ROLE AND VALUE OF SIMULATION IN PLASTIC SURGERY EDUCATION AND TRAINING: RECOMMENDATIONS FOR IMPLEMENTATION

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Abstract

The aim of the study was to elucidate the role and value of simulation in postgraduate plastic surgery training. The research questions were: What are the role and value of simulation in postgraduate plastic surgery training? Is simulation useful in addressing the lack of opportunities for clinical exposure and practice? What are points of departure to consider for the use of simulation in training? Data were collected through semi-structured interviews with national and international experts in simulation and postgraduate education, and by a Delphi process collecting expert opinions of plastic surgeons. We discuss the role and value of simulation and matters to consider when contemplating the implementation of simulation. We also describe factors that influence and drive the implementation of simulation. The research outcomes resulted recommendations regarding the successful implementation of simulation in postgraduate plastic surgery training, thus indicating how simulation might be used to enhance learning and to improve students' knowledge, clinical competence, clinical skills, and professional conduct.

Keywords: Simulation, postgraduate plastic surgery education and training, health professions education.

1. INTRODUCTION

Clinical simulation plays a valuable role in the development of clinical skills and competencies, and in creating a safe, non-threatening medical training environment. Simulation figures prominently in building a safer health care system and has the potential to address challenges facing postgraduate plastic surgery education (Nel, Van Zyl & Labuschagne, 2020). The ability to perform clinical procedures is crucial, requiring a combination of various skills and competencies, which may be mastered by using simulation during registrar training (Labuschagne, 2012). Over the past two decades simulation has been emphasised increasingly to improve education and training opportunities (Fincher & Lewis, 2002; Gaba, 2000; Issenberg *et al.,* 1999; Issenberg *et al.,* 2005; Cook *et al*., 2018; Nel, 2019). Yet, the role and value of simulation in plastic surgery education and training have not been thoroughly investigated and described, and recommendations for implementation are needed.

Rosen *et al.* (2009) contend that surgical training in the 21st century is marked by an objective, standardised approach, using equipment such as simulators to ensure optimal patient safety, surgical excellence, efficient and effective use of hospital resources to limit errors. Simulation has been proven to render improved results and decrease risk and procedure costs by providing students in training with ample opportunities to hone their skills and competence in no-risk situations (Ziv *et al.,* 2006). The use of simulation thus is valuable in addressing the lack of opportunities for clinical exposure and practice.

The challenges described are not unique to specific countries, but a worldwide phenomenon. The problem that arises when increasing the number of students entering medical schools is that more students have to compete for clinical cases(Maran & Glavin, 2003). The number of conditions primary health care professionals are expected to deal with (case mix) leads to simulation being used to fill the gap in medical training (Maran & Glavin, 2003). Patients nowadays are better informed, have greater expectations and may exercise their right not to be involved in student education (Bradley & Postlethwaite 2003: 6), resulting in an even smaller teaching platform.

Labuschagne *et al.* (2014) contend that the HIV and tuberculosis epidemics in South Africa (SA) and other developing countries ensued in a change in case mix. Medical schools in SA are required to increase the numbers of medical graduates and to train students in the largest possible range of diseases and conditions; thus, the current case mix in academic and public sector hospitals and on the training platform should be expanded. This platform, however, has shifted to primary healthcare, resulting in a decrease in beds at teaching hospitals and the number of patients available for training purposes, impacting the quality and competence of students graduating from medical schools. Clinical simulation training can fill this void by providing students with opportunities to be exposed to conditions which are unsafe for patients, and to high-risk, low-incidence conditions (Labuschagne *et al.* 2014).

As the American College of Surgeons (ACS) decided to introduce simulation in the training of general surgery (ABMS & ACGME, 2013; Mittal *et al.,* 2012), Mittal *et al.* (2012) proposed that plastic surgery should follow suit. Arbogast and Rosen (2012) proposed modifications to simulation to address plastic surgery-specific challenges, contending that a unified commitment by medical educators to use simulation was necessary to simultaneously standardize the training curriculum, individualize the method of acquiring information, and objectively evaluate the training process" (Arbogast & Rosen, 2012: 252).

Arbogast and Rosen (2012: 241-244) listed 20 skills required of postgraduate residents (registrars/specialists in training) in general and plastic surgery respectively, as well as procedures required of residents in plastic surgery that can be simulated. In our research simulation was indicated as a valuable, important training method for 208 of 453 proposed learning outcomes for plastic surgeons (Nel *et al.*, 2019; Nel *et al*., 2020).

The incorporation of innovative technology in the curriculum is essential in preparing for the future and shaping it. In this article we discuss the identification of factors that influence and drive the implementation of simulation and make recommendations for implementing simulation as educational strategy.

Rosen *et al.* (2009) proclaimed that surgical simulation was aimed at developing measuring instruments to evaluate how skills mastered through simulation translated to improving real surgical skills, execution of procedures, and team cooperation in the operating room. They proposed that a training system be designed to promote the use of computers, virtual reality, and simulation in the training of plastic surgery residents.

Through this research we endeavoured to broaden awareness of the potential of simulation to enhance plastic surgery training, with a resultant positive impact on patient safety and health care outcomes.

2. METHODS

This report deals with one aspect of a comprehensive descriptive study in which simulation in post-graduate plastic surgery education and training was investigated. Semi-structured interviews and a Delphi process were used for data collection. Approval to conduct the study was obtained from the Health Sciences Research Ethics Committee, University of the Free State (ECUFS 122/2015).

2.1. Data collection

2.1.1.Semi-structured interviews

Key national and international role players' opinions and perceptions on simulation-based medical education were explored during semi-structured interviews aimed at obtaining an in-depth, comprehensive overview of the possible contribution of simulation to post-graduate plastic surgery education and training. A self-developed interview guide based on a literature review was used. Occasionally, additional questions arose during the semi-structured interviews and the information thus collected was included in the data. Data on Questions 8, 9, 10, 11 and 13 of the interview guide are reported in this article. The questions were (original questionnaire numbers in brackets):

i (8) Does simulation have a contribution to make, that is, a role to play in, or a specific value to add to postgraduate education?

ii (9) What would your main consideration be if you decided to include simulation in your teaching and training programme?

iii (10) If you have to guide a team of experts tasked to develop a curriculum with simulation as one of the training/learning methods, which important guidelines will you put on paper?

iv (11) Do you wish to make recommendations for compiling guidelines for simulation in postgraduate plastic surgery?
v (13) Will you please share (a) lessons learned regarding the implementation of simulation in a curriculum, as well as (b) the biggest challenge in implementing simulation in training?

The findings of the rest of the questionnaire and Delphi process were reported elsewhere (Nel, Van Zyl & Labuschagne, 2019; Nel *et al.,* 2020.)

Six national (from three universities) and two international (USA & UK) medical education professionals with experience in simulation and postgraduate education participated in the semi-structured interviews. They were simulation unit directors (D1; D2), clinical HoDs and specialists (C1-C3), a programme director and education management specialist (S1), a researcher (R1), and a representative from the simulation industry (I1). The interviewees consented in writing to participate and were assigned letters/numbers for use in reporting. Some responses of interviewees are quoted verbatim to enhance their authenticity.

Using a self-generated interview guide, individual interviews were conducted with eight participants between June and October 2018. All interviews were digitally recorded and transcribed by the researcher; who conducted the interviews and took field notes. The transcriptions were checked by an independent language expert with a sound grounding in medical education and nomenclature, which served well to catch the nuances of the interviews. The data were analysed using a grounded theory (GT) approach, which included open, axial and selective coding (Byrne, 2001; Mertens, 2005), requiring continuous comparison of data, following the data analysis steps of coding, categorisation and theory generation (Labuschagne *et al.*, 2014). Axial coding entails breaking down core themes and relating codes to each other through inductive thinking (GT approach). Codes were grouped into concepts, and then in categories. Theory generation thus occurred by finding patterns in the data until data saturation was reached (*cf.* Byrne, 2001). Explanations were grounded in interviewees' 'reality'.

In the qualitative interviews conducted, reliability was enhanced by a carefully constructed interview guide, an interview process that was recorded and precisely transcribed, and strict sampling criteria (also see Robson, 2002). Three common threats to data validity prevail, namely researcher bias, reactivity**,** and respondent bias (Creswell & Miller, 2000; Lincoln & Guba, 1985). Strategies that address these threats to validity include prolonged involvement, triangulation, member checking, and keeping an audit trail. These strategies formed part of the investigation, and scientific record-keeping ensured dependability. To enhance transferability sufficient descriptive data (thick description) were provided to enable readers to evaluate the applicability of the data in other contexts (*cf.* Lincoln & Guba, 1985). These same strategies were applied to enhance trustworthiness and validity during the Delphi process.

2.1.2. Delphi process

Nine experts in plastic surgery and clinical simulation were selected for the Delphi exercise, mainly based on their expertise and experience in the field of study (Nel *et al.,* 2019). They were qualified plastic surgeons, knowledgeable in medical education, serving as policymakers, leaders, and managers in postgraduate education, and of high national and international academic and scientific standing.

The survey questionnaire sent to the Delphi panel comprised three parts. Part 1 (Delphi questions regarding the importance of simulation) contained learning outcomes in two categories, namely medical knowledge and patient care; eighteen sections in total, divided into five education and training levels, totalling 453 learning outcomes. The panellists had to indicate the importance of simulation as an instructional strategy for each of the outcomes by indicating whether simulation was essential, useful, or not applicable/important in training for the specific outcome.

In Part 2 of the questionnaire (simulation modalities), the panellists were requested to indicate which type of simulation modality (low-tech simulation or high-tech simulation) would be best suited for achieving each learning outcome. In Part 3 of the questionnaire (cognitive levels), the panellists had to indicate which level of learning would be facilitated by simulation to achieve each specific outcome.

For the purpose of analysis the responses were entered into a computer spreadsheet (*Excel*) to calculate the level of consensus or stability. The results were reported separately, listing the experts' comments on simulation as a method to train plastic surgeons, the uses and applicability of simulation modalities, as well as the levels of cognition that might be addressed by simulation.

3. INTERVIEW RESULTS: ROLE AND VALUE OF SIMULATION

In response to the research question about whether simulation has a role to play in, or a specific value to add to postgraduate plastic surgery education, interviewee responses indicated that simulation can contribute to patient safety. Registrars/specialists in training can practise their skills in a non-threatening, controlled, safe environment, providing them with the opportunity to learn gradually, in their own time and according to their own pace. Once they are competent, the acquired knowledge, skills, clinical competencies and professional conduct and behaviour can be transferred to real clinical settings and patients. This minimises risks to patients and ensures a proficient registrar, competent to attain exceptional outcomes. Simulation training exposes registrars to higher levels of critical thinking, complexity, and interdisciplinary, high-fidelity practice during large-group simulations, triggering effective learning. As highlighted by one interviewee: "To get learners to think about their actions, to analyse, taking ownership of own learning; practise reflective learning" (D2).

According to the responses of the majority of interviewees, simulation provides controlled and safe practice opportunities by affording registrars time to sharpen their skills and competencies in protected, no-risk circumstances. Registrars also have the opportunity to practise in an environment where they feel safe and relaxed. For instance, one interviewee remarked: "Simulation leads to less stress where registrar has the opportunity to practise in a safe environment" (C3); and continued: "What happens here, stays in the simulation lab" (C3).

In some interviewees' opinion, simulation facilitates student learning, knowledge building, clinical competence, skills, and professional behaviour by providing a favourable learning environment; Interviewee C1 summarised this as follows: "… a very good learning situation and provides the opportunity to learn in another way".

Interviewees also indicated that simulation could enhance learning effectiveness at different cognitive levels, for instance, feedback during or after simulation also influences the effectiveness of learning. One interviewee remarked: "Simulation enhances learning – registrar can identify own problems and rectify where and when necessary" (D1). Another mentioned that simulation "provides the opportunity for registrars to learn gradually and progress to higher competency and/or cognitive levels" (C1).

Six interviewees referred to the important role simulation plays: In clinical, holistic, and integrated health care training (D1), mentioning opportunities to practise specific skills individually, and to be trained in multi-professional health care groups (C1), mastering skills in complex scenarios (C3). Fewer, and in some disciplines, smaller training platforms, shrinking financial resources, and a demand for more health care professionals require additional options for clinical training and assessment (R1). This situation limits education time and available cases, while simulation provides registrars with opportunities to experience rare clinical cases (C2; R1). Interviewees responded that: "By making use of simulated patients you can teach and train a wide range of topics, for example, history taking, transferring bad news, and/or medico-legal issues" (C1); "Practising certain procedures beforehand through simulation makes it easier for registrars when they do it for the first time on real patients" (C1); and "Simulation gives registrars the opportunity to experience clinical cases that they perhaps won't see in their discipline" (S1).

Simulation provides opportunities for deliberate practice, which, together with repetitive practice plays an important role in mastering skills, and keeping abreast of skills and topics. This ensures a proficient, competent, excellent outcome (R1; C2; D1).

Simulation provides opportunities to practise safely, as highlighted by these examples: "Learning on simulated patients minimises the risk on real patients" (C2); and "Simulation enhances medical training" (R1).

Simulation creates opportunities for clinical exposure and practice - more exposure leads to fewer medical errors. Some of the interviewees proclaimed: "Assess students to identify what has been missed, or lack of opportunity” (C2); “Simulation training according to a specific schedule is a way to protect registrars’ training time” (D1); “Simulation is useful to teach registrars patient communication skills” (C2); and “Simulation definitely satisfies a need” (D2).

Simulation seems to provide for a solid educational and social grounding strategy that enhances a safe environment where registrars can learn from their errors without the risk of harming a patient (C2; R1). Interviewee R1 said, for instance: ‘‘Simulation provides an opportunity for both formative assessment (debriefing, feedback), summative assessment and a competency-based training environment” (R1).

Simulation also seems to improve clinical grounding, patient care and patient safety. It thus proves to be seen as a valuable method to train a variety of skills in a controlled clinical environment. Several Interviewees have pointed this out. One said, ‘‘Through surgical simulation, skills can be transferred to the operating theatre, decreasing operation time, complications and costs’’ (R1); while another remarked ‘‘Evaluation of skills through simulation can give feedback on the competency level of a registrar by using rubrics for procedures and may predict whether the candidate is ready to sit for a final exam’’ (D1).

Furthermore, simulation allows individualisation of education and training through the standardisation of the curriculum, accommodating the learning styles of registrars, and the opportunity for deliberate practice. One interviewee verbalised this aspect as follows: ‘‘Feedback during simulation helps registrar to identify problems and he/she can deliberately practise certain skills as needed’’ (D1); and ‘‘Constructive feedback and debriefing during simulation add value to the learning process” (D1).

It became clear from the interview data that simulation has a role to play and can add value to postgraduate education and training – thus making a sound contribution.

4. CONSIDERATIONS TO TAKE INTO ACCOUNT WHEN INCLUDING SIMULATION IN A PROGRAMME

Interviewees also expressed views on aspects to be considered when contemplating the inclusion of simulation in a postgraduate programme. They provided suggestions on a number of key issues to guide a team of experts developing a curriculum with simulation as one of the instructional methods.

4.1. Aspects to consider

The first consideration is to revisit the curriculum outcomes of the relevant postgraduate programme. Simulation has to be an integrated part of the curriculum, and outcomes for high-risk and low-frequency cases/conditions should be identified for simulation. For example, some interviewees suggested the following: ‘‘… identify the outcomes that the registrars find difficult to reach, for example specific skills’’ (D1); and ‘‘Develop a basic surgeon across all plastic surgery disciplines” (S1).

Such recommendations suggest that curriculum developers probably need to revise and reconsider the current curriculum - not only the purpose and outcomes of the programme, but also the knowledge, skills, clinical competencies, and professional conduct qualities a plastic surgeon needs to practise safely and be proficient/competent/excellent.

The second consideration is to identify what to simulate. Four aspects were emphasised: Identifying plastic surgeons’ role in practice; planning and structuring clinical scenarios well; developing complete scenarios with clear outcomes; and continuously improve, reform and adapt curricula to facilitate effective learning. The following serve as examples of what interviewees suggested: ‘’You need to know what your starting point is – actually called zone of simulation’’ (I1); ‘‘ … identify the scarce clinical conditions – things you really want the registrars to see and be able to treat” (C3); “the life-threatening conditions/cases that you do not see regularly’’ (D1); “ … discipline-unique cases to simulate’’ (D1); “ … problem areas that can be simulated’’ (C1).

These perspectives make it clear that decisions on what to simulate in a specific training programme and how to meet the needs of the profession are of utmost importance.

The third consideration mentioned was to review simulation facilities and equipment, in one's own institution, nationally and globally, to gain perspective on the types of simulation facilities available, and whether and how one's own facilities can fit in with other facilities. One interviewee suggested, for example: ''Plan in detail how to use simulators optimally" (C1, referring to simulator adaptability); "Identify what is already available on your training platform – simulation not better than real patient'' (C1).

Fourthly, it is important to attend to the assessment opportunities offered by simulation. Two aspects were emphasised: feedback during and after assessment should be effective learning experiences; and simulation can be employed for different forms of assessment and certification. Some examples of interviewees' suggestions include the following: "Assess the registrar on a continuing basis on preparation, knowledge, skills, oral expertise, professional behaviour, making correct diagnoses, executing procedures, and not harming patients'' (C2); and ''Simulated OSCEs as part of examinations" (C3).

4.2. Suggestions for developing a curriculum with simulation as one of the teaching-learning methods

The interviewees were asked to make suggestions to direct a team of experts in developing a curriculum with simulation as one of the teaching-learning methods. Their responses had a bearing on three key issues, namely training, staff and market analysis.

4.2.1 Training, curricula, and outcomes

Regarding training, the curriculum and outcomes, the interviewees suggested that first of all the holistic picture be identified. They suggested creating a framework indicating simulation's place in the holistic training picture/process (I1), and identifying curricula with similar content to promote cooperation in implementing simulation (D1). The expectations (outcomes) for completion of specialisation must be identified for knowledge, skills, competencies, attitudes, and so forth, as well as the role of simulation in realising the expectations (I1). Outcomes must be aligned with the objectives of simulation (C1), and revisited and adapted according to requirements and needs (D1).

Concerning the content of the curriculum and the place of the simulation in teaching and learning, the interviewees suggested that simulation should be a compulsory part of the curriculum (D1), and curriculum planners should decide beforehand where simulation would fit best (C1). To combat the problems of a lack of scheduled time for clinical training and curriculum overload, the interviewees suggested that simulation and debriefing sessions be scheduled to fit in with the teaching and training programme, allowing for the nature of the simulation sessions [C1), and protecting registrars' training time, including time for simulation (D1). Care should be taken not to overload the curriculum (C1), and to plan for student support throughout the training years (I1).

4.2.2 Expertise and staff

Referring to expertise and staff, the interviewees recommended that content experts be identified to develop new and innovative materials for simulation to overcome issues in a resource-constrained environment (C1; D1; I1). All available expertise should be used (D1), and a *train the trainers* course should be developed and offered (C1; I1; D1). Champions should be identified per department to promote and drive simulation (D1).

4.2.3 Market analysis and research

Interviewees recommended that market analysis be done to identify applicable research, best practices, and available simulator modalities (C1; C3; S1), and that research be conducted to test new concepts and identify clinical needs (C3).

Interviewees also indicated that the development of curricula (D1), the alignment of outcomes (C1), and building staff expertise were pre-requisites (D1; C1) that should be based on sound scientific research (S1).

4.3 Suggestions for developing guidelines for the use of simulation in plastic surgery education and training

Recommendations from the interviewees for the development of guidelines to steer the implementation of simulation in plastic surgery training included a warning not to attach the wrong value or weight to simulation in the curriculum. One interviewee, for example, remarked: "… it is a method for training, not the main aim of clinical education and training" (C1). Other interviewees suggested that simulation must be compulsory, that it should be integrated in the curriculum as a required component, and that it must support aspects that are difficult to train on real patients (C1; D1; R1). Alignment of theory, practice and assessment is essential, and training must be standardised and individualised (R1). Learning objectives to be replaced by or reserved for simulation must be identified (I1). In compiling guidelines for the implementation of simulation it is important to acknowledge that staff members are not necessarily trained to teach by means of simulation. One interviewee expressed this as follows: " … registrars/specialists in training do not necessarily understand the process of fast training in simulation and integrated practice (skills transfer) in a clinical environment" (I1); therefore, "guidelines for simulation and its implementation must be clearly formulated" [I1].

It is worth taking cognisance of these suggestions when decisions are made about introducing and implementing simulation in a training programme.

4.4 Lessons learned and challenges experienced in implementing simulation

Interviewees shared the perspective that curriculum developers should realise that simulation does not replace real patients (C1; C3; I1; S2). Reconsidering and re-planning the curriculum and learning outcomes, scheduling enough time for compulsory simulation sessions, and identifying beforehand what to simulate are vital (D1; C1; D2). Observation and feedback improve the effectiveness of learning (C2).

Among the challenges that interviewees pointed out that might be experienced when implementing simulation in training counted the lack of sufficient scheduled time for teaching and training registrars resulting mainly from poor service delivery, and ensuing in underutilisation of simulation. Other challenges mentioned were time constraints, increasing student numbers, financial constraints, and staff resource challenges. To get staff to work in a team in integrated scenarios, undergo training and manage a simulation lab may be challenging, as well as to get staff buy-in and to identify and appoint an academic driver for simulation.

Among the challenges pertaining to the programme are identifying what to simulate, unwillingness to integrate simulation in the curriculum, and group scenarios involving different but similar clinical disciplines and other health care professionals. A major challenge is to ensure that students do not develop fears about working with real patients.

The final challenge is to provide a relaxed atmosphere, which allows students to practise skills on a continuous basis until competency is attained. First identify the space and then buy the equipment; also, start with simulators and buy other equipment over time.

5. RESULTS: THE DELPHI STUDY

After completing Round 2 of the Delphi process, sufficient consensus (92.05%) was achieved, and the process was terminated. Panellists indicated that they would not change their responses in a third round. Consensus was reached on 208 of the 453 learning outcomes (descriptors in the form of statements), indicating that simulation as a training method for plastic surgeons was important (45,92%). Consensus was reached on 209 statements (46,14%), indicating that simulation was not applicable/not important as a training method. Consensus could not be reached on 36 statements (7,95%), but stability was reached (Nel *et al.*, 2020; Nel *et al.,* 2021).

The Delphi panellists indicated the importance of simulation as an education and training method for each of the outcomes by indicating whether simulation was an essential method, a useful method, or not applicable/important in training a plastic surgeon as far as that specific outcome was concerned. The panellists also indicated which type of simulation modality, namely low-tech and/or high-tech, would be most appropriate in each case, as well as the cognitive levels that would be addressed by simulation (Nel *et al.*, 2020; Nel *et al.*, 2021).

6. DISCUSSION: FACTORS IMPACTING THE IMPLEMENTATION OF SIMULATION IN POSTGRADUATE PLASTIC SURGERY

From relevant literature and the empirical findings, a number of factors that can potentially influence and drive the implementation of simulation in postgraduate plastic surgery programmes were identified [see Figure 1 and Nel, 2019].

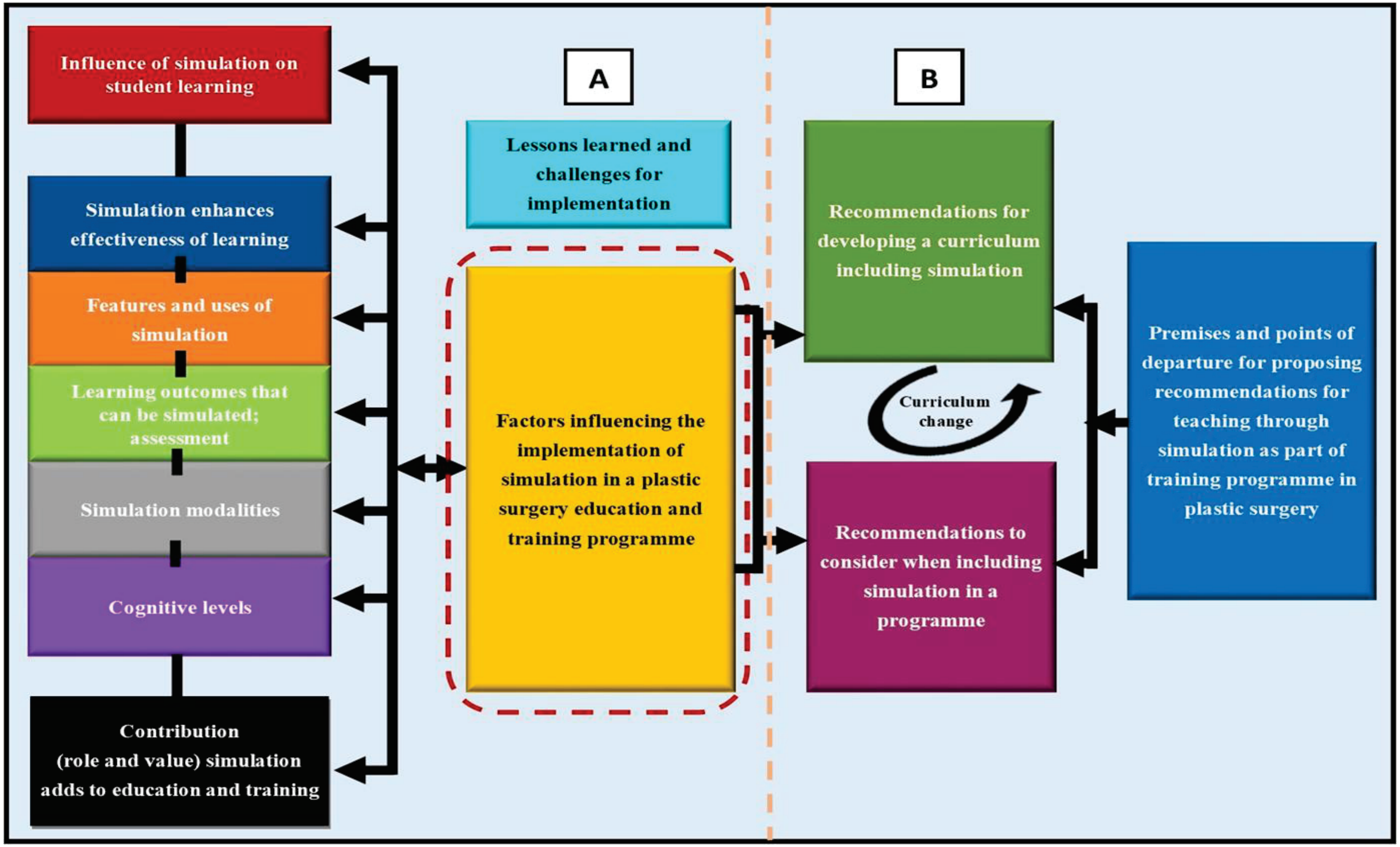

Figure 1: (A) Factors that will influence and drive the implementation of simulation in a postgraduate programme and serve as a directive for successful implementation; and (B) actions for proposing recommendations for implementation of simulation.

The factors as depicted in Figure 1 are elucidated briefly. This discussion clearly shows the important link between the findings from the empirical data and those reported by relevant literature in the present study.

6.1. Impact of simulation on student learning

Simulation is a specific and holistic instructional strategy that builds on adult learning principles. Clinical registrars are adult learners who participate in educational activities to obtain a specialist qualification. They are qualified professionals, taking responsibility for their own learning. Most prominent theories of learning have humanism and constructivism as foundation, emphasising the development of the individual in a learner-centred approach where students learn through interaction and reflection (Massyn, 2009: 125-140). Adult learners engage in transformational learning, which points towards enhanced learning experiences, dialogue and critical reflection, promoting effective learning. As emphasised by Merriam and Brockett (2007: 145): "Adult learning, self-directed learning and transformational learning focus on developing the potential of the individual; prior experiences, relevant learning of real-life scenarios and reflection". All these instructional elements are promoted by using simulation.

However, to be effective, simulation needs to be properly integrated into a curriculum. Simulation can replace other educational strategies such as theoretical lectures by bringing simulated case engagement into the strategy. Preparation prior to using simulation is important to ensure the theoretical grounding necessary to facilitate learning. The simulation of rare clinical cases or life-threatening scenarios is motivational, while the inclusion of health professionals from different disciplines fosters learning. Repetition to master skills before practising on patients, and ensuring that a certain level of competence is attained or maintained have a direct influence on being competent and/or proficient (Nel *et al.,* 2021).

6.2. Simulation enhances the effectiveness of learning

To understand the concept of learning effectiveness and learning at different cognitive levels or domains of competence, it is necessary to examine learning theories and to apply them to plastic surgery (*cf.* Kolb's Learning Cycle, Bloom's Taxonomy and Miller's Pyramid in Nel *et al.,* 2020). The non-threatening environment that simulation provides enhances the effectiveness of learning, reduces registrars' stress, and holds various advantages for clinical teaching, such as patient safety, shorter operation time, fewer complications, and lower costs. Through deliberate and repetitive practice, constructive feedback and debriefing, the realism of clinical scenarios and quality assessment procedures, learning is promoted. Simulation also fosters the expansion of the training platform while promoting the effectiveness of learning. Assessment enhances learning and plays a role in the evaluation of clinical skills and competencies. Furthermore, using simulated and/or standardised patients for clinical examinations enhances learning and assessment (Nel *et al*., 2021).

6.3. Cognitive levels of learning

One way of formulating learning outcomes might be to use Bloom's taxonomy (or Anderson's adapted version), designating the levels of cognition, namely knowledge, understanding, application, analysis, synthesis, and evaluation (Nel *et al.,* 2020). This approach can identify the level of competence or expertise needed by a plastic surgeon (a qualified professional). Through training the registrar has to attain and maintain competence at a specific level. Well-defined objectives (outcomes) are thus required to assess the different levels of competence. Simulation provides an opportunity to achieve outcomes at different cognitive levels.

Using interprofessional teams in multipurpose and complex scenarios offering real-world experiences takes the registrar through all the cognitive levels of learning. Simulation at higher cognitive levels is essential, especially for team-based competence, communication skills and professionalism. Simulation at different cognitive levels is a strong driving force in clinical learning (Cook *et al*., 2011; Nel *et al.,* 2020; Weller *et al.*, 2012).

6.4. Simulation modalities

For the present study simulation modalities were divided into two main families, namely ‘low-tech’ and ‘high-tech’ simulation modalities (*cf*. Nel, 2019). Simulated patients (SPs) represent low-tech simulation. Using SPs for teaching or during assessment promotes effective learning in a controlled and safe environment, and promotes the mastering of communication skills. The use of SPs has a proven significant impact on students’ learning and assessment (Issenberg *et al.,* 2005).

High-tech and high-fidelity simulations focus more on integrated scenarios in high performance and critical incidents. To create a holistic simulation experience, it is necessary to include high-tech and high-fidelity simulators to emphasise integration, group work and a multi-disciplinary approach. Training with high-tech simulators promotes effective learning and is a driving force for simulation implementation (Cook *et al*., 2011; Issenberg *et al., 2005;* Nel *et al*., 2020; Weller *et al.*, 2012).

6.5. Learning outcomes for simulation

To identify learning outcomes for postgraduate plastic surgery education and training, linked to specific cognitive levels, is an important step in implementing simulation. In the Delphi process used for the present study, a total of 208 learning outcomes were identified for the use of simulation in plastic surgery postgraduate programmes (Nel *et al.,* 2020). Identifying learning outcomes for simulation thus may contribute in an important way to the smooth implementation of simulation.

6.6. Contribution (role and value) of simulation to education and training

Simulation is not an alternative to bedside teaching, but a valuable way to enhance clinical education. It is a complementary teaching method and makes an important contribution to patient safety. It provides registrars with the opportunity to practise required skills. They can push the limits, because they find themselves in a safe environment with safety aspects in place. Also when they feel sufficiently equipped with knowledge, skills, competencies and professional behavioural skills, they can transfer these attributes of training to real clinical settings and patients. Through training the trainer, a clinical educator with the specific skills to teach and train, can add value to clinical education. Simulation, therefore, provides for a non-threatening learning environment, controlled and safe practice opportunities, as well as providing a unique learning situation in which the registrars learn and hone their skills (Issenberg *et al*., 2005).

Simulation has another important role in clinical training, namely to offer opportunities for reasoning at a higher level of complexity and applicable to interdisciplinary, large-group training using high-fidelity simulators. Similarly, debriefing that follows a simulation session presents powerful learning opportunities (Labuschagne, 2012).

Simulation is a deliberate and repetitive practice to master skills and to keep abreast of clinical challenges. It has the potential to minimise risk to patients, to enhance patient communication skills, and to address the lack of opportunities for clinical exposure and practice. Simulation allows registrars to identify problem areas and to deliberately practise specific skills until the required level of competence is reached (Rosen *et al.,* 2009).

Overall, simulation seems to contribute to clinical training through the role that it plays and the value it adds. The particular value that simulation adds to registrar training is that it provides a complementary learning strategy to bedside teaching. Simulation also creates valuable learning opportunities in a safe environment, addressing the individual needs of students.

7. IMPLEMENTING SIMULATION AS AN EDUCATIONAL STRATEGY IN POSTGRADUATE PLASTIC SURGERY TRAINING

Research data were analysed according to the GT approach; the findings were grounded in interviewees’ 'reality'. The ensuing recommendations to direct the development of guidelines for simulation implementation thus require careful consideration of the factors/forces influencing simulation, indicating how simulation can be used to enhance learning, students’ knowledge, clinical competence, skills, and professional conduct.

Interviewees in the semi-structured interviews were asked for suggestions to direct a curriculum development process, and to make recommendations for developing guidelines for incorporating simulation in plastic surgery training (see 4.3). The suggestions of the interviewees must be read together with the other results and findings of the research, and the perspectives gained from literature. The rationale and justification for making recommendations rest on four premises that are not negotiable (Nel, 2019), as manifested in the suggestions and recommendations of the interviewees:

(i) Recommendations must be based on valid scientific research results, in this study obtained from combining findings from international and national literature, and feedback from interviewees and Delphi experts.

(ii) The premise of relevance has a bearing on a need that was established. The goal of simulation must be to enhance postgraduate education and training of specialists. Simulation must be a required component of the curriculum, with a clearly defined purpose and final outcome.

(iii) A flexible approach should be followed in making recommendations for the implementation of simulation in a teaching-training programme. All relevant aspects and factors influencing simulation should be incorporated. This will allow institutions and programmes to focus on specific areas of need and adapt the recommendations or compile guidelines that are applicable to enhance teaching and learning.

(iv) Regarding transportability, the absence of guidelines for implementing simulation in plastic surgery training programmes highlights the global need for fundamental principles upon which such guidelines can be based. Guidelines must be transportable, useful, and implementable, irrespective of the phase in which simulation is employed.

Nel (2019) identified points of departure for developing recommendations for the implementation of simulation: Recommendations should be formulated within the overarching professional and educational policy frameworks – applying discretion to provide for various and diverse ideologies, beliefs, ethical principles, leadership, and managerial initiatives as applicable.

Recommendations should be uncomplicated, and easy to understand and use, especially when specific guidelines for the implementation of simulation are designed.

It has to be ensured that simulation facilities and opportunities are affordable and accessible, and that running such units is cost-effective, while at the same time ensuring the enhancement of quality over the full spectrum of education, training, and patient care.

Clinical simulation must enhance the postgraduate education and training of specialists, and must be integrated as a required component in the curriculum, with a clearly defined purpose and outcomes. Simulation has to be implemented in a safe environment that is conducive to good teaching practices.

Developing meaningful recommendations for implementing simulation to enhance plastic surgery education and training requires that the role-players involved must be identified and recognised at different levels and in various functionalities. The team that drives the implementation of simulation must be knowledgeable and clear on the contribution that simulation makes to education and training; acknowledging challenges to be overcome and lessons learned from other implementation initiatives.

It is recommended that curriculum developers be clear about the purpose and outcomes of the training programme, including knowledge, skills, clinical competence, and professional conduct qualities required to practise safely and be proficient/excellent. Theory, practice, and assessment must be aligned, with the role of simulation clearly indicated. An integrated, structured education and training programme, including theoretical lectures, simulation sessions and clinical work on real patients, must be developed, maintaining a balance among various components.

These recommendations can and should influence and drive the implementation of simulation in a postgraduate programme and serve as a directive for successful implementation.

8. CONCLUSION

The present study has shown that simulation in postgraduate plastic surgery has a unique role and adds significant value to postgraduate training. The most prominent factors that were identified act as forces in education and training to influence and drive the implementation of simulation in postgraduate programmes and might serve as a directive for successful implementation.

By using simulation in the training of plastic surgeons much value seems to be added to specialist training. The outcomes of this research may thus serve as a 'roadmap' for using simulation in postgraduate plastic surgery education and training to enhance learning, and to improve students' knowledge, clinical competence, skills and professional conduct. The present research may also create and develop an understanding of the need or demand for simulation in other higher education and/or health sciences postgraduate programmes.

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