Simulation Based Medical Education: an opportunity to learn from errors

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SUMMARY
Medical professionals and educators recognize that Simulation Based Medical Education (SBME) can contribute considerably to improving medical care by boosting medical professionals' performance and enhancing patient safety. A central characteristic of SBME is its unique approach to making (and learning from) mistakes, which is regarded as a powerful educational experience and as an opportunity for professional improvement. The basic assumption underlying SBME is that increased practice in learning from mistakes and in error management in a simulated environment will reduce occurrences of errors in real life and will provide professionals with the correct attitude and skills to cope competently with those mistakes that could not be prevented. The main message of the present paper is that this assumption, which serves as the driving force of SBME, should also serve as a starting point for critical thinking and questioning regarding the multiple aspects and components of SBME. These questions, in turn, should lead to empirical research that will provide feedback concerning changes that may be necessary in order to attain the goal of improving medical professionals’ performance. Based on such research, SBME will be held accountable for its outcomes, i.e. whether its educational techniques indeed result in decreased occurrence of errors in real life and whether the ability to cope with the errors that do occur is significantly improved. The first of three issues that were addressed concerns individuals’ experience of performing mistakes. It is suggested that in order to benefit fully from the experience of performing mistakes in a simulated context, medical educators should create a balance between the emotional load associated with the experience and the professional lessons that can be learned. Furthermore, research should focus on the long-term effects of the experience in changing professionals’ attitudes and behaviour. The second question concerned the contribution of the different components of the educational experience to creating the desired changes in professionals’ performance. Analysis of the teaching and learning involved in each stage of the educational event should serve as the basis for research that aims at identifying the unique contribution and efficiency of each element, and defining the essential core activities of a simulated experience. Finally, the need to define a newly emerging profession—SBME educator—was addressed. The professional qualifications are, clearly, multidisciplinary and should be based on the growing experience of medical educators in training students and professionals. Defining the profession is essential in order to create academic environments in which professionals will be trained to develop and implement new programmes, accompanied by research and assessment.

Introduction
Advantages of Simulation-Based Medical Education
SBME in its widest sense can be defined as any educational activity that utilizes simulative aids to replicate clinical scenarios. Simulation tools serve as an alternative to the real patient and permit educators to gain full control over a pre-selected clinical scenario, without distressing patients or encountering other unwanted aspects of learning on real patients. SBME is a method of medical education that integrates with, and complements, other traditional and

This contribution was inspired by the late Miriam Friedman Ben-David’s visionary and innovative approach to Medical Education. We were privileged to have had a very close personal and working relationship with Miriam and are, thus, intimately acquainted with her unique philosophy concerning a variety of topics in Medical Education including Simulation Based Medical Education (SBME). We have attempted to apply Miriam’s message regarding the importance of constantly and critically questioning the value of our actions. Accordingly, the paper focuses on a conceptual analysis of a central component in SBME—experiencing, and learning from errors—and from insights and questions that may arise following its adoption.

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non-traditional training approaches, such as lectures, problem-based learning (PBL) and bedside teaching. The defined goals of SBME are to improve medical care and to enhance patient safety. Specifically, an important objective of SBME is to contribute to the reduction of error occurrences during medical treatment. It strives to do so by improving competence and performance in a variety of domains, including clinical skills, practical procedures, teamwork, patient management and decision-making.

The success of SBME should ultimately be assessed by its effectiveness, i.e. whether SBME has resulted in improved medical care or not. In the spirit of Best Evidence Medical Education (BEME) (Hart & Harden, 2000), it is essential to set standards by which improvement can be measured. Miriam Friedman Ben-David, in her last lecture at the 2004 Ottawa Conference, emphasized that accountability must be a major component in any medical education method involved in the actual practice of medicine. Consequently, a major challenge in SBME is to develop standards and measures of success in training. The desired outcome largely determines the means and process that are employed to accomplish it. Accordingly, SBME takes place in an environment that ensures implementation of the Hippocratic Oath: “First do no harm” (Ziv et al., 2003). In light of the inherent safety message of SBME (Ziv et al., 2000), a pivotal feature of this educational technique is that it can improve medical care by providing medical students and professionals with an opportunity to learn through (rather than from) their own and others’ mistakes.

The role of mistakes in SBME

An ancient Chinese story tells of a pottery master who was approached by an individual who requested that he teach him to make bowls from clay. The master presented him with a bowl that one of his own teachers had made, and said: “This is how your bowl should look. Use it as a model, try to copy it over and over again, make a lot of mistakes and corrections, and come back to me after you have attempted to make 10 000 bowls.” Implied in the master’s teaching are important assumptions about both the teacher and the learner, as well as about the learning process. The teacher’s role is to determine the goal, set the standards and judge the learner’s performance. The learner is assumed to have a strong desire to achieve that goal, which can be accomplished by a lot of practice and by learning through mistakes. Underlying this educational approach is a philosophical view that values effort, practice and experiencing mistakes as critical for instilling humility in an individual during the training process. Implied is the belief that humility and awareness of the likelihood and value of mistakes will always remain an integral part in the individual’s everyday practice in the ongoing struggle for perfection.

While it is simple to agree with the humanistic and educational values implied in the story, applying this approach to Western medicine is problematic. Medical errors, unfortunately, can harm patients and in certain cases are fatal. A broad definition of medical errors suggests that they consist of all incidents in which a planned action, aimed at enhancing the patient’s well-being, failed to occur (Kohn et al., 1999). Such incidents include adverse drug reactions, unmatched transfusions, surgical injuries and wrong-side surgery, wrong diagnoses of clinical conditions, restraint-related injuries, non-optimal patient care that results in falls, burns and pressure ulcers, mistaken patient identities and avoidable deaths. High error rates with serious consequences are most likely to occur in intensive care units, operating rooms and emergency departments, reflecting the complexity of patient care in these clinical environments as well as the challenging demand for high-quality teamwork.

Total prevention of mistakes, however, is not feasible because medicine is conducted by human beings who err, as recently pointed out in the NIOM report ‘To err is human’ (Leonard et al., 2004). The report highlights the vast amount of fatal mistakes that occur during medical care and calls medical professionals and educators to urgently develop means to confront the problem and reduce medical errors. SBME may offer unique ways to cope with this challenge and can be regarded as a mistake-driven educational method.

Reduction of mistakes in order to enhance patient safety and improve medical care is a central goal of SBME. In an attempt to accomplish this goal, SBME creates conditions in which making mistakes is not harmful or dangerous to patients but is, rather, a powerful learning experience for students and professionals. They are permitted to err and are provided with the opportunity to practise and to receive constructive feedback which, it is hoped, will prevent repetition of such mistakes in real-life patients. Belief in this approach should lead SBME educators to set an important additional goal: training professionals to manage their errors and to be accountable for them.

Error management refers to multiple skills that together comprise a professional approach towards minimizing blunders that specifically characterize the medical system, and include all participants in the medical care process. Hence, these skills reflect the need for the individual professional’s accountability along with the importance of teamwork. Specific required skills include the individual’s awareness of the possibility of imminent mistakes, appreciation of one’s competence and limitations, recognition of the need to call for help and strategies to recover from a mistake while minimizing its harmful consequences for the patient. Furthermore, the perpetrator must analyse the mistake in real time (for purpose of optimal recovery) and in retrospect (in order to optimize the learning process). In circumstances of mistake-driven crisis the team leader is responsible for informing the patient and family about the error as well as reporting it to superiors and risk-management officers.

These skills are best taught and implemented within the framework of an error-management programme that includes several stages:
1. identification and acknowledgement of mistakes performed by individuals or teams;
2. analysis of errors in an attempt to discover the root causes and course of events that led to their occurrence (at individual, team and system levels);
3. determination of changes and corrections to be implemented;
4. internalization and implementation of the lessons learned.
Teaching error-management skills is an important objective of SBME. The medical teacher trained in this domain has a crucial role in assisting medical professionals to establish the ability to work through each of the above-mentioned stages. To attain this goal, trainees participate in carefully planned simulated scenarios in which experiencing mistakes is central. The actual experience is followed by several stages of reflection and analysis using a variety of educational and debriefing techniques.

The educational techniques aimed at developing error-management skills of medical professionals consist of personal experience, peer learning and group discussion, and, typically, include some or all of the following stages:

1. a clinical encounter with a simulated patient or manikin;
2. personal reflection on the manner in which the trainee handled the case and his/her notion of possible causes for errors and suggestions for corrections;
3. students’ and professionals’ observation of peers coping with a similar scenario to their own;
4. a feedback meeting with the simulated patient who acted out the case (if applicable);
5. an intimate one-on-one review of the audiovisual documentation of the educational session with experts in communication skills and/or in specific clinical domains. The review focuses on the individual’s performance, both in instances of positive coping and particularly when errors have occurred;
6. group discussions facilitated by an SBME teacher based on video recordings of the participants while handling the simulated case.

The overall message to trainees should be that enhancing medical professionals’ understanding of the nature and causes of mistakes, along with adopting ways to lessen and cope with mistakes, will result in strengthening their sense of competence and professionalism.

In summary, SBME strives to reduce errors and improve medical care and patient safety. To accomplish this goal, SBME, for learning purposes, integrates examples of mistakes into simulated scenarios in which medical students and professionals participate. A central element of SBME is teaching medical professionals error-management skills that should be exercised and implemented in their everyday practice. Similar to the Chinese master’s message, the message conveyed in SBME should also emphasize basic humanistic values such as honesty, humility, transparency and trust.

In order to appreciate the potential of SBME in advancing the goal of reducing medical errors and increasing patient safety, it is important to point out the wide range of medical environments that are simulated. The simulated learning environment aims at covering most of the contexts in which medical errors occur and at simulating an extensive array of medical errors that professionals might encounter and be required to cope with.

The simulated learning environment

The challenge of SBME is first to simulate an authentic healthcare environment that will enable trainees to immerse themselves into the simulated scenario as if it were real and, consequently, to maximize their learning from the situation. In order to create such an environment, three integral aspects of the medical encounter should be carefully considered and simulated: the physical set-up, the human set-up and the medical tasks expected to be performed by the trainee. Multiple combinations of all three factors generate a large variety of learning scenarios in which trainees have the opportunity to err and to recognize important root causes of both common and rare mistakes in medical practice.

The physical environment

This includes a wide spectrum of set-ups that reflect the reality of healthcare delivery locations, including: hospital set-ups (emergency rooms, operating rooms, intensive care units, etc.), outpatient clinics (hospital or community), chronic home care environment and field/street/work/home set-ups where emergency care is expected to be delivered in certain circumstances.

Simulating physical environments consists of creating an authentic visual appearance with real medical devices and tools, and additionally simulating other physical aspects or special effects of the scene, for example: battlefield sounds such as shooting or helicopter noise in military field trauma-management training, crying babies in a nursery set-up for neonatal emergency care training or sirens in an ambulance set-up for paramedics in training; marketplace smells for paramedics providing emergency care, or pharmacy odours for students training to work in a community pharmacy set-up.

The human environment

This encompasses all the human components that may surface in a medical encounter. The large variety of healthcare situations are created by combining three aspects: patient (or patients), medical staff (professional team members) and clinical pathologies.

- Patients—enacted by simulated patients (and/or additional non-professional participants such as family members)—can vary in age, gender, demographic and cultural backgrounds, and can also differ in their behaviour and the effect they express during the medical encounter. For example, they can act-out a non-compliant attitude or violent behaviour directed towards other simulated participants or towards the trainees themselves.
- Medical staff—whether individual professionals or medical team members. A team may consist of a nurse, a senior or junior physician, and an inexperienced student. Scenarios should be fashioned to represent problematic interaction patterns among professionals because healthcare is seldom delivered in a single-patient–single provider context. Patient safety literature teaches us that the quality of human interaction among health professionals is an important element in optimal delivery of healthcare (Blum et al., 2004; Leonard et al., 2004). Various behavioural patterns of professionals can also be simulated, for example, arrogance or anxiety.
- Clinical pathologies—numerous clinical and anatomical findings can be simulated, such as bleeding, wheezing,
enlarged liver or pathological heart murmurs, etc. as well as various human behaviour patterns such as depression or mania.

Medical tasks

Any medical task should be regarded as a subject for simulation and can be presented to trainees as an isolated task, e.g. suturing a simulated cut, or as an integrated task within a more comprehensive medical mission, e.g. suturing a simulated cut on a screaming (simulated) baby within a context of a chaotic emergency room. The different types of medical tasks that can be simulated include the following:

- **manual, or procedural tasks**, such as physical exam or surgery;
- **diagnostic tasks**, for example: establishing a diagnostic work-up plan or interpretation of ECGs, lab results or X-rays;
- **management tasks**, for example: leading a resuscitation team, or managing a mass trauma event with multiple patients and staff members;
- **communication tasks** (verbal, non-verbal and written) with patients, families and staff.

The common reality in healthcare consists of multiple simultaneous tasks, ranging in degree of complexity, which create the context for high risk of error. An important challenge of SBME is to construct learning experiences in which the various factors involved in the clinical instances are controlled and adapted to the needs and training stage of the learners. The richness of scenarios, contexts and degrees of complexity that can be simulated is possible because of the multiplicity of simulation techniques and tools available ranging from simple low-tech simulators to the peak of high-tech modalities—computer-based interactive patient simulators and virtual-reality-based task trainers and procedural simulators (Issenberg et al., 1999; Satava, 2001; Maran & Glavin, 2003).

**Vision and challenges**

During the last decade, SBME has been accorded growing recognition as a unique and powerful method for training medical students and health professionals in clinical and communication skills (Gaba, 2004). New simulation centres are being planned and established in medical centres throughout the Western world. Existing centres, such as the Israel Center for Medical Simulation (MSR) (Ziv & Berkenstadt, 2004)—a national inter-disciplinary, multi-modality centre—operate intensively and train thousands of health professionals every year (Riley et al., 2003). The scope, success and potential of such simulation activities prove the feasibility of establishing and operating simulation centres and demonstrate the breadth of domains that can be successfully simulated. In addition, they reflect the desire and belief of medical professionals and educators that SBME will significantly improve medical care and assist in solving one of the profession’s fundamental problems, namely the unacceptable status of patient safety.

However, feasibility and volume of activity cannot serve as measures of the efficiency and success of SBME in enhancing clinical competence, reducing errors and improving healthcare. This was one of Miriam Friedman Ben-David’s basic and important insights regarding the current state of SBME. She urged medical educators to pose challenging questions concerning the efficacy of SBME that will assist in developing measures to directly evaluate this educational method and motivate research in the field. Thus, the remainder of the paper will present questions regarding three aspects of SBME. The first concerns the personal experience involved in performing serious mistakes, the second addresses the various stages involved in the simulative educational process and the last question relates to the issue of training SBME professionals.

**The experience of making mistakes**

Good simulation creates scenarios that are close to real life and succeeds in instilling within the trainees a mental stance that is also similar to what they would go through when handling a real case, analogous to the simulated one (Gordon et al., 2004). This particularly applies to the experience of performing mistakes, and means that, just as in real life, the experience is not an easy one. Consequently, important questions regarding educational and ethical aspects of SBME should be addressed.

The majority of trainees provide positive feedback regarding the simulative experience that involves making mistakes. Their feedback reflects appreciation of the ability of SBME to raise individuals’ awareness of aspects in their performance, largely ignored in other educational methods, and to increase the chances of better performance in real life. However, spontaneous and structured responses of some trainees during and immediately after performing poorly on a simulated task might also reflect the anxiety and discomfort that may be associated with the experience. Among these responses are attempts by individuals to deny their mistakes, accusing the simulation exercise of not being realistic and of causing them embarrassment.

Some of the questions that these responses raise are: Should the educational process involve traumatic experiences or negative feelings leading to embarrassment? How far should the simulated experience of committing mistakes go; should the exercise, perhaps, be stopped just before the critical moment of performing a serious mistake? Is there proof of the value and efficacy of such ‘shock treatment’? What is the teacher’s role when encountering such responses, and are there ways to turn the initial negative experience into a positive one that results in meaningful learning?

Four years of planning and implementing SBME courses and activities at MSR, Israel, have raised the professional teams’ awareness of the importance of these questions and led to preliminary attempts to address both the ethical and educational issues involved. In tackling these issues, comparison of medical simulation to simulation in other high-stakes professions may be helpful (Grogan et al., 2004). In aviation, for example, simulation is used in order to train pilots to cope with the most extreme, dangerous and critical situations, in which the costs of mistakes may be high because they pose direct threats to human life. It is believed that a powerful, even if traumatic, experience in simulation has the potential to reduce the chances if or when similar crises occur in real life.
Applying a similar approach to medical practice makes sense because it too, involves threats to human life and strives to prevent or minimize such disasters. Realistically simulating the anxiety, confusion and lack of confidence that are characteristic of extreme and hard-to-handle cases is an important means to improve the ability to cope with similar instances in real life. Thus, the intensity and difficulty of the simulated experience may be critical in turning it into a powerful and efficient learning experience.

However, in order for the experience to be constructive, it is essential to create a balance between an individual’s difficulty in confronting his/her own errors on the one hand and his/her recognition of the importance and value of the experience in changing both attitude and behavioural patterns on the other. In order to accomplish such a balance, the experience of conducting errors should be embedded in an educational environment that builds an atmosphere of trust and transparency and encourages reflective thinking (Dannefer & Henson, 2004). An important role of the teacher is to facilitate a learning process in which gaining insights into individuals’ performance leads to deepening their appreciation of both practical and humanistic aspects of the medical profession and results in strengthening one’s sense of competence. When a constructive and trustful ambience exists, responses of embarrassment and discomfort should, perhaps, be permitted rather than avoided. These emotional responses should be channelled towards raising an individual’s awareness of the possibility of errors, encouraging him/her to take responsibility for making required changes, adaptations and corrections for the benefit of patients and him/herself alike.

Finally, teachers should be sensitive to learners’ responses and adapt both the actual experience and the debriefing that follows to individual traits, sensitivities and learning styles. This guideline is relatively easy to apply in SBME because an important feature of SBME lies in its adaptive nature, namely the possibility of tailoring various educational routes to different individuals.

Clearly, questions regarding the efficacy of experiencing and learning from serious mistakes should not only be ethically and educationally analysed, but also empirically investigated. Comparison of the effect on the lessons learned of alternative mistake-driven simulated experiences differing in emotional load will provide important insights. Ultimately, the success of SBME in changing professionals’ attitude towards mistakes and in affecting their real-life performance should be evidence-based and measured by long-term studies (Hart & Harden, 2000; Issenberg et al., 2005). These studies should examine the relation between different simulated experiences and the long-lasting clinical implementation of what was gained through simulation (Gaba et al., 1998).

The teaching and learning process

As described in the first section of the paper, the simulation-based educational experience consists of several stages, including a personal encounter with a patient, peer learning and group discussion. Together, these different components construct a powerful learning experience, in which the important lessons show up in more than one manner and from multiple angles (Kneebone, 2003).

An important question, though, concerns the necessity and unique contribution of each of the stages involved in the process of attaining the goal of improving clinical performance and reducing errors. For example, what is the benefit of a personal encounter with a simulated patient versus group debriefing regarding a number of similar cases handled by several individuals? What are the advantages or disadvantages of a feedback session with a simulated patient compared with feedback from an expert in the specific medical domain or in communication?

Addressing these and similar questions requires a detailed analysis of the characteristics of the teaching and learning involved in every stage, and calls for an interdisciplinary approach, integrating education, psychology, communication, media technology, etc.

The initial stage of encountering the simulated patient or the challenging simulated clinical crisis, for instance, may be characterized by a strong emotional component due to the difficulty of handling the case. In addition, learning in this stage relies on the individual’s clinical problem-solving skills accompanied by reflective thinking regarding one’s own performance. In contrast, in group debriefing the teacher plays an active role in highlighting crucial aspects in the different clinical encounters, utilizing video recordings of the encounters, creating a constructive and open atmosphere and facilitating discussion among the group members.

A personal feedback meeting with a standardized patient also has its unique characteristics in terms of the teaching and learning involved. The simulated patient, rather than being a professional teacher or an expert in medical content, is the closest to representing the perspective of the real patient. Consequently, simulated patients can provide trainees with intimate feedback regarding their communication skills, building of trust with patients, expressing support and empathy, etc.

Based on the suggested analysis of the different components involved in SBME, empirical studies should compare the efficacy of different combinations of these components in best attaining the pre-defined goals. Clearly, there will be variations in the preferred combination depending on various factors, such as the content domain, the goals of the educational experience and the participants—whether students in early or advanced stages of their medical training, or experienced professionals. It is imperative, however, to establish whether there are necessary core components that define the simulation-based educational process and if so, to identify those elements that cannot be excluded from any simulation course or replaced by other components.

Qualifications and training of SBME professionals

As Miriam Friedman Ben-David emphasized, the essence of modern medical education is its focus on performance and its attempt to create innovative and efficient methods to teach and assess such clinical performance (Friedman Ben-David, 1999, 2000).

Acknowledgement of the importance of teaching and assessing clinical skills has grown during recent decades and reflects a significant change in the conception and practice of medical education. In the past, clinical skills were mainly modelled rather than explicitly taught. The modelling was
performed in an apprentice mode by experienced physicians during their routine practice, and usually took place at the patient’s bedside, thus gaining the title ‘bedside teaching’. In this model, there was no clear distinction between the physician and the educator and, more broadly, between medical practice and medical education. Thus, the process of gaining proficiency in clinical skills was dependent on incidental exposure to clinical cases and was determined by the actions performed in different, unplanned medical contexts.

Today’s medical education is, naturally, still strongly linked to actual medical practice and includes real medical experience but, in addition, it recognizes the need for a carefully planned curriculum and for professionally designed educational tools that will complement ‘bedside teaching’. These principles readily apply to SBME and highlight the professional skills and qualities that are required for SBME educators. Consequently, SBME should be regarded as a professional domain that demands its own process of professional training.

The first step in this direction should be defining the qualifications required for professionals in SBME. Based on the earlier description of the practical aspects involved in utilizing SBME and on the discussion of the ethical and education aspects involved, it is clear that the profession relies on a wide range of interdisciplinary knowledge. Among the knowledge domains that compose SBME are the following: education and pedagogy, medical assessment and psychometrics, research methodology, psychology (focusing on inter-personal communication, ethics, debriefing and group facilitation), media-based facilitation and education (mainly video recordings of trainees’ performance), medical technology and risk management.

Addressing this need for highly trained educators remains a major challenge for SBME.

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Addendum

In the 2003 AMEE symposium, celebrating 30 years of the OSCE (Friedman Ben-David, 2003), Miriam emphasized the importance of performance-based and performance-assessed education. She stressed the need for ongoing research and development of new educational and assessment modalities that would encompass the complex professional training process of the many components of the medical profession.

A central issue in Miriam’s conception of Medical Education was the relation between assessment and learning (Friedman Ben-David, 1999). She repeatedly emphasized the important role of assessment in improving medical professionals’ performance. Recently, Miriam suggested broadening this notion by considering assessment as a central means to expand professional horizons (Friedman Ben-David, 2000). This revised notion expresses Miriam’s view that assessment can contribute to improving our understanding of the multiple forms of knowledge and the dimensions involved in the education of the medical profession.

Miriam played a significant role in leading the search for innovative educational methods aimed at improving the analysis and understanding of the performance of medical professionals. This paper reflects our attempt to continue in this vein based on our appreciation of Miriam’s educational concepts and on its relevance to SBME. We believe that this approach will indeed open new horizons in medical education in the years to come.

No less important, were Miriam’s humanistic qualities that were evident in both her academic and educational concepts and in her personal encounters with colleagues, students and friends. She truly loved people and deeply cared about students. We are determined to incorporate her consideration and concern for people into SBME courses.

Miriam Friedman-Ben-David in her lifetime was a highly-valued, innovative, humane and analytical leader in the field of medical education and in the implementation of SBME and assessment of its true value. In her death she remains an inspiration to us, who were intimately involved in her work, and to all in the field who appreciate the visionary concepts motivating her expert contributions relating to the science and art of teaching the healing of the sick.

References


