READY TO WORK?

Does a simulation education program improve the competence of final year medical students to perform common invasive procedures?

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Ad. Ed & Training

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The University of Melbourne
ABSTRACT

Ready to work? Does a simulation education program improve the competence of final year medical students to perform common invasive procedures?

From the day they commence work new medical interns must be ready to perform common invasive procedures. In contrast to this requirement from employing health services, medical schools in Australia have not been required to demonstrate that a graduating student is competent at the appropriate procedural skills. This project investigated the effect of an immersive simulation Educational Intervention (EI) on the competence of final year medical students to perform four common and important procedural skills. A Competency-Based Assessment (CBA) implemented in the simulated environment was developed to measure the students’ performance of the four procedural skills; Intravenous Cannulation, Venepuncture, Male Indwelling Catheter Insertion and Basic Life Support.

The prospective, quasi-experimental study enrolled a cohort of final year medical students who were undertaking their final semester of education between two metropolitan hospital-based Clinical Schools. The students were allocated by convenience into one of three Streams of the study, where they undertook either the usual curriculum or the Educational Intervention. All Streams undertook the internal CBA and their final external university examinations. Results indicated that, compared to the usual procedural skills curriculum, the EI, especially in combination with the CBA, improved competence. Students’ results improved when the CBA was used for formative feedback before summative assessment. Both the EI and the CBA programs have been adopted into a metropolitan medical school curriculum.
DECLARATION

The following declaration page, signed by the candidate:

This is to certify that:

i. the thesis comprises only my original work towards the masters except where indicated in the Preface,

ii. due acknowledgement has been made in the text to all other material used,

iii. the thesis is less than 24,200 words in length, exclusive of tables, maps, bibliographies and appendices. As approved by the Research Higher Degrees Committee.

Signed:

Meredith Heily 5th May, 2014
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APPROVALS

1. The University of Melbourne Ethics Committee
   Approval Ethics Identification Number 1136932.1

2. Professor Geoff McColl, Director, Medical Education Unit, Melbourne Medical School, The University of Melbourne

3. The Royal Melbourne Hospital Clinical School, Melbourne Medical School, The University of Melbourne

4. The Western Hospital Clinical School, Melbourne Medical School, The University of Melbourne
**GLOSSARY**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Trephining</td>
<td>To remove a circular section from a bone, especially the skull, or from corneal tissue with a trephine. (Better Health Channel 2014)</td>
</tr>
<tr>
<td>Trephine</td>
<td>A cylindrical sharp or sawtooth-edged surgical instrument, used especially to cut a hole in the skull (Better Health Channel 2014)</td>
</tr>
<tr>
<td>Iatrogenic</td>
<td>Caused by medical treatment. Describes a symptom or illness brought on unintentionally by something that a doctor does or says (Better Health Channel 2014)</td>
</tr>
<tr>
<td>Part-Task Trainer</td>
<td>A model of a body part used for training, commonly for a medical procedure (Stanford School of Medicine, 2014)</td>
</tr>
<tr>
<td>Mannequin</td>
<td>Model of a human body (Stanford School of Medicine, 2014).</td>
</tr>
<tr>
<td>Simulated Learning Environment (SLE) –</td>
<td>A room or space that has been designed for simulation education (Sutton et al, 2010).</td>
</tr>
<tr>
<td>Simulation-Based Education (SBE) –</td>
<td>Any educational activity that utilizes simulation aides to replicate a real-life scenario (Sutton et al, 2010).</td>
</tr>
<tr>
<td>Simulationist</td>
<td>An educator who specialises in teaching in the simulated environment (Stanford School of Medicine, 2014).</td>
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CHAPTER ONE

INTRODUCTION

1.1 Preamble

Performing procedures, particularly invasive procedures, is one of the common daily tasks that junior doctors undertake during their intern year (Australian Medical Council 2010a). Public and professional expectations are that interns perform these skills at clinically appropriate times and with a safe, competent technique. However, anecdotal evidence and the literature suggest that many interns are, in fact, not competent to perform these procedures (Ringsted et al 2001; Promes et al 2009).

In early 2011, in line with past practice, hospitals had not required graduating students applying for intern positions to provide evidence of their procedural skills education and competency. This is in spite of the fact that most medical schools do some level of assessment on students’ procedural skills competency at University level (Australian Medical Council 2010a).

At the time of developing this study, medical schools had not yet been formally required by governing bodies to include procedural skills competency as part of compulsory academic assessment (Hafferty, 1998; Australian Medical Education Study, 2008). Historically, procedural skills practice was acquired by medical students through ad hoc and opportunistic clinical experience (Burg, Lloyd & Templeton 1982; Bradley 2006). Unlike other student health professionals, medical students commonly did not undertake compulsory assessment of procedural skills pertinent to their graduate role (Davis & Harden 2003; Spencer 2005).

Perceived changes in both health professional and hospital accountabilities have led to a review of medical education curricula (Sutton et al 2010). Public and professional expectations now are that new interns perform common procedural skills appropriately
and competently (Salas, Wilson, Burke & Priest 2005). Concerns about safety and outcomes regarding patients undergoing these procedures prompted the Australian Medical Council (AMC) and the Clinical Deans of Australia and New Zealand to produce skill outcomes recommendations, but by the end of 2010 there were still no Australasia-wide standardised curricula for the teaching and assessment of procedural skills (Australian Medical Education Study 2008; Australian Medical Council 2010a).

Within the Melbourne Medical School (MMS), University of Melbourne, procedural skills teaching has increased since 2002 (Department of Medicine 2007). Some of the hospital-based campuses, called Clinical Schools, had begun introducing simulation education into the clinical curricula. Procedural skills assessment, however, remained a very minor component of overall academic requirements.

The MMS supported the view that it was timely to develop both the teaching and assessment of the clinical and procedural curriculum for final year medical students. Emphasis was placed on designing new programs that could help prepare students for the transition to the intern year. There had been an increased focus on clinical and procedural competency i.e. it was time to establish a process for preparing and assessing the competency of a final year medical student to perform these procedures as an independent intern.

This study describes the process of designing and implementing a program of teaching and assessment of the procedural skills competency of final year medical students at two Clinical Schools of the Melbourne Medical School, University of Melbourne. The tools used to measure the student outcomes are described, as are the results.

1.2 Background

1.2.1 History

Patients have been treated by invasive procedures from trained or untrained health workers since humans evolved sufficiently to imagine cause, action and effect.
Neolithic archaeological finds have found evidence on skeletons to show that trephining was practiced and that the patient recovered from the procedure. The rationale for the trephining remains a matter for speculation. Importantly, clearly demonstrated by the pattern of bone regrowth, is that the procedure was performed competently enough that the patient healed and lived for some time after the trephining (Brothwell 1963).

The medical profession evolved as knowledge was discovered, both deliberately and accidentally. Due to lost or unrecorded work, many developments may be difficult to track. Bynum (2008) looks at the evolution of medicine from these domains: bedside, library, hospital, social and laboratory. Invasive procedural skills pertinent to a contemporary hospital intern role developed as the science of medicine rapidly developed (Bynum 2008)

Skill acquisition and competent performance of simple invasive procedures had a scarcity of published documentation or studies in the years prior to 1982. (Burg et al 1982). Anecdotally, many nursing staff had noted that junior doctors were often unaware of, and/or incompetent at, the common invasive procedural skills they were expected to perform. Medical students and junior doctors were expected to acquire procedural skills expertise through direct patient contact. Supervision and teaching was ad hoc and left entirely to clinical staff (Pfefferkorn 1933; Burg et al 1982; Mason & Strike 2003).

1.2.2 Curriculum Developments

In 1998, the change of undergraduate medical curriculum at the University of Melbourne brought about the standardised teaching of procedures. As part of the new curriculum, it also decided to examine one of these skills at the times of formal academic assessment. Of note, students were able to fail the procedural skills examination, but still pass their overall year (Personal communications Professor Geoff McColl¹, Dr Jenny Conn², Dr David Smallwood³ & A/Professor Agnes Dodd⁴,

¹ Professor Geoff McColl, Director, Medical Education Unit, Melbourne Medical School, University of Melbourne. Email received Sunday, 15/04/2012, 12.08 PM
² Dr Jennifer Conn, Senior Honorary Fellow Melbourne Medical School, University of Melbourne. Emails received Friday 13/04/2012, 3.50 PM and Friday, 13/04/2012, 5.55 PM
The curriculum assessment requirements for procedural skills remained unchanged throughout the MBBS program (Melbourne Medical School 2011a).

By 2009, the then joint Royal Melbourne and Western Hospitals Clinical Schools (RMH/WH) had developed an immersive two-day simulation education program for students undertaking their final semester. This program incorporated a case-based approach to honing the procedural, clinical and communication skills required by a new medical intern. 2009 was also the year in which Western Hospital Clinical School enrolled a small cohort of medical students entering their first clinical year. This was the beginning of a planned expansion of Western Hospital Clinical School to become a completely independent Clinical School by 2012.

In 2010, a planned update of the overall medical curriculum by the Melbourne Medical School allowed an opportunity to lobby for a review of the teaching and assessment of procedural skills. The clinical and educational environment had changed in a way that encouraged opportunities to design a program that would both enhance and test these curriculum developments. The MMS allocated the researcher with the task to develop and pilot a procedural skills certification program. If successful, benefits would apply to patients as the junior doctors engaged in their first positions as new graduates.

1.2.3 Research Context

The research developed as a confluence of events occurred. The required development of a procedural assessment program would potentially enable the testing of the educational efficacy of the simulation education program. In preparation for the planned 2012 separation of the two Clinical Schools, the small final year cohort of the first Western Hospital students would have all their experience and classes only at Western Hospital. These students would not receive the RMH specific Educational Intervention, but would instead receive the usual curriculum given to students at all other Clinical

---

3 Dr David Smallwood, Senior Lecturer, Chair, Clinical Assessment Committee, Medical Education Unit, Melbourne Medical School, University of Melbourne. Email received Wednesday 11/04/2012, 1.56PM
4 Associate Professor Agnes Dodd, Medical Education Unit, Melbourne Medical School, University of Melbourne. Email received 13/4/2012, 12.34 PM
School campuses. The usual curriculum consisted of procedural skills classes on appropriate teaching models (part-task trainers). The classes concentrated on technical skills revision.

The balance of the final year RMH/WH student cohort would continue to have rotations between both hospitals. This allowed testing of the immersive Simulation Education program against the usual curriculum i.e. the WH students could be used as a small control group.

Thus, the prospective research cohort would have

- Students studying solely at Western Hospital Clinical School, who would undertake the usual procedural skills curriculum
- 89 students who would rotate between the Western Hospital and Royal Melbourne Hospital Clinical Schools, who would undertake the Educational Intervention when at the Royal Melbourne Hospital.

It was determined that further differentiation would be possible when implementing the Testing program within the joint group of 89 students, allowing other measurements of the Educational Intervention effect. The final study cohort was streamed into three groups. Table 1.1 demonstrates the programs each Stream would undertake.

<table>
<thead>
<tr>
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<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>WH only</td>
<td>WH/RMH</td>
<td>WH/RMH</td>
</tr>
<tr>
<td>Pre-Program Testing</td>
<td></td>
<td></td>
<td>Pre-Program Testing</td>
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<tr>
<td>Usual curriculum</td>
<td></td>
<td>Educational Intervention</td>
<td>Educational Intervention</td>
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<td>Post-Program Testing</td>
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<tr>
<td>External Exams</td>
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Legend: WH = Western Hospital Clinical School
         RMH = The Royal Melbourne Hospital Clinical School
1.3 Statement of the problem

Interns are expected to be competent at common procedural skills as they enter their first year of employment as doctors. Evidence discussed in the literature review (see chapter 2.3.5) indicates this is not universally the case. By the end of 2010 there still were still no mandatory teaching and assessment curricula in Australian and New Zealand medical courses. The governing bodies have recommended which skills students should be competent in at the time of graduation (Australian Medical Council, 2010a). However, the detailed procedural skills teaching and assessment curricula to be followed have not yet been defined or designed.

A curriculum needed to be developed that would revise, enhance and assess medical students’ procedural skills competency. Given that the Australian Medical Council expects students to be competent by graduation, this revision and assessment should occur in their final (pre-intern) semester prior to graduation (2010a).

1.4 Purposes of the study

The purposes of the study were two-fold:

1. To measure the effectiveness of an immersive Educational Intervention (EI) program compared to the usual curriculum when preparing final year medical students for the performance of four common procedural skills;

2. To design and pilot a Competency-Based Assessment (CBA) program, with the aim of future implementation in medical curricula.

1.5 Research Questions

The research questions related to the effect of both the Educational Intervention and the assessment programs. Overall, the CBA and the University examinations were used to inform the specific questions:
• Did the Educational Intervention improve procedural skills performance of final year medical students?

• Was the CBA program a feasible and reliable method for testing the procedural skills competency of final year medical students?

The answers to the two main questions were explored by a series of research sub-questions which looked at the in-house and external examination results. The results and data obtained relating to all sub-questions were to be analysed for statistical significance.

1. Internal Competency-Based Assessment
   a. Was there a difference in the results between the three Streams of the study cohort?
   b. Was there a difference between the Intervention Streams compared to the Non-Intervention stream? If so, was it due to the Intervention or other causes?
   c. Was there a performance difference between Streams Two and Three related to test familiarity?
   d. Was there a performance difference in the Stream Two sub-groups with varying time delays between Educational Intervention and Competency Based Assessment? Was skill retention a factor?
   e. Was there a performance difference within the sub-groups of Stream Three? Could clinical exposure be an influence on the results?

2. External Objective Structured Clinical Examination
   a. Was there a difference in results between the study cohort and their peers at other metropolitan Clinical Schools?
   b. Was there a difference between the cohort Streams?
   c. Did test-retest familiarity cause an improvement in performance of the study cohort?
1.6 Statement of the Hypotheses

Utilising the literature, the mandatory overall curriculum requirements, the compulsory student rotations and the available educational resources, the following hypotheses were formulated:

- Participation in an immersive, two-day simulation-based educational intervention improves the procedural skills competence of final year medical students.

- Development of a Competency-Based Assessment (CBA) program based in the simulated setting enables reliable measurement of students’ procedural skills competence.

Secondary hypotheses formulated were:

- Standardised Competency-Based Assessment can be feasibly and reliably delivered in more than one setting.

- The Educational Intervention has more effect on competency performance than test familiarity.

1.7 Significance of the Study

The potential implications of this study impact on both the clinical and educational settings.

1.7.1 Clinical

Clinically, improved performance of procedural skills by interns may lead to better patient outcomes by reducing the complication rate from invasive procedures. The current rates of infection caused by invasive devices, particularly intravenous cannula and indwelling urinary catheters, may be reduced. Complications of device insertion, such as pain and bleeding, may also be reduced (Maki, Kluger & Crnich 2006; Graves...
et al 2007). The complex nature of the clinical environment makes the causes of device-associated complications multifactorial and difficult to isolate any single factor (Maki, Kluger & Crnich 2006; Graves et al 2007).

1.7.2 Educational

Educationally, medical curriculum developers will have a viable program to implement an improved procedural skills teaching and assessment curriculum. This program has been designed using the theoretical principles behind Simulation Education to better prepare future interns for this component of their work (Issenberg, McGaghie, Petrusa, Lee Gordon & Scalese 2005). Medical Faculties have a duty of care to the public to ensure that graduating students are safe and competent in their performance of procedural skills (Australian Medical Council 2010a).

1.8 Assumptions

To be able to establish a feasible study, the following assumptions were made:

- All students were able to complete all components of the Educational Intervention and the assessment.
- The students had completed all components of their total medical curriculum up to the start of this, their final semester.
- The Melbourne Medical School external academic assessment procedures were reliable and valid.

1.9. Limitations of the Study

The limitations of the study were related to the clinical and educational environments. The numbers in the cohort streams were uneven, leading to a more problematic
statistical analysis. Although every effort was made to reduce causal interference, the nature of clinical exposure, the two hospital environments and the pre-determined main curriculum for the students’ final semester meant that these potential influences could not be eliminated or measured.

Due to the priorities and constraints of the research, this study focuses on the measurement for the performance of procedural skills only. The Educational Intervention offered many practical, theoretical and communication experiences, into which procedural skills were embedded. It was beyond the scope of this study to investigate the effect of the Educational Intervention on any other aspects of students’ clinical or academic performance.

1.10 Definition of Terms

- Educational Intervention (EI) - The two-day immersion simulation education program.

- Final year medical student - A student completing the final semester of a six year Bachelor of Medicine, Bachelor of Surgery (MBBS) program at the Melbourne Medical School, University of Melbourne.

- Competency-Based Assessment (CBA) - A form of assessment commonly used to assess if the candidate is ready to perform the task/s required in the prospective work place (Gonczi, Hager & Athanasou, 1994).

- Objective Structured Clinical Examination (OSCE) - A short, focused, simulated clinical examination used by the academic departments of many health professions.

- Melbourne Medical School (MMS) - A Division of the Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne.
• Clinical School - A hospital-based campus of the Melbourne Medical School providing the clinical education curriculum to medical students. MMS Clinical Schools do not have students from other Health Science disciplines.

1.11 Summary

In this chapter the research problem, the rationale, the hypotheses, the research questions and the essential elements of the Educational Intervention have been introduced. The following chapters will outline the background literature, the methodology, the results and finish with a discussion of the results, conclusions and recommendations.
CHAPTER TWO

LITERATURE REVIEW

2.1 Preamble

For this thesis, the literature informing the Education Intervention (EI) and the methods used for the measurement of student performance has been drawn from two areas: that of Simulation-Based health education and that of educational assessment. A review of the development of these topics and some of the educational theories behind them will be explored. A background to the development of the thesis methodology will be provided. Gaps in the literature will be identified and these will be used to inform the design of the thesis investigation.

2.2 Simulation Based Education (SBE)

2.2.1 Background

“The term ‘simulation’ is used generically to apply to all technologies that are used to imitate tasks. In health care, it refers to any teaching activity in which a real life situation is replicated” (p2, Department of Health, Victorian Simulated Learning Environment Strategic Plan, 2011).

This definition outlines that simulation is not real, but is attempting to stimulate development of real learning in the participants (Haque & Srinivasan 2006; Gordon, Hayden, Ahmed, Pawlowski, Khoury & Oriol 2010). This learning needs to be able to be transposed to the clinical (real) patient environment to be considered successful (Mezirow 2000; Kneebone 2009). Most of the health educational research argues for efficacy of the simulation environment, although there are differing views (Sutton et al 2010; Wenk et al 2009). For a summary of these views, see Table 2.1, section 2.2.6
The phenomenon of learning can occur on a deep or a more superficial level. Deep learning means that the learner understands the concepts and has a specific intention to learn the meaning behind ideas. Shallow learning is more related to learning tasks and skills (Entwhistle 2000). A well designed SBE includes a suitably qualified instructor, with a well-designed program, who understands the concept of simulation debriefing in stimulating the acquisition of deep learning for key components of the required curriculum (Rudolph, Simon, Raemer & Eppich, 2008; Raemer, Rudolph, Simon & Flanagan 2010).

Simulation Education has long been a part of many health professional curricula, where the prevailing pedagogy is to establish a setting where students may gain knowledge and skills by the experiential learning mode. Dr William Smellie, a Scottish obstetrician and medical educator, is just one of several medical academics who described the educational use of obstetric simulation models in 1742 (Boyd 1958).

High fidelity, high technology simulation was first developed in 1964 by the aviation/space industry in the United States of America (Rosen 2008). The successful use of this technology by flying instructors to teach prospective pilots in the safety of the simulated environment led to an expansion of flight simulation centres. This technology was rapidly adapted by health professional educators for use in more technically advanced education formats (Bradley 2006).

In the last decade, there has been a marked rise in the delivery of health education programs via simulation. Simulation equipment technical improvements, patient availabilities, complex interventional technical skills, educational needs and political decisions taken at Federal and State levels have influenced the development of what is now known as the Simulated Learning Environment (SLE).

2.2.2 Simulated Learning Environments (SLE)

Simulation using basic, plastic and portable mannequins designed for resuscitation first began in the 1960’s. Later, more complex models were designed with electronic
capabilities to imitate advanced resuscitation scenarios. Technology for these mannequins has advanced until they are now capable of replicating multiple human physiological functions and can be programmed to respond according to the educator’s requirement. A number of whole and part-models have been developed which have specific functions, such as training in surgical procedures (Cooper & Taqueti 2004).

The Simulated Learning Environment (SLE) now assumes that at least one room in the education centre is fitted out with an advanced mannequin. Increasingly, the SLE is also able to support interactive audio-visual simulations. These may be used for a number of purposes, including knowledge testing and communication scenarios (Spencer 2005). The SLE should also have at least one separate room, where participants can undergo the debriefing required to process and transform the scenario into clinically usable learning (Pea 2004; Fanning & Gaba 2007).

Simulation equipment continues to evolve. Initially, the simple equipment utilised meant it was mobile, capable of being transported to any room or environment. In the last decade, the expensive, dedicated SLE has meant students could only undergo these programs in dedicated rooms. However, the recent development of interactive, portable media e.g. the interactive tablet, has regained the technical capability of Simulation Based Education becoming more portable and capable of greater distribution (Haque & Srinivasan 2006; Bulle 2007; Kneebone et al 2010).

2.2.3 Educational Theories

The literature discussing the educational theory related directly to medical Simulation-Based Education (SBE) is not expansive. Much theory relies on general adult or educational theory. An inference to be drawn is that programs have been implemented on the basis of being intuitively obvious, and a way to fill the clinical experience deficit, but theoretical underpinnings are only now just catching up (Colliver 2002). Much of the literature begins by referencing two seminal educational theories used by SBE: that of Experiential Learning Theory and Constructivism, particularly Social Constructivism.
2.2.3.1 Experiential Learning Theory

Experiential Learning Theory is a specific explanation of how adults learn. It is called Experiential Learning Theory to emphasise the central role that experience plays in the learning process. Experiential Learning Theory is a holistic perspective on the notion that an integrated process that combines experience, perception, cognition and behaviour will lead to adults learning. According to this theory, adults will do the majority of their learning in four different ways:

- Concrete experience;
- Abstract conceptualisation;
- Reflective observation;
- Active experimentation.

Kolb details further influences upon the individual’s learning styles, such as school education, university education, career, and workplace peers (Kolb & Fry 1974; Kolb 1984; Kolb, Boyatzis & Mainemelis 1999). Kolb’s seminal work has greatly influenced much theoretical thought about medical education, clinical learning and SBE (Kneebone, Nestel, Vincent & Darzi 2007; Sutton et al 2010; Buykx et al 2011). Simulation-based education aims to provide all of Kolb’s learning modes, to enable maximum learning opportunities for all students.

Clapper reviews several theorists, and describes the development of Adult Learning Theories and their application to SBE. He pays tribute to Malcolm Knowles, quoting his theory called ‘Androgogy’ meaning “the art and science of helping adults learn” (Knowles, 1973; Clapper, 2010) Knowles described particular characteristics of the adult learner, quite distinguishable from children. He includes characteristics such as self-directedness, life experience that becomes a reservoir for learning, readiness to learn and a desire for the knowledge to have a direct application for a purpose e.g. work. Knowles later acknowledged the influence of the learner’s physical, political and social environment on the adult’s ability to learn (Knowles 1973; Clapper 2010).
Transformative Learning Theory was articulated by Mezirow in 1991 and 2000. This theory incorporates and builds upon Kolb’s work. Mezirow describes adult learners as “focussing on using a prior interpretation to construe a new or revised interpretation on one’s experience in order to guide future action” (p5, Mezirow 2000). This is organised into pedagogy by the structure of the simulation encounter emphasising the importance of debriefing, reflection and processing by the learner (Fanning & Gaba 2007). SBE, when used for health professional education, focuses on providing experience in a way that will facilitate learning by the adult participant.

2.2.3.2 Constructivism and Associated Theories.

Pea states that “Constructivism is based on the fundamental assumption that people create knowledge from the interaction between their existing knowledge or beliefs and the new ideas or situations they encounter” (p445, Pea 2004). Further to this, Constructivism is divided into two schools of thought: the Piaget developmental model, and Social Constructivism. In the Piaget model, the individual constructs their different levels of thoughts then learns via developmental bio-psychological cognitive processes (Piaget 1952; Airasian & Walsh 1997).

The second, and more widely utilised view, is that of ‘Social’ Constructivism, also called ‘Situated Social Constructivist Perspective’. In this theory, the individual constructs learning and meaning through interaction within the social and cultural milieu that the individual inhabits (Airasian & Walsh 1997). Given that team work and working with and learning from people are essential components of medical education curricula, the social constructivist view is widespread in health education.

Rolloff expands upon the constructivist theory by adding the concept of scaffolding when describing the building of evidence-based knowledge layer by layer in nurses (Rolloff 2010). Pea describes the concept of ‘Scaffolding’ as a way of building knowledge and skill through supervised experience, until the learner is capable of independent action (Pea 2004).
Another adaptation of the social constructivist model is the ‘Situated Learning Theory’. Case studies are described to demonstrate how newcomers to various occupational groups learn. This theory assumes that training cannot be separated from learning in practice, and that knowledge is situated within the community of practice rather than existing somewhere else. The practical application is facilitated learning, rather than didactic or ‘power knowledge’ teaching from an expert lecturer (Lave & Wenger 1991). Rush and colleagues describe how, despite comments from some critics, the Situated Learning Theory is being utilised to design SBE (Rush, Acton, Tolley, Marks-Marar & Burke 2010).

2.2.4 Curriculum Design

For SBE curricula, the concepts of objective, ‘outcomes-based education’ and ‘backward design’ are ideally used to design education sessions (University of Chicago & Tyler 1950; Spady 1993; Wiggins & McTighe 2005). Medical student knowledge outcomes continue to be assessed at written examination level, but many of the clinical skills (including clinical knowledge) are now examined in both the clinical and simulated environments i.e. on a practical as well as academic basis (Australian Medical Council 2010a). Further description of ‘outcomes-based education’ and its application to SBE and assessment is found in section 2.3.4.4 and 2.3.6 of this chapter.

The curriculum time required delivering simulation education at any level of fidelity or intensity is significant (See section 2.2.5). In contrast to traditional classroom teaching, sessions are conducted in small groups, ideally with no more than one teacher to six students, or for some high intensity courses, two instructors for six candidates (Australian Resuscitation Council, 2011).

A medical student cohort at a Melbourne metropolitan Clinical School is typically 60-70 students per year, with two cohorts in situ at any one time. This requires a high session repetition rate to deliver the program to all students, which impacts upon timetabling for all other teaching and learning activities.
Teaching staff need to be both clinically expert in the topic being taught, but also have a clear understanding and demonstrated ability to deliver the pedagogically correct simulation. The higher technologically advanced simulations require extra expertise to run the session. Sutton reported that “faculty development is a critical issue in effective Simulation Based Education” (p29, Sutton et al 2010).

The simulation curriculum therefore requires teaching staff who are not just expert in their field, but expert specialist medical educators. Previously, these specialists were all doctors, but there has been a move to appoint appropriately qualified Clinical Nurse Educators in this role in recent years (Department of Medicine 2007).

2.2.5 Pedagogies and Fidelity

The educational process and pedagogies would usually include didactic theoretical delivery (via lecture, pre-reading or multi-media, simulation experience/practice and then debriefing and feedback). The level of technical set-up and the focus of the learning experience (e.g. technical procedural skill or a complex patient management case) will determine the opportunities for further practice and reinforcement (Kneebone 2009; Raemer, Rudolph, Simon & Flanagan 2010).

The more complex the scenario, the more the educational focus may be on higher-order thinking. This requires increased time to be set aside for structured debriefing, to allow the student to process and consolidate their learning and for deficits to be corrected (Fanning & Gaba 2007; Kuiper, Heinrich, Matthias, Graham & Bell-Kotwall 2008).

The simulation educator (or simulationist) will make the educational decisions relating to fidelity and the technical level to be established, appropriate for the desired educational outcomes.

Simulations are rated according to fidelity. High and low fidelity ratings refer not to the level of technology employed, but the realism of the room or educational space set-up and how it reflects the clinical situation. High fidelity refers to extremely realistic,
clinically accurate scenarios and low fidelity reflects simple staging to merely suggest the clinical situation. Simulation may also be at a very simple level, with little or no technology.

This type of simulation is often used for rapid, portable teaching. An example of this is teaching the application of a sling during a first aid course, where a simulated patient could be a volunteer with a ‘sore arm’ and the sling someone’s borrowed scarf. This situation is low technology, but high fidelity (Bradley 2006).

High fidelity can also encompass human simulated patients set in a clinically realistic scenario but where a procedure, such as intravenous cannulation, is performed on a part-task trainer. The part-task trainer is placed close to the human volunteer patient for maximum fidelity. High fidelity may also encompass the use of the technologically advanced mannequin capable of simulating many human physiological functions.

A variety of levels of simulation exist in between these two extremes of very low and very high technical set up, where an equal variety of equipment, staff and pedagogies are employed (Flanagan, Clavisi & Nestel 2007; Fanning & Gaba 2007; Fritz, Gray & Flanagan 2008; Gordon et al 2010).

2.2.6 Efficacy

A literature meta-analysis found that SBE is widely implemented, but that there are relatively few studies of robust educational design exploring measurement of educational and performance outcomes (Flanagan et al 2007). This concurs with the opinion of several others (Bradley 2006; Okuda et al 2009).

Meta-analyses found that so far, although participant learning had improved in the required domains, few studies had been conducted that could assess that this learning could be translated into positive patient outcomes (Okuda et al 2009).

Unfortunately, study design may be problematic from a legal and ethical standpoint. For example, how does one conduct a randomised controlled trial into the educational
effectiveness of the teaching of a lifesaving technique, requiring that half the student cohort do not get a chance to learn and practice the knowledge and skills before needing them in the clinical environment? The ethical implications of this question cannot be ignored (Ziv, Wolpe, Small & Glick 2003; Salas, Wilson, Burke & Priest 2005).

Other authors are concerned with the retention of procedural skills learnt by a student. Procedural skills may be learnt, practiced and the student assessed as competent. It is noted that students who undertake simulation skills programs do demonstrate better performance of procedural skills. Although many medical curricula now deliver procedural skills programs at all years of study, there is a concern about a perceived lack of retention of performance of skills from one year to the next (Lynagh, Burton & Sanson-Fisher 2007; Arthur, Bennett, Stanush & McNelly 1998). A review by Gray and colleagues found that the optimum interval between revision classes had not yet been clarified (Gray et al 2008).

Most studies have found that participants enjoyed these programs and felt more confident and more prepared to implement the skills and knowledge that they had acquired (Issenberg et al 2005; Sutherland et al 2006; Flanagan et al 2007; Okuda et al 2009; McGaghie, Issenberg, Petrusa & Scalese 2010), but did this enjoyment and confidence translate into improved clinical performance?

Wenk and colleagues conducted a small randomised study testing medical students’ learning and application of knowledge and skills learnt during their anaesthetics course. They found that there was no statistical difference between students who learnt the material and techniques through problem-based discussion and those who underwent a simulation program. They were concerned to find that the simulation students had overrated their knowledge and skills compared to the performance they demonstrated (Wenk et al 2008).

Table 2.1 summarises some of the available literature on the efficacy and effectiveness of SBE.
<table>
<thead>
<tr>
<th>Author &amp; Purpose</th>
<th>Method</th>
<th>Results Summary</th>
<th>Quality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanagan et al (2007) Review efficacy</td>
<td>Meta-analyses of both quantitative and qualitative studies. 458 Papers met their criteria for SBE.</td>
<td>Authors concerns: - few RCT studies. - Widely varied study designs led to often unreliable results - Most studies focussed on participant satisfaction and confidence. - Unclear on transferability of SBE to clinical field. 22 papers demonstrated participant improvement following an SBE program. - Measured in domains such as Transfer of skills (SBE to Clinical), Clinical Skills, Decision Making, Patient Communication, Teamwork and Leadership.</td>
<td>Wide-ranging, but a concise report. Limited solid performance effect data. Limitations of study noted. -Valuable in noting studies that elucidate difference between competency in/after the SBE and performance in the clinical setting.</td>
</tr>
<tr>
<td>Salas et al</td>
<td>Literature review.</td>
<td>Places SBE as a positive</td>
<td>Concise article. No new</td>
</tr>
<tr>
<td>Author &amp; Purpose</td>
<td>Method</td>
<td>Results Summary</td>
<td>Quality Assessment</td>
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<td>(2005) Proposes SBE improves patient safety.</td>
<td></td>
<td>contributor concurrently with other health professional programs.</td>
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<tr>
<td>Lynagh et al (2007) Meta-analysis of medical skills performance transferred from SBE to the Clinical setting.</td>
<td>Meta-analysis. 44 papers met the search criteria of Randomised Controlled Trials.</td>
<td>Demonstrated improved results in SBE or animal models. -Two studies researched clinical setting skill transference. -These studies were limited in scope.</td>
<td>Good review of available research specific to clinical improvement.</td>
</tr>
<tr>
<td>Issenberg et al (2005) Demonstrate the educational benefit of SBE.</td>
<td>Longitudinal qualitative data analysis. Search criteria identified 109 studies.</td>
<td>High-fidelity SBE is educationally effective when delivered within certain conditions listed by the authors.</td>
<td>Concise meta-analysis. Authors acknowledge 80% of base research outcomes equivocal. Article is widely referenced in the SBE literature.</td>
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<table>
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<tr>
<th><strong>Author &amp; Purpose</strong></th>
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<th><strong>Quality Assessment</strong></th>
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<tr>
<td>training against other methods.</td>
<td>preventing good analysis.</td>
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<tr>
<td>Wenk et al (2008) Compared SBE to a Problem Based Learning approach to teach medical students anaesthetic skills.</td>
<td>Small quantitative, comparative study. PBL tutorial vs SBE (high fidelity). Measured confidence vs performance on a high-fidelity simulator</td>
<td>Skill performance similar between groups. - Post-intervention confidence level much higher in simulator group. - Authors concerned about unwarranted overconfidence in simulator group.</td>
<td>Small study. Limits noted when drawing comparisons (PBL group had simulator familiarisation pre-testing). Important discussion re cost-benefit ratio of simulator education.</td>
</tr>
</tbody>
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Note: RCT – Randomised Control Trial

### 2.2.7 The Australian Political, Clinical and Educational Context

A number of factors have led to the rapid development of Simulated Learning Environments in Australia. Clinically, there has been a marked decrease in the number of inpatients in public hospitals. More patients are having day hospital or home-based care. This has led to a decrease in opportunities for medical students to have supervised practice, as home or day patients commonly have their procedures delivered away from student placements.

At the same time, the clinical and technical complexity of managing inpatients has increased (Sutton et al 2010; Department of Health 2011). Concerns about, and from, patients indicate that it is inappropriate for complete novices to be attempting particularly sensitive, invasive, clinical and procedural skills on a patient without prior instruction and learning in a safe environment (Bradley 2006; Gordon et al 2010; Sutton et al 2010).
Ziv raises this as an ethical concern, stating that SBE is now institutionalized in other high-hazard professions such as aviation and the military, so must be of equal importance in medical education. He related the original medical ethical principle of ‘first, do no harm’ (p 783) to the educational ‘beneficence’ (p 783) SBE can bring to the medical novice and therefore to the patient (Ziv et al 2003).

The Federal and State governments have responded to the perceived national Australian deficit of medical and nursing personnel by funding an expansion of University medical and nursing places for undergraduates. This has meant that there are more students for even fewer clinical learning spaces (Sutton et al 2010; Department of Health 2011).

Believing it is plausible that SBE may offer meaningful learning and experience, the response by Federal and State health departments has been to fund an increase in SLEs. Dedicated multidisciplinary committees have been formed to explore, plan, report and implement the expansion of the SLE throughout selected hospitals and universities. One of the roles of Health Workforce Australia (HWA) has been to coordinate and manage the implementation of the SLE development throughout Australia (Australian Medical Education Study 2008; Sutton et al 2010; Carmichael & Hourn 2011).

### 2.3 Procedural Skills Assessment

#### 2.3.1 Background

It is the requirement of medical education curricula that medical students undertake measurable assessments to ascertain if the student has attained the required curriculum outcomes. All programs require the students to pass examinations and assessments in a variety of domains. These domains will include academic, clinical and may include some level of procedural assessment. Traditionally, all assessments, including procedural skills, have been graded. Procedural skills competency, if assessed, has constituted a minor component of overall assessment. On this basis, a student could fail their procedural skills component, but be still be allowed to graduate and practice as an intern (Swanson, Norman & Linn 1995; Tetzlaff, Dannerfer & Fishleder 2009).
It is the purpose of this component to investigate the literature related to the assessment of procedural skills and procedural skills curricula. This will include a review of the background and rationale of Competency-Based Assessment (CBA).

2.3.2 Competency

Carmichael and Hourn, reporting for the Australian and New Zealand Medical Deans on competencies, list the following definitions:

“Competency/competencies

- An observable ability of a health professional

- Reflects a spectrum

- Integrates multiple components such as knowledge, skills, values and attitudes

- Multiple competencies can be combined

- Measureable with respect to a defined outcome” (p5, Carmichael Hourn 2011).

They further define the concept of ‘competency-based medical education’ through the following statement:

“Competency-Based Medical Education - Is an outcomes-based approach to the design, implementation, assessment and evaluation of a medical education program using an organising framework of competencies” (p5, Carmichael & Hourn 2011).

These definitions are consistent with other authors, who define competency as an integrated set of knowledge, skills, attitudes and judgments that enable one to effectively perform the activities of a given occupation or function to the standards expected in employment (Burg et al 1982; Eraut 1998; Curran et al 2009).
2.3.3 Procedural Skills

Practical procedures are essential for diagnosing and/or treating many patient conditions. In health care, a procedural skill may be defined as any practical procedure in which the provider must be trained to perform this skill on a patient for diagnostic, monitoring or therapeutic purposes (Bradley 2006; Murin & Stollenwerk 2010).

The procedure may be further defined as invasive or non-invasive. Invasive procedures entail entering the patient’s body in some way, for example by introducing a needle or a tube. Venepuncture (obtaining a sample of blood from a vein) is an example of a simple procedure, while brain surgery is an example of a complicated, advanced procedure. Non-invasive procedures can be conducted without entering the body, such as application of oxygen masks, or recording of an electrocardiograph (Sutton et al 2010).

2.3.4 Competency-Based Assessment: Educational Theories

2.3.4.1 Overview

Application of learning theories to curriculum design and subsequent competency-based assessment for medical curricula is still in its early stages, but some development has been achieved. Many of the theories share common ground with those summarised for Simulation-Based Education.

2.3.4.2 Miller’s Pyramid of Clinical Competence

Many designers of Competency-Based Assessment (CBA) refer to Miller’s pyramid of competency, pictured in Figure 2.1 (Miller 1990).
Miller describes how this conceptualisation represents base knowledge (knows) and applied knowledge (knows how). Both of these areas can be tested in the written format, such as with multiple choice questions. However, the behavioural components (shows how) and (does), require a far more complex format for appropriate assessment.

Mehay and Burns (2009) adapted Miller’s pyramid to extend the measurement of performance. Figure 2.2 demonstrates the conceptualisation they made about the role of simulation and the clinical environment.

Simulation can provide observational information about the ‘knows how’ component, but only direct observation in the clinical setting will provide valid information about a
potential doctor’s ability to perform competently, then with mastery (Miller 1990; Mehay & Burns, 2009; Sutton et al 2010).

2.3.4.3 Other Theories

One group describe the utilisation of the Cognitive-Constructivist theory (Piaget 1952) when writing and delivering a basic life support education program that had student competency as the major objective. Durak’s group interpreted this theory by designing a curriculum based on The Cognitive Apprenticeship model. Cognitive Constructivist models describe three phases involved in skills development:

1. Initial skills acquisition
2. Skill compilation (proceduralisation)
3. Skill automaticity

(Durak, Certug, Caliskan & van Dalen 2006).

The model reflects a seven-step design described by Ford and Kraiger that seeks to outline a situated perspective which follows a seven-step process:

1. Contextualise learning
2. Demonstrate expert modelling
3. Encourage learning by coaching
4. Scaffolding
5. Articulation
6. Reflection
7. Exploration

The first four principles are under the control of the instructor, the last three are the responsibility of the learner (Ford & Kraiger 1995).
2.3.4.4 Outcomes-Based Assessment

CBA assumes that the curriculum has delivered the required teaching and learning first (Durak et al 2006; Bandali, Parker, Mummery & Preece 2008). This also assumes that the students were aware of both the overt and tacit curricula.

Wass and associates postulate that ‘assessment drives learning’ (p 945, Wass, van der Vleuten, Shatzer & Jones 2001) in that students feel overloaded and respond by only studying what will be assessed. It is therefore important that the curriculum builds in both formative and summative assessment processes to allow feedback, reflection and practice to take place before the assessment (Rudolph, et al 2008).

Fardows agrees with this when she states that “good assessment practice demands that the teacher explains the aims of the assessment and discusses with the students the major outcomes” (p 620, Fardows 2011). From a study she conducted, she reports that students who underwent outcomes-based assessment during their studies did very well in their careers (Fardows 2011).

Outcomes-based assessment is taken further by Cate, who uses the term ‘backward visioning’ to describe a process where essential tasks she calls Entrustable Professional Activities relate to competencies as part of a grid that can be used to map backwards as a guide to curriculum planning and assessment. This involves the use of subjective judgment by the assessor in the workplace, necessitating the assessor to be expert in the field of assessment. The end result is that competence is assessed at the top level of Miller’s pyramid - ‘Does’ (Cate, Snell & Caraccio 2010).

2.3.5 The Development of Procedural Skills Competencies

In Australia, the growing awareness of the importance of benchmarking a defined set of behavioural and learning outcomes for graduating medical students has culminated in a variety of reports and recommendations. A 2008 report for the Federal Australian Department of Education, Science and Training noted of junior doctors that “a lack of
work readiness is a recurrent theme in the submissions provided by state health departments” (p96, Australian Medical Education Study 2008).

Further to this, they also reported that “…some procedural skills…were identified as potentially deficient” (p97, Australian Medical Education Study 2008). Since then, a concerted response by political, health and education bodies has been made to address the perceived requirements for graduating medical students and junior doctors to have procedural skills competency.

General curricula recommendations have been made, but guidelines for specific assessment modes have not (Australian Medical Education Study 2008; Sutton et al 2010; Australian Medical Council 2010a; Department of Health 2011). Where procedural skills are assessed, most medical faculties use a graded or norm-referenced system (Ricketts 2009). Potentially, the student may make a crucial error, but lose only a few marks and still pass the test. The need to clarify the difference between passing a test and demonstrating competence exists. This will be explored further in Section 2.3.6.

The literature around setting standards and testing medical student competency prior to Burg and colleagues is scant. Burg raised the issue of the importance of technical skills competency, as he summarised the debates of the 1970’s. He described the confusion medical educators were conveying about the need for definitions of competence and clarifications of “the logical elements of competence for physicians” (p60, Burg et al 1982). The previously unwritten, underlying assumption up to this point was that medical students and doctors did not require examination or assessment of their ability to perform procedural skills on patients. In a ground-breaking development, Burg designed a curriculum framework, which included ‘technical skills’, concluding that he hoped his article stimulated discussion and development of competence standards in medicine (Burg et al 1982).

The widespread lack of formal procedural skills curricula is an example of a ‘hidden curriculum’, where documentation, formal teaching and assessment are absent, and yet there is an expectation that students will acquire the relevant skills (Hafferty 1998).
Some years after Burg, investigation into the teaching and performance of procedural skills by medical students was conducted (Pales, Gual, Gomar & Estrach 2008; Tetzlaff et al 2009; Sullivan et al 2010).

These papers reported on the implementation of a procedural skills assessment program in their institution. They measured and utilised, for curriculum development, student satisfaction and confidence to perform (Pales et al, 2008; Sullivan et al, 2010) but did not measure performance outcomes. Implementation of a competency based assessment for a variety of performance domains is reported by Tetzlaff et al (2009), including clinical skills. This paper reports the implementation process, rather than outcome results.

Some authors state that untrained and un-assessed performance of procedures by novices is not appropriate, safe or accepted by either the public, health service providers or by medical faculties (Scheele et al 2008; Murin & Stollenwerk 2010). The notion that retention of procedural skills competency was not fixed over time and that ongoing practice was required to retain proficiency has also been investigated (Schendel & Hagman 1982; Anderson, Gaetz & Masse 2011).

In a systematic literature review of Randomised Controlled Trials investigating simulator training programs and procedural skill proficiency, one group found just two articles out of forty-four that measured maintenance of procedural skills. Both of these programs measured retention of indwelling catheter insertion skills at four months... Two studies reviewed in a meta-analysis reported conflicting results. Follow-up studies were not performed (Lynagh et al 2007). Refer to Table 2.1 for a summary of the results.

**2.3.6 Competency: Setting standards and deciding student outcomes.**

The challenge of any CBA is actually to determine the acceptable evidence that decides competency and then to design the curriculum that will support this (Eraut 1998). CBA entails students undergoing a process where they perform a specific task, with a requirement that they complete each step satisfactorily according to a validated test.
Setting CBA means setting standards, where each individual student must reach the required standard. Students are graded against each standard, not against each other (Wass et al 2001; Australian Medical Council 2010a).

Before reaching this level of assessment program detail, the work of the educational researchers Wiggins and McTighe has been utilised by some CBA curriculum designers. Wiggins and McTighe defined a curriculum planning and design theory known as Backwards Design, also known as Understanding by Design (UbD). The three principles of UbD are:

1. Determine the outcomes;
2. Determine the acceptable evidence that will measure whether the desired outcomes have been achieved; and
3. Plan the learning experiences and instruction.

(Wiggins & McTighe 2005)

This notion is the foundation of many vocational adult education courses, where, for future employment, the proof of a ‘fitness to work’ outcome is crucial for the student (Yourke 2006; Schaeper 2009).

In determining competence by medical practitioners, Cate proposes a focus on outcomes and competence by describing three assumptions:

1. Competencies are most relevant when they are defined in the context of the clinical environment;
2. Competence varies as the environment changes;
3. That although it is important to assess what a physician knows or can do, it is more important to assess and predict the results of those actions within the clinical environment. (Cate et al 2010)

The challenge in assessment of procedural skills is that clinical (real patient) testing can be difficult to implement, particularly for the novice where risk of patient harm exists
and/or the procedure is particularly complex (Murray, Boulet, Ziv, Woodhouse & Kras 2002; Scalese, Obeso & Issenberg 2008; Bandali et al 2008; Murin & Stollenwerk 2010). It is in these cases that the SLE can provide safe, experiential learning and assessment (Scalese et al 2008).

In common with the discussion of transfer of knowledge from the SLE to the clinical setting, uncertainties about the transferability of procedural knowledge and skills from simulation to the clinical setting still exist (Sutton et al 2010). Conversely, some studies report that technical skills in particular are well transferred and lead to better performance in the clinical field (Girzadas, Clay, Caris, Rzechula & Harwood 2007; Zamora, Clark, Winslow, Schatzschneider & Burkard 2011).

The specific defined technical requirements of procedural skills make the development of standards and outcomes less subjective than with other areas of medical practice, for example, patient assessment or patient counselling. Each procedure has a clearly defined process of patient interaction and consent, enactment of the procedure and completion (Bandali et al 2008; Iobst et al 2010; Dawson 2011).

Subsequently, one would think that defining suitable assessment protocols for procedural skills, and a supporting curriculum, would be straightforward. Instead, curriculum planning can be problematic. Reliability and validity of any teaching and assessment process can be difficult to institute and maintain (Sutton et al 2010).

2.3.7 Competency-Based Assessment: Reliability

Reliability can be defined as the measure of the reproducibility or consistency of a test over repeated measurements (Kervin 2006). Wass et al describe a process whereby assessment is required to be both reliable and valid. This can be affected by many factors, such as examiners’ judgments, candidates’ nervousness and test conditions (Wass et al 2001). Inter-rater reliability is a tool used to measure the consistency of rating performance of different examiners. Swanson noted that many examiners
assessing one item each are more reliable than one examiner assessing all items (Swanson, 1987).

When describing medical student clinical examinations, Swanson named another human phenomenon that also affects reliability, called ‘inter-case reliability’. In this phenomenon, the reliability of the assessment is affected by both the candidates and examiners. Swanson demonstrated that examiners do not perform consistently from task to task, suggesting that the candidate should be assessed by a different examiner for each station, rather than one examiner transferring from one station to another with the student. Swanson indicates that in any assessment of a clinical skill, competency testing does not rely on just one skill, and that adequate time is given for the assessment (Swanson et al 1995).

Other potential influences on reliability are described where they also report variations between observers (inter-observer reliability). This variation within observers is common after the observer becomes tired and loses concentration and can include the nature of the test itself, called test-retest reliability (Davies & Howells 2004). It is also possible to mathematically model the circumstances that would be required (in terms of number of observations and numbers of independent observers) to achieve a given reliability. This means that it is possible to plan assessment in a way that ensures adequate reliability will be achieved. Conventionally, a reliability coefficient of 0.8 is desirable for high stakes assessments such as certification procedures, although a lower reliability may be acceptable for widespread screening assessments (Davies & Howells 2004).

2.3.8 Competency-Based Assessment: Validity

Validity can be explained as whether a test actually succeeds in measuring the item that that it is designed to measure (Kervin 2006). There are a number of different types of validity including construct, content, and criteria. Reliability is essential to the defensibility of an assessment, but demonstrated validity is also a fundamental requirement. It does not matter how reliable a test is; if it is not actually assessing the
area of interest, it is not worth using. Unfortunately, no easy valid assessment methods that measure all aspects of clinical competence have been designed. (Davies & Howell 2004).

A case has been made for validity being achievable in simulation assessment. Andreatta and Gruppen describe a transformation in how psychometricians and measurement experts conceptualise validity. They report that validity is fundamentally about decisions made from the interpretation of scores derived from assessment methods, such as simulator metrics or a performance rating scale. It is a function of what you are trying to measure or judge (the construct); how you are going to measure it (the context and the tool); and how you are going to use those data to make decisions. Constructs can be further explained as a theoretical entity – something we believe exists and which can be described, but may be difficult to measure directly. Familiar constructs may include diagnostic reasoning, procedures, cardiopulmonary arrest management and teamwork (Andreatta & Gruppen 2009).

2.3.9 Objective Structured Clinical Examination (OSCE)

Utilising Miller’s model, competency testing is achieved by designing clear outcome measures. The Objective Structured Clinical Exam (OSCE) is an example of one of these measuring tools. The OSCE is a short (usually eight-ten minutes) clinically-based examination in which the student is tested on a focused topic relevant to specific clinical knowledge and skills (Harden, Stevenson, Downie & Wilson, 1975).

Common OSCE topics include a focused physical examination, a targeted medical interview, and a specific procedural skill. The OSCE provides a consistent format for the assessment program utilised by many medical schools (Harden & Gleeson 1979). The OSCE format in simulation has been shown to demonstrate reliability, and it is postulated that validity is possible, particularly for invasive procedural skills in the clinical setting (Okuda et al 2009; O’Flynn & Shorten 2009).
The OSCE fits into the third tier of Miller’s Framework of Clinical Competence, that of ‘Shows How’ (Miller 1990). An OSCE is a frequently-used tool for measuring clinical competence for assessing undergraduate medical students who are not yet expected to be expert, or independent, practitioners (Okuda et al 2009).

2.3.10 OSCE Scoring: Cut Scores or Hurdle Assessment

2.3.10.1 Scoring Options

As stated previously, unlike many other forms of academic assessment, the aim of competency assessment is not to rank the students against each other, but against clearly defined minimum standards (Boulet, de Champlain & McKinley 2003). As such, examination committees have to decide upon the design of the scoring process to measure the performance standard of the student. Two processes commonly used are that of the ‘Cut Score’ and also the hurdle assessment mode of pass/fail, including the nomination of Critical Error (Australian Medical Council 2010b).

2.3.10.2 Cut Scores

Boulet et al comment on the need to set ‘...defensible performance standards...” (p245) when designing the OSCE. This is particularly important for high-stakes summative OSCEs. A component of setting these standards is making clear decisions on the scoring process. As with other educational assessment researchers, they recommend the ‘Cut Score’ method. Cut Scores involve a panel of clinical experts agreeing on a check list of items and awarding points for each item. Through a regression analysis (Chapter 3.7.3) a minimal score out of the total points available is agreed upon whereby a student will considered competent if they are graded at or above that score (Wilkinson, Newble & Frampton 2001; Boulet et al 2003).

2.3.10.3 Hurdles

A second form of OSCE scoring is the hurdle, or Pass/Fail option. This scoring format utilises the Criterion Referenced assessment (Ricketts 2009). The key steps or criteria in each clinical assessment OSCE are detailed, above.
However, instead of attributing points to each step when satisfactorily completed, candidates are only awarded a pass or fail. Pass or failure of the whole test is based around the notion of ‘Critical Error’.

The Australian Medical Council defines a Critical Error as:

“Where critical errors are made by a medical practitioner, these can result in the wrong diagnosis being made, the diagnosis being made much later than ideal, wrong treatment being given, or complication occurring which would otherwise have been unlikely (p10, Australian Medical Council 2010b).

In the Critical Error assessment format, even if a candidate passes all steps satisfactorily except for one that may result in patient harm, the candidate will be considered to have failed the test (Australian Medical Council 2010b).

Researchers in Newcastle-upon-Tyne established a competency-based program where the examination panel established an assessment system with both cut scores and critical errors assessment. They defined critical errors as “pre-specified ’critical' domains within each station i.e. those tasks which if not completed correctly or omitted would expose the patient, staff or the host organisation to clinical risk either directly or indirectly e.g. hand washing, failure to check equipment or sharp disposal” (p3, Gray et al 2008).

They found that although 90% of their junior doctor candidates passed according to the Cut Score competency, in fact they found a concerning number of critical errors. The conclusions drawn were that Cut Scores did not clearly define clinical safety and competence (Gray et al 2008).

Further discussion on the implementation of the OSCE model of assessment can be found in Chapter 3.4.6.
2.4 Identified Research Gaps

The value of SBE in educating medical students to become knowledgeable, clinically competent doctors has yet to be clearly and unequivocally determined. The addition of SBE to medical student curricula is based far more on logic than on outcomes-based research. Further reliable studies are required to determine the theoretical, educational and clinical value of SBE.

The literature review has identified that simulation education programs may prepare students to independently perform invasive procedures in the clinical setting, but the literature describing objective measurement of performance improvement is limited.

The literature review has also identified that further research has been recommended to evaluate feasible, reliable and valid methods of testing procedural skills competence to determine if a final year medical student is safe to practice independently in the clinical environment upon starting work as a junior doctor.

2.5 Summary

This chapter has summarised literature describing and investigating the development, implementation and evidence for simulation-based education and procedural skills. Literature describing Competency-Based Assessment and the application of this form of assessment to procedural skills has also been reviewed. This review and the identified research gaps have been used to design the research questions and the research design.

The next chapter describes the design of the Educational Intervention, the Competency-Based Assessment and the methodology used to deliver and measure the programs. Chapter Four will detail the results, with Chapter Five discussing the results and implications.
CHAPTER THREE

METHODOLOGY

3.1 Preamble

In this chapter, the research design will be outlined, the methodology for the research will be justified and the analytical methods will be explained, in the context of addressing the research questions.

3.2 Research Context

3.2.1 Overview

The prospective study design was influenced by several internal and external factors. The most influential of these factors include the design of the final semester’s curriculum, the development of a new Clinical School, and the nature of the clinical exposure program.

3.2.2 The Final Semester

In common with much student-specific educational research, the research design was required to fit in with the existing mandatory curriculum. In this Bachelor of Medicine & Bachelor of Surgery (MBBS) six year course, the final semester for all Melbourne Medical School (MMS) students in 2011 comprised three terms, each lasting five weeks.

The 325 medical students had been attached to one of five metropolitan or four rural Clinical Schools from their fourth year. A small number of students changed Clinical
Schools between fourth and sixth year, but all had received the same core curriculum and assessments set by the MMS, regardless of Clinical School.

Royal Melbourne and Western Hospital Clinical School students rotated through the three terms with their usual tutorial group, which had an average size of nine students. Each group was named alphabetically. Table 3.1 demonstrates the rotations each group underwent during the three terms.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, K, L</td>
<td>General Practice</td>
<td>Medicine</td>
<td>Surgery</td>
</tr>
<tr>
<td>C, E, F, G</td>
<td>Medicine</td>
<td>Surgery</td>
<td>General Practice</td>
</tr>
<tr>
<td>D, H, I, J</td>
<td>Surgery</td>
<td>General Practice</td>
<td>Medicine</td>
</tr>
</tbody>
</table>

The terms consisted of two hospital and one community-based rotation: one Medical, one Surgical, and one General Practice. Each term had mandatory academic and clinical curriculum components. Whilst on rotation, students were attached to a supervising medical team to gain experience in that particular field (Melbourne Medical School 2011a).

The students left their clinical rotation to attend the simulation and procedural skills programs, so timetabling was mindful of this factor. At the end of the semester, all students were required to sit their final external MMS examinations, one of which was a procedural skill Objective Structured Clinical Examination (OSCE).

### 3.2.3 The New Clinical School

2011 was the final year in which The Royal Melbourne Hospital (RMH) and Western Hospitals (WH) would have a combined Clinical School. The expansion of the WH Clinical School meant that in preparation for becoming an independent campus in 2012,
they already had 18 students (Groups A & B) for whom they had had complete academic and clinical responsibility since fourth year.

Unlike the other 89 students in the RMH/WH cohort, these students did not rotate to RMH. This meant that these 18 students would not receive the Educational Intervention (EI) at RMH, but instead would receive the MMS standard (or usual) curriculum at the Western Hospital Clinical School. This group was therefore an ideal comparator against Streams Two and Three, who did receive the EI.

In summary, most students in the study cohort would spend one term at Western Hospital (WH) and one term at The Royal Melbourne Hospital (RMH). Some students also rotated to Epworth Hospital as a component of their RMH rotations. Students undertook their General Practice term anywhere in Victoria. In common with their peers at all other Melbourne Medical School Clinical Schools, all WH and RMH/WH students were required to undertake the final external end of year university examinations.

3.3 Methodology

3.3.1 Quasi-Experimental Research

Quasi-experimental research design can be explained as multiple groups or multiple waves of measurement, where the sample population is not randomly assigned. The difference between quasi-experimental and non-experimental relates to the presence or absence of a control group (Trochim 2006). True, or random experiments are advocated by Campbell when he states “...detailed consideration…reinforces my belief in the superiority of true experiments. ...Yet they present special moral problems which we will have to consider” (p231, Campbell 1991).

When considering the needs of preparing medical students to act in the clinical field, complete random experimentation can be unworkable. Quasi-experimentation is, however, both feasible and reasonable as a research design. Certain characteristics and
draw-backs to this mode have to be considered and compensated for when designing the research.

The drawbacks can be attributed to the independent variables, where there can be unique components and error in the independent variables. This may lead to underadjustment of adjustment procedures, such as matching, co-variance, and partialing (Campbell, 1991). In an explanation covering the problems and merits of types of analysis and wrongful conclusions previously drawn, Campbell rebuts some of his and others’ earlier work, and recommends that all studies lacking a pre-test/post-test, or a random design be ruled out (Campbell 1991).

Other educational researchers recommend efforts to reduce the causal bias, a risk inherent in quasi-experimentalism. Multiple options within the research design have been advocated. Analyses techniques should also be varied, with the aim of similar results leading to more confidence in interpreting the research outcomes (Shadish, Cook & Houts 1986).

3.3.2 The Simulated Environment and Assessment

Although competency of many procedural skills can be measured in the clinical setting, the dynamic nature of patients and ward environments means that it is difficult to reliably align suitable and consenting patients with both the assessor and the student. Some skills, such as Basic Life Support, are not at all feasible to examine in the clinical setting. One solution is to design a competency-based assessment for medical students to undergo in the simulated setting (Varkey & Natt 2007).

3.3.3 Educational Constructs

De Vaus defines Construct Validity as “the evaluation of the validity of a measure by comparing results using that measure with the results expected on the basis of theory” (p57, De Vaus 2002). Trochim offers an additional question to be asked and answered “…is the (study or program) label an accurate one? When you measure (your construct)
is that what you were really measuring?” (p1, Trochim 2006). Trochim looks at the development of an educational construct in two parts. First, the cause and effect construct. Sequential to that, the program and outcome constructs.

In this study, two different but related educational constructs were developed.

- Simulation education (the cause) led to a measurable improvement in performance (the effect).

- Competency-Based Assessment (CBA) of procedural skills (the program) could measure a student’s readiness to perform these skills in the simulated setting (the outcome).

See Table 3.2 for the constructs.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation-Based Education</td>
<td>Performance Improves</td>
</tr>
<tr>
<td>Competency-Based Assessment</td>
<td>Observation</td>
</tr>
<tr>
<td></td>
<td>Ready to work</td>
</tr>
</tbody>
</table>

From these constructs, the specific research questions and measurable variables were developed.

### 3.4 Methods

#### 3.4.1 Overview

In this prospective, quantitative, quasi-experimental study, all constructs had to be operationalized. In addition, all key program and research components had to be delivered and completed within one semester. All feasible measures to optimise reliability and validity of the study were utilised, and are outlined in Section 3.4.9.
3.4.2 Research Design

The three main components of the design were the intervention, the student assessment, and the data collection of the program-specific outcome measurements (the Procedural Skill CBA). The CBA was administered utilising the Objective Structured Clinical Examination (OSCE) format. The External Melbourne Medical School examination was also administered using the OSCE format. Appendix 1 outlines the timeline for all activities.

3.4.3 Sampling

The mandatory rotations meant that students were allocated by convenience into one of three streams: - Stream One received the standard curriculum and post program testing; - Stream Two received the EI and post-program testing, and Stream Three received pre- and post-EI testing.

The timetabling of the Educational Intervention and the Competency-Based Assessment was based on university and hospital pre-determined rotations as previously described. The Educational Intervention Stream students were rotated between both the Royal Melbourne and Western Hospital locations. Immediately upon completing their Post-Test CBA examinations, students from all Streams received their results and a review of their mark sheet, with specific feedback on their performance.

Separately, along with their peers at other Clinical Schools, all students had to undertake the Melbourne Medical School (MMS) external end of year final examinations. In common with previous years and all other Clinical Schools, all WH and RMH/WH students were able to voluntarily attend pre-MMS examination revision classes. The MMS examinations included one procedural skill OSCE, the content of which was blinded to the students until the point of examination. Table 3.3 summarises by Stream the predicted distribution and activities of the total possible study cohort.
Table 3.3 Predicted Sample by Stream

<table>
<thead>
<tr>
<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=18</td>
<td>n=47</td>
<td>n=42</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>Pre-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>Usual curriculum</td>
<td>Educational Intervention</td>
<td>Educational Intervention</td>
</tr>
<tr>
<td>Post-Test</td>
<td>Post-Test</td>
<td>Post-Test</td>
</tr>
<tr>
<td>External exam</td>
<td>External exam</td>
<td>External exam</td>
</tr>
</tbody>
</table>

Table 3.4 demonstrates the final sample by Stream, from which all CBA analysis was utilised.

Table 3.4 Final Sample by Stream

<table>
<thead>
<tr>
<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=18</td>
<td>n=43</td>
<td>n=39</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>Pre-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>Usual curriculum</td>
<td>Educational Intervention</td>
<td>Educational Intervention</td>
</tr>
<tr>
<td>Post-Test</td>
<td>Post-Test</td>
<td>Post-Test</td>
</tr>
<tr>
<td>External exam</td>
<td>External exam</td>
<td>External exam</td>
</tr>
</tbody>
</table>

The unavoidably much smaller Stream size of Stream One precluded the performance of an accurate Power Calculation. A Power Calculation was therefore not included.

3.4.4 Ethics

Ethics Identification Number: 1136932.1 (University of Melbourne)

Ethics approval from The University of Melbourne Graduate School of Research was granted for the research. Use of all appropriate de-identified data sets was granted. Individual student consent was not required, as the intervention and assessment were
introduced as an added component to their mandatory curriculum. There were no ethical or educational risks to any participants in the study. All care was taken that no student was compromised by this study.

All students were guaranteed to receive, at the least, the usual final-year curriculum for procedural skills training. Stream One received the standard curriculum only, while Streams Two and Three received additional teaching beyond that required by the standard curriculum. Students in all three Streams of the study had a potential advantage over their peers at other MMS affiliated Clinical Schools of at least one extra formal practice examination.

The results of the CBA program were not included in the study cohort’s academic results, which ensured that Stream Two and Three students were not potentially academically compromised or advantaged by the research process, compared to their peers at other Clinical Schools.

All data sets were de-identified and stored according to University of Melbourne ethics guidelines.

3.4.5 The Educational Intervention

The Educational Intervention (EI), entitled ‘Transition to Intern’, incorporated procedural skills into a two-day immersion simulation program. The aim was to produce an immersive case-based simulated experience of common tasks and decisions required of interns on a daily or frequent basis. Interns are expected to perform a number of tasks and common procedures unsupervised. The EI aimed to give them a simulated facilitated clinical experience to practice their readiness to independently perform these tasks. It was beyond the scope of the program to include uncommon or more senior tasks above the intern’s job description.
The Educational Intervention objectives were to:

- Revise and practice invasive and non-invasive procedural skills learned over the previous 5.5 years.
- Appropriately implement these skills during simulated patient scenarios (utilising two volunteer simulated patients and mannequins).
- Use high-fidelity case-based sessions to enhance clinical reasoning, teamwork, procedural, charting and communication skills.
- Enhance basic and advanced life support knowledge and skills, including completing an advanced life support certificate (Australian Resuscitation Council 2011b).
- Consolidate case-based assessment, history taking, clinical decisions and management.
- Review and practice interactive communication skills with patients, peers and supervising senior doctors.

Students undertook the intervention when placed at The Royal Melbourne Hospital Clinical School, during either their Surgical or Medical rotation. In total, this intervention was delivered five times to groups of 18 students on each occasion. The students rotated between concurrent sessions in teams of six, allocated in no particular order (See Appendices 2 & 3 for timetables).

Key features of the Educational Intervention planning ensured the program was underpinned by the concept of scaffolded learning where the sessions began with base skills and knowledge, then escalated in a graduated complexity over the two days (Issenberg et al 2005).
These features included:

- Procedural skills practice on part-task trainers.
- Medium fidelity case-based simulation sessions with a mannequin.
- High fidelity case-based simulation sessions with trained Volunteer Simulated Patients (VSP) and appropriate part-task trainers placed in anatomically correct positions to the patient. All medical equipment and consumables were available to assess and ‘treat’ the patient, such as an electrocardiograph (ECG) machine, continuous cardiac monitoring and defibrillator, intravenous cannulae, intravenous fluids and oxygen therapy. Clinical decisions were required to select the appropriate management. Enhancing communication with the patient as well as with each other was a focus.
- All sessions utilised appropriate feedback techniques. Procedural skill sessions used a check list and direct observation supervision for correct technique guidance. The medium fidelity sessions utilised the ‘Plus/Delta’ format. The high fidelity VSP sessions utilised the ‘Advocacy/Inquiry’ technique (Fanning & Gaba 2007, Rudolph et al 2008).
- All sessions were embedded with communication skills and techniques such as ISBAR (Thomson et al, 2011), communication with patients, relatives, colleagues and medical hierarchy.
- Timetabling and conditions that simulated a day’s work. Students were briefed on the requirement for punctuality and compulsory attendance. This included a discussion on handover between shifts.

The students were randomly allocated into teams of five or six for each day. Over the two days, each student had several occasions in which they alternately led or were a team member in assessment and management of the simulated cases.

3.4.6 Competency-Based Assessment Program: The OSCE

The Objective Structured Clinical Examination (OSCE) provides an assessment format utilised by many medical schools. The OSCE consists of focused clinically-based tasks
the student must complete within a few minutes e.g. examine a joint, or take a specific history, such as dietary history for a diabetic patient. The OSCE format is particularly suited to technical skills.

Since its introduction in the 1970s (Harden & Gleeson 1979), the OSCE has been used to produce a reliable format for testing large numbers of students. The OSCE format can be used for both high-stakes and formative assessments (Pugh, Touchie, Wood & Humphrey-Murto 2011). The OSCE to assess procedural skills has been studied and recommended for use (Chipman & Schmitz 2009; Promes et al 2009; Pugh et al 2011).

The study cohort students had undertaken OSCE examinations in both pre-clinical and clinical years of their MBBS course. Since 2001 it was common practice for one procedure to be included in summative external Melbourne Medical School (MMS) OSCE examinations held in the clinical years. The standard MMS time limit allocated for the procedural OSCEs was eight minutes (Personal communication Dr David Smallwood). These OSCEs had always been norm-referenced, with students awarded a mark out of 40 (Ricketts 2009). Taking all factors into consideration, including program feasibility and students’ familiarity, this study utilised the OSCE format. The assessment format was altered to a criterion-based pass/fail hurdle assessment (Ricketts 2009). This would deliver the required, consistent standards for each component of the procedures.

The assessment program design started with setting priorities and outcomes:

- Select the four most common invasive and/or clinically important procedures that an intern performs.
- Establish a feasible, reliable and contextually valid procedural skills assessment process to assess these skills.
- Design the assessment program for implementation in both WH and RMH Clinical Schools

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5 Dr David Smallwood, Senior Lecturer, Chair, Clinical Assessment Committee, Medical Education Unit, Melbourne Medical School, University of Melbourne. Email received Wednesday 11/04/2012, 1.56PM
• Adapt previously graded procedural skills OSCEs to reflect minimum procedural competency standards.

The selection of the skills for assessment was made by a panel of experts. The panel included the Clinical Nurse Educators Group (MMS) and members of the Clinical Assessment Committee (MMS). Panel members combined expertise in clinical, procedural and academic domains. Most panel members worked within the public hospital system, and were familiar with, and supervised, the daily work of the intern. The four procedural skills selected were Intravenous Cannulation, Venepuncture, Male Indwelling Catheter Insertion (Catheterisation) and Basic Life Support. It was decided that students who failed a Post-Test CBA would be remediated, but it was beyond the scope of this study to analyse that data.

3.4.7 Competency-Based Assessment - Deciding Critical Errors

Setting best-practice clinical standards was the notion guiding the design of the assessment tools. The marking guide needed to be clear on the standard of performance the student was required to demonstrate.

The specific and detailed decisions guiding the adaption of the OSCE tools were made using the procedural policies found in the two hospitals to which the students were attached: The Royal Melbourne and Western Hospitals (Melbourne Health 2010a; Western Health 2010).

The decisions were made by determining the Critical Errors (See Chapter Two, 2.3.10.3) The use of Critical Errors was indicated for the decisions on competency standards, because improper performance or omission of particular steps of each procedure was considered detrimental to safety for either the patient or staff performing these procedures in the clinical setting (Australian Medical Council 2010b).

For the purpose of this prospective study, each step in the relevant procedural policies was assessed by a panel of experts (The Melbourne Medical School Clinical
Nurse Educators Group) to decide which steps were so important that an error in the step constituted a Critical Error.

Final decisions regarding the CBA marking guides were

- Students who made a Critical Error would fail the CBA
- Students who made two or more non-Critical Errors would fail the CBA. In the results, this would be identified as knowledge or technique errors. Two non-Critical errors would constitute one Critical Error, for the purpose of data collation.

Previously validated OSCEs for the skills to be tested were obtained from the Clinical Assessment Committee, Melbourne Medical School (MMS), The University of Melbourne.

These OSCEs were then updated and adapted according to the clinical and educational procedural decisions made after the RMH/WH policy and CBA criteria reviews. These adjusted OSCEs were then reviewed and approved for the study implementation by the Clinical Assessment Committee, MMS. See Appendices 7, 8, 9 & 10 for the CBA examination mark sheets.

3.4.8 The External MMS OSCE - Cut Score Standard-Setting

The Borderline Regression Method when used for Cut Score calculation involves detecting the number of borderline candidates, where the examiners are unsure if the candidate has passed or failed. All candidates then receive a global rating of pass/borderline/fail of the candidates’ overall performance as nominated by the examiner, in addition to the total score achieved. To calculate the cut score using the Borderline Regression Method, the checklist score (the OSCE marking guide) and the global rating scores from all the examiners from that station are used to produce a regression equation. The advantage of the Borderline Regression Method is that it uses all of the candidates’ data for setting the pass mark and not just the scores from the
candidates rated as borderline (Wood, Humphrey-Murto & Norman 2006; Liu & Liu, 2008). The MMS Cut Score for the external Procedural Skill OSCE data is presented in Chapter Four.

**3.4.9 Competency-Based Assessment Implementation**

The Competency Based Assessment was implemented mindful of the requirement to reduce the potential for inter-rater, inter-case, and inter-observer error (Swanson, 1987). See section 2.3.7 for a description of these phenomena. The use of two separate locations for the assessments required some very specific pre-planning.

The following procedures were implemented to reduce these errors. The two Clinical Schools co-ordinated to provide consistent assessment programs with the pre- and post-testing stations replicated as closely as possible. Each station was eight minutes long, with standardised instructions. Examiners expert in each skill were selected and briefed in writing and by demonstration (Appendix 5).

Standardised equipment and set-up of each station was established by photographs and instructions. Each task was performed on a part-task trainer. Students were briefed in writing and immediately before the CBA on the examination topics and process. The procedures being examined were clarified by ensuring the student instructions matched the room and the equipment setup with the OSCE assessment sheet.

Prior to testing, OSCE-experienced Clinical School administration staff from both Clinical Schools met to agree on a co-ordinated implementation of the examination timing and flow of students from station to station. The first testing was held at RMH Clinical School and the WH Clinical School staff participated to clarify and confirm consistency between venues. Administration staff collected the marking sheets and entered results into a data base. All paperwork (including marking sheets) was kept in locked, secure files.
All students were familiar with the assessment style, having undergone OSCEs in each year of their six-year course. They had previously undertaken one procedural OSCE in their fourth and fifth year examinations respectively, with previous OSCE examination practice in the simulated learning environment. Students were unfamiliar with the AMC concept of a critical error leading to a failure of the test, but the change of assessment format did not change the undertaking of the procedural examinations from the students’ perspective.

3.4.10 Student Confidence

As a voluntary exercise, students in each stream completed a non-validated survey based upon an intern’s job description (Australian Curriculum Framework 2006; Melbourne Health 2010b) immediately prior to their Competency-Based Assessments and the external OSCE. The survey was used as a simple assessment tool to enable the researcher to compare confidence to perform the procedures and assessment outcomes.

A modified Likert scale was used by the students to rate their confidence to perform a variety of tasks unsupervised, including performance of the four procedures measured in this research (Likert 1932). To the statement “Today, I feel confident to perform unsupervised the following skills in my intern year,” students were asked to answer with either “Yes”, “Somewhat”, or “Not at all” (See Appendix 4).

The outcomes from both their CBA and external OSCE were later compared to their self-reported confidence level.

3.5 Variables

One independent and one dependent variable were measured. One outcome, with two components, was determined.

- The Independent Variable for this research is the curriculum the student received.
- The Dependent Variable for this research is the performance of the student.
• The Outcomes of the research are the findings, demonstrated by the results in the Competency-Based Assessment, and the results in the final procedural OSCE examination.

3.6 Data Collection

All student data sets were collected, collated and each student was allocated a de-identified number to allow tracking of student results throughout the research period. In the Competency-Based Assessment, completed confidence sheets and mark sheets were collected, collated and de-identified. The CBA results were entered into a dedicated database after each testing occasion. The day prior to the MMS OSCE, the cohort students completed the final Confidence sheet.

From the external MMS examinations, two types of data sets were obtained. In the first data set, individual results from the study cohort were obtained. In the second data set, the overall results summary of all final year students was obtained. This included summarised results from other Clinical Schools. All confidence sheets and MMS OSCE data sets were collated, added to the file of the cohort student’s CBA results, and de-identified.

3.7 Statistical Analysis

3.7.1 Overview

The traditional approach to sample size calculation is limited in this study context because of the uneven cohort size. This reduced the chance of finding a statistically significant result in the analysis, although significance testing remains useful to look for the direction of an effect (Harris, cited in Mitchell & Jolley, 2007). Statistical analysis was designed while being mindful of the application and interpretation of the results (Myles & Gin 2000). A Confidence Interval of 95% was calculated (Myles & Gin 2000).
3.7.2 The Competency-Based Assessment Analysis

The Competency-Based Assessment was designed to give one of only two results: Pass or Fail, making this dichotomous, categorical data. Analysis methods recommended for this data include a Fisher’s Exact Test or chi-square as appropriate. The Fisher’s Exact Test calculates an exact probability (Myles & Gin 2000), and is used for analysis of a 2X2 table used for smaller samples if the expected cell frequency is less than 10 (Bower 2003). Chi-square testing was used to analyse all other components of categorical data (Myles & Gin 2000).

The level of significance was set at a p value less than 0.05 for all tests.

3.7.3 The External MMS Objective Structured Clinical Examination

The external academic OSCE examination was analysed using a different technique. This examination was graded, with students able to obtain any score between 0-40. This technique results in data classified as both continuous and either an interval or ratio scale (Myles & Gin 2000). Techniques that calculate the variances between the groups were utilised. The cohort of students in the study was measured against their peers at other metropolitan Clinical Schools, allowing more power to the calculations. The One-Way ANOVA was utilised to test for significant differences between the means of the two groups. Continuous data (the examination results) was assessed for normality.

The level of significance was set at a P value of less than 0.05 for all tests. The descriptive statistics were presented as mean and 95% Confidence Interval and a percent N (%) for categorical data (De Vaus 2002; Morgan, Leech Gloeckner & Barrett 2011).

The MMS utilises the mode of ‘Cut Scores’ (see Chapter Two section 2.3.10.2) to determine if a candidate has passed or failed an OSCE. The Borderline Regression method was used to calculate the Cut Score in this OSCE (Reid & Dodd 2011).
3.8 Reliability and Validity of the Research

3.8.1 Overview

Reliability can be defined as the reproducibility or consistency of a test or program. This can be affected by many factors, both human and environmental (Wass et al 2001). Validity relates to whether we do or measure what we set out to do or measure. In this study, the researcher aimed to develop a reliable and valid process that would consistently deliver an appropriate Educational Intervention (EI) and measure the effects of this EI on one component of student performance (procedural skills competency in the simulated setting).

Students were examined and data collected on five separate occasions for both the Intervention and the performance measurement. Validity can be difficult to guarantee and can be affected by many known and unknown factors. All feasible strategies were used to optimise the reliability and validity of the intervention, assessment and data collection (Davies & Howells 2004). Section 3.4.9 outlines these strategies.

3.8.2 The Educational Intervention

The Educational Intervention (EI) was in its third iteration, having been already delivered to the final year RMH/WH clinical school students in 2009 and 2010. All key clinical teachers were also involved in the preparation, delivery and evaluation of the first two iterations.

This enabled a smoothly-run simulation education program delivered by staff experienced in the sessions (see Appendices 2 & 3) for program. All teachers were experienced medical educators, as well as being clinical experts in their fields. Participants completed program evaluations at the end of each of the two days. These evaluations were reviewed after each intervention.

To optimise the relevance of the EI, it was designed according to the published recommendations for simulated learning for health professional education. Curricula
recommendations for interns, combined with clinical and educational experience, were used to design specific session content (Australian Curriculum Framework 2006).

### 3.8.3. Competency-Based Assessment

As stated earlier, (sections 3.4.6, 3.4.7 & 3.4.9), The Royal Melbourne and Western Hospital Clinical Schools worked jointly on both the design and delivery of the OSCE-style assessments. Briefings for both administration staff and examiners were extensive. The strategies to optimise inter-rater reliability, inter-case reliability and inter-observer reliability were implemented (Swanson, 1987; Swanson et al 1995; Davies & Howells 2004). The same adapted OSCE-style mark sheets were used at all CBA examinations.

At the end of each examination session, the administration staff collected the assessment sheets, entered results into the data base and securely filed the hard copies. The research/teaching staff did not view any overall results until the end of the research period. This was aimed to reduce any potential in-semester influences on the teaching and assessment from the researcher and teaching colleagues.

### 3.8.4 Melbourne Medical School OSCE

The researcher considered the external examination as both valid and reliable, as it had gone through the formal University of Melbourne assessment validation processes. OSCE results data sets provided by the Melbourne Medical School were analysed with the assessment and statistical analysis methods as described.

Reliability and standardisation in the seven different examination Clinical School sites was obtained by the previously standardised and delivered MMS methods. This included written and verbal examiner briefings, photographic and written descriptions of the equipment and set up, and the standardised marking guide. All students sat the same examination in all locations. All Metropolitan students undertook their MMS OSCEs at a Clinical School different from their own. This is standard practice by the MMS to enhance examiner objectivity and reduce the potential for examiner-student familiarity and bias. This is not feasible for Rural Clinical School students, due to the
geographical distances involved for students to swap between hospitals. Hence, this factor precluded any Rural Clinical School student results being utilised for the MMS OSCE analysis for the purposes of this study.

3.9 Summary

In this chapter, the research design, methodology, methods and limitations have been presented. The rationale for choosing to undertake a quasi-experimental study has been outlined. An explanation of the selection of the analysis techniques has also been provided. It is hoped that the care with which this was done, within the constraints and limitations of having to deal with existing course and cohort structures supports the claim that the results are plausible and even trustworthy (i.e. valid and reliable). In the next chapter, the results obtained from the research will be presented and analysed.
CHAPTER FOUR

RESULTS

4.1 Preamble

This project sought to evaluate whether the Educational Intervention (EI) improved performance of procedural skills in a cohort of final year medical students. In this chapter, the results of the study will be presented.

Section 4.2 describes the sample population and the distribution of students across the three Streams used in the study.

Section 4.3 will present the results of the in-house Competency-Based Assessment (CBA) for the study cohort over four assessment tasks.

Section 4.4 will present the results comparing the study cohort with the external examination results from other Melbourne Medical School (MMS) Clinical Schools, University of Melbourne.

Section 4.5 and 4.6 will present results from the Competency-Based Assessment reliability outcomes, and selections from the Confidence survey.

4.2 The Sample

The final size of the study cohort was 100 students. Seven students were withdrawn from the study when they were unable to complete all Competency-Based Assessment program components allocated to their Stream. The students who were withdrawn from the study still received their allocated teaching. Table 4.1 demonstrates the final sample in each Stream from which the data sets were used for results analysis.
### Table 4.1 Final Sample by Stream

<table>
<thead>
<tr>
<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=18</td>
<td>n=43</td>
<td>n=39</td>
</tr>
</tbody>
</table>

- **Pre-Test**: Usual curriculum, Educational Intervention, Educational Intervention
- **Post-Test**: Post-Test, Post-Test, Post-Test
- **External exam**: External exam, External exam, External exam

A comparison of the results of the students in this study cohort against the results of the students from other University of Melbourne Clinical Schools was considered an endpoint in this evaluation to determine efficacy of the learning strategy within the Clinical School study cohort. Given that the populations to be studied were of a predetermined size, a prospective sample size calculation was not relevant.

However, as this study comprised a number of smaller, secondary queries investigated with smaller samples sizes via Streams, data is evaluated mindful of the risk of a Type II error (Schneider, Whithead, Elliott, Wood-Lobiondo & Haber 2007).

The collated descriptive data will now be reported.

### 4.3 Competency-Based Assessment

#### 4.3.1 Competency-Based Assessment Outcomes

The results of the 100 students in the three Streams were examined. Outcomes of the four procedural skills are presented by each Stream. See Appendix 1 for the timeline of the research activities.
Stream One (n=18) became the comparison group in this project. Stream One was examined after receiving the existing ‘usual’ curriculum for procedural skills education and revision for final year medical students.

Students from Stream Two (n=43) received the EI on one of five possible occasions. Their assessment occurred between 18 - 60 days post the EI.

Students in Stream Three (n=39) received the EI on one of five possible occasions. They undertook pre- and post-EI testing. Students in this Stream were tested within 28 days of completing the EI.

The results by Stream over each of the four assessment tasks were analysed. Assessment in each Stream resulted in a categorical outcome of pass or fail. Chi-square testing identified that there was no statistically significant difference in results in three of the four assessment tasks. Table 4.2 demonstrates the Post-Test CBA outcomes by Stream.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Stream One Pass (%) n=18</th>
<th>Stream Two Pass (%) n=43</th>
<th>Stream Three Pass (%) n=39</th>
<th>χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP</td>
<td>15 (83%)</td>
<td>34 (79%)</td>
<td>37 (95%)</td>
<td>4.371</td>
<td>0.11</td>
</tr>
<tr>
<td>IVC</td>
<td>8 (44%)</td>
<td>30 (70%)</td>
<td>34 (87%)</td>
<td>11.343</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>BLS</td>
<td>10 (56%)</td>
<td>34 (79%)</td>
<td>27 (69%)</td>
<td>3.505</td>
<td>0.17</td>
</tr>
<tr>
<td>IDC</td>
<td>6 (33%)</td>
<td>22 (51%)</td>
<td>18 (46%)</td>
<td>1.624</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Note: P<0.01* Legend: VP = Venepuncture, IVC = Intravenous Cannulation, BLS = Basic Life Support, IDC = Male Indwelling Catheterisation

The Intravenous Cannulation examination revealed a statistically significant (0.003, p<0.01) improvement in both Intervention streams compared to Stream One. It is noted that this is the only procedural skill tested that produced a statistically significant result.
All Streams recorded low pass rates in the Male Indwelling Catheter examination, with Stream Two the only Stream to have more than half the cohort (51%) pass the examination. Potential reasons for the outcomes in this procedure will be presented in Chapter Five.

Stream Three performed slightly better overall than Stream Two, and both recorded more total passes per student than did Stream One. A number of students passed all four Post-Test CBA examinations. Per student, Stream Three students passed all four examinations more frequently. See Table 4.3 for the Post-Test CBA pass rates.

<table>
<thead>
<tr>
<th>Table 4.3 Post-Test CBA Outcomes Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-program Results Totals</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total number of CBA’s per Stream</td>
</tr>
<tr>
<td>Total Passes</td>
</tr>
<tr>
<td>No. students passed all four CBA’s</td>
</tr>
</tbody>
</table>

* Fisher’s Exact test p value < 0.05

There is a statistical significance in outcomes between Streams for combined totals of passes. Results also indicate that students from the EI Streams Two and Three were more likely to pass all four of the Post-Test examinations. The suppositions for this will be discussed in Chapter Five.

**4.3.2 Critical Error Analysis**

This section reports the incidence of Post-Test Critical Errors made by students that led to failure of a CBA examination (See Section 3.4.7 and Appendices 7 - 10). Some students failed in more than one category in each CBA, particularly evident in Intravenous Cannulation and Indwelling Catheterisation. The category of ‘Timed Out’ indicates the student had not completed the examination within the allocated eight minutes. The OSCE time limit of eight minutes was set because this was the standard
time used since 1998 by the MMS for procedural skills that had been examined in the external OSCE (see section 3.4.6) Some students did not pass the Post-Test CBA because they failed to competently perform two or more non-Critical Error steps in the examination and these points of failure are categorised into Knowledge or Technique.

Table 4.4 demonstrates the number of students who failed a Post-Test CBA with the total number of Critical Errors per failed student.

Table 4.4 Summary: Post-Test CBA Critical Errors

<table>
<thead>
<tr>
<th>Post-Test CBA</th>
<th>Stream One n= 18</th>
<th>Stream Two n=43</th>
<th>Stream Three n=39</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP</td>
<td>FS No. (%)</td>
<td>CE (Total)</td>
<td>CE Range</td>
</tr>
<tr>
<td></td>
<td>3 (17%)</td>
<td>3 1</td>
<td></td>
</tr>
<tr>
<td>IVC</td>
<td>10 (56%)</td>
<td>18 1-3</td>
<td></td>
</tr>
<tr>
<td>BLS</td>
<td>8 (44%)</td>
<td>8 1</td>
<td></td>
</tr>
<tr>
<td>IDC</td>
<td>12 (67%)</td>
<td>23 1-4</td>
<td></td>
</tr>
</tbody>
</table>

Legend: FS = No of failed students
: CE = Critical Error
: CE Range = Number of Critical Errors per failed student

Tables 4.5 - 4.8 detail the categories of Critical Error that led to a student failing each Post-Test CBA examination. The category labelled ‘Knowledge or Technique’ summarises where students were noted to have deficits in correct patient identification technique, knowledge of equipment use, or the sequence of steps to follow when performing the procedure. Potential reasons for these results will be discussed in Chapter Five.

Tables 4.5 - 4.7 detail the type of Critical Errors made in each Post-Test CBA. The number of failures is less than the number of Critical Errors because some students recorded more than one Critical Error.
Table 4.5 Critical Errors in Venepuncture

<table>
<thead>
<tr>
<th>Stream (FS/n)</th>
<th>Hand Hygiene</th>
<th>Asepsis</th>
<th>Timed Out</th>
<th>Sharps Breach</th>
<th>Technique or knowledge</th>
<th>Students with &gt; one error</th>
</tr>
</thead>
<tbody>
<tr>
<td>One (3/18)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Two (9/43)</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Three (2/39)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend: FS = Failed student

In venepuncture, most errors were made in the knowledge or technique category. Stream Two demonstrated more errors per examination failure than the other Streams.

Table 4.6 Critical Errors in Intravenous Cannulation

<table>
<thead>
<tr>
<th>Stream (FS/n)</th>
<th>Hand Hygiene</th>
<th>Asepsis</th>
<th>Timed Out</th>
<th>Sharps Breach</th>
<th>Technique or knowledge</th>
<th>Students with &gt; one error</th>
</tr>
</thead>
<tbody>
<tr>
<td>One (10/18)</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Two (13/43)</td>
<td>0</td>
<td>12</td>
<td>1</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Three (5/39)</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend: FS = Failed student

Intravenous cannulation demonstrated a high number of errors in the Asepsis, Sharps and Technique categories. Many students made more than one error during the examination. The contrasting low number of errors by Stream Three is noted.
Table 4.7 Critical Error in Basic Life Support

<table>
<thead>
<tr>
<th>Stream (FS/n)</th>
<th>Timed Out</th>
<th>Technique or knowledge</th>
<th>Students with &gt; one error</th>
</tr>
</thead>
<tbody>
<tr>
<td>One (8/18)</td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Two (9/43)</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Three (12/39)</td>
<td>3</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>

Legend: FS = Failed student

In Basic Life Support, the majority of errors occurred with flaws in the technique or knowledge category. The higher number of errors made by Stream Three compared to Stream Two is noted.

Table 4.8 Critical Errors in Male Indwelling Catheterisation

<table>
<thead>
<tr>
<th>Stream (FS/n)</th>
<th>Hand Hygiene</th>
<th>Asepsis</th>
<th>Timed Out</th>
<th>Technique or knowledge</th>
<th>Students with &gt; one error</th>
</tr>
</thead>
<tbody>
<tr>
<td>One (12/18)</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Two (21/43)</td>
<td>7</td>
<td>11</td>
<td>9</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Three (21/39)</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>17</td>
<td>9</td>
</tr>
</tbody>
</table>

Legend: FS = Failed student

In Indwelling Catheterisation, the number of Critical Errors per student for both Stream One and Three is more than for Stream Two. The number of Hand Hygiene and Asepsis Critical Errors made by Stream One and Two is noted. The number of Technique & Knowledge Errors made by Stream Three is also noted.

Each Stream had a higher number of students failing this CBA more than any other Post-Test examination. Discussion around the different Critical Errors made in this examination can be found in Chapter Five.
4.3.3 Test Familiarity Effects

To assess for a potential Test Familiarity response, the Post-Intervention results were compared between Stream Two and Stream Three. Stream Three had received the potential advantage of a Pre-EI CBA Test. The assessment component of the Pre-Test replicated all assessment components of the Post-Test. The point of difference was that Stream Three did not receive any individual or specific group feed-back on their Pre-Test results. The results for each Stream are found in Table 4.9. The Fisher’s Exact Test for two proportions was used to determine statistical significance.

Table 4.9 Test Familiarity Outcomes for Streams Two & Three.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Stream 2</th>
<th>Stream 3</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=43</td>
<td>n=39</td>
<td></td>
</tr>
<tr>
<td>VP</td>
<td>Pass (%)</td>
<td>Pass (%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>34 (79%)</td>
<td>37 (95%)</td>
<td>0.05</td>
</tr>
<tr>
<td>IVC</td>
<td>30 (70%)</td>
<td>34 (87%)</td>
<td>0.07</td>
</tr>
<tr>
<td>BLS</td>
<td>34 (79%)</td>
<td>27 (69%)</td>
<td>0.33</td>
</tr>
<tr>
<td>IDC</td>
<td>22 (51%)</td>
<td>18 (46%)</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*Fisher’s Exact Test p value <0.05
Legend: VP = Venepuncture, IVC = Intravenous Cannulation, BLS = Basic Life Support, IDC = Male Indwelling Catheterisation

Overall, Stream Two recorded a higher pass rate in Basic Life Support and Male Indwelling Catheterisation, while Stream Three recorded a higher pass rate in Venepuncture and Intravenous Cannulation. None of these comparisons were statistically significant.

4.3.4 Skill Retention

Comparison was made within Stream Two, investigating results for the sub-group who had a 60-day interval between EI and Post-Test CBA and the sub-group of students who had their Post-Test CBA 18-25 days after the EI. To reduce potential skewing of results by different testing venue influences, comparison was made only between the two
Stream Two sub-groups who were tested at Western Hospital. The Stream Two sub-group tested at RMH had attended Epworth Hospital and were therefore potentially influenced by a different hospital environment, as well as a different testing venue. A Fisher’s Exact Test of two proportions was applied to investigate the results. Table 4.10 demonstrates the results.

Table 4.10 Post-CBA Outcomes: Skill Retention

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Interval 18-25 days n=15 Pass (%)</th>
<th>Interval 60 days n=13 Pass (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP</td>
<td>12 (80%)</td>
<td>8 (62%)</td>
<td>0.41</td>
</tr>
<tr>
<td>IVC</td>
<td>12 (80%)</td>
<td>6 (46%)</td>
<td>0.11</td>
</tr>
<tr>
<td>BLS</td>
<td>11 (73%)</td>
<td>11 (85%)</td>
<td>0.66</td>
</tr>
<tr>
<td>IDC</td>
<td>11 (73%)</td>
<td>8 (62%)</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*Fisher’s Exact Test p value < 0.05

Legend: VP = Venepuncture, IVC = Intravenous Cannulation, BLS = Basic Life Support, IDC = Male Indwelling Catheterisation

In three out of four Post-Test CBA examinations, the short-interval sub-group obtained more passes. The trend is most notable in Venepuncture and Intravenous Cannulation. Almost twice as many short-interval students passed Intravenous Cannulation, than did the long-interval group. The long-interval sub-group obtained more passes in Basic Life Support. Given the small numbers, there was no statistically significant difference between sub-groups.

4.3.5 Clinical Exposure Effects

Stream Three students undertook both Pre and Post CBA Testing. Stream Three were divided into three sub-groups, according to whether they were in term 1, 2 or 3. Appendices 1 and 2 outline the term rotations as well as the Pre-Post testing and EI timelines.
Most students failed most tests at the Pre-Test, irrespective of the term in which they undertook the CBA. Table 4.11 demonstrates the Stream Three Pre-Post Test Outcomes. Each Stream Three term 1, 2 or 3 sub-group demonstrated a statistically significant difference between the Pre and Post-Test outcomes (p<0.01).

Table 4.11 Summary of Stream Three Pre-Post Test Outcomes

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Overall n=39</th>
<th>No. Pass (%)</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>VP</td>
<td>3 (8%)</td>
<td>37 (95%)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>IVC</td>
<td>3 (8%)</td>
<td>34 (87%)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>BLS</td>
<td>1 (2%)</td>
<td>27 (69%)</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>IDC</td>
<td>3 (8%)</td>
<td>18 (46%)</td>
<td>&lt;0.01*</td>
</tr>
</tbody>
</table>

*Fisher’s Exact Test p < 0.01

The Stream Three term sub-group results are presented. Clinical exposure did not improve the Pre-Test CBA outcomes of either term 2 or term 3 sub-groups. The term 2 sub-group had the potential advantage of one term of clinical exposure. The term 3 sub-group had the potential advantage of two terms of clinical exposure, but the Pre-Test results were not markedly different from the term 1 sub-group. The term 1 sub-group were tested on the first day of their final semester, before any clinical exposure. Table 4.12 demonstrates the term sub-group Pre-and Post-EI test results.
Table 4.12 Stream Three Sub-Groups Pre-Post Test Outcomes

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Term One n=13</th>
<th>Term Two n=14</th>
<th>Term Three n=12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post Test</td>
<td>Pre-test</td>
</tr>
<tr>
<td>VP</td>
<td>0</td>
<td>12 (92%)</td>
<td>2 (14%)</td>
</tr>
<tr>
<td>IVC</td>
<td>1 (7%)</td>
<td>13 (100%)</td>
<td>2 (14%)</td>
</tr>
<tr>
<td>BLS</td>
<td>0</td>
<td>6 (46%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>IDC</td>
<td>0</td>
<td>7 (54%)</td>
<td>2 (14%)</td>
</tr>
</tbody>
</table>

Legend: VP = Venepuncture, IVC = Intravenous Cannulation, BLS = Basic Life Support, IDC = Male Indwelling Catheterisation

Students in all terms passed more examinations following attendance at the EI. Overall Pre-Post Testing CBA results demonstrate a statistically significant result (p<0.001) for all procedures after the EI. Suppositions for this will be discussed Chapter Five.

4.4 Melbourne Medical School External Objective Structured Clinical Examination

4.4.1 The Sample

A total of 325 Melbourne Medical School students sat the final external examinations. These examinations took the form of Objective Structured Clinical Examinations (OSCE). This population was comprised of the study cohort and all other final year medical students. The population distribution was:

- Metropolitan Clinical School A (n=110)
- Metropolitan Clinical School B (n=77)
- Rural Clinical Schools (n=31)
- Western Hospital Clinical School, who were Stream One in the Study cohort (n=18)
Royal Melbourne & Western Hospitals Clinical Schools (n=89), who included the 82 students from the Study cohorts of Stream Two & Three, as well as the seven students (who had undertaken the Educational Intervention) who were not able to be included in the CBA analysis.

From this total population, data was analysed from the WH and WH/RMH study Streams and the educationally and clinically similar Metropolitan Schools A and B. For the consistency of comparisons based on metropolitan conditions, results from rural-based students were not included. The population for this evaluation, n=294 therefore became the final sample.

The Melbourne Medical School selected Intravenous Cannulation as the procedure to be tested at these examinations, in conjunction with two physical and two medical history stations. All students were kept blinded to the procedural skill OSCE until each student began the station.

4.4.2 Metropolitan Clinical School Outcomes

The Intravenous (IV) Cannulation OSCE assessment task allowed students to achieve a maximum of 40 marks for this examination. All results presented are adapted from the MMS results report ‘Semester 12 Assessment Results 2011’ (Reid & Dodd 2011).

Results followed the normal distribution. This report includes all RMH/WH students, including the seven students whose results were not entered into the CBA analysis. Table 4.13 reports the mean and spread of results for each of the Metropolitan Clinical Schools (n=294) in this assessment task.
Table 4.13 Clinical Schools Intravenous Cannulation OSCE Outcomes

<table>
<thead>
<tr>
<th>Clinical School</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Metro School A</td>
<td>31.5</td>
<td>4.63</td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>Metro School B</td>
<td>32.4</td>
<td>4.22</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>RMH/WH</td>
<td>34.0</td>
<td>4.24</td>
<td>19</td>
<td>40</td>
</tr>
<tr>
<td>Western Health</td>
<td>33.4</td>
<td>4.12</td>
<td>22</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: adapted from Semester 12 Assessment Results (Reid & Dodd, 2011, p.4).

Table 4.13 identifies that The Royal Melbourne and Western Hospital (WH) Clinical Schools' students achieved the highest mean and the smallest spread of results as evidenced by the range. Metropolitan School B demonstrated the widest spread of minimum to maximum results.

Using the Borderline Regression Method (Chapter 3.7.3), the predicted cut score (the pass score) for the examination was set at 28.1 out of 40. From the 294 students, 40 students (17%) failed this examination. The outcomes for Clinical Schools A & B have been combined for this table. Table 4.14 demonstrates the distribution of the metropolitan students who passed with a score of 28.1 or higher. This table includes the non-study students for RMH and WH.
### Table 4.14 OSCE Pass rates by Cut Score

<table>
<thead>
<tr>
<th></th>
<th>WH n=18</th>
<th>WH/RMH n=89</th>
<th>Metro A &amp; B n=187</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>17 (94%)</td>
<td>79 (89%)</td>
<td>148 (79%)</td>
</tr>
</tbody>
</table>

#### 4.4.3 Study Cohort Stream Results

This section compares the overall results of the OSCE examination between the study cohort streams. The Intravenous (IV) Cannulation OSCE assessment task enabled students to achieve a maximum of 40 marks for this examination. Results followed the normal distribution. Stream One n=18; Stream Two n=43; and Stream Three n=39 were compared. The box and whisker plot demonstrates the median, interquartile range and range (Myles & Gin 2000): see Figure 4.1. Stream Three recorded the highest mean and smallest range of results.

![Boxplot of IV cannula OSCE/40](image)

Figure 4.1 IV Cannulation assessment outcomes between streams

Statistical analysis comparing the OSCE Intravenous Cannulation results of Streams One, Two and Three was conducted using a One-way ANOVA. The mean result in Stream Two was less than for the Streams One and Three, however results were not statistically significantly different between streams, p=0.12.
4.4.4 Comparisons with Metropolitan Schools A and B

The individual cohort Stream results were compared to Clinical Schools A and B. Table 4.15 shows the descriptive results for each stream compared to Metropolitan Clinical Schools A & B.

Table 4.15 Study Cohort Comparisons with Metropolitan Schools

<table>
<thead>
<tr>
<th>Clinical School</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro School A</td>
<td>31.5</td>
<td>4.63</td>
<td>18-40</td>
<td>110</td>
</tr>
<tr>
<td>Metro School B</td>
<td>32.4</td>
<td>4.22</td>
<td>15-40</td>
<td>77</td>
</tr>
<tr>
<td>Stream Three</td>
<td>35.0</td>
<td>3.34</td>
<td>24-40</td>
<td>39</td>
</tr>
<tr>
<td>Stream Two</td>
<td>33.19</td>
<td>4.92</td>
<td>19-39</td>
<td>43</td>
</tr>
<tr>
<td>Stream One</td>
<td>33.4</td>
<td>4.12</td>
<td>22-40</td>
<td>18</td>
</tr>
</tbody>
</table>

Source: adapted from Semester 12 Assessment Results (Reid & Dodd 2011)

All three cohort study Streams had better results than comparable Clinical Schools Metropolitan A and B. Stream Three had a higher mean and a smaller range than either of the other Streams and Clinical Schools A and B.

Table 4.16 demonstrates the study cohort Cut Score pass rates. All Streams had a higher pass rate than did Metropolitan Schools A and B, with Stream One and Two students achieving the most passes per student.

Table 4.16 Cut Score Pass Rates Comparisons

<table>
<thead>
<tr>
<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
<th>Metro A &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=18</td>
<td>n=43</td>
<td>n=39</td>
<td>n=187</td>
</tr>
<tr>
<td>Pass</td>
<td>17 (95%)</td>
<td>37 (86%)</td>
<td>37 (95%)</td>
</tr>
</tbody>
</table>

Possible explanations of these results will be discussed in Chapter Five.
4.4.5 Stream Comparisons Between Post-Test CBA and OSCE Outcomes

Comparison between Streams was made regarding the Post-Test Intravenous Cannulation CBA pass rate and the pass rate for the MMS Intravenous Cannulation OSCE. Results are reviewed mindful of the different assessment methods and the variable Post-Test CBA dates for students. Table 4.17 demonstrates the outcomes comparison.

<table>
<thead>
<tr>
<th></th>
<th>Stream One n=18</th>
<th>Stream Two n=43</th>
<th>Stream Three n=39</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Test CBA (IVC)</td>
<td>8 (44%)</td>
<td>30 (70%)</td>
<td>34 (87%)</td>
</tr>
<tr>
<td>MMS OSCE Pass</td>
<td>17 (94%)</td>
<td>37 (86%)</td>
<td>37 (95%)</td>
</tr>
</tbody>
</table>

The improved pass rates from the Post-Test CBA and the MMS OSCE for all Streams is noted. The marked improved of Stream One is noticeable. Reasons for this will be raised in Chapter Five.

4.5 Competency-Based Assessment: Feasibility and Reliability.

All components of the CBA program were delivered in two separate Clinical Schools. CBA was implemented on five separate occasions over a four-month period. Feasibility of the program was demonstrated.

To assess for reliability, the Fisher’s Exact Test for two proportions was used to determine if there was a difference in results at the two testing venues. Due to the previously-noted MMS mandatory final semester rostering, this test was conducted on the Stream Two sub-groups who undertook their Post-Test CBA at either the Western Hospital or Royal Melbourne Hospital Clinical Schools. The Stream allocation was made independent of this project. Table 4.18 reports these results.
Table 4.18 Venue Reliability: Stream Two Outcomes

<table>
<thead>
<tr>
<th>Procedure</th>
<th>WH Pass (%) (n=28)</th>
<th>RMH Pass (%) (n=15)</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP</td>
<td>23 (82%)</td>
<td>11 (73%)</td>
<td>0.69</td>
</tr>
<tr>
<td>IVC</td>
<td>18 (64%)</td>
<td>12 (80%)</td>
<td>0.48</td>
</tr>
<tr>
<td>BLS</td>
<td>22 (79%)</td>
<td>12 (80%)</td>
<td>1.00</td>
</tr>
<tr>
<td>IDC</td>
<td>19 (68%)</td>
<td>3 (20%)</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

Fisher’s Exact Test p<0.01*
Legend: VP = Venepuncture, IVC = Intravenous Cannulation, BLS = Basic Life Support, IDC = Male Indwelling Catheterisation

Results are reviewed mindful of the small samples in the sub-groups. The results of the Male Indwelling Catheterisation tests are notably different, with a statistically significant p-value of 0.004 (p<0.01). Suppositions for the difference will be raised in Chapter Five. No other statistically significant results were found.

4.6 Confidence to Perform Procedural Skills

As described in Chapter Three (3.4.10), a voluntary, non-validated survey was taken immediately prior to the students undertaking their allocated CBA and MMS OSCE examinations. The survey asked the students to rate their confidence to independently perform all four procedures, unsupervised. Students rated their confidence as ‘Yes’, ‘Somewhat’ or ‘Not confident’. At the time of the MMS survey, students were blinded to the topic of the procedural OSCE. See Appendix 4 for the questionnaire.

Tables 4.19 and 4.20 demonstrate the summary of the confidence levels and the corresponding summary for all CBA outcomes. As Stream Three undertook Pre-Post Testing, the Pre-Post confidence levels and CBA outcomes are shown separately in Table 4.20.
Table 4.19 Summary of Stream One and Two Post-Test Confidence and Outcomes

<table>
<thead>
<tr>
<th>Stream</th>
<th>No. CBA Passed</th>
<th>No. CBA Not passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream One (n=18, 72 Post-Tests)</td>
<td>39 (54%)</td>
<td>33 (46%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>Not confident</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Stream Two (n=43, 172 Post-Tests)</td>
<td>120 (71%)</td>
<td>52 (39%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident</td>
<td>119</td>
<td>52</td>
</tr>
<tr>
<td>Not confident</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Stream Three responded that there was no change in the self-reported confidence level between the Pre-Post Tests, although there was a change in the pass rate. Table 4.20 shows these results.

Table 4.20 Summary of Stream Three Pre-Post Test Confidence and CBA Outcomes

<table>
<thead>
<tr>
<th>Stream Three</th>
<th>No. CBA Passed</th>
<th>No. CBA Not passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test (n=39, 156 Pre-tests)</td>
<td>10 (6%)</td>
<td>146 (94%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident</td>
<td>10</td>
<td>146</td>
</tr>
<tr>
<td>Not confident</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Post-Test (n=39, 156 Post-tests)</td>
<td>120 (77%)</td>
<td>36 (23%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident</td>
<td>120</td>
<td>36</td>
</tr>
<tr>
<td>Not confident</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The review of confidence responses from each Stream demonstrates that these students were generally confident to independently perform the procedures unsupervised in the clinical setting. CBA Outcomes were commonly contrary to the confidence levels. Students from all Streams were surveyed twenty-four hours before their MMS external OSCEs. The self-reported confidence levels and the examination results from the Intravenous Cannulation OSCE are summarised in Table 4.21. A pass in the Intravenous Cannulation MMS OSCE was awarded when a student scored at or higher than 28.1 out of 40.

<table>
<thead>
<tr>
<th>Stream</th>
<th>MMS OSCE (IVC) passed</th>
<th>MMS OSCE (IVC) CBA Not passed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stream One (n=18)</strong></td>
<td>17 (94%)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Confident</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Not confident</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Stream Two (n=43)</strong></td>
<td>37 (86%)</td>
<td>6 (14%)</td>
</tr>
<tr>
<td>Confident</td>
<td>37</td>
<td>6</td>
</tr>
<tr>
<td>Not confident</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Stream Three (n=39)</strong></td>
<td>37 (95%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Confident</td>
<td>37</td>
<td>2</td>
</tr>
<tr>
<td>Not Confident</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

All students reported they were confident to perform Intravenous Cannulation unsupervised. Again, this confidence level was often contrary to the individual student’s result. The comparisons between self-reported confidence and outcomes will be discussed in Chapter Five.
4.7 Summary

In this chapter, the results of the study were presented. The research questions were answered according to the quantitative data collected. The reported analysis addressed the research questions.

Part one of the chapter presented the results of the in-house Competency-Based Assessment for the study cohort. Students achieved either a pass or a fail after undertaking each procedural test. Results from each test were presented. Suppositions exploring the mixed results will be explored further in the Discussion Chapter.

Part Two of the chapter presented the results comparing the study cohort with the results obtained from other University of Melbourne Medical Clinical Schools. One single procedure, intravenous cannulation, was examined at the end of year external examinations. This was graded, marks from each step adding up to a maximum total of 40. The suppositions into the statistically significant results for the study cohort will be explored in the Discussion Chapter.

Where appropriate, this data was analysed to answer components of other Research Questions. The data relating to venue reliability, skill retention and test familiarity has been presented. A summary from the confidence survey has been presented.

The next chapter, Chapter Five, will discuss the implications of the results. Conclusions will be drawn from this study and recommendations made for proposed curriculum development and for future teaching and learning enquiries.
CHAPTER FIVE

DISCUSSION

5.1 Preamble

In this chapter, the results of this prospective, quasi-experimental research will be interpreted. The research questions will be discussed within the context of this quantitative study. The findings will be considered and reference made to the literature where relevant. Implications from the results of the study will be drawn and recommendations made for medical course curriculum development. Some of these recommendations have already been adopted by the Melbourne Medical School (MMS).

5.2 Recapitulation

5.2.1 Research

The study was designed to fulfil two purposes;

- To measure the effectiveness of an immersive Educational Intervention (EI) program compared to the usual curriculum when preparing final year medical students for the performance of four common procedural skills;
- To design and pilot a Competency-Based Assessment (CBA) program, with the aim of future implementation in medical curricula.

The CBA examination results became the data that was analysed to measure the effectiveness of the EI. The study cohort of one hundred final semester medical students was divided into three Streams allocated centrally by the MMS. As is evident, this partitioning of the student cohort did not act in the interests of the study design. Every five weeks, all three Streams rotated between three terms (Medical, Surgical and...
General Practice) within this fifteen-week semester. The EI and the CBA programs were implemented when students were undertaking either their Medical or Surgical rotation. Table 5.1 demonstrates the activities by Stream.

<table>
<thead>
<tr>
<th>Stream One</th>
<th>Stream Two</th>
<th>Stream Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=18</td>
<td>N=43</td>
<td>N=39</td>
</tr>
<tr>
<td>Pre-Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual curriculum</td>
<td>Educational Intervention</td>
<td>Educational Intervention</td>
</tr>
<tr>
<td>Post-Test</td>
<td>Post-Test</td>
<td>Post-Test</td>
</tr>
<tr>
<td>Results &amp; Feedback</td>
<td>Results &amp; Feedback</td>
<td>Results &amp; Feedback</td>
</tr>
<tr>
<td>Optional revision</td>
<td>Optional revision</td>
<td>Optional revision</td>
</tr>
<tr>
<td>External exam</td>
<td>External exam</td>
<td>External exam</td>
</tr>
</tbody>
</table>

5.2.2 Summary of Results

The trends of the results suggest that the EI aim of improving procedural skills competence was achieved, with some results demonstrating statistical significance in favour of the EI. The CBA results demonstrated that the EI Streams Two and Three achieved more passes per student in all four examinations than Stream One (usual curriculum).

The combined Post-Test CBA results for all three Streams show that Stream One passed 39 of a possible 72 examinations (54%), Stream Two passed 120 out of a possible 172 examinations (71%) and Stream Three passed 120 out of a possible 156 examinations (81%).

In one of these examinations, Intravenous Cannulation, chi-squared analysis revealed a statistically significant difference in favour of the EI streams (0.003, p< 0.01). Analysis of the Pre-and Post-Testing results in Stream Three demonstrated that the EI was a
significantly more positive influence on performance than clinical exposure. In the one skill examined at the external Melbourne Medical School (MMS) Objective Structured Clinical Examination (OSCE), Stream Three performed the most consistently, resulting in a higher mean score than both Stream Two and Stream One (Stream Three = 35.0, Stream Two = 33.19, Stream One = 33.4). All Streams had a higher mean score than Metropolitan Clinical Schools A and B, indicating that at the time of the examination, all Three Streams performed the procedure more satisfactorily than the other Clinical Schools (Metro School A = mean of 31.5, Metro School B = mean of 32.4).

5.3 Overview

The process of implementing and reviewing the results of the study led the researcher to some particular observations. These observations can be articulated as:

- Findings common to the three Streams of the study cohort, where the Educational Intervention effect was not apparent.
- Findings not common to the three Streams of the study cohort, where the Educational Intervention effect was evident.
- Findings relating to the implementation and cohort effects of the Competency-Based Assessment program.

5.4 Common findings

5.4.1 Male Indwelling Catheterisation results

Male Indwelling Urinary Catheterisation (IDC) was the procedure with the lowest CBA pass rates. Although it was notable for being performed poorly by all Streams, the Intervention Streams did achieve moderately more passes per student than Stream One. Analysis of the Post-Test results for Streams One, Two and Three revealed that in this particular procedure, in the best performed Stream, (Stream Two) only 51% of students
passed, and less than that (33% and 46%) respectively for Streams One and Three. The comparison between Streams did not demonstrate a statistically significant difference (p=0.44). Review of the mark sheets did not suggest any particular non-student factors that would have led to the low pass rates. Findings included:

- The same examiner was allocated to all the Stream Three term 1, 2 & 3 sub-groups and also to all of the Stream Two students who sat their CBA at The Royal Melbourne Hospital site, thus optimising inter-rater reliability.
- The Post-Test results for Stream Three were disproportionately influenced by the poor performance of the Term 2 sub-group (see Table 4.12), but there appears to be no structural reason for this difference between the sub-groups.
- It was noted that the term 2 sub-group of Stream Three failed different components of the IDC examination compared to Stream One. This will be discussed in Section 5.5.2, Critical Error Analysis.

A likely explanation of the poor results for all three Streams is the procedural complexity of IDC insertion. Insertion involves multiple steps and several equipment components, including difficult fine-motor manipulation of equipment and patient. This could certainly have the consequence of poor recall of the procedure for the novice. It would then follow that the inexperience of the students means that they need much more time to practice than the EI provided. Kneebone suggests that inexperienced students need a curriculum with a significant increase in feedback and clinically-relevant simulation sessions, to enable automaticity of this and other procedures (Kneebone 2009).

Two other authors found poor insertion technique for Urinary Catheterisation. In his article entitled ‘Catheterisation: your urethra in their hands’, Carter’s group report on the results of a survey that showed a gross knowledge deficiency among a group of junior doctors (Carter, Aitchinson, Mufti & Scott 1990). Fourteen years later, Barnsley and colleagues conducted a study of junior doctors that showed similar results in knowledge as well as practical skill. The junior doctors in Barnsley’s study did not have
the benefit of a recent training program prior to their assessment, but were expected to perform IDC as part of their routine work (Barnsley et al. 2004).

The combination of the study results and research described by these authors, plus the findings of this study, indicates that much more practice is required to be competent at IDC than had been allowed for in curriculum design. This finding was taken into account in the recommendations for curriculum development at the end of this chapter.

5.4.2 Venepuncture Results

Venepuncture was the only Post-Test CBA in which Stream One achieved slightly more passes per student than either one of the EI Streams, in this case, Stream Two (83% vs. 79%, p=0.11). The reasons for this are unclear, given it is contrary to the results of the other Post-Test CBA.

Possibilities include that Stream One may have had more time for practice prior to the Post-Test (data not collected), more supervised clinical exposure in this skill; and familiarity with the equipment. No firm conclusions can be drawn from this result. See the following section, 5.4.3, for considerations on the potential influence of the clinical exposure effect.

The very good, but statistically insignificant, 95% pass rate for Stream Three is noted, and demonstrates an improvement compared to Stream Two. This will be discussed in Section 5.7 Test-Enhanced learning.

5.4.3 Clinical Exposure Effects

The Stream Three sub-groups from terms 1, 2 & 3, were analysed to investigate the effect of clinical exposure on procedural skill competency. Although most rotations would have given them opportunity for clinical exposure, students did not have a formal procedural skills curriculum during the preceding twelve months of the speciality rotations. In this 2011 final semester curriculum 35 hours per week were allocated for
medically supervised clinical exposure, with an average of five hours per week timetabled for lectures.

The Pre-Test CBA results indicated that clinical exposure only, offered no procedural skills competency advantage. The term 3 sub-group of Stream Three had a potential advantage over the term 1 and 2 sub-groups. Term 3 had acquired two terms of clinical experience in their Medical and General Practice terms. And yet, they performed no better in the Pre-Test CBA examinations than the term 1 and term 2 sub-groups (see Tables 4.11 & 4.12).

The Pre-Test CBA results showed that all Stream Three sub-groups performed very poorly. All Stream Three sub-groups combined passed only ten (6%) Pre-Test examinations out of the 156 Pre-Test examinations undertaken by the 39 students. In a disturbing finding, when the Pre-Test Critical Errors were analysed, the Pre-Test results and examiner observations for the term 1, 2 & 3 sub-groups of Stream Three indicated that clinical exposure may, in fact, contribute a negative influence.

It was not just that these students simply forgot how to perform a procedure; they actually performed actions they were not taught in their first clinical year of education. Errors included- incorrect selection of skin preparations, inappropriate short cuts and requests for inappropriate equipment that was not a visible available choice on the examination room procedure trolleys. The requests for not visible, inappropriate equipment led to the suspicion that students learned this behaviour in a clinical environment without appropriate rigorous supervision.

Sub-standard or absent clinical supervision of medical students or junior doctors has been previously reported. Mason found that nurses were more likely than doctors to have formal clinical teaching and be supervised when first performing procedures on patients, leading to improved procedural skills competence compared to junior doctors. Additionally, for a number of the reasons reviewed in Chapter Two (section 2.3.5) Mason found that actual clinical experience in performing procedures varied
considerably among medical students and junior doctors, making consistency difficult (Mason & Strike 2003).

Another study conducted on procedural skills competence also found that it is not just the amount of clinical experience that medical students are exposed to, but also the variable quality of the supervision they have received from clinical staff that will impact on the competence of medical students (Gray et al 2008).

Given the weight accorded to Clinical Exposure in the MMS curriculum, including the assumption that students undertake supervised procedural skills on real patients (Melbourne Medical School 2011a), the poor results demonstrated at the Pre-Test examinations were unexpected.

Recommendations made at the end of this chapter include improving the quality of supervision in the clinical field. This should encompass explicit training and standard setting for clinical staff involved in both the care of the patient and supervision of students (Melbourne Medical School 2011a).

5.4.4 Skill Decay and Retention

In this study, the mandatory rotations made it possible to compare the effect of time elapsed before assessment on skill decay on two small sub-groups of Stream Two. They undertook their Post-Test CBA at intervals of either three weeks or eight weeks. The results indicated that the sub-group with the longer delay between EI and CBA recorded more failures in three out of the four examinations. Although not statistically significant, the results of this small sub-group suggested that skill retention over eight weeks could be problematic for some students. This finding is in common with the previous, but limited, studies discussed in 2.2.6 (Lynagh et al 2007; Arthur et al 1998).

This is of importance in the clinical setting, given that it is common for students to have up to an eight-week break between graduation and commencement of their intern year.
It is reasonable for educators to take the eight week break into account when planning orientation/induction and revision programs for new interns.

5.4.5 Confidence

Confidence surveys were repeated over the semester, to investigate if there was a link between the students’ confidence to perform procedural skills independently and their examination results. Each survey was taken immediately prior to the CBA (Pre and Post-Test as applicable) and the MMS OSCE. The one hundred students rated their confidence to perform the four procedures, leading to four hundred total responses.

The review suggested that Stream allocation did not alter the self-reported confidence levels. From the Post-Test CBA survey, there were four responses (out of a total 400 responses) where students reported they were not confident to perform that procedure. These students passed their Post-Test CBA. All students were confident the day before their MMS OSCE. Failure or success in the CBA did not alter the students’ perception of their confidence when surveyed again the day before their MMS OSCE.

The overall outcomes from the MMS OSCEs demonstrated the challenge for some students in obtaining procedural skill competence. On review of outcomes for all stations (two physical examinations, two patient history taking, and one procedure), the station which had the largest number of students failing was the Intravenous Cannulation examination at 8.4% (Reid & Dodd 2011). Stream Three students were always confident on each of the three occasions they were measured, including the two students who failed all procedures on each of the three testing occasions.

As stated in Chapter 4.6, given that the questionnaire had not been validated, statistical analysis of the results was not performed. The following discussion relates to some of the observations noted when comparing the student confidence level with their results.

The CBA examiners noted on the mark sheets that knowledge of the theoretical indicators for the procedures was not a substitute for detailed procedural knowledge and
practice. Repeated measure of the students indicated that their confidence to perform was independent of clinical exposure, the displayed knowledge, and the curriculum they had undergone.

Inappropriately high confidence could potentially impact upon patient safety. High confidence levels could pre-dispose medical students and junior doctors to have a reduced desire to seek tuition and appropriate supervision. Studies from both Barnsley and Lurie have found that procedural skills are more complex to remember and perform properly than historically believed, a clear contrast to the individual confidence to perform the procedures reported by the students and junior doctors in their research (Barnsley et al 2004; Lurie 2012).

Accurate self-assessment in the health professions has been shown to be problematic (Arnold & Willoughby 1985; Gordon 1991; Boud 1999). Ideally, accurate monitoring of confidence levels or self-assessment would allow the medical student to identify their strengths and weaknesses, thus enabling safe implementation of clinical practice and realistic expectations of clinical performance. However, Eva & Regehr (2005) believe that accurate self-assessment is highly complex. Accuracy requires that a clinician must be able to enact self-assessment in three forms – summatively, predictively and concurrently. They argue that instead of using self-assessment as a tool for identifying and redressing gaps, it is more appropriate and relevant to use it as a mechanism for ongoing self-monitoring (Eva & Regehr, 2005). A qualitative study conducted by Sergeant et al (2010) further investigated the notion of informed self-assessment. They concluded that the dynamics and multiple components comprising self-assessment increases understanding of why inconsistencies between measured performance and self-confidence exist. More research is required to develop tools and methods to more accurately allow clinicians to self-assess (Sergeant et al, 2010).

In summary, the self-reported confidence questionnaires demonstrated that students commonly do not have an accurate sense of their level of competence, whatever procedural skills curriculum they undertake.
5.5 Variable findings

5.5.1 Preamble

The Streams receiving the Educational Intervention passed more Post-Test CBA examinations per student than did Stream One (Tables 4.2 and 4.3). The EI would appear to have had an effect, although this was not statistically significant, apart from the Intravenous Cannulation (IVC) examination (0.003, p<0.01).

The following discussion will cover differences found between the EI Streams and Stream One, with regards to Critical Errors and Skill Retention.

5.5.2 Critical Error Analysis

Review of the Critical Errors made during the CBA examinations indicated that Stream One were much less competent at the basic skills of Hand Hygiene and Aseptic Technique. These important components were steps required in three out of the four examinations.

A plausible explanation of this difference might be that the EI offered Streams Two and Three multiple occasions during the program in which Hand Hygiene and Aseptic Technique skills were reinforced until the students gained automaticity. Although these steps were taught in the usual curriculum, the Critical Error analysis supports the view that these skills were learnt more effectively in the high-fidelity simulation environment. Competent Hand Hygiene remains a key component in preventing iatrogenic infections and thus is a crucial point of inclusion when planning procedural skills curricula (Cork, Maxwell & Yeo 2011).

By design, during the case-based simulations, the EI Stream students had the opportunity to practice venepuncture and intravenous cannulation more often than IDC. The design of the immersive EI, being based upon an intern’s workload, was weighted in favour of multiple opportunities to practice these two skills. The comparatively reduced simulation practice in IDC (although still more than in the usual curriculum),
coupled with the complexity of the procedure, was likely to have negatively influenced the outcomes of the IDC examination in the EI Streams.

When students from the EI Streams did fail, it was more commonly due to poor technical skill and knowledge, rather than breaches of hand hygiene or asepsis (as was found in Stream One). This pattern of success with well-rehearsed procedures, and failure when opportunities for practice were limited, was sufficiently consistent to support the value of the EI in providing important opportunities for practicing procedural skills within the simulated clinical context.

5.5.3 Variability between Streams

The only program difference between Stream One and Stream Two was the procedural curriculum they received. The positive effect of the EI was demonstrated in three out of four examinations, where Stream Two achieved more passes per student (see Table 4.3). The performance of Stream Three (which was also better than Stream One) was more variable.

The differences noted between Streams Two and Three were also variable between skills. The outcomes of Stream Three in Venepuncture and Intravenous Cannulation will be further discussed in section 5.7, examining the synergistic effect of the combined EI with the Pre-Post Test program undertaken by Stream Three.

As stated previously, the EI Streams passed more examinations per student than did Stream One. However, the BLS Post-Test CBA offered some variable outcomes. Although the researcher was surprised that only one Stream Three student passed the Pre-Test BLS, it was even more surprising that a number of Stream Three (12 out of 39) students failed their Post-Test BLS. It was of note that Stream Two out-performed Stream Three in the number of students passing BLS. This result indicated that test familiarity was not a particular advantage to these Stream Three students. The background to this variability is unclear, given the overall design of the EI. See section 5.4.3, for the potential effect of clinical exposure on student performance.
As yet, no clearly defined revision interval has been established for the retention of Basic Life Support psychomotor skills (Australian Resuscitation Council Guidelines 2013). Another study that observed resuscitation skill retention in medical students reported similar skill retention compared to the cohort of this study, demonstrating similar pass/fail rates in key components of Basic Life Support (Nicol, Carr, Cleary & Celenza 2011).

Suggestions for the high failure rate on the BLS assessment have been made. Lack of clinical experience has been postulated, and the effect of causal/internal factors such as nervousness and anxiety provoked by the emergent nature of the test cannot be discounted as a factor (Nicol et al 2013; Li et al, 2013). However, one would have expected to find the influence of this factor across all three Streams.

A perspective on the students’ performance would be enhanced by an investigation utilising a Human Factor view. This could be a consideration for further research into these results (Leonard, Graham, & Bonacum, 2004; Christian, Wallace, Bradley, & Burke, 2009).

5.5.4 Summary: Educational Intervention Effect

The researcher was encouraged by the overall improved performance of the Intervention Streams compared to Stream One. The Male Indwelling Catheter results indicate more practice could be a solution to enabling competency. The Competency-Based Assessments can be tools for a formative assessment, and these will guide the amount and type of practice each student needs. The implementation and the implications of the CBA will be discussed in section 5.6.

Analysis of the examination sheets and results led the researcher to consider that the EI had a positive effect on student performance, when considering the overall results, the type of Critical Errors made, skill decay and skill retention.
5.6 Reflections on the Program of Assessment

5.6.1 Preamble

The use of Competency-Based Assessment for the Pre-Test/Post-Test assessment method enabled two overall observations:

- The assessment program was feasible and reliable.
- The CBA program enhanced student learning.

The following discussion will examine these observations.

5.6.2 Competency-Based Assessment Implementation

The goal of implementing the CBA examinations a total of eight times in two venues across a four month period during 2011 was achieved. Of the one hundred and seven students in the cohort, one hundred completed their allocated testing components and were able to be included in final sample.

Despite the varieties of student rotations across two campuses and with students often in remote locations for their General Practice (GP) terms, only seven students were unable to attend the CBA. Four students were absent due to personal reasons. Three students allocated to the Western Hospital examination days missed because of remote GP rotations.

The fact that the majority of students were able to attend demonstrated that the CBA process is feasible. Recommendations to achieve full cohort attendance in the future would include eliminating the allocation of students to any CBA examinations during their GP or community-based rotations.

The implementation of the CBA examinations showed that reasonable reliability could be obtained. The CBA was closely replicated in the two venues. There was a noted statistical difference in the venue results of the Male Indwelling Catheter examination,
with the RMH venue recording poor results (0.004, p < 0.01). Analysis of these results was discussed in section 5.4.1, where venue and examiner-related causes were not identified.

It was beyond the scope of this thesis to report analysis on the follow-up and remediation of students after they failed their first attempt at the Post-Test CBA. All students were given detailed feedback and remediation where required. What can be noted is that students who failed their Post-Test CBA required more remedial teaching staff time than estimated. Briefing of each student on their results, remediation and then re-testing required several more staff hours than had been allocated. There were larger than-expected numbers of students recording fails, thus the time required for Post-Test discussion with all of these students was under-estimated. The implementation of the CBA led the researcher to a more realistic estimate of student performance and of the feedback and remediation time required per student.

### 5.6.3 Student Reactions

Students had been briefed on the CBA concepts, but had not undergone this type of hurdle assessment before. Students were accustomed to graded, or norm-referenced, assessments, so the concept of test failure due to one Critical Error appeared to be difficult for them to understand. The hurdle, criterion-referenced design of the Competency-Based Assessment, although based on the familiar OSCE format, meant that students were exposed to an event many of them had previously never faced – examination failure. The researcher underestimated the level of assistance required by students to understand the information regarding, and consequences of, this style of assessment. In an explanation of criterion and norm-referenced assessment, Ricketts describe the lengthy time required for criterion-referenced assessment to be understood and smoothly implemented (Ricketts 2009).

The omission of a step such as hand hygiene led to a fail and there were a number of disputes from the students when this or other errors led to a fail for an examination. Commonly, medical students are academic high achievers. Failing these examinations,
viewed by them as academically simple, appeared to cause some students considerable anxiety and distress, similar to that described in papers by Colbert-Getz and Brannick (Colbert-Getz, Fleishman, Jung & Shilkofski 2013; Brannick 2013).

Future students will benefit from early and improved familiarisation with CBA program objectives and implementation. It is to be hoped that criterion-referenced assessments, such as found in the OSCE-style CBA program implemented in this study, have the potential to facilitate more realistic student awareness and learning to gain competence in procedural skills.

5.6.4 Quality and Safety

The aim of the CBA program was to determine whether each final year student was competent in common procedural skills in the simulated setting. The advantage of this program is that when students demonstrated deficits, these were identified so that remediation could be provided. All students who failed the Post-Test CBA were provided with feedback, practice, and were given a later opportunity to re-sit the CBA. A much improved performance was then demonstrated. Analysis of the re-assessment data was beyond the scope of this study.

The application of Critical Error criteria provided clear guidelines to determine if the student had safe technical and procedural skill standards before graduation. As has been previously demonstrated, novice students and junior doctors tend to overestimate their abilities to perform procedural skills (Pell, Fuller, Homer & Roberts 2012). The CBA program gave students a realistic assessment of their ability to complete the individual steps critical to patient safety and procedural success. This use of a simulated setting hopefully prevents future patients from being harmed. Students now had the opportunity to safely identify and correct their Critical Errors.
5.7 Test-enhanced learning

5.7.1 Test Familiarity

The external MMS OSCE results reflected the post-program CBA results, in that Stream Three performed the best, followed by Stream One and Stream Two. However, the improvement of Stream One from the Intravenous Cannulation CBA to the MMS OSCE Intravenous Cannulation examination was notable (Table 4.13). Only eight out of the 18 students passed Intravenous Cannulation in the CBA, but a statistically significant improvement of 17 out of the 18 students received higher than the Cut Score i.e. a pass, in the OSCE (p<0.01).

Stream Two and Three achieved even better OSCE results, with Stream Three achieving the highest mean and greatest consistency out of the Streams. It is possible that test familiarity improved the performance of all three Streams, when comparing the results of Stream One to Metropolitan Clinical Schools A and B.

The notion of Test-Familiarity improving results is supported by Lurie. He suggests that repeating tests reduces performance anxiety and enhances retention of knowledge and skills (Lurie 2012). Several authors support the concept that assessment drives learning (Brannick 2013; Cleland, Mackenzie, Ross, Sinclair & Lee 2010). When considering the improvement of all Streams, including Stream One, the MMS OSCE results support the development of outcomes-based education (Wiggins & McTighe 2005).

The mixed Post-Test CBA results displayed by Stream Three need to be remembered when considering the usefulness of test familiarity in assisting students’ outcomes. This Stream had the potential learning advantage of the CBA Pre-Post Test replication. The absence of significant improvement over Stream Two results was noted. Although Stream Three students had the Pre-Test familiarity, they had not had any individual feedback or seen their examination results sheets. Thus they did not have the opportunity for true formative assessment followed by remediation (Cleland et al 2010; Rudolph et al 2008). This likely impacted on their Post-Test CBA performances, particularly in the urgent and complex skills of BLS and IDC.
The researcher now supports the view advocated by other curriculum designers, which is that medical educators responsible for procedural skills should consider using Competency-Based Assessment for formative, as well as summative, assessment (Cleland et al 2010). This will provide future students with a more beneficial method for effective learning, remediation and assessment of the intricacies of procedural skills. This concept, called Test-Enhanced Learning, will now be discussed.

5.7.2 Test Enhanced Learning

Test Enhanced Learning is a concept based upon achieving clear outcomes (Larsen, Butler & Roediger 2008). A student is tested on an item, given feedback and an opportunity to practice, and then re-tested. The technical requirement of mastering a procedural skill matches well with setting clear final outcomes (Larsen, Butler & Roediger, 2008).

The comparison of pass rates from the Intravenous Cannulation Post-Test CBA and the MMS Intravenous Cannulation OSCE, demonstrate that all Streams improved their performance. The marked improvement of Stream One students from a Post-Test CBA 44% pass rate (8/18 students passed) to a MMS OSCE 94% pass rate (17/18 students passed) suggested the effectiveness of the CBA testing program in improving performance.

Prior to the MMS OSCE, students from all three Streams were given the potential benefit of direct feedback on their Post-Test CBA results. This was in conjunction with the optional revision sessions always offered to students before any major examinations. Thus, the students of the RMH/WH Clinical Schools were the first cohort, and the only MMS students, to receive specific formative feedback, directed practice, then summative assessment at the MMS OSCE.

Most students in the study cohort showed improvement, especially in Stream Three from Pre-Test to Post-Test. A few students did not and did not pass either the Pre-Post CBA or the MMS OSCE. These observations support the results presented by Pell. His
group conducted a three-year longitudinal study, which demonstrated that students who require a lot of remediation do not retain their knowledge from year to year. These students are commonly identified as being weak in several areas. In contrast, the majority of students in his study passed the re-sit CBA after minimal remediation, whereas the weak students in Pell’s study remained weak. His article supports the research findings that most students will benefit from assessment through the identification and remediation of deficits of skills and knowledge. However, some students do not improve, or maintain the improvement (Pell et al 2012).

As noted in section 5.4.4, students commonly have a time lag of eight weeks between graduation and commencement of their intern year. Weak students who gain intern positions may need special revision when medical educators are planning their intern orientation.

The Post-Test CBA process was effective in providing concise, detailed, individual skill performance feedback for each student. Each student was able to utilise this feedback for guided procedural skills practice, irrespective of their Stream. The combination of the EI with the test familiarity of the CBA would appear to have provided Stream Three students with an advantage at the MMS OSCE.

Analysis of the CBA Post-Test Critical Errors made by students who failed revealed that Stream Three students did not make the same common errors, such as poor hand hygiene, that they made in the Pre-Test CBA. They were more likely to make errors related to technical knowledge and fluency. Compared to Stream Two, Stream Three would appear to have gained improved performance of the technical skills common to three of the four procedures.

This suggests that there is a synergistic effect from the one extra CBA pre-Intervention testing event, where, compared to Stream One and Stream Two, Stream Three gained a performance advantage. The notion of ‘Test-Enhanced Learning’ is described by Larsen and colleagues “…tests can directly affect learning and if spaced out in time, promote better retention of information” (p959 Larsen et al 2008). The Stream Three results are further supported by Wood, who states that “Repeated testing during learning was
shown to promote better memory for content than a single test at learning” (p43 Wood 2009).

The Confidence Survey suggested that in common with their peers, Stream Three had an inaccurate perception of their competence. If they had received feedback after undertaking the Pre-Test this may have allowed a more realistic self-assessment of their skills and demonstrated precisely where the students needed remediation. The Educational Intervention did give the students the opportunity to practice and receive direct feedback on their knowledge and technique before undertaking the replicated Post-Test CBA.

The omission of any feedback to Stream Three students after the Pre-Test CBA was aimed to prevent Stream Three from receiving an advantage (i.e. extra teaching) over either Stream One or Stream Two, thus the EI effect could be measured. However, Stream Three Post-Test Critical Error analysis suggests that if the students had received specific, individual feedback, they may have further improved their performance in all skills after the EI. This is particularly important in the context of the less practiced, more poorly performed, IDC. Future procedural skills CBA would optimally include feedback to the individual student after any formative or summative assessment.

5.8 Research Limitations

The predicted and visible limitations and efforts to reduce, manage or account for their influence on the research are outlined in Chapter One, section 1.9. In summary, these limits included the MMS mandated curriculum and rotations, the uneven Stream sizes and the difficulty of measuring the impact of clinical exposure.

Other limitations were noted during the implementation and analysis phase of the research. Potentially, some students may have been affected early in the CBA examinations when examiners new to the OSCE format were gaining experience.
The Confidence Survey was unable to be fully utilised for results analysis as it was not a validated questionnaire.

A qualitative component to this investigation would have added insight into the results and discussion. This was unfortunately beyond the scope of this thesis. Future investigation into this topic would benefit from a qualitative component.

### 5.9 Summary

The Educational Intervention provided the study cohort with an improved ability to perform procedural skills in the simulated setting, compared to their peers undertaking the usual curriculum. Indications are that this may translate into the clinical field, thus making the graduating students better prepared for the intern year.

Competency-Based Assessment in a simulated setting is feasible and reliable, when compared to other modes of assessment. A procedural skills curriculum that utilises CBA in both the formative and summative modes provides a constructive platform to ensure that medical students are competent at common procedural skills.

The combination of Educational Intervention and Competency-Based Assessment further improves the performance of procedural skills by medical students.

### 5.10 Implications of the Findings

This research has demonstrated that in the performance of common procedural skills, final year medical students may be positively influenced by a Simulation-Based Education curriculum. Consideration should be given by medical curriculum designers to include this teaching modality when planning the teaching of procedural skills.

This research has also demonstrated that implementation of a Competency-Based Assessment of procedural skills is feasible. Students received a realistic measurement of
their competence to perform these skills satisfactorily. The improvement demonstrated by all three study streams in the external OSCE examination suggests that CBA is both a measure of, and a stimulant for, attainment of competence.

Since this study was completed, the Melbourne Medical School, University of Melbourne, has formally incorporated Simulation-Based Education into a Preparation for Practice curriculum for final year medical students undertaking the new Doctor of Medicine degree. This curriculum will include the procedural and case-based simulations that were utilised in this study (Melbourne Medical School 2014b).

The Competency-Based Assessment program of procedural skills has been refined and included in the mandatory academic assessment program for both second and final year students in the MMS Doctor of Medicine (MD) curriculum. Students are assessed in a program that contains the components of formative assessment, remediation, and summative assessment. Depending upon the procedural skill, summative assessment is either held in the simulated environment, or by direct observation on real patients in the clinical environment (Melbourne Medical School, 2014b).

The long-term implications of this study are that patients will benefit from being treated by interns who have undertaken a curriculum that includes Simulation Education and Competency-Based Assessment of procedural skills. The intern will have a reduced risk of causing iatrogenic complications when they perform common procedures as a component of their medical management of patients.

5. 11 Recommendations

1. Simulation-based education for procedural skills should be considered a mandatory component of medical student curricula.
2. Procedural skills education should be an ongoing, recurring component of medical curricula, with teaching, supervision and assessment in both the simulated and clinical settings. The newly implemented (2013) on-line student
logging of procedural skills clinical activities could be evaluated for this data. 
(https://mdconnect.medicine.unimelb.edu.au/student/procedure)

3. Clinical supervisors must be experienced and trained to the clinical standards appropriate for clinical teaching and procedural skills assessment.

4. Competency-Based Assessment should be incorporated into procedural skills curricula.

5. Following a comprehensive simulation and clinically-based curriculum, final year students should undertake high-stakes summative assessment, demonstrating competency at all examinable procedural skills.

6. Students at the pre-intern level must demonstrate that they are, in fact, ready for the procedural skills component of their work. A remediation and reassessment program for students who do not demonstrate competency should be a part of curriculum planning.

7. The procedural skills most commonly performed by an intern, Intravenous Cannulation and Venepuncture, can be and should be summatively assessed by Direct Observation in the clinical environment, after formative assessment in the simulated environment.

5.12 Future Research

Future researchers could investigate two areas: that of curriculum development and patient safety. This study has been confined to one cohort of students in two Clinical Schools enrolled in a single medical school. Further investigation into the impact of the EI and CBA programs should take place on a larger, multi-centre final year medical student population. More research into procedural skill acquisition and retention would benefit curriculum planning. Validated research on the influence of realistic confidence levels as either a barrier or an enabler for students to attain procedural skills competency would be a useful companion to these concepts.

Hospital-based Quality and Safety Units should monitor iatrogenic complication rates for patients whose treatment from junior doctors includes common invasive procedures.
This may allow evidence to be collected about the longer-term efficacy of the Educational Intervention.

5.13 Conclusion

This study has been the result of a program of procedural skills curriculum development over a period of ten years. The hypothesised need to develop better teaching methods for procedural skills has been tested and a useful and feasible Educational Intervention has been found.

The anecdotal observations that not all medical students achieve procedural skills competency has now been tested by an assessment program that is replicable and reliable. More experience in running Competency-Based Assessment will further improve its feasibility, reliability and hopefully, clinical validity.

Medical students and future employers can look to a future where students can safely demonstrate performance of common procedural skills. They will be assessed under the controlled conditions of Simulation Education, before undertaking potentially harmful procedures on real patients.
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APPENDICES

1. Intervention and assessment timeline, July-November 2011
2. Educational Intervention Timetable Day: One
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4. Confidence Survey
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6. Instructions to students
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8. Intravenous Cannulation: assessment tool
10. Male Indwelling Catheterisation: assessment tool
11. 2014 Graduates certificates
Appendix 1.
Intervention and assessment timetable July-November 2011

<table>
<thead>
<tr>
<th>Stream</th>
<th>July</th>
<th>Aug</th>
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Legend: OSCE = Objective Structured Clinical Examination (external MMS academic exam)

- X = intervention
- 0 = Pre or Post-Test
- Pink = Tested at Western Hospital Campus
- Green = Stream Two
- Blue = Stream Three
Appendix 2

Educational Intervention Timetable: Day One

**SEMESTER 12, RMH CLINICAL SCHOOL**

**CORE PROGRAM CLINICAL SKILLS TIMETABLE 2011** *(Instructor’s Copy)*

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<td>0800 – 0815</td>
<td>INTRODUCTION</td>
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<td>Case 2 – (Dehydration)</td>
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<td></td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td>Group 2</td>
</tr>
<tr>
<td>1450 – 1530</td>
<td>Group 2</td>
</tr>
<tr>
<td></td>
<td>Group 3</td>
</tr>
<tr>
<td></td>
<td>Group 1</td>
</tr>
<tr>
<td>1530 – 1545</td>
<td>CONCLUSION &amp; EVALUATION</td>
</tr>
</tbody>
</table>
## Appendix 3

Educational Intervention: Day Two

**SEMESTER 12, 2011**

**AUSTRALIAN RESUSCITATION COUNCIL**

**Immediate Life Support Course**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>0745 - 0750</td>
<td>Candidate Registration/Faculty Meeting</td>
</tr>
<tr>
<td>0750 - 0805</td>
<td><strong>Lecture:</strong> Introduction</td>
</tr>
<tr>
<td>0805 - 0835</td>
<td><strong>Lecture:</strong> Causes &amp; Prevention of cardiorespiratory arrest</td>
</tr>
<tr>
<td>0835 - 0920</td>
<td><strong>Skill Station:</strong> The ABCDE Approach</td>
</tr>
<tr>
<td></td>
<td><strong>Group 1</strong></td>
</tr>
<tr>
<td>0920 - 0945</td>
<td>Morning Tea</td>
</tr>
<tr>
<td>0945 - 1015</td>
<td><strong>Lecture:</strong> The ALS Algorithm</td>
</tr>
<tr>
<td>1015 - 1030</td>
<td><strong>Cardiac Arrest Scenario Demonstration</strong></td>
</tr>
<tr>
<td>1030 - 1200</td>
<td><strong>Skill Station:</strong> Initial Resuscitation &amp; Defibrillation</td>
</tr>
<tr>
<td></td>
<td><strong>Group 3</strong></td>
</tr>
<tr>
<td>1200 - 1230</td>
<td>LUNCH</td>
</tr>
<tr>
<td>1230 - 1310</td>
<td><strong>Skill Station:</strong> Airway</td>
</tr>
<tr>
<td>1310 - 1350</td>
<td><strong>Skill Station:</strong> Crisis Resource Management</td>
</tr>
<tr>
<td>1350 - 1530</td>
<td><strong>Skill Station:</strong> Cardiac Arrest Scenario Teaching</td>
</tr>
<tr>
<td></td>
<td><strong>Group 2</strong></td>
</tr>
<tr>
<td>1530 - 1600</td>
<td>Summary and Evaluation</td>
</tr>
</tbody>
</table>
Appendix 4

READINESS TO PRACTICE AS INTERN
2011 CONFIDENCE SURVEY

NAME: 

GROUP

Please tick the box that best represents your confidence level today. There is no right or wrong answer. Thank you for your time.

Meredith Heily

Today, I feel confident to perform unsupervised the following **procedural skills** in my intern year

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>YES</th>
<th>SOMEWHAT</th>
<th>NOT AT ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venepuncture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Cultures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV Cannulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Life Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Life Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECG recording</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma Skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen therapy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Catheterisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes Skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Catheterisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAP Smear/pelvic exam</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Today, I feel confident to perform unsupervised the following **communication skills** in the intern year

<table>
<thead>
<tr>
<th>COMMUNICATION SKILL</th>
<th>YES</th>
<th>SOMEWHAT</th>
<th>NOT AT ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intern to intern patient handover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern to registrar patient handover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern to consultant phone call</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern to patient communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern to relatives communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern to nursing staff patient management orders</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Today, I feel confident to perform unsupervised the following **documentation skills** in my intern year.

<table>
<thead>
<tr>
<th>CHARTING REQUIREMENT</th>
<th>YES</th>
<th>SOMEWHAT</th>
<th>NOT AT ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient admission notes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient progress notes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathology request slips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other investigation request slips e.g. X-ray</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication charts/IV Therapy charts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Referrals to in-hospital medical units/professionals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge summaries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Letters to other health professionals e.g. LMO</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5

Instructions for examiners

SEMESTER 12 PROCEDURAL SKILLS ASSESSMENT 2011
Instructions for Examiners:

Please do the following:

1. Write your name on the score sheet
2. Write student name on the score sheet
3. Set the timer for seven (7) minutes
4. Hand the instruction sheet to the student if they wish to read them again
5. Tell student that you will supply the answers if there are questions to ask the ‘patient’.
6. Begin the test. All key sections marked * and * underlined must be passed to achieve an overall pass. Mark the student as Pass or Fail for each section. Continue the test even if the student has already failed.
7. After seven (7) minutes read the questions on the score sheet to the student
8. At the completion of the test, mark the student overall PASS/FAIL. If the student has failed an *underlined section, or scored two or more non-bold fails, they have failed the station overall.
9. Do not allow the student to leave until the eight minute bell rings.

If this is a:

- **PRE-TEST** – No resits. Retain marking guide for collection by admin staff. Do not tell students their result.
- **POST-TEST** – Tell student if they are pass or fail. Ask the student to give the marking guide to the admin assistant. If they fail, they will be scheduled to re-sit the station at the end of the session. Students will be allowed to re-sit each station ONCE only.
Appendix 6

Student Instructions

1. Venepuncture

Please perform a venepuncture on the part-task trainer arm. Take blood for FBE and Coagulation profile. Assume the arm is a real patient, and interact accordingly. You have eight (8) minutes to complete the task and answer two (2) questions about the venepuncture.

2. Intravenous Cannulation

Please insert an intravenous cannula into the part-task trainer arm. Assume the arm is a real patient, and interact accordingly. The examiner will simulate patient answers. You have eight (8) minutes to complete the task and answer two (2) questions about intravenous cannulation.

3. Basic Life Support

Your patient, Mr Brown, has collapsed while lying in bed. Assume the manikin is a real patient, and interact and treat him accordingly. When appropriate, the examiner will simulate patient responses and/or provide patient updates. The examiner is NOT available to help you. You have eight (8) minutes to complete the task and answer two (2) questions about basic life support.

4. Male Indwelling Catheterisation

Please insert a male urinary catheter into the part-task trainer. You are expected to interact with the model as if it is a real person. The examiner will respond as the patient if required. You have eight (8) minutes to complete the procedure and answer two (2) questions.
# Appendix 7

## 2011 SEMESTER 12 PROCEDURAL SKILLS TEST

### 2. VENEPUNCTURE – MARKING GUIDE

**Student Name:** ……………………………………………………………………………………………

**Examiner Name:** ………………………………………………………………………………………

<table>
<thead>
<tr>
<th>Preparations</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparations for the procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Student simulates hand hygiene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Identifies patient correctly, with verbal, request slip and identification band confirmation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explains what the venepuncture will involve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asks if the patient has an allergy to adhesive tape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Obtains verbal consent to begin the procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positions arm for procedure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prepares the equipment**

*Note: it is acceptable to palpate the vein at any time prior to decontamination.*

<table>
<thead>
<tr>
<th>Preparations</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepares the equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sets out equipment for the procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects equipment correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Handles sharps safely</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Dons Personal Protective Equipment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prepares for the venepuncture**

<table>
<thead>
<tr>
<th>Preparations</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepares for the venepuncture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applies tourniquet with adequate pressure, placing fingers beneath the buckle as it is tightened to avoid pinching the skin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selects a suitable vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Decontaminates area with alcohol swab</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Collects venous specimen**

<table>
<thead>
<tr>
<th>Preparations</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collects venous specimen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inserts needle with bevel pointing upwards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>And at a suitable angle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Advances needle until there is a flashback
Advances needle a few millimetres further at a less acute angle
Withdraws a suitable amount of blood, changing tubes appropriately
Loosens tourniquet immediately

<table>
<thead>
<tr>
<th>Completes the procedure</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Places cotton wool over puncture site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Withdraws needle from vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applies pressure to the puncture site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secures cotton ball with tape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Disposes of needle safely in sharps bin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Maintains asepsis for length of procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Labels blood tubes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions

1. **Name two complications of venepuncture**
   Any of: pain, fainting, haematoma, haemorrhage, infection

2. **Name two reasons to avoid venepuncture in a specific area**
   Any of: skin infection or injury, ischaemic area, arm of lymph node clearance site, limb of arterio-venous fistula formation

OVERALL PASS OR FAIL
2011 SEMESTER 12 PROCEDURAL SKILLS TEST
INTRAVENOUS CANNULATION

STUDENT
NAME.................................................................................................................

EXAMINER
NAME.................................................................................................................

ASEPTIC TECHNIQUE
Student will fail the station if they breach aseptic technique and do not realize and report how they would recover from the breach.
However - if the student appropriately makes clear that they would fix the breach e.g. by replacing equipment or restarting the procedure, the examiner should say ‘assume this is done’ and continue the station. The student will not fail if a clinically appropriate solution is supplied.

<table>
<thead>
<tr>
<th>Prepare for the procedure</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Student simulates hand hygiene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Identifies patient correctly, with verbal and identification band confirmation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explains what the procedure will involve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asks if the patient has any allergies to adhesive tape or solutions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Obtains verbal consent to begin the procedure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prepare the equipment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: it is acceptable to palpate the vein at any time prior to decontamination.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sets out equipment for the procedure, using aseptic technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects equipment correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Handles sharps safely</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Dons Personal Protective Equipment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prepare for Cannulation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applies tourniquet above elbow with two fingers under the buckle so skin is not pinched.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selects suitable vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepares insertion area with suitable solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inserts cannula</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*Does NOT palpate insertion site after decontamination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchors vein below insertion site with non-dominant hand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Inserts cannula with bevel upwards and angled at 30-40 degrees until flashback
Decreases angle of cannula and advances in vein

<table>
<thead>
<tr>
<th>Completet the procedure</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removes tourniquet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removes introducer while occluding proximal vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Disposes of sharp safely in sharps bin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inserts bung</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secures cannula with transparent dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flushes cannula with normal saline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dates dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposes of infectious waste appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Maintains asepsis during procedure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions:
Please tell me three (3) complications of having an intravenous cannula in situ
Any of: infection, thrombosis, extravasation, phlebitis, cannula embolus and inadvertent arterial Cannulation

How long may an intravenous cannula stay in situ?
48-72 hours

OVERALL PASS OR FAIL
Appendix 9

2011 SEMESTER 12 PROCEDURAL SKILLS ASSESSMENT
BASIC LIFE SUPPORT

STUDENT …………………………………………………………………………………………

EXAMINER ……………………………………………………………………………………

- Please read out the prompts and questions in bold then wait for the student to respond to each prompt.
- If the student fails to respond in a reasonable time, mark them a fail for that section, give them the answer and move to the next section.
- Sections that students must pass to complete the test satisfactorily are marked with an asterisk* and underlined.

Your patient, Mr Brown, has collapsed in bed. On your arrival he is making these noises. (Examiner, please imitate snoring noises).

First, could you please tell me Mr Brown’s most urgent problem?
*His airway is obstructed

Please demonstrate your immediate response to this situation.
Checks for dangers
Calls for help. (Indicate that help is on the way but delayed.)
Shake and shout
Inspects airway
Inspects chest wall movement
*Performs jaw thrust by applying pressure behind the angles of the jaw or chin lift by anterior movement of mandible
(If completed - indicate there is some improvement in breathing)
Uses pillow to achieve “sniffing” position
It is acceptable for the student to use Guedel airway at this point or later. See below for marking guide.
Checks pulse (Examiner to inform the student that Mr Brown has a regular pulse of 55 ONLY if the student checks the manikin for a pulse).
If the student tries to place the manikin on his side, say that the patient is still snoring.
Utilises suction and oxygen equipment to aid in airway clearance and patient oxygenation.

Mr Brown is still unconscious and you notice that he has noisier breathing at a rate of six (6) breaths per minute. Please show me what you would do now.

PASS FAIL
Measures Guedel size from either angle of the jaw or tragus to incisors
Inserts Guedel airway by pointing upwards then rotating 180 degrees halfway in.

*Selects bag/valve/mask device.

Correctly positions the mask

Ensures there is an adequate seal

*Commences bag/valve/mask (BVM) ventilation at twelve (12) breaths per minute. 
It is also acceptable for the student to attempt BVM without using the Guedel airway. 
If this is the case, please ask the student to demonstrate sizing and insertion of the airway.

**How will you assess that your action has been successful?**
Look at chest wall movement.

You re-check Mr Brown and find he has no signs of life. Demonstrate your immediate response.

*Commences cardiac compression

- Hands positioned lower sternum, elbows locked

- Chest compression at 100 per minute

- *Compression to Ventilation ratio is 30:2

Quality of CPR including depth, rate and timing of chest compressions judged by examiner

*Reassesses patient at the end of two minutes (5 loops of 30:2)

**Stop student at this point.**

**Question 1. What are two (2) potential complications of Bag/Valve/Mask ventilation?**

Two of – barotrauma, pneumothorax, gastric insufflation, passive aspiration of dislodged stomach contents, increased intrathoracic pressure leading to tamponade of heart and great vessels.

**Question 2. What are two (2) potential complications of external cardiac compression?**

Two of – fractured ribs/sternum, pneumothorax, cardiac tamponade, perforated heart, ruptured abdominal viscera

**OVERALL PASS OR FAIL**
### ASEPTIC TECHNIQUE

Student will fail the station if they breach aseptic technique and do not realize and report how they would recover from the breach. However - if the student appropriately makes clear that they would fix the breach e.g. by replacing equipment or restarting the procedure, the examiner should say ‘assume this is done’ and continue the station. The student will not fail if a clinically appropriate solution is supplied.

<table>
<thead>
<tr>
<th>Consents patient for procedure</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Identifies patient using verbal &amp; identification band.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Verbally consents the patient.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sets up sterile field</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses appropriate hand rub/simulates simple hand wash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Adds equipment without breaching sterile field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepares patient for procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Student simulates procedure hand wash.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>When student begins – inform them that they may assume they have completed the wash.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dons simulated sterile gloves (may use single or double glove technique)</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drapes patient before cleaning penis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleans penis using sterile technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inserts simulated lignocaine gel using sterile technique.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student states they would wait two minutes for effect.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Say to student – assume two minutes has passed, and proceed.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Inserts the catheter to the hilt. | PASS | FAIL |
| Inflates the balloon using sterile water. |      |      |
Withdraws catheter until balloon is wedged.
Attaches the drainage bag
Begins to clean up equipment.
*Stop the student from tearing the drape so that it may be reused for another set up.*

Questions

1. **State three (3) possible complications of urinary catheter insertion.**
   
   Any of – perforation, haemorrhage, infection, pain, voiding around the catheter

2. **State three (3) indications for urinary catheter insertion**
   
   Any of – trauma to urinary tract, accurate measurement of urinary output, intravesical chemotherapy, bladder irrigation, management of incontinence

OVERALL PASS/FAIL

<table>
<thead>
<tr>
<th>PASS</th>
<th>FAIL</th>
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Appendix 11.

Photograph of the official Procedural Skills Certificates awarded to the first graduates (Doctor of Medicine degree) to complete the Procedural Skills curriculum and assessment (Melbourne Medical School, University of Melbourne, 2014).
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HEILY, MEREDITH

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