 75/50 mmHg and a pulse rate of 150 beats/minute. Her temperature was 38.5°C. These readings were written in red pen in the outpatient folder, where there was no documentation of a diagnosis of septic shock. Antimicrobials were given early; hence the icon of a tick. However, management of the patient did not follow the current Surviving Sepsis Guidelines. These guidelines advocate rapid goal-directed fluid resuscitation and early administration of broad-spectrum antibiotics, followed by urgent surgical source control. Although intravenous fluids were prescribed, there was no documentation of the type or volume of fluid, choice of intravenous line, whether a central venous pressure line was inserted and if there was any response to resuscitation. The admitting surgical staff member failed to recognise a patient in severe septic shock. He/she failed to recognise the need to secure a definitive airway followed by urgent surgical drainage and ICU admission. The patient was sent to a general ward, where two hours later she deteriorated. By 19h10 she had impending upper airway obstruction with poor saturation readings. She required an emergency intubation followed by surgical debridement.

Table 1. Peri-operative blood values

Parameter	Value
Arterial blood gas	21.30 mmHg
pH	6.95
HCO_3^-	8.8 mEq/L
Base excess	-23.3 mmol/L
Lactate	7.7 mmol/L

Table 2. Blood values after resuscitation

Parameter	Value
Arterial blood gas	21.00 mmHg
pH	7.13
HCO_3^-	13.3 mEq/L
Base excess	-15.9 mmol/L
Lactate	8.3 mmol/L