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Evaluation of learning from Practical Obstetrical Multi-professional Training and its impact on patient outcomes using Kirkpatrick's method

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Evaluation of learning from Practical Obstetrical Multi-professional Training and its impact on patient outcomes using Kirkpatrick's method

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Abstract

Objectives

- To evaluate the Practical Obstetric Multi-professional Training **(**PROMPT) simulation using the Kirkpatrick's framework to explore participants' (medical and midwifery teams) acquisition of knowledge and skills and its impact on clinical outcome.
- To explore organisational change to integrate the PROMPT program as a credentialing tool
- To assess participants' perception of usefulness of the PROMPT program in their clinical practice

Study design The study follows a mixed methods approach with a pre-test / post-test design

Setting Healthcare network providing obstetric care in southeast Victoria, Australia

Population Medical and midwifery staff participating in birthing

Intervention The intervention is attendance of the PROMPT program, which is a simulation program taught in multidisciplinary teams (medical and midwifery staff) to facilitate teaching emergency obstetric skills.

Main outcome measure Clinical outcomes compared for a two-year period before and after embedding PROMPT program in educational practice.

Secondary outcome measure Assessment of knowledge gained by participants though a qualitative analysis and description of process of embedding PROMPT in educational practice.

Results There was a change in the management of postpartum haemorrhage by early recognition and intervention. The key learning themes described by participants were being prepared with a prior understanding of procedures and equipment, communication, leadership, and learning in a safe, supportive environment. Participants reported a positive learning experience and increase in confidence in managing emergency obstetric situations, through the PROMPT program which was perceived as a realistic demonstration of the emergencies.

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Conclusion Participants reported an improvement of both clinical and non-technical skills highlighting principles of teamwork, communication, leadership and prioritisation in an emergency situation**.** An improvement was observed in management of postpartum haemorrhage but no significant change was noted in clinical outcomes over a two-year period after PROMPT. However, the skills acquired by medical and midwifery staff justify embedding PROMPT in educational programs, the process of which is described here.

Tweetable abstract Obstetric multiprofessional simulation improves staff learning and clinical outcome.

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Introduction

Interprofessional team-based, simulated training programs are becoming an increasingly popular to improve the performance of clinical workforce particularly in emergency responses, and resultant clinical outcomes. The provision of high quality birth suite care is no exception. Staff training in technical clinical skills is put to test in complex obstetric situations that require critical time critical management. Team members must be instantly engaged to achieve synergism in managing acute obstetric emergencies. Hence, acquisition of non-technical skills (NTS), such as effective communication and teamwork, are as important as mastering "hands-on" clinical skills [1].

Interprofessional education (IPE) focuses on "staff members working together to learn *with*, *from* and *about* each other"[2]. IPE programs help individuals to develop an understanding of other professional roles within the multidisciplinary team. Such an understanding is thought important for safe and effective clinical practice as a team [3]. In order to maintain a level of confidence in managing these difficult clinical emergencies regular up-skilling sessions are necessary.

PROMPT (PRactical Obstetric Multi-Professional Training) is a multi-professional training package designed to expose participants (obstetricians, midwives, paediatricians and anaesthetists) to obstetric emergencies in a real time environment [4-8]. This simulation-based program aims to recreate clinical problems either "in-situ" in a birth unit or in a simulation centre and presents them to participants as realistically as possible. The scenarios can be designed specifically for the level of the participants and the available facilities. Evaluation of these programs is necessary to assess if their objectives are met. Programs can be evaluated using various frameworks, one of them being the six level modification of Kirkpatrick's

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framework [2 9 10]. The various levels assess participant's satisfaction, change in attitude or identification of what was learnt, if these skills changed participant behaviour in a clinical setting or ultimately affected clinical organisational change and patient outcome (see Table 1).

We introduced the Victorian state version [11] of the PROMPT program to our maternity service in 2013. In this study, we aimed to evaluate the impact of PROMPT in our health service by assessing the various levels in the six-level framework. Specifically, we wished to identify the "key learning points" acquired, "how" useful this workshop style teaching was rated and whether there was any evidence of change in patient outcomes. We also describe the process of "embedding" this program in educational up-skilling of staff.

Methods

Study design

The study follows a mixed methods design with quantitative analysis of patient outcome data and for participant rating of the intervention. The data regarding the key learning messages was extracted using qualitative content analysis identifying key themes. The study was approved as a quality assurance project by the institutional research ethics committee.

Setting and participants

Monash Health maternity service provides birthing care for over 9000 women annually at three separate hospital sites, each with different levels of acuity, all within metropolitan Melbourne, Victoria. The three sites share common clinical practice guidelines, policies and procedures. Monash Health implemented PROMPT in its current form 2013 onwards across all sites. Midwifery educators and dedicated senior obstetric medical staff ran the program. The PROMPT sessions are conducted ten times per year at each site at monthly intervals.

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Midwifery and medical staff (junior and senior) are required to participate at least every two years. All medical and midwifery staff who had attended the PROMPT session at least once were invited to participate in the study.

PROMPT program scenarios

The half-day program consists of short, interactive lectures and scenario-based drills. Each drill is followed by a debrief covering clinical and non-technical skills. The clinical scenarios include eclampsia, shoulder dystocia, neonatal resuscitation and postpartum haemorrhage (PPH). These are topics that were already covered in the pre-reading material provided to the participants.

Questionnaires

The evaluation of PROMPT workshop followed a pre-test and a post-test research design using paper-based questionnaires. Each questionnaire had 26 items where participants' responses are recorded using a 5-point Likert scale. The pre-test evaluated levels of knowledge and confidence managing the obstetric emergencies covered. They are also asked about participants' professional background and experience in these clinical emergencies. At the end of the workshop the post-test evaluated the satisfaction and learning acquired from the program. Participants were also asked to reflect on the essential learning points attained that were thought to be transferable to their (individual or team-based) clinical practice using free text.

Textual data was analysed independently and inductively using content analysis undertaken by two researchers independently (AK, SS) to produce key themes [12]. The results were discussed and after establishing consensus, all data were recoded. Some categories overlapped

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but items were counted only once. Discrepancies were negotiated enabling final attribution of text within categories.

Clinical outcome measures

A retrospective cohort study examined all documented cases of the three major obstetric emergencies covered during the drills (eclampsia, shoulder dystocia combined with neonatal resuscitation, and post-partum haemorrhage). Data were collected for two different cohorts, before the implementation of PROMPT (2011-2012) and after (2014-July 2015). Patient outcomes were evaluated using the following measures. For shoulder dystocia we measured the use of external and internal manoeuvres, time between delivery of the head and the body, completion of documentation, major maternal perineal trauma (3^{rd} and 4^{th} degree tears), and neonatal outcomes including brachial plexus injury, clavicle or humerus fracture, Apgar score <7 at 5 minutes, umbilical cord lactates >8 mg/dl, admission to newborn services and perinatal death. For PPH, we classified women into two groups according to the estimated volume of blood loss (1000ml-1499ml or >=1500ml) reporting rates of blood transfusion, transfer to the operating theatre, intravenous fluid resuscitation and use of a (Bakri®) balloon tamponade.

Data was extracted from an electronic database of birthing outcomes, the Birthing Outcomes System (BOS®) [13], that records outcomes for all births ≥20 weeks of gestation and is routinely entered by midwifery staff. Where necessary BOS data was supplemented by individual case record review.

Statistical analysis

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Data was analysed with Prism for Mac version 7.0a (Graph pad software, San Diego, CA, USA). Continuous data were expressed as means and standard deviation or medians and interquartile range (IQR) as appropriate.

Results

Participation

Since 2013 we have run 70 PROMPT sessions across our three sites with a total of 508 participants. Approximately one-third (n=178, 35%) of participants were medical staff (junior and senior). The remaining were midwifery staff (n=287, 56%), medical or midwifery students (n=34, 7%) or special care nursery staff (n=9, 2%). By 2015, 76% midwives and 90% senior medical staff had participated at least once in PROMPT.

Satisfaction with the simulation activity (Level 1 Kirpatricks's framework)

Figure 1 summarises the participant knowledge, confidence and prior experience in managing obstetric emergency. Staff confidence in management of eclampsia was lower than that for the other obstetric emergencies. The confidence and knowledge concerning neonatal resuscitation was higher for midwives than the medical staff (Figure 1A and B). In general, the workshops were rated highly by both medical and midwifery participants {median Likert score of 5 (maximum) for both groups} in regards to clinical usefulness of material covered and debriefing experience.

Knowledge acquired from the workshop (Level 2b Kirkpatrick's framework)

430 comments made by 237 participants were available for content analysis (Table 2). The key themes related to improved communication between staff members (n=87), developing knowledge of equipment and procedures (78 responses), learning leadership and followership

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(73 responses), being in a supportive learning environment (63 responses), the realism of the simulation (48 responses), understanding the roles of staff from another profession (46 responses) and prioritisation of tasks (33 responses).

Communication

Clear communication established directly with the members of the team (by using the individual's name) and with others who assist in the process e.g. with switchboard calling an emergency code. Where appropriate, specific terminology should be used. The loop of communication should be closed by obtaining a response from the recipient, to ensure accountability of the individual undertaking the task. The communication was seen to be even more crucial at certain times like the handover of a task to another member of the team.

Situational awareness

Identification and knowledge of equipment, its location in the birth unit, organisation of the equipment and knowing if it was in working order was recognised as relevant for the staff using it in the emergency situation with time constraints. A prior familiarity of content and a practice of using the postpartum and eclampsia kit, was found to be essential. Necessary gear found missing at the time of workshop or kept in the wrong location, delayed the management and caused stress to the team.

Similarly staff members were keen to have a prior awareness of protocols and procedures, more so in complex situations like eclampsia and neonatal resuscitation and where clinical manoeuvres were needed like shoulder dystocia and breech vaginal birth. The organisational pathways needed like calling an emergency code and methods to access operating theatres in a hurry were also emphasised.

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Learning leadership and followership

The importance of leading an emergency team presented as an unexpectedly prominent theme. The key characteristics of a leader were to maintain a "helicopter view" at all times and be clear and assertive with instructions to participants. Establishing and announcing who the leader of the team was (either by the leader or another participant) and appointing one if already not designated. The leader could change during the emergency scenario depending on individual capability and who was available. Handover from one leader to another needed clear communication. In such situations, the new leader should initially "step back" and assimilate the situation prior to taking over.

The rest of the team should patiently wait for instructions, offer to help (based on their individual scope of practice) and contribute to the team management by playing their designated role. If the instructions were unclear or participants were unable to perform the allocated task, they should speak up and close the communication loop.

Supportive learning environment

The PROMPT workshop was acknowledged to improve participants' confidence and learning of clinical knowledge and skills through individual opportunity to practice and team feedback. In a simulated setting, the technical skills and procedures could be "unpacked" into small steps during the feedback session. The combination of learning emergency skills in a simulated environment was seen as a step towards improving women safety.

Realism in simulation

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The participants perceived the workshop to be similar to a real emergency through the role of an actor, scenario design, experiencing stress, working within timelines and location in a birth unit. The scenarios were based on rare emergencies and followed an unpredictable course resulting in participants feeling anxious and voiced the need to "stay calm".

Role of interprofessional staff

Participants displayed a preference to revert to their natural/ usual clinical roles when managing a clinical emergency as this was based on their strengths and scope of practice. The participants wanted to have a clear well defined role allocation which was "task specific". Both medical and midwifery staff members were keen to share learning in the interprofessional setting and wanted to understand roles of the other discipline in the team. Both teams referred to learning teamwork and task sharing.

Prioritisation

Participants demonstrated a need to organize the tasks systematically and to get help early. They emphasized on timely escalation of tasks due to their awareness of their limitations in managing emergency situations and their scope of practice.

Organisational change to "embed" the PROMPT program (Level 4a Kirkpatrick's framework)

We describe the process of embedding the PROMPT program using Kurt Lewin's 3-phase model[14].

Step 1 – Unfreeze

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The key issue of poor communication (occasionally leading to conflict) among medical and midwifery staff was recognised through incident reporting as a component of a risk management process. This was seen to delay mobilising resources required in an emergency setting, hence compromising optimum patient safety. In a time critical situation, where effective teamwork is the key, a need to create change was recognised by medical and midwifery leaders at the institution. The need to change was communicated both to the health care network executive group and to the clinical staff delivering patient care. This coincided with introduction of the PROMPT program in the state of Victoria resulting in strategic inclusion of the team-training program for medical and midwifery staff.

Change

The change described here is embedding the PROMPT program as a component of routine educational practice. The principles learnt through the program focussed on communication, leadership and situational awareness, similar to the vision shared by the institution. The benefits of attending the program were communicated to the staff and feedback encouraged from participants. Problems that hindered attendance (like rostering issues, managing patient workload on teaching days) were dealt with promptly. Funding was obtained from the institution by reporting benefits of change in attitude of interprofessional staff and observed improvement in performance, although this was not formally evaluated. This funding further facilitated the operational management of the program, as dedicated clinical staff members could be employed to sustain the quality of teaching.

Refreeze

The observed improvement in attitudes of the interprofessional staff and effort to meet higher standards of clinical practice was encouraged. Leadership and operational support required to

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run the program was improved (by increased numbers of faculty members facilitating the program) and on-going training support provided to them. A process of providing team-based feedback was developed (using the PROMPT guidelines) and the role of learning through PROMPT was formalised which lent itself to its use as credentialing tool. A mandatory requirement of two-yearly attendance was set up for all medical and midwifery staff.

Clinical Outcomes (Level 4b Kirkpatrick's framework)

In 2011-2012 there were 15,361 births and in 2014 to July 2015, 12,388 births at Monash Health.

Eclampsia

Across the four years, four women had an eclamptic seizure, two in 2011-2012 (0.13/1000) and two in 2014-2015 (0.16/1000). All four women were managed as per protocol for Magnesium sulphate infusion.

Shoulder Dystocia (Table 3)

Table 3 summarises the incidence and outcomes related to shoulder dystocia. The rate of shoulder dystocia in 2011-12 (n=268; 1.7%) was significantly lower than in 2014-15 (n=290; 2.3%, p=0.001) No neonatal deaths were recorded in either group. The interval between delivery of head and body was shorter in the recent cohort (2.0 min (IQR 1-2) vs 2.0 min (IQR 1-3), p = 0.04). In the cohort after implementation of PROMPT we observed lower incidences of brachial plexus injury, humerus or clavicle fractures, low Apgar scores and nursery admissions, although these differences were not statistically significant (Table 3). There was a significant decrease in the completion of the required shoulder dystocia emergency 'management sheet' (24% vs 17%; p = 0.04).

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Post Partum Haemorrhage (Table 4 and 5)

For women with a PPH of 1000-1499ml, there was no significant change in the number of cases between cohorts (n=561 (3.7%) vs n=511 (4.1%)), and no significant differences were observed in maternal outcomes or management strategies. For women with a PPH of >1500ml, a significant difference was seen in the number of patients transferred to theatre after vaginal birth (30% vs 38%; $p = 0.049$), and the use of Bakri balloons (6% vs 12%; $p = 0.02$) which were introduced in 2011.

Discussion:

Main findings

Through a formal evaluation of PROMPT and a review of clinical outcomes we have observed that this multidisciplinary training has a positive effect on managing of obstetric emergencies within our service. Consistent with mandatory workforce training requirements, participation of both medical and midwifery staff was excellent across all of our sites such that PROMPT has become an embedded component of ongoing professional development. In this paper we have evaluated our PROMPT program using the various levels of Kirkpatrick's framework, observing encouraging results. All levels examined showed positive effects after implementation of this structured training. In addition, the evaluation allowed us to identify areas for future improvement such as record keeping of therapeutic measures.

Participants found PROMPT an effective approach for the acquisition of new skills and knowledge. Medical and midwifery staff members reported an increase in confidence and had high satisfaction scores on learning as a team (Level 1 Kirkpatrick's framework).

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Our next level of assessment focussed on key "take-home" learnings acquired by the participants (Level 2 Kirkpatrick's framework). Communication and situational awareness were considered important NTS learnings by the majority of participants and is a finding consistent with other studies [5 6]. The theme on "leadership" and "following the leader" are thought critical for safe team-based management, both in simulated and real emergencies [6 15]. Poor performance in leadership in spite of good communication can also occur [16], hence, making leadership an independent learning goal of the workshop. Developing improved "situational awareness" with knowledge of equipment use and efficient use of team members is an often -reported learning outcome of the PROMPT program[5].

Our final analysis reviewed the birthing outcome and safety data (Kirkpatrick's level 4b). In the recent cohort we observed a significant increase in the incidence of shoulder dystocia. This could be related to an increased awareness of this condition but could also reflect the increasing numbers of obese pregnant women delivering at our centres. We observed a small but statistically significantly difference in the interval between the delivery of head and body, the clinical relevance of which is debatable. The significant increase in the number of patients transferred to theatre for control of massive post-partum bleeding (PPH >1500mls), and the increase in the use of (Bakri) balloon tamponade may reflect a greater awareness of the benefits of early and aggressive control of excessive bleeding following our PROMPT implementation, also noted in a recent randomised control trial where the units that participated in simulation based team training had a higher incidence of blood transfusion and surgical treatment of PPH [8].

Strengths and limitations

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The current study is one of few mixed methods studies attempting to draw a link between perceived learning, clinical practice and outcomes by using various levels of Kirkpatrick's framework. As far as we are aware only a few studies have evaluated simulation-based intervention through multiple "lenses" of assessment, as reported in a recent review on obstetric emergencies [17]. Most researchers have limited evaluations to either level 1 or 2 with some studies demonstrating a change in team behaviour and retention of skills [18]. Studies looking at clinical outcome are scant [8 11 17]. Our evaluation includes participant satisfaction with the scenario and debrief (level 1) but also learning skills and knowledge acquired by the two major interprofessional groups (level 2). We demonstrate the process from introduction of the intervention and it's "embedding" in curricular training and "credentialing" (level 4a). The PROMPT program has been successfully integrated with teaching programs globally, however, the description of the program with change management principles is worthy of sharing. Above all, we have also compared the birthing outcome before and after the intervention was introduced into practice (Level 4b).

However, due to challenges related to study design that entails direct observation of participants in a "natural" setting, we were unable to assess a change in observed clinical behaviour/teamwork that may have helped to directly connect workshop learning with clinical practice, which may be done using clinical checklists [19].

Patient care and clinical outcomes are rarely reported as evidence of effectiveness of educational programs [20]. Most likely this is because programs need to be embedded prior to evaluation and coverage of a sufficient proportion of the workforce needs to be achieved before improved care and outcomes would be expected. This can take many years [21-23]. We were unable to explore detailed outcome data prior to 2010 as previously documented notes

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had missing clinically relevant details, hence precluding us from assessing five years before and after PROMPT which may have provided a better reflection of birthing outcomes. However, this may not have changed the result as a similar study failed to show a significant reduction in the composite obstetric outcome in units where multi-professional simulation training was introduced [8].

A major strength of this evaluation is that it allowed insights into service delivery and identification of potential deficiencies. For instance, we observed a reduction in the completion of shoulder dystocia management forms. In addition our current record form lack certain outcome measures that would be of interest to evaluate clinical management, such as fluid volume usage during PPH.

Interpretation

Participants indicated that communication, situational awareness and leadership skills are key factors for managing emergencies as a successful team. The next level of evaluation planned will be to check the team performance in a real obstetric emergency setting to determine if the transfer of learning has occurred. This can be achieved by integration of level 3 assessment (behaviour) into our training development strategy by direct observation of performance in a simulated and/or clinical setting. Apart from more proactive management noted in postpartum haemorrhage, no significant difference was noted in clinical outcome. This may be due to existence of previously run simulation programs, which focussed on individual skills but not on effective teamwork. Although, participants recognise the importance of teamwork and communication in their learning, this was not transferable to a change in clinical outcome.

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This evaluation has already resulted in changing the organisational practice at our institution (Level 4a in the modified Kirkpatrick's six level framework, [24]. An annual attendance of PROMPT is encouraged for all staff and a two-yearly attendance is a mandatory requirement for staff working on the birth unit. It is used for credentialing the staff members with remediation plans for participants unable to meet the expected standards of performance for both technical and non-technical skills. Our goal will be to continue to strengthen this process and to formalise it further, linking it with professional development.

Conclusions

The study highlights the need for teaching teamwork, communication and leadership skills in managing obstetric emergencies through a high fidelity simulation program. The impact on clinical outcomes seems limited, yet we identified some differences related to management of shoulder dystocia and postpartum haemorrhage that could have made a difference in certain individual cases. Improved participant confidence with up-skilling of both procedural and non-technical skills has a potential to change clinical practice and outcomes, hence, validating the incorporation of these IPE simulation strategies in clinical care.

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Contribution to authorship: AK conceived and designed the study, analysed the data, wrote the first draft of the manuscript and finalised the submission. SS, who is a shared first author performed the study, analysed the data, edited the manuscript, and approved the final submission. DL, JM, PN, MS and SS performed the study, and approved the final submission. EMW conceived and designed the study, contributed to analysis tools, edited and finalised the submission. DN analysed the data and contributed to analysis tools. PD is the senior author, conceived, designed, performed and supervised the study, analysed data and approved the final submission.

Details of ethics approval:

The study was approved by Monash human research ethics committee as a quality assurance project.

Funding:

No specific funding was obtained for the study.

Data sharing:

There is no other unpublished data from this study

Access to the data is available only to the research team in a secure (coded) format

Clinical data has been obtained from Birthing Outcome Software (BOS®) and is accessible to only registered BOS® users in the healthcare network.

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References

1. Leonard M, Graham S, Bonacum D. The human factor: The critical importance of effective teamwork and communication in providing safe care. Qual Saf Health Care 2004;**13**(SUPPL. 1):i85-i90.
2. Barr H, Koppel I, Reeves S, et al. *Effective Interprofessional Education: Argument, Assumption and Evidence*: Blackwell Publishing Ltd, 2005.
3. Wong AHW, Gang M, Szyld D, et al. Using a simulation-enhanced interprofessional education strategy to improve attitudes toward teamwork and communication. Simul Healthc 2016;**11**(2):117-25.
4. Crofts JF, Ellis D, Draycott TJ, et al. Change in knowledge of midwives and obstetricians following obstetric emergency training: A randomised controlled trial of local hospital, simulation centre and teamwork training. BJOG Int J Obstet Gynaecol 2007;**114**(12):1534-41.
5. Siassakos D, Fox R, Bristowe K, et al. What makes maternity teams effective and safe? Lessons from a series of research on teamwork, leadership and team training. Acta Obstet Gynecol Scand 2013;**92**(11):1239-43.
6. Siassakos D, Fox R, Crofts JF, et al. The management of a simulated emergency: Better teamwork, better performance. Resuscitation 2011;**82**(2):203-06.
7. Siassakos D, Marshall L, Draycott T. Improving collaboration in maternity with interprofessional learning. J Midwifery Women's Health 2011;**56**(2):183.
8. Fransen AF, van de Ven J, Schuit E, et al. Simulation-based team training for multi-professional obstetric care teams to improve patient outcome: a multicentre, cluster randomised controlled trial. BJOG : an international journal of obstetrics and gynaecology 2016.
9. Hammick M, Freeth D, Koppel I, et al. A best evidence systematic review of interprofessional education: BEME Guide no. 9. Med Teach 2007;**29**(8):735-51.
10. Freeth D, Hammick M, Koppel I, et al. *A critical review of evaluations of interprofessional education.* . London: Learning and Support Network, Centre for Health Sciences and Practice., 2002.
11. Shoushtarian M, Barnett M, McMahon F, et al. Impact of introducing Practical Obstetric Multi-Professional Training (PROMPT) into maternity units in Victoria, Australia. BJOG Int J Obstet Gynaecol 2014;**121**(13):1710-18.
12. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology 2006;**3**(2):77-101.
13. Bosse HM, Mohr J, Buss B, et al. The benefit of repetitive skills training and frequency of expert feedback in the early acquisition of procedural skills. BMC Med Educ 2015;**15**(1).
14. Lewin K. Frontiers in Group Dynamics: Concept, Method and Reality in Social Science; Social Equilibria and Social Change. Hum Relat 1947;**1**(1):5-41.
15. Cornthwaite K, Edwards S, Siassakos D. Reducing risk in maternity by optimising teamwork and leadership: An evidence-based approach to save mothers and babies. Best Pract Res Clin Obstet Gynaecol 2013;**27**(4):571-81.
16. Cooper S, Cant R, Connell C, et al. Measuring teamwork performance: Validity testing of the Team Emergency Assessment Measure (TEAM) with clinical resuscitation teams. Resuscitation 2016;**101**:97-101.
17. Bergh AM, Baloyi S, Pattinson RC. What is the impact of multi-professional emergency obstetric and neonatal care training? Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1028-43.
18. Ameh CA, Van Den Broek N. Making It Happen: Training health-care providers in emergency obstetric and newborn care. Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1077-91.
19. Bajaj K, Rivera-Chiauzzi EY, Lee C, et al. Validating Obstetric Emergency Checklists using Simulation: A Randomized Controlled Trial. American Journal of Perinatology 2016.
20. Crofts JF, Winter C, Sowter MC. Practical simulation training for maternity care-where we are and where next. BJOG Int J Obstet Gynaecol 2011;**118**(SUPPL. 3):11-16.

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21. Gillan C, Lovrics E, Halpern E, et al. The evaluation of learner outcomes in interprofessional continuing education: A literature review and an analysis of survey instruments. Med Teach 2011;**33**(9):e461-e70.
22. Calvert KL, McGurgan PM, Debenham EM, et al. Emergency obstetric simulation training: How do we know where we are going, if we don't know where we have been? Aust New Zealand J Obstet Gynaecol 2013;**53**(6):509-16.
23. Draycott T, Crofts J. Structured team training in obstetrics and its impact on outcome. Fetal Matern Med Rev 2006;**17**(3):229-37.
24. Freeth D, Hammick M, Reeves S, et al. *Effective Interprofessional Education: Development, Delivery and Evaluation*: Blackwell Publishing Ltd, 2008.

Table 1: Modified Kirkpatrick's framework (adapted from Barr's six level classification)

Level 1	Participant reaction	Learners' views on the learning experience and its interprofssional nature
Level 2a	Change in attitudes	Changes in attitues towards team members of the interproessnal groups
Level 2b	Change in knowledge or skills	Including knowledge and skills related to the interprofessional activity
Level 3	Behavioural change	Identify individual transfer of interproessional learning
Level 4a	Change in organizational practice	Wider change in oraganisationalpractice and delivery of care
Level 4b	Change in clinical outcome	Improvemnt in change in patient care

* Adapted with permission from (Barr, Koppel, Reeves, Hammick, & Freeth, 2005)

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Table 2: Learning acquired from the PROMPT program

Theme	Responses	Comments
Communication	87	*"Allocating task to a certain individual and not to someone!"* *"Use closed loop communication"* *"Use team members' names"* *"use specific terminology"* *"Effective communication between team members leads to effective management"* *"Communication becomes even more important in an emergency situation"* *"Communication asking who is in charge (of the situation)"* *"to ask what's happening for documentation, to tell when obs/anything is to be done"*
Knowledge of equipment and procedure	78	*"Ring 999 only for an emergency CS"* *"I learnt where things are kept so they can be accessed immediately in an emergency"* *"Familiarity with the ward and procedures to initiate emergency responses"* *"Need to spend time learning to hook up the resuscitation cot to the gases in birth rooms"* *"using the resusitaire, turning it on and setting 02 + gas"* *"familiarise yourself with the content of the emergency*

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		boxes" "*it was difficult to find the equipment like the IV pump for the simulation. I understand we need to know where these things are, but there were none in any of the spots"*
Learning leadership and followership	**73**	*"Put hand up if free when already completed a task in an emergency situation"* *"Its ok to not have a job and wait"* *"Learned to identify the importance of clarifying leadership role in every scenario"* *"Step in with a helicopter leader role"* *"Ask who is the leader/what is going on/what can I do"* *"I needed to be more assertive as team leader"* *"clear instructions and explicitly determining who the emergency leader is"*
Supportive learning environment	**68**	*"useful to practise these things in team prior to the real deal"* *"it consolidated training/knowledge that I have come across in pieces"* *"it identifies my weaknesses so I can work on them"* *"learning about eclampsia and PPH in a relaxed environment"*

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Realism in simulation	**48**	*"Having a serious actress helped to keep it real"* *"Stay calm in a stressful emergency"* *"Practical experience of emergencies we don't normally get to manage"* *"....hard knowing what you are walking into a situation and having to act - not giving the order of scenarios"*
Interprofessional roles and teamwork	**46**	*"Teamwork improves working together"* *"My specific role as a RMO (junior doctor) in the emergency situation...."* *"....taking on roles/tasks that I can do instead of RMO"* *"That you could have a small role that makes up effective care"*
Prioritisation	**33**	*"(checking) Fetal heart rate during eclamptic fit is not a priority"* *"Think of first line of management in a maternity emergency"* *"IV fluids very important in PPH, possibly more than drugs"* *"the importance of airway and fluid resuscitation"* *"The first steps in managing an eclamptic woman"*

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Table 3: Shoulder dystocia

	2011-2012	**2014-2015**	***p-value***
Cases	268 (1.7%)	290 (2.3%)	**0.001**
Live born	268 (100%)	290 (100%)	1.00
Internal manoeuvres	51 (19%)	54 (19%)	0.91
Interval between head and body	2.0 (IQR 1-3)	2.0 (IQR 1-2)	**0.04**
Brachial plexus injury	17 (6%)	10 (3%)	0.12
Fracture*	14 (5%)	7 (2%)	0.12
Apgar <7 @ 5min	21 (8%)	15 (5%)	0.31
Lactate >8 mg/dL	12 (4%)	22 (8%)	0.16
Admission SCN/NICU	87 (32%)	74 (26%)	0.08
Major perineal trauma	31 (12%)	27 (9%)	0.41
3rd degree tear	28 (10%)	26 (9%)	0.48
4th degree tear	3 (1%)	1 (0.3%)	0.36
Management sheet completed	63 (24%)	48 (17%)	**0.04**

* Humerus or clavicle

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Table 4: PPH 1000-1499 mL

	2011-2012	**2014-2015**	***p-value***
Cases	561 (3.7%)	511 (4.1%)	0.09
LUCS	196 (35%)	176 (34%)	0.90
Transfer to theatre after vaginal birth	65 (12%)	76 (15%)	0.12
IV access before theatre	260 (99.6%)	252 (100%)	1.00
Bakri balloon	2 (0.4%)	6 (1%)	0.16
ICU admission	0	3 (0.6%)	0.12
RBC transfusion	65 (12%)	75 (15%)	0.15

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Table 5: PPH >1500mL

	2011-2012	**2014-2015**	***p-value***
Cases	329 (2.2%)	287 (2.3%)	0.48
LUCS	101 (31%)	64 (22%)	**0.03**
Transfer to theatre after vaginal birth	99 (30%)	108 (38%)	**0.049**
IV access before theatre	199 (99.5%)	171 (99.4%)	1.00
Bakri balloon	21 (6%)	34 (12%)	**0.02**
ICU admission	23 (7%)	24 (8.3%)	0.55
RBC transfusion	156 (47%)	149 (52%)	0.29

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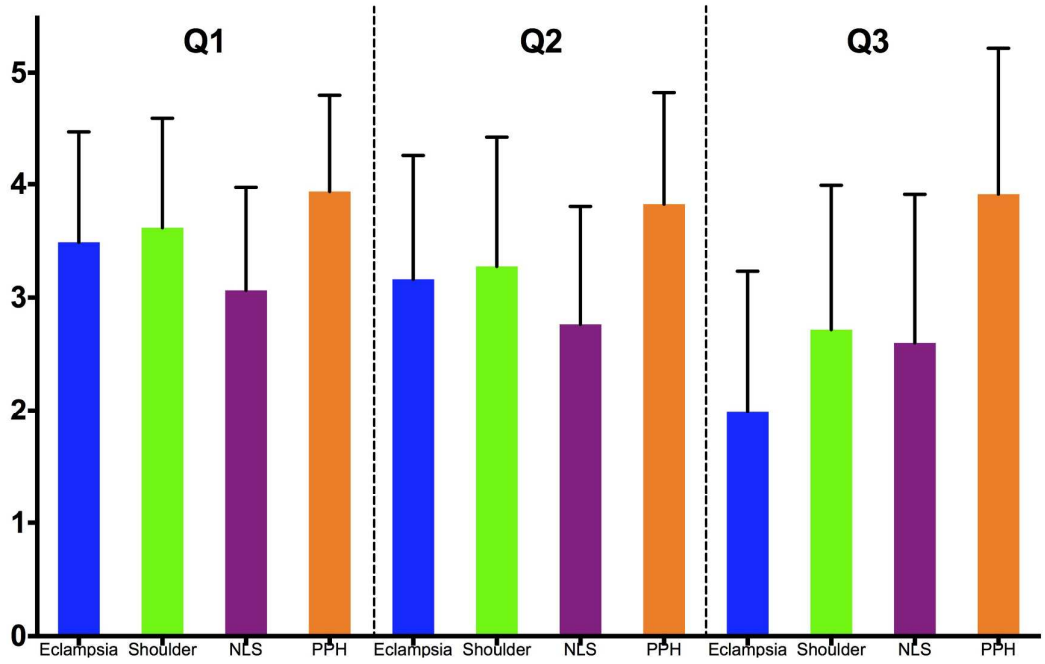
Figure 1A: Medical Staff

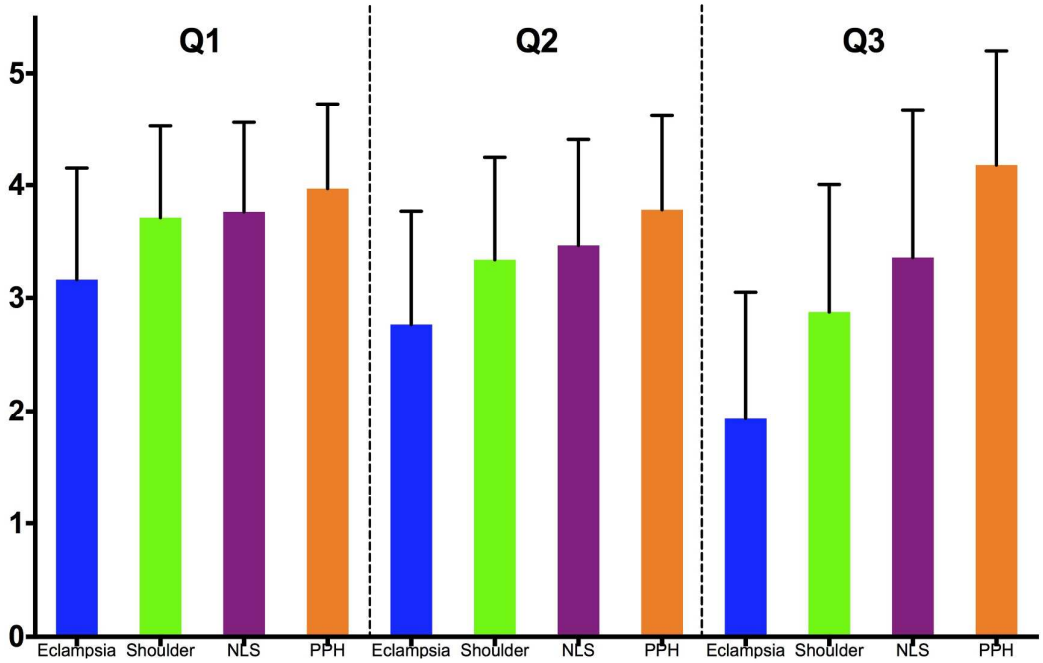


Bar diagrams showing level of knowledge (Q1), confidence (Q2) or prior experience (Q3) of medical staff in dealing with eclampsia, shoulder dystocia, neonatal resuscitation (NLS) and postpartum haemorrhage (PPH).

1-5 on the y- axis denotes likert scale rating, where 5 is the highest rating.

view only

Figure 1B: Midwifery staff



Bar diagrams showing level of knowledge (Q1), confidence (Q2) or prior experience (Q3) of midwifery staff in dealing with eclampsia, shoulder dystocia, neonatal resuscitation (NLS) and postpartum haemorrhage (PPH). 1-5 on the y-axis denotes Likert scale rating, where 5 is the highest rating.

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STROBE Statement for PROMPT study
(Research checklist)

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Evaluation of learning from Practical Obstetrical Multi-Professional Training and its impact on patient outcomes in Australia using Kirkpatrick's method: A mixed methods study

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Evaluation of learning from Practical Obstetrical Multi-Professional Training and its impact on patient outcomes in Australia using Kirkpatrick's framework: A mixed methods study

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Abstract

Objectives: The aim of this study was to evaluate the implementation of the Practical Obstetric Multi-Professional Training **(**PROMPT) simulation using the Kirkpatrick's framework. We explored participants' acquisition of knowledge and skills, its impact on clinical outcomes and organisational change to integrate the PROMPT program as a credentialing tool. We also aimed to assess participants' perception of usefulness of PROMPT in their clinical practice.

Study design: Mixed methods approach with a pre-test / post-test design.

Setting: Healthcare network providing obstetric care in Victoria, Australia.

Participants: Medical and midwifery staff attending PROMPT between 2013 and 2015 (n=508); clinical outcomes were evaluated in two cohorts 2011-2012 (n=15,361 births) and 2014-2015 (n=12,388 births)

Intervention: Attendance of the PROMPT program, a simulation program taught in multidisciplinary teams to facilitate teaching emergency obstetric skills.

Main outcome measure: Clinical outcomes compared before and after embedding PROMPT in educational practice.

Secondary outcome measure: Assessment of knowledge gained by participants through a qualitative analysis and description of process of embedding PROMPT in educational practice.

Results: There was a change in the management of postpartum haemorrhage by early recognition and intervention. The key learning themes described by participants were being prepared with a prior understanding of procedures and equipment, communication, leadership, and learning in a safe, supportive environment. Participants reported a positive learning experience and increase in confidence in managing emergency obstetric situations, through the PROMPT program which was perceived as a realistic demonstration of the emergencies.

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Conclusion: Participants reported an improvement of both clinical and non-technical skills highlighting principles of teamwork, communication, leadership and prioritisation in an emergency situation**.** An improvement was observed in management of postpartum haemorrhage but no significant change was noted in clinical outcomes over a two-year period after PROMPT. However, the skills acquired by medical and midwifery staff justify embedding PROMPT in educational programs.

Strengths and limitations of the study

- This is one of the few mixed methods studies using multiple levels of Kirkpatrick's assessment including data on patient outcome that are rarely reported.
- The evaluation allowed insight into the service delivery and revealed deficiencies that could be corrected prospectively.
- The participants' behaviour could not be studied in either simulation or a clinical setting.

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Introduction

Interprofessional team-based, simulated training programs are becoming increasingly popular to improve the performance of clinical workforce in emergency responses, and its resultant clinical outcomes. The provision of high quality birth suite care is no exception. Staff training in technical clinical skills is put to test in complex obstetric situations that require time critical management. Team members must be instantly engaged to achieve synergism in managing acute obstetric emergencies. Hence, acquisition of non-technical skills (NTS), such as effective communication and teamwork, are as important as mastering "hands-on" clinical skills.[1]

Interprofessional education (IPE) focuses on "staff members working together to learn *with*, *from* and *about* each other".[2] IPE programs help individuals to develop an understanding of other professional roles within the multidisciplinary team. Such an understanding is thought important for safe and effective clinical practice as a team.[3] In order to maintain a level of confidence in managing these difficult clinical emergencies regular up-skilling sessions are necessary.

PROMPT (PRactical Obstetric Multi-Professional Training) is a multi-professional training package designed to expose participants (obstetricians, midwives, paediatricians and anaesthetists) to obstetric emergencies in a real time environment.[4-8] This simulation-based program aims to recreate clinical problems either "in-situ" in a birth unit or in a simulation centre and presents them to participants as realistically as possible. The scenarios can be designed specifically for the level of the participants and the available facilities. Evaluation of these programs is necessary to assess if their objectives are met. Programs can be evaluated using various frameworks, one of them being the six level modification of Kirkpatrick's

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framework.[2 9 10] The various levels assess participant's satisfaction, change in attitude or identification of what was learnt, if these skills changed participant behaviour in a clinical setting or ultimately affected clinical organisational change and patient outcomes (see Table 1).

We introduced the Victorian state version of the PROMPT program to our maternity service in 2013.[11] In this study, we aimed to evaluate the impact of PROMPT in our health service by assessing the various levels in the six-level framework. Specifically, we wished to identify the "key learning points" acquired, "how" useful this workshop style teaching was rated and whether there was any evidence of change in patient outcomes. We also describe the process of "embedding" this program in educational up-skilling of staff.

Methods

Study design

The study follows a mixed methods design with quantitative analysis of patient outcome data and for participant rating of the intervention. The data regarding the key learning messages was extracted using qualitative content analysis identifying key themes. The study was approved as a quality assurance project by the institutional research ethics committee.

Setting and participants

Monash Health maternity service provides birthing care for over 9000 women annually at three separate hospital sites, each with different levels of acuity, all within metropolitan Melbourne, Victoria. The three sites share common clinical practice guidelines, policies and procedures. Monash Health implemented the PROMPT program in its current format across all its sites since 2013. Midwifery educators and dedicated senior obstetric medical staff run

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the program. The PROMPT sessions are conducted ten times per year at each site at monthly intervals. Midwifery and medical staff (junior and senior) are required to participate at least every two years. All medical and midwifery staff who had attended the PROMPT session at least once between 2013 and 2015 were invited to participate in the study.

PROMPT program scenarios

The half-day program consists of short, interactive lectures and scenario-based drills. Each drill is followed by a debrief covering clinical and non-technical skills. The clinical scenarios include eclampsia, shoulder dystocia, neonatal resuscitation and postpartum haemorrhage (PPH). These are topics that were already covered in the pre-reading material provided to the participants.

Questionnaires

The evaluation of the PROMPT workshop followed a pre-test and a post-test research design using paper-based questionnaires. The questionnaires were drafted, revised and agreed upon by the PROMPT committee (represented by both medical and midwifery educators) to establish content validity. The questionnaires had been pilot tested in a home birth based simulation program (in a different participant group that included home birth midwives) at Monash Health and results published in a peer reviewed journal.[12] Each questionnaire had 26 items where participants' responses are recorded using a 5-point Likert scale. The pre-test evaluated levels of knowledge and confidence managing the obstetric emergencies covered. They are also asked about participants' professional background and experience in these clinical emergencies. At the end of the workshop the post-test evaluated the satisfaction and learning acquired from the program. Participants were also asked to reflect on the essential

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learning points attained that were thought to be transferable to their (individual or team-based) clinical practice using free text.

Textual data were analysed independently and inductively using content analysis undertaken by two researchers independently (AK, SS) to produce key themes.[13] The results were discussed and after establishing consensus, all data were recoded. Some categories overlapped but items were counted only once. Discrepancies were negotiated enabling final attribution of text within categories.

Clinical outcome measures

A retrospective cohort study examined all documented cases of the three major obstetric emergencies covered during the drills (eclampsia, shoulder dystocia combined with neonatal resuscitation, and post-partum haemorrhage). Clinical outcomes were evaluated in two cohorts: before the implementation of PROMPT in 2011-2012 (n=15,361 births) and after the implementation of PROMPT in 2014-2015 (n=12,388 births). Patient outcomes were evaluated using the following measures. For shoulder dystocia we measured the use of external and internal manoeuvres, time between delivery of the head and the body, completion of documentation, major maternal perineal trauma (3rd and 4th degree tears), and neonatal outcomes including brachial plexus injury, clavicle or humerus fracture, Apgar score <7 at 5 minutes, umbilical cord lactates >8 mg/dl, admission to newborn services and perinatal death. For PPH, we classified women into two groups according to the estimated volume of blood loss (1000ml-1499ml or >=1500ml) reporting rates of blood transfusion, transfer to the operating theatre, intravenous fluid resuscitation and use of a (Bakri®) balloon tamponade.

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Data were extracted from an electronic database of birthing outcomes, the Birthing Outcomes System (BOS®), that records outcomes for all births ≥20 weeks of gestation and is routinely entered by midwifery staff.[14] Where necessary BOS data was supplemented by individual case record review.

Statistical analysis

Data were analysed with Prism for Mac version 7.0a (Graph pad software, San Diego, CA, USA). Continuous data were expressed as means and standard deviation or medians and interquartile range (IQR) as appropriate.

Results

Participation

Since 2013 we have run 70 PROMPT sessions across our three sites with a total of 508 participants. Approximately one-third (n=178, 35%) of participants were medical staff (junior and senior). The remaining were midwifery staff (n=287, 56%), medical or midwifery students (n=34, 7%) or special care nursery staff (n=9, 2%). By 2015, 76% midwives and 90% senior medical staff had participated at least once in PROMPT.

Satisfaction with the simulation activity (Level 1 Kirkpatrick's framework)

Figure 1 summarises the participant knowledge, confidence and prior experience in managing obstetric emergencies. Staff confidence in management of eclampsia was lower than that for the other obstetric emergencies. The confidence and knowledge concerning neonatal resuscitation was higher for midwives than the medical staff (Figure 1). In general, the workshops were rated highly by both medical and midwifery participants (median Likert

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score of 5 (maximum) for both groups) in regards to clinical usefulness of material covered and debriefing experience.

Knowledge acquired from the workshop (Level 2b Kirkpatrick's framework)

430 comments made by 237 participants were available for content analysis (Table 2). The key themes related to improved communication between staff members (n=87), developing knowledge of equipment and procedures (78 responses), learning leadership and followership (73 responses), being in a supportive learning environment (63 responses), the realism of the simulation (48 responses), understanding the roles of staff from another profession (46 responses) and prioritisation of tasks (33 responses).

Communication

Clear communication established directly with the members of the team (by using the individual's name) and with others who assist in the process e.g. with switchboard calling an emergency code. Where appropriate, specific terminology should be used. The loop of communication should be closed by obtaining a response from the recipient, to ensure accountability of the individual undertaking the task. The communication was seen to be even more crucial at certain times like the handover of a task to another member of the team.

Situational awareness

Identification and knowledge of equipment, its location in the birth unit, organisation of the equipment and knowing if it was in working order was recognised as relevant for the staff using it in an emergency with time constraints. A prior familiarity of content and a practice of using the postpartum and eclampsia kit, was found to be essential. Necessary gear found

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missing at the time of workshop or kept in the wrong location, delayed the management and caused stress to the team.

Similarly staff members were keen to have a prior awareness of protocols and procedures, more so in complex situations like eclampsia and neonatal resuscitation and where clinical manoeuvres were needed like shoulder dystocia. The organisational pathways needed like calling an emergency code and methods to access operating theatres in an emergency were also emphasised.

Learning leadership and followership

The importance of leading an emergency team presented as an unexpectedly prominent theme. The key characteristics of a leader were to maintain a "helicopter view" at all times and be clear and assertive with instructions to participants. Establishing and announcing who the leader of the team was (either by the leader or another participant) and appointing one if already not designated. The leader could change during the emergency scenario depending on individual capability and who was available. Handover from one leader to another needed clear communication. In such situations, the new leader should initially "step back" and assimilate the situation prior to taking over.

The rest of the team should patiently wait for instructions, offer to help (based on their individual scope of practice) and contribute to the team management by playing their designated role. If the instructions were unclear or participants were unable to perform the allocated task, they should speak up and close the communication loop.

Supportive learning environment

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The PROMPT workshop was acknowledged to improve participants' confidence and learning of clinical knowledge and skills through individual opportunity to practice and team feedback. In a simulated setting, the technical skills and procedures could be "unpacked" into small steps during the feedback session. The combination of learning emergency skills in a simulated environment was seen as a step towards improving women safety.

Realism in simulation

The participants perceived the workshop to be similar to a real emergency through the role of an actor, scenario design, experiencing stress, working within timelines and location in a birth unit. The scenarios were based on rare emergencies and followed an unpredictable course resulting in participants feeling anxious and voiced the need to "stay calm".

Role of interprofessional staff

Participants displayed a preference to revert to their natural/ usual clinical roles when managing a clinical emergency as this was based on their strengths and scope of practice. The participants wanted to have a clear well defined role allocation which was "task specific". Both medical and midwifery staff members were keen to share learning in the interprofessional setting and wanted to understand roles of the other discipline in the team. Both teams referred to learning teamwork and task sharing.

Prioritisation

Participants demonstrated a need to organize the tasks systematically and to get help early. They emphasized on timely escalation of tasks due to their awareness of their limitations in managing emergency situations and their scope of practice.

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Organisational change to "embed" the PROMPT program (Level 4a Kirkpatrick's framework)

We describe the process of embedding the PROMPT program using Kurt Lewin's 3-phase model.[15]

Step 1 - Unfreeze

The key issue of poor communication (occasionally leading to conflict) among medical and midwifery staff was recognised through incident reporting as a component of a risk management process. This was seen to delay mobilising resources required in an emergency setting, hence compromising optimum patient safety. In a time critical situation, where effective teamwork is the key, a need to create change was recognised by medical and midwifery leaders at the institution. The need to change was communicated both to the health care network executive group and to the clinical staff delivering patient care. This coincided with introduction of the PROMPT program in the state of Victoria resulting in strategic inclusion of the team-training program for medical and midwifery staff.

Step 2 - Change

The change described here is embedding the PROMPT program as a component of routine educational practice. The principles learnt through the program focussed on communication, leadership and situational awareness, similar to the vision shared by the institution. The benefits of attending the program were communicated to the staff and feedback encouraged from participants. Problems that hindered attendance (like rostering issues, managing patient workload on teaching days) were dealt with promptly. Funding was obtained from the institution by reporting benefits of change in attitude of interprofessional staff and observed improvement in performance, although this was not formally evaluated. This funding further

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facilitated the operational management of the program, as dedicated clinical staff members could be employed to sustain the quality of teaching.

Step 3 - Refreeze

The observed improvement in attitudes of the interprofessional staff and effort to meet higher standards of clinical practice was encouraged. Leadership and operational support required to run the program was improved (by increasing the numbers of faculty members facilitating the program) and on-going training support provided to them. A process of providing team-based feedback was developed (using the PROMPT guidelines) and the role of learning through PROMPT was formalised which lent itself to its use as credentialing tool. A mandatory requirement of two-yearly attendance was set up for all medical and midwifery staff.

Clinical Outcomes (Level 4b Kirkpatrick's framework)

In 2011-2012 there were 15,361 births and in 2014-2015, 12,388 births at Monash Health.

Eclampsia

Across the four years, four women had an eclamptic seizure, two in 2011-2012 (0.13/1000) and two in 2014-2015 (0.16/1000). All four women were managed as per local protocol.

Shoulder Dystocia (Table 3)

Table 3 summarises the incidence and outcomes related to shoulder dystocia. The rate of shoulder dystocia in 2011-12 (n=268; 1.7%) was significantly lower than in 2014-15 (n=290; 2.3%, p=0.001) No neonatal deaths were recorded in either group. The interval between delivery of head and body was shorter in the recent cohort (2.0 min (IQR 1-2) vs 2.0 min (IQR 1-3), p = 0.04). In the cohort after implementation of PROMPT we observed lower

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incidences of brachial plexus injury, humerus or clavicle fractures, low Apgar scores and nursery admissions, although these differences were not statistically significant (Table 3). There was a significant decrease in the completion of the required shoulder dystocia emergency 'management sheet' (24% vs 17%; $p = 0.04$).

Post Partum Haemorrhage (Table 4 and 5)

For women with a PPH of 1000-1499ml, there was no significant change in the number of cases between cohorts [n=561 (3.7%) vs n=511 (4.1%)], and no significant differences were observed in maternal outcomes or management strategies. For women with a PPH of >1500ml, a significant difference was seen in the number of patients transferred to theatre after vaginal birth (30% vs 38%; $p = 0.049$), and the use of Bakri balloons (6% vs 12%; $p = 0.02$) which were introduced in 2011.

Discussion

Main findings

Through a formal evaluation of PROMPT and a review of clinical outcomes we have observed that this multidisciplinary training has a positive effect on managing of obstetric emergencies within our service. Consistent with mandatory workforce training requirements, participation of both medical and midwifery staff was excellent across all of our sites such that PROMPT has become an embedded component of ongoing professional development. In this paper we have evaluated our PROMPT program using the various levels of Kirkpatrick's framework, observing encouraging results. All levels examined showed positive effects after implementation of this structured training. In addition, the evaluation allowed us to identify areas for future improvement such as record keeping of therapeutic measures.

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Participants found PROMPT an effective approach for the acquisition of new skills and knowledge. Medical and midwifery staff members reported an increase in confidence and had high satisfaction scores on learning as a team (Level 1 Kirkpatrick's framework).

Our next level of assessment focussed on key "take-home" learnings acquired by the participants (Level 2 Kirkpatrick's framework). Communication and situational awareness were considered important NTS learnings by the majority of participants and is a finding consistent with other studies.[5 6] The theme on "leadership" and "following the leader" are thought critical for safe team-based management, both in simulated and real emergencies.[6 16] Poor performance in leadership despite good communication can also occur, hence, making leadership an independent learning goal of the workshop.[17] Developing improved "situational awareness" with knowledge of equipment use and efficient use of team members is an often - reported learning outcome of the PROMPT program.[5]

Our final analysis reviewed the birthing outcome and safety data (Kirkpatrick's level 4b). In the recent cohort we observed a significantly increased incidence of shoulder dystocia. This could be related to an increased awareness of this condition but could also reflect the increasing numbers of obese pregnant women delivering at our centres. We observed a small but statistically significant difference in the interval between the delivery of head and body, the clinical relevance of which is debatable. These could be assessed individually using case reviews and learning gaps addressed through clinical case review meetings. The significant increase in the number of patients transferred to theatre for control of massive post-partum bleeding (PPH >1500mls), and the increase in the use of (Bakri) balloon tamponade may reflect a greater awareness of the benefits of early and aggressive control of excessive bleeding following our PROMPT implementation. This was also noted in a recent randomised

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control trial where the units that participated in simulation based team training had a higher incidence of blood transfusion and surgical treatment of PPH.[8]

Strengths and limitations

The current study is one of few mixed methods studies attempting to draw a link between perceived learning, clinical practice and outcomes by using various levels of Kirkpatrick's framework. As far as we are aware only a few studies have evaluated simulation-based intervention through multiple "lenses" of assessment, as reported in a recent review on obstetric emergencies.[18] Most researchers have limited evaluations to either level 1 or 2 with some studies demonstrating a change in team behaviour and retention of skills.[19] Studies looking at clinical outcome are scant.[8 11 18 20] Our evaluation includes participant satisfaction with the scenario and debrief (level 1) but also learning skills and knowledge acquired by the two major interprofessional groups (level 2). We demonstrate the process from introduction of the intervention and its "embedding" in curricular training and "credentialing" (level 4a). The PROMPT program has been successfully integrated with teaching programs globally, however, the description of the program with change management principles is worthy of sharing. Above all, we have also compared the birthing outcome before and after the intervention was introduced into practice (Level 4b).

However, due to challenges related to study design that entails direct observation of participants in a "natural" setting, we were unable to assess a change in observed clinical behaviour/teamwork that may have helped to directly connect workshop learning with clinical practice, which may be done using clinical checklists.[21]

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Patient care and clinical outcomes are rarely reported as evidence of effectiveness of educational programs.[22] Most likely this is because programs need to be embedded prior to evaluation and coverage of a sufficient proportion of the workforce needs to be achieved before improved care and outcomes would be expected. This can take many years.[23-25] An evaluation of the PROMPT program elsewhere, demonstrated a significant decrease in brachial plexus injury, incidence of pH less than 7, and a reduction of hypoxic ischemic encephalopathy by 50% when assessed over a 7-year interval.[20] We were unable to explore detailed outcome data prior to 2010 as previously documented notes had missing clinically relevant details, hence precluding us from assessing five years before and after PROMPT which may have provided a better reflection of birthing outcomes. However, this may not have changed the result as a similar study failed to show a significant reduction in the composite obstetric outcome in units where multi-professional simulation training was introduced.[8]

A major strength of this evaluation is that it allowed insights into service delivery and identification of potential deficiencies. For instance, we observed a reduction in the completion of shoulder dystocia management forms. In addition our current record form lack certain outcome measures that would be of interest to evaluate clinical management, such as fluid volume usage during PPH.

Interpretation

Participants indicated that communication, situational awareness and leadership skills are key factors for managing emergencies as a successful team. The next level of evaluation planned will be to check the team performance in a real obstetric emergency setting to determine if the transfer of learning has occurred. This can be achieved by integration of level 3-assessment

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(behaviour) into our training development strategy by direct observation of performance in a simulated and/or clinical setting. Apart from more proactive management noted in postpartum haemorrhage, no significant difference was noted in clinical outcome. This may be due to existence of previously run simulation programs, which focussed on individual skills but not on effective teamwork. Although, participants recognise the importance of teamwork and communication in their learning, this was not transferable to a change in clinical outcome.

This evaluation has already resulted in changing the organisational practice at our institution (Level 4a).[26] An annual attendance of PROMPT is encouraged for all staff and a two-yearly attendance is a mandatory requirement for staff working on the birth unit. It is used for credentialing the staff members with remediation plans for participants unable to meet the expected standards of performance for both technical and non-technical skills. Our goal will be to continue to strengthen this process and to formalise it further, linking it with professional development.

Conclusions

The study highlights the need for teaching teamwork, communication and leadership skills in managing obstetric emergencies through a high fidelity simulation program. The impact on clinical outcomes seems limited, yet we identified some differences related to management of shoulder dystocia and postpartum haemorrhage that could have made a difference in certain individual cases. Improved participant confidence with up-skilling of both procedural and non-technical skills has a potential to change clinical practice and outcomes, hence, validating the incorporation of these IPE simulation strategies in clinical care.

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Contribution to authorship: AK conceived and designed the study, analysed the data, wrote the first draft of the manuscript and finalised the submission. SS performed the study, analysed the data, edited the manuscript, and approved the final submission. DL, JM, PN, MS and SS performed the study, and approved the final submission. EMW conceived and designed the study, contributed to analysis tools, edited and finalised the submission. DN analysed the data and contributed to analysis tools. PD is the senior author, conceived, designed, performed and supervised the study, analysed data and approved the final submission.

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Funding: The PROMPT program at Monash Health was supported by funding of the Victorian Managed Insurance Authority (VMIA), when it was introduced.

Data sharing: There is no other unpublished data from this study

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Access to the data is available only to the research team in a secure (coded) format

Clinical data has been obtained from Birthing Outcome Software (BOS®) and is accessible to only registered BOS® users in the healthcare network.

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References

1. Leonard M, Graham S, Bonacum D. The human factor: The critical importance of effective teamwork and communication in providing safe care. Qual Saf Health Care 2004;**13**(SUPPL. 1):i85-i90.
2. Barr H, Koppel I, Reeves S, et al. *Effective Interprofessional Education: Argument, Assumption and Evidence*: Blackwell Publishing Ltd, 2005.
3. Wong AHW, Gang M, Szyld D, et al. Using a simulation-enhanced interprofessional education strategy to improve attitudes toward teamwork and communication. Simul Healthc 2016;**11**(2):117-25.
4. Crofts JF, Ellis D, Draycott TJ, et al. Change in knowledge of midwives and obstetricians following obstetric emergency training: A randomised controlled trial of local hospital, simulation centre and teamwork training. BJOG Int J Obstet Gynaecol 2007;**114**(12):1534-41.
5. Siassakos D, Fox R, Bristowe K, et al. What makes maternity teams effective and safe? Lessons from a series of research on teamwork, leadership and team training. Acta Obstet Gynecol Scand 2013;**92**(11):1239-43.
6. Siassakos D, Fox R, Crofts JF, et al. The management of a simulated emergency: Better teamwork, better performance. Resuscitation 2011;**82**(2):203-06.
7. Siassakos D, Marshall L, Draycott T. Improving collaboration in maternity with interprofessional learning. J Midwifery Women's Health 2011;**56**(2):183.
8. Fransen AF, van de Ven J, Schuit E, et al. Simulation-based team training for multi-professional obstetric care teams to improve patient outcome: a multicentre, cluster randomised controlled trial. BJOG : an international journal of obstetrics and gynaecology 2016.
9. Hammick M, Freeth D, Koppel I, et al. A best evidence systematic review of interprofessional education: BEME Guide no. 9. Med Teach 2007;**29**(8):735-51.
10. Freeth D, Hammick M, Koppel I, et al. *A critical review of evaluations of interprofessional education.* . London: Learning and Support Network, Centre for Health Sciences and Practice., 2002.
11. Shoushtarian M, Barnett M, McMahon F, et al. Impact of introducing Practical Obstetric Multi-Professional Training (PROMPT) into maternity units in Victoria, Australia. BJOG Int J Obstet Gynaecol 2014;**121**(13):1710-18.
12. Kumar A, Nestel D, Stoyles S, et al. Simulation based training in a publicly funded home birth programme in Australia: A qualitative study. Women Birth 2016;**29**(1):47-53.
13. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology 2006;**3**(2):77-101.
14. Bosse HM, Mohr J, Buss B, et al. The benefit of repetitive skills training and frequency of expert feedback in the early acquisition of procedural skills. BMC Med Educ 2015;**15**(1).
15. Lewin K. Frontiers in Group Dynamics: Concept, Method and Reality in Social Science; Social Equilibria and Social Change. Hum Relat 1947;**1**(1):5-41.
16. Cornthwaite K, Edwards S, Siassakos D. Reducing risk in maternity by optimising teamwork and leadership: An evidence-based approach to save mothers and babies. Best Pract Res Clin Obstet Gynaecol 2013;**27**(4):571-81.
17. Cooper S, Cant R, Connell C, et al. Measuring teamwork performance: Validity testing of the Team Emergency Assessment Measure (TEAM) with clinical resuscitation teams. Resuscitation 2016;**101**:97-101.
18. Bergh AM, Baloyi S, Pattinson RC. What is the impact of multi-professional emergency obstetric and neonatal care training? Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1028-43.
19. Ameh CA, Van Den Broek N. Making It Happen: Training health-care providers in emergency obstetric and newborn care. Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1077-91.
20. Weiner CP, Collins L, Bentley S, et al. Multi-professional training for obstetric emergencies in a US hospital over a 7-year interval: An observational study. Journal of Perinatology 2016;**36**(1):19-24.

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21. Bajaj K, Rivera-Chiauzzi EY, Lee C, et al. Validating Obstetric Emergency Checklists using Simulation: A Randomized Controlled Trial. American Journal of Perinatology 2016.
22. Crofts JF, Winter C, Sowter MC. Practical simulation training for maternity care-where we are and where next. BJOG Int J Obstet Gynaecol 2011;**118**(SUPPL. 3):11-16.
23. Gillan C, Lovrics E, Halpern E, et al. The evaluation of learner outcomes in interprofessional continuing education: A literature review and an analysis of survey instruments. Med Teach 2011;**33**(9):e461-e70.
24. Calvert KL, McGurgan PM, Debenham EM, et al. Emergency obstetric simulation training: How do we know where we are going, if we don't know where we have been? Aust New Zealand J Obstet Gynaecol 2013;**53**(6):509-16.
25. Draycott T, Crofts J. Structured team training in obstetrics and its impact on outcome. Fetal Matern Med Rev 2006;**17**(3):229-37.
26. Freeth D, Hammick M, Reeves S, et al. *Effective Interprofessional Education: Development, Delivery and Evaluation*: Blackwell Publishing Ltd, 2008.

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Table 1: Modified Kirkpatrick's framework (adapted from Barr's six level classification)

Level 1	Participant reaction	Learners' views on the learning experience and its interprofessional nature
Level 2a	Change in attitudes	Changes in attitudes towards team members of the interprofessional groups
Level 2b	Change in knowledge or skills	Including knowledge and skills related to the interprofessional activity
Level 3	Behavioural change	Identify individual transfer of interprofessional learning
Level 4a	Change in organizational practice	Wider change in organisational practice and delivery of care
Level 4b	Change in clinical outcome	Improvement in change in patient care

* Adapted with permission from Barr *et al* [2]

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Table 2: Learning acquired from the PROMPT program

Theme	Responses	Comments
Communication	87	*"Allocating task to a certain individual and not to someone!"* *"Use closed loop communication"* *"Use team members' names"* *"Use specific terminology"* *"Effective communication between team members leads to effective management"* *"Communication becomes even more important in an emergency situation"* *"Asking who is in charge (of the situation)"* *"To ask what's happening for documentation, to tell when observations/anything is to be done"*
Knowledge of equipment and procedure	78	*"I learnt where things are kept so they can be accessed immediately in an emergency"* *"Familiarity with the ward and procedures to initiate emergency responses"* *"Need to spend time learning to hook up the resuscitation cot to the gases in birth rooms"* *"Using the resuscitaire, turning it on"* *"Familiarise yourself with the content of the emergency boxes"* "*It was difficult to find the equipment like the IV pump for the simulation. I understand we need to know where these*

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		things are."
Learning leadership and followership	**73**	*"Put hand up if free when already completed a task in an emergency situation"* *"It's ok to not have a job and wait"* *"Learned to identify the importance of clarifying leadership role in every scenario"* *"Step in with a helicopter leader role"* *"Ask who is the leader/what is going on/what can I do?"* *"I needed to be more assertive as team leader"* *"Clear instructions and explicitly determining who the emergency leader is"*
Supportive learning environment	**68**	*"Useful to practise these things in team prior to the real deal"* *"It consolidated training/knowledge that I have come across in pieces"* *"It identifies my weaknesses so I can work on them"* *"Learning about eclampsia and PPH in a relaxed environment"*
Realism in simulation	**48**	*"Having a serious actress helped to keep it real"* *"Stay calm in a stressful emergency"* *"Practical experience of emergencies we don't normally get to manage"*
Interprofessional roles and teamwork	**46**	*"Teamwork improves working together"* *"My specific role as a RMO (junior doctor) in an emergency situation…."*

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		"….taking on roles/tasks that I can do instead of RMO" *"That you could have a small role that makes up effective care"*
Prioritisation	**33**	*"(checking) Fetal heart rate during eclamptic fit is not a priority"* *"Think of first line of management in a maternity emergency"* *"IV fluids very important in PPH, possibly more than drugs"* *"The importance of airway and fluid resuscitation"* *"The first steps in managing an eclamptic woman"*

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Table 3: Shoulder dystocia

	2011-2012	**2014-2015**	***p-value***
Cases	268 (1.7%)	290 (2.3%)	**0.001**
Live born	268 (100%)	290 (100%)	1.00
Internal manoeuvres	51 (19%)	54 (19%)	0.91
Interval between head and body	2.0 (IQR 1-3)	2.0 (IQR 1-2)	**0.04**
Brachial plexus injury	17 (6%)	10 (3%)	0.12
Fracture*	14 (5%)	7 (2%)	0.12
Apgar <7 @ 5min	21 (8%)	15 (5%)	0.31
Lactate >8 mg/dL	12 (4%)	22 (8%)	0.16
Admission SCN/NICU	87 (32%)	74 (26%)	0.08
Major perineal trauma	31 (12%)	27 (9%)	0.41
3rd degree tear	28 (10%)	26 (9%)	0.48
4th degree tear	3 (1%)	1 (0.3%)	0.36
Management sheet completed	63 (24%)	48 (17%)	**0.04**

* Humerus or clavicle

SCN: special care nursery; NICU: neonatal intensive care unit

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Table 4: Postpartum haemorrhage 1000-1499 mL

	2011-2012	**2014-2015**	***p-value***
Cases	561 (3.7%)	511 (4.1%)	0.09
CS	196 (35%)	176 (34%)	0.90
Transfer to theatre after vaginal birth	65 (12%)	76 (15%)	0.12
IV access before theatre	260 (99.6%)	252 (100%)	1.00
Bakri balloon	2 (0.4%)	6 (1%)	0.16
ICU admission	0	3 (0.6%)	0.12
RBC transfusion	65 (12%)	75 (15%)	0.15

CS: caesarean section; ICU: intensive care unit; RBC: red blood cells

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Table 5: Postpartum haemorrhage >1500mL

	2011-2012	**2014-2015**	***p-value***
Cases	329 (2.2%)	287 (2.3%)	0.48
CS	101 (31%)	64 (22%)	**0.03**
Transfer to theatre after vaginal birth	99 (30%)	108 (38%)	**0.049**
IV access before theatre	199 (99.5%)	171 (99.4%)	1.00
Bakri balloon	21 (6%)	34 (12%)	**0.02**
ICU admission	23 (7%)	24 (8.3%)	0.55
RBC transfusion	156 (47%)	149 (52%)	0.29

CS: caesarean section; ICU: intensive care unit; RBC: red blood cells

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Figure Legend

Figure 1: Bar diagrams showing level of knowledge (Q1), confidence (Q2) or prior experience (Q3) of medical staff (top panel) and midwifery staff (bottom panel) in dealing with eclampsia, shoulder dystocia, neonatal resuscitation (NLS) and postpartum haemorrhage (PPH).

1-5 on the y- axis denotes likert scale rating, where 5 is the highest rating.

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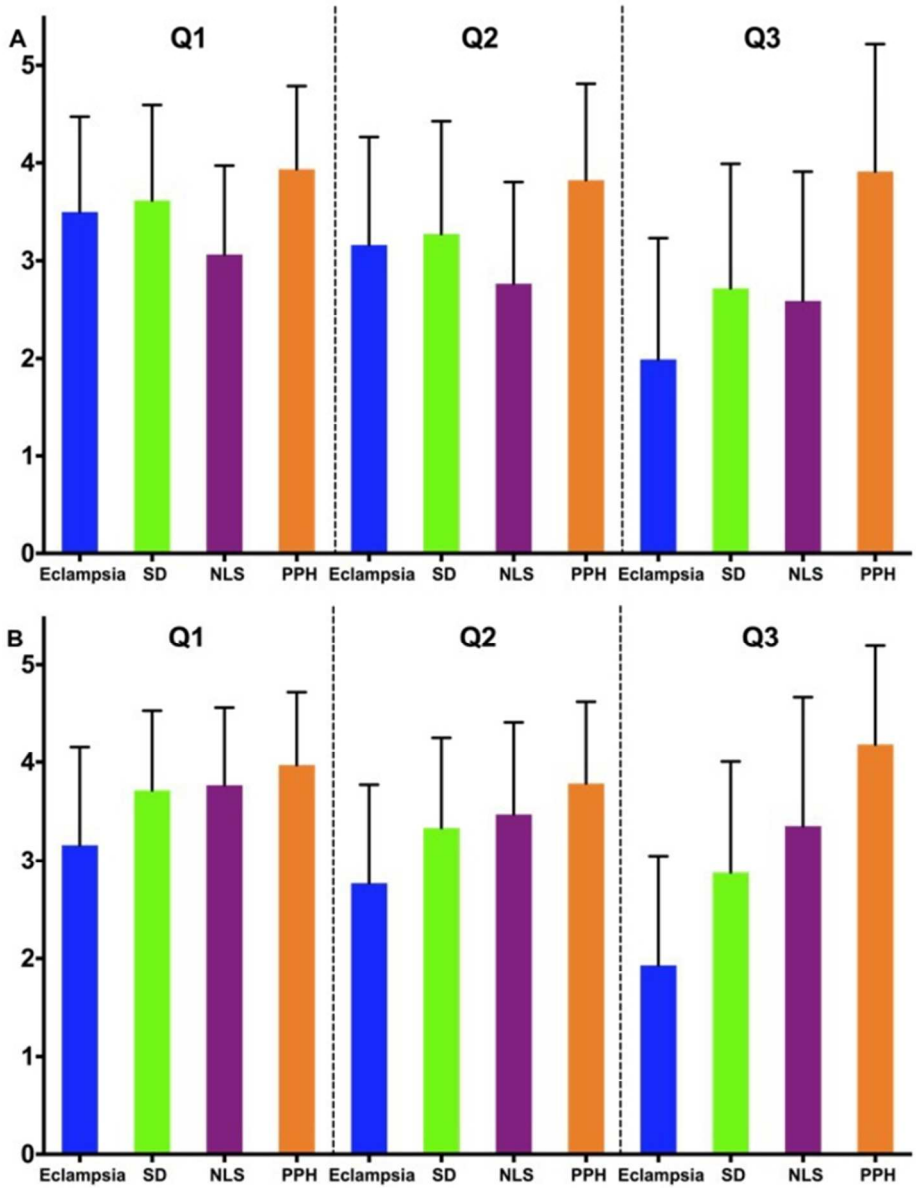

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STROBE Statement for PROMPT study
(Research checklist)

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Evaluation of learning from Practical Obstetrical Multi-Professional Training and its impact on patient outcomes in Australia using Kirkpatrick's method: A mixed methods study

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Manuscripts

Evaluation of learning from Practical Obstetrical Multi-Professional Training and its impact on patient outcomes in Australia using Kirkpatrick's framework: A mixed methods study

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Abstract

Objectives: The aim of this study was to evaluate the implementation of the Practical Obstetric Multi-Professional Training **(**PROMPT) simulation using the Kirkpatrick's framework. We explored participants' acquisition of knowledge and skills, its impact on clinical outcomes and organisational change to integrate the PROMPT program as a credentialing tool. We also aimed to assess participants' perception of usefulness of PROMPT in their clinical practice.

Study design: Mixed methods approach with a pre-test / post-test design.

Setting: Healthcare network providing obstetric care in Victoria, Australia.

Participants: Medical and midwifery staff attending PROMPT between 2013 and 2015 (n=508); clinical outcomes were evaluated in two cohorts 2011-2012 (n=15,361 births) and 2014-2015 (n=12,388 births)

Intervention: Attendance of the PROMPT program, a simulation program taught in multidisciplinary teams to facilitate teaching emergency obstetric skills.

Main outcome measure: Clinical outcomes compared before and after embedding PROMPT in educational practice.

Secondary outcome measure: Assessment of knowledge gained by participants through a qualitative analysis and description of process of embedding PROMPT in educational practice.

Results: There was a change in the management of postpartum haemorrhage by early recognition and intervention. The key learning themes described by participants were being prepared with a prior understanding of procedures and equipment, communication, leadership, and learning in a safe, supportive environment. Participants reported a positive learning experience and increase in confidence in managing emergency obstetric situations, through the PROMPT program which was perceived as a realistic demonstration of the emergencies.

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Conclusion: Participants reported an improvement of both clinical and non-technical skills highlighting principles of teamwork, communication, leadership and prioritisation in an emergency situation**.** An improvement was observed in management of postpartum haemorrhage but no significant change was noted in clinical outcomes over a two-year period after PROMPT. However, the skills acquired by medical and midwifery staff justify embedding PROMPT in educational programs.

Strengths and limitations of the study

- This is one of the few mixed methods studies on evaluation of training programs using multiple levels of Kirkpatrick's assessment capturing participant reaction, knowledge acquisition, organisational change and patient outcome.
- This is an outcome-based evaluation using the high levels of the Kirkpatrick's framework (evaluating impact on the health service and patient outcome) providing evidence of training effectiveness.
- The participants' behaviour (under direct observation or by using videos) could not be studied in either simulation or a clinical setting.

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Introduction

Interprofessional team-based, simulated training programs are becoming increasingly popular to improve the performance of clinical workforce in emergency responses, and its resultant clinical outcomes. The provision of high quality birth suite care is no exception. Staff training in technical clinical skills is put to test in complex obstetric situations that require time critical management. Team members must be instantly engaged to achieve synergism in managing acute obstetric emergencies. Hence, acquisition of non-technical skills (NTS), such as effective communication and teamwork, are as important as mastering "hands-on" clinical skills.[1]

Interprofessional education (IPE) focuses on "staff members working together to learn *with*, *from* and *about* each other".[2] IPE programs help individuals to develop an understanding of other professional roles within the multidisciplinary team. Such an understanding is thought important for safe and effective clinical practice as a team.[3] In order to maintain a level of confidence in managing these difficult clinical emergencies regular up-skilling sessions are necessary.

PROMPT (PRactical Obstetric Multi-Professional Training) is a multi-professional training package designed to expose participants (obstetricians, midwives, paediatricians and anaesthetists) to obstetric emergencies in a real time environment.[4-8] This simulation-based program aims to recreate clinical problems either "in-situ" in a birth unit or in a simulation centre and presents them to participants as realistically as possible. The scenarios can be designed specifically for the level of the participants and the available facilities. Evaluation of these programs is necessary to assess if their objectives are met. Programs can be evaluated using various frameworks, one of them being the six level modification of Kirkpatrick's

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framework.[2 9 10] The various levels assess participant's satisfaction, change in attitude or identification of what was learnt, if these skills changed participant behaviour in a clinical setting or ultimately affected clinical organisational change and patient outcomes (see Table 1).

We introduced the Victorian state version of the PROMPT program to our maternity service in 2013.[11] In this study, we aimed to evaluate the impact of PROMPT in our health service by assessing the various levels in the six-level framework. Specifically, we wished to identify the "key learning points" acquired, "how" useful this workshop style teaching was rated and whether there was any evidence of change in patient outcomes. We also describe the process of "embedding" this program in educational up-skilling of staff.

Methods

Study design

The study follows a mixed methods design with quantitative analysis of patient outcome data and for participant rating of the intervention. The data regarding the key learning messages was extracted using qualitative content analysis identifying key themes. The study was approved as a quality assurance project by the institutional research ethics committee.

Setting and participants

Monash Health maternity service provides birthing care for over 9000 women annually at three separate hospital sites, each with different levels of acuity, all within metropolitan Melbourne, Victoria. The three sites share common clinical practice guidelines, policies and procedures. Monash Health implemented the PROMPT program in its current format across all its sites since 2013. Midwifery educators and dedicated senior obstetric medical staff run

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the program. The PROMPT sessions are conducted ten times per year at each site at monthly intervals. Midwifery and medical staff (junior and senior) are required to participate at least every two years. All medical and midwifery staff who had attended the PROMPT session at least once between 2013 and 2015 were invited to participate in the study.

PROMPT program scenarios

The half-day program consists of short, interactive lectures and scenario-based drills. Each drill is followed by a debrief covering clinical and non-technical skills. The clinical scenarios include eclampsia, shoulder dystocia, neonatal resuscitation and postpartum haemorrhage (PPH). These are topics that were already covered in the pre-reading material provided to the participants.

Questionnaires

The evaluation of the PROMPT workshop followed a pre-test and a post-test research design using paper-based questionnaires. The questionnaires were drafted, revised and agreed upon by the PROMPT committee (represented by both medical and midwifery educators) to establish content validity. The questionnaires had been pilot tested in a home birth based simulation program (in a different participant group that included home birth midwives) at Monash Health and results published in a peer reviewed journal.[12] Each questionnaire had 26 items where participants' responses are recorded using a 5-point Likert scale. The pre-test evaluated levels of knowledge and confidence managing the obstetric emergencies covered. They are also asked about participants' professional background and experience in these clinical emergencies. At the end of the workshop the post-test evaluated the satisfaction and learning acquired from the program. Participants were also asked to reflect on the essential

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learning points attained that were thought to be transferable to their (individual or team-based) clinical practice using free text.

Textual data were analysed independently and inductively using content analysis undertaken by two researchers independently (AK, SS) to produce key themes.[13] The results were discussed and after establishing consensus, all data were recoded. Some categories overlapped but items were counted only once. Discrepancies were negotiated enabling final attribution of text within categories.

Clinical outcome measures

A retrospective cohort study examined all documented cases of the three major obstetric emergencies covered during the drills (eclampsia, shoulder dystocia combined with neonatal resuscitation, and post-partum haemorrhage). Clinical outcomes were evaluated in two cohorts: before the implementation of PROMPT in 2011-2012 (n=15,361 births) and after the implementation of PROMPT in 2014-2015 (n=12,388 births). Patient outcomes were evaluated using the following measures. For shoulder dystocia we measured the use of external and internal manoeuvres, time between delivery of the head and the body, completion of documentation, major maternal perineal trauma (3rd and 4th degree tears), and neonatal outcomes including brachial plexus injury, clavicle or humerus fracture, Apgar score <7 at 5 minutes, umbilical cord lactates >8 mg/dl, admission to newborn services and perinatal death. For PPH, we classified women into two groups according to the estimated volume of blood loss (1000ml-1499ml or >=1500ml) reporting rates of blood transfusion, transfer to the operating theatre, intravenous fluid resuscitation and use of a (Bakri®) balloon tamponade.

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Data were extracted from an electronic database of birthing outcomes, the Birthing Outcomes System (BOS®), that records outcomes for all births ≥20 weeks of gestation and is routinely entered by midwifery staff.[14] Where necessary BOS data was supplemented by individual case record review.

Statistical analysis

Data were analysed with Prism for Mac version 7.0a (Graph pad software, San Diego, CA, USA). Continuous data were expressed as medians and interquartile range (IQR) because of skewed distributions. To compare the two cohorts, we used a Mann-Whitney *U* test for quantitative data and a Fisher's exact test for contingency testing. A p-value < 0.05 was considered statistically significant.

Results

Participation

Since 2013 we have run 70 PROMPT sessions across our three sites with a total of 508 participants. Approximately one-third (n=178, 35%) of participants were medical staff (junior and senior). The remaining were midwifery staff (n=287, 56%), medical or midwifery students (n=34, 7%) or special care nursery staff (n=9, 2%). By 2015, 76% midwives and 90% senior medical staff had participated at least once in PROMPT.

Satisfaction with the simulation activity (Level 1 Kirkpatrick's framework)

Figure 1 summarises the participant knowledge, confidence and prior experience in managing obstetric emergencies. Staff confidence in management of eclampsia was lower than that for the other obstetric emergencies. The confidence and knowledge concerning neonatal resuscitation was higher for midwives than the medical staff (Figure 1). In general, the

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workshops were rated highly by both medical and midwifery participants (median Likert score of 5 (maximum) for both groups) in regards to clinical usefulness of material covered and debriefing experience.

Knowledge acquired from the workshop (Level 2b Kirkpatrick's framework)

430 comments made by 237 participants were available for content analysis (Table 2). The key themes related to improved communication between staff members (n=87), developing knowledge of equipment and procedures (78 responses), learning leadership and followership (73 responses), being in a supportive learning environment (63 responses), the realism of the simulation (48 responses), understanding the roles of staff from another profession (46 responses) and prioritisation of tasks (33 responses).

Communication

Clear communication established directly with the members of the team (by using the individual's name) and with others who assist in the process e.g. with switchboard calling an emergency code. Where appropriate, specific terminology should be used. The loop of communication should be closed by obtaining a response from the recipient, to ensure accountability of the individual undertaking the task. The communication was seen to be even more crucial at certain times like the handover of a task to another member of the team.

Situational awareness

Identification and knowledge of equipment, its location in the birth unit, organisation of the equipment and knowing if it was in working order was recognised as relevant for the staff using it in an emergency with time constraints. A prior familiarity of content and a practice of using the postpartum and eclampsia kit, was found to be essential. Necessary gear found

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missing at the time of workshop or kept in the wrong location, delayed the management and caused stress to the team.

Similarly staff members were keen to have a prior awareness of protocols and procedures, more so in complex situations like eclampsia and neonatal resuscitation and where clinical manoeuvres were needed like shoulder dystocia. The organisational pathways needed like calling an emergency code and methods to access operating theatres in an emergency were also emphasised.

Learning leadership and followership

The importance of leading an emergency team presented as an unexpectedly prominent theme. The key characteristics of a leader were to maintain a "helicopter view" at all times and be clear and assertive with instructions to participants. Establishing and announcing who the leader of the team was (either by the leader or another participant) and appointing one if already not designated. The leader could change during the emergency scenario depending on individual capability and who was available. Handover from one leader to another needed clear communication. In such situations, the new leader should initially "step back" and assimilate the situation prior to taking over.

The rest of the team should patiently wait for instructions, offer to help (based on their individual scope of practice) and contribute to the team management by playing their designated role. If the instructions were unclear or participants were unable to perform the allocated task, they should speak up and close the communication loop.

Supportive learning environment

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The PROMPT workshop was acknowledged to improve participants' confidence and learning of clinical knowledge and skills through individual opportunity to practice and team feedback. In a simulated setting, the technical skills and procedures could be "unpacked" into small steps during the feedback session. The combination of learning emergency skills in a simulated environment was seen as a step towards improving women safety.

Realism in simulation

The participants perceived the workshop to be similar to a real emergency through the role of an actor, scenario design, experiencing stress, working within timelines and location in a birth unit. The scenarios were based on rare emergencies and followed an unpredictable course resulting in participants feeling anxious and voiced the need to "stay calm".

Role of interprofessional staff

Participants displayed a preference to revert to their natural/ usual clinical roles when managing a clinical emergency as this was based on their strengths and scope of practice. The participants wanted to have a clear well defined role allocation which was "task specific". Both medical and midwifery staff members were keen to share learning in the interprofessional setting and wanted to understand roles of the other discipline in the team. Both teams referred to learning teamwork and task sharing.

Prioritisation

Participants demonstrated a need to organize the tasks systematically and to get help early. They emphasized on timely escalation of tasks due to their awareness of their limitations in managing emergency situations and their scope of practice.

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Organisational change to "embed" the PROMPT program (Level 4a Kirkpatrick's framework)

We describe the process of embedding the PROMPT program using Kurt Lewin's 3-phase model.[15]

Step 1 - Unfreeze

The key issue of poor communication (occasionally leading to conflict) among medical and midwifery staff was recognised through incident reporting as a component of a risk management process. This was seen to delay mobilising resources required in an emergency setting, hence compromising optimum patient safety. In a time critical situation, where effective teamwork is the key, a need to create change was recognised by medical and midwifery leaders at the institution. The need to change was communicated both to the health care network executive group and to the clinical staff delivering patient care. This coincided with introduction of the PROMPT program in the state of Victoria resulting in strategic inclusion of the team-training program for medical and midwifery staff.

Step 2 - Change

The change described here is embedding the PROMPT program as a component of routine educational practice. The principles learnt through the program focussed on communication, leadership and situational awareness, similar to the vision shared by the institution. The benefits of attending the program were communicated to the staff and feedback encouraged from participants. Problems that hindered attendance (like rostering issues, managing patient workload on teaching days) were dealt with promptly. Funding was obtained from the institution by reporting benefits of change in attitude of interprofessional staff and observed improvement in performance, although this was not formally evaluated. This funding further

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facilitated the operational management of the program, as dedicated clinical staff members could be employed to sustain the quality of teaching.

Step 3 - Refreeze

The observed improvement in attitudes of the interprofessional staff and effort to meet higher standards of clinical practice was encouraged. Leadership and operational support required to run the program was improved (by increasing the numbers of faculty members facilitating the program) and on-going training support provided to them. A process of providing team-based feedback was developed (using the PROMPT guidelines) and the role of learning through PROMPT was formalised which lent itself to its use as credentialing tool. A mandatory requirement of two-yearly attendance was set up for all medical and midwifery staff.

Clinical Outcomes (Level 4b Kirkpatrick's framework)

In 2011-2012 there were 15,361 births and in 2014-2015, 12,388 births at Monash Health.

Eclampsia

Across the four years, four women had an eclamptic seizure, two in 2011-2012 (0.13/1000) and two in 2014-2015 (0.16/1000). All four women were managed as per local protocol.

Shoulder Dystocia (Table 3)

Table 3 summarises the incidence and outcomes related to shoulder dystocia. The rate of shoulder dystocia in 2011-12 (n=268; 1.7%) was significantly lower than in 2014-15 (n=290; 2.3%, p=0.001) No neonatal deaths were recorded in either group. The interval between delivery of head and body was shorter in the recent cohort (2.0 min (IQR 1-2) vs 2.0 min (IQR 1-3), p = 0.04). In the cohort after implementation of PROMPT we observed lower

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incidences of brachial plexus injury, humerus or clavicle fractures, low Apgar scores and nursery admissions, although these differences were not statistically significant (Table 3). There was a significant decrease in the completion of the required shoulder dystocia emergency 'management sheet' (24% vs 17%; $p = 0.04$).

Post Partum Haemorrhage (Table 4 and 5)

For women with a PPH of 1000-1499ml, there was no significant change in the number of cases between cohorts [n=561 (3.7%) vs n=511 (4.1%)], and no significant differences were observed in maternal outcomes or management strategies. For women with a PPH of >1500ml, a significant difference was seen in the number of patients transferred to theatre after vaginal birth (30% vs 38%; $p = 0.049$), and the use of Bakri balloons (6% vs 12%; $p = 0.02$) which were introduced in 2011.

Discussion

Main findings

Through a formal evaluation of PROMPT and a review of clinical outcomes we have observed that this multidisciplinary training has a positive effect on managing of obstetric emergencies within our service. Consistent with mandatory workforce training requirements, participation of both medical and midwifery staff was excellent across all of our sites such that PROMPT has become an embedded component of ongoing professional development. In this paper we have evaluated our PROMPT program using the various levels of Kirkpatrick's framework, observing encouraging results. All levels examined showed positive effects after implementation of this structured training. In addition, the evaluation allowed us to identify areas for future improvement such as record keeping of therapeutic measures.

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Participants found PROMPT an effective approach for the acquisition of new skills and knowledge. Medical and midwifery staff members reported an increase in confidence and had high satisfaction scores on learning as a team (Level 1 Kirkpatrick's framework).

Our next level of assessment focussed on key "take-home" learnings acquired by the participants (Level 2 Kirkpatrick's framework). Communication and situational awareness were considered important NTS learnings by the majority of participants and is a finding consistent with other studies.[5 6] The theme on "leadership" and "following the leader" are thought critical for safe team-based management, both in simulated and real emergencies.[6 16] Poor performance in leadership despite good communication can also occur, hence, making leadership an independent learning goal of the workshop.[17] Developing improved "situational awareness" with knowledge of equipment use and efficient use of team members is an often - reported learning outcome of the PROMPT program.[5]

Our final analysis reviewed the birthing outcome and safety data (Kirkpatrick's level 4b). In the recent cohort we observed a significantly increased incidence of shoulder dystocia. This could be related to an increased awareness of this condition but could also reflect the increasing numbers of obese pregnant women delivering at our centres. We observed a small but statistically significant difference in the interval between the delivery of head and body, the clinical relevance of which is debatable. These could be assessed individually using case reviews and learning gaps addressed through clinical case review meetings. The significant increase in the number of patients transferred to theatre for control of massive post-partum bleeding (PPH >1500mls), and the increase in the use of (Bakri) balloon tamponade may reflect a greater awareness of the benefits of early and aggressive control of excessive bleeding following our PROMPT implementation. This was also noted in a recent randomised

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control trial where the units that participated in simulation based team training had a higher incidence of blood transfusion and surgical treatment of PPH.[8]

Strengths and limitations

The current study is one of few mixed methods studies attempting to draw a link between perceived learning, clinical practice and outcomes by using various levels of Kirkpatrick's framework. As far as we are aware only a few studies have evaluated simulation-based intervention through multiple "lenses" of assessment, as reported in a recent review on obstetric emergencies.[18] Most researchers have limited evaluations to either level 1 or 2 with some studies demonstrating a change in team behaviour and retention of skills.[19] Studies looking at clinical outcome are scant.[8 11 18 20] Our evaluation includes participant satisfaction with the scenario and debrief (level 1) but also learning skills and knowledge acquired by the two major interprofessional groups (level 2). We demonstrate the process from introduction of the intervention and its "embedding" in curricular training and "credentialing" (level 4a). The PROMPT program has been successfully integrated with teaching programs globally, however, the description of the program with change management principles is worthy of sharing. Above all, we have also compared the birthing outcome before and after the intervention was introduced into practice (Level 4b).

However, due to challenges related to study design that entails direct observation of participants in a "natural" setting, we were unable to assess a change in observed clinical behaviour/teamwork that may have helped to directly connect workshop learning with clinical practice, which may be done using clinical checklists.[21]

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Patient care and clinical outcomes are rarely reported as evidence of effectiveness of educational programs.[22] Most likely this is because programs need to be embedded prior to evaluation and coverage of a sufficient proportion of the workforce needs to be achieved before improved care and outcomes would be expected. This can take many years.[23-25] An evaluation of the PROMPT program elsewhere, demonstrated a significant decrease in brachial plexus injury, incidence of pH less than 7, and a reduction of hypoxic ischemic encephalopathy by 50% when assessed over a 7-year interval.[20] We were unable to explore detailed outcome data prior to 2010 as previously documented notes had missing clinically relevant details, hence precluding us from assessing five years before and after PROMPT which may have provided a better reflection of birthing outcomes. However, this may not have changed the result as a similar study failed to show a significant reduction in the composite obstetric outcome in units where multi-professional simulation training was introduced.[8]

A major strength of this evaluation is that it allowed insights into service delivery and identification of potential deficiencies. For instance, we observed a reduction in the completion of shoulder dystocia management forms. In addition our current record form lack certain outcome measures that would be of interest to evaluate clinical management, such as fluid volume usage during PPH.

Interpretation

Participants indicated that communication, situational awareness and leadership skills are key factors for managing emergencies as a successful team. The next level of evaluation planned will be to check the team performance in a real obstetric emergency setting to determine if the transfer of learning has occurred. This can be achieved by integration of level 3-assessment

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(behaviour) into our training development strategy by direct observation of performance in a simulated and/or clinical setting. Apart from more proactive management noted in postpartum haemorrhage, no significant difference was noted in clinical outcome. This may be due to existence of previously run simulation programs, which focussed on individual skills but not on effective teamwork. Although, participants recognise the importance of teamwork and communication in their learning, this was not transferable to a change in clinical outcome.

This evaluation has already resulted in changing the organisational practice at our institution (Level 4a).[26] An annual attendance of PROMPT is encouraged for all staff and a two-yearly attendance is a mandatory requirement for staff working on the birth unit. It is used for credentialing the staff members with remediation plans for participants unable to meet the expected standards of performance for both technical and non-technical skills. Our goal will be to continue to strengthen this process and to formalise it further, linking it with professional development.

Conclusions

The study highlights the need for teaching teamwork, communication and leadership skills in managing obstetric emergencies through a high fidelity simulation program. The impact on clinical outcomes seems limited, yet we identified some differences related to management of shoulder dystocia and postpartum haemorrhage that could have made a difference in certain individual cases. Improved participant confidence with up-skilling of both procedural and non-technical skills has a potential to change clinical practice and outcomes, hence, validating the incorporation of these IPE simulation strategies in clinical care.

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Contribution to authorship: AK conceived and designed the study, analysed the data, wrote the first draft of the manuscript and finalised the submission. SS performed the study, analysed the data, edited the manuscript, and approved the final submission. DL, JM, PN, MS and SS performed the study, and approved the final submission. EMW conceived and designed the study, contributed to analysis tools, edited and finalised the submission. DN analysed the data and contributed to analysis tools. PD is the senior author, conceived, designed, performed and supervised the study, analysed data and approved the final submission.

Details of ethics approval: The study was approved by Monash human research ethics committee as a quality assurance project.

Funding: The PROMPT program at Monash Health was supported by funding of the Victorian Managed Insurance Authority (VMIA), when it was introduced.

Data sharing: There is no other unpublished data from this study

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Access to the data is available only to the research team in a secure (coded) format

Clinical data has been obtained from Birthing Outcome Software (BOS®) and is accessible to only registered BOS® users in the healthcare network.

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References

1. Leonard M, Graham S, Bonacum D. The human factor: The critical importance of effective teamwork and communication in providing safe care. Qual Saf Health Care 2004;**13**(SUPPL. 1):i85-i90.
2. Barr H, Koppel I, Reeves S, et al. *Effective Interprofessional Education: Argument, Assumption and Evidence*: Blackwell Publishing Ltd, 2005.
3. Wong AHW, Gang M, Szyld D, et al. Using a simulation-enhanced interprofessional education strategy to improve attitudes toward teamwork and communication. Simul Healthc 2016;**11**(2):117-25.
4. Crofts JF, Ellis D, Draycott TJ, et al. Change in knowledge of midwives and obstetricians following obstetric emergency training: A randomised controlled trial of local hospital, simulation centre and teamwork training. BJOG Int J Obstet Gynaecol 2007;**114**(12):1534-41.
5. Siassakos D, Fox R, Bristowe K, et al. What makes maternity teams effective and safe? Lessons from a series of research on teamwork, leadership and team training. Acta Obstet Gynecol Scand 2013;**92**(11):1239-43.
6. Siassakos D, Fox R, Crofts JF, et al. The management of a simulated emergency: Better teamwork, better performance. Resuscitation 2011;**82**(2):203-06.
7. Siassakos D, Marshall L, Draycott T. Improving collaboration in maternity with interprofessional learning. J Midwifery Women's Health 2011;**56**(2):183.
8. Fransen AF, van de Ven J, Schuit E, et al. Simulation-based team training for multi-professional obstetric care teams to improve patient outcome: a multicentre, cluster randomised controlled trial. BJOG : an international journal of obstetrics and gynaecology 2016.
9. Hammick M, Freeth D, Koppel I, et al. A best evidence systematic review of interprofessional education: BEME Guide no. 9. Med Teach 2007;**29**(8):735-51.
10. Freeth D, Hammick M, Koppel I, et al. *A critical review of evaluations of interprofessional education.* . London: Learning and Support Network, Centre for Health Sciences and Practice., 2002.
11. Shoushtarian M, Barnett M, McMahon F, et al. Impact of introducing Practical Obstetric Multi-Professional Training (PROMPT) into maternity units in Victoria, Australia. BJOG Int J Obstet Gynaecol 2014;**121**(13):1710-18.
12. Kumar A, Nestel D, Stoyles S, et al. Simulation based training in a publicly funded home birth programme in Australia: A qualitative study. Women Birth 2016;**29**(1):47-53.
13. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology 2006;**3**(2):77-101.
14. Bosse HM, Mohr J, Buss B, et al. The benefit of repetitive skills training and frequency of expert feedback in the early acquisition of procedural skills. BMC Med Educ 2015;**15**(1).
15. Lewin K. Frontiers in Group Dynamics: Concept, Method and Reality in Social Science; Social Equilibria and Social Change. Hum Relat 1947;**1**(1):5-41.
16. Cornthwaite K, Edwards S, Siassakos D. Reducing risk in maternity by optimising teamwork and leadership: An evidence-based approach to save mothers and babies. Best Pract Res Clin Obstet Gynaecol 2013;**27**(4):571-81.
17. Cooper S, Cant R, Connell C, et al. Measuring teamwork performance: Validity testing of the Team Emergency Assessment Measure (TEAM) with clinical resuscitation teams. Resuscitation 2016;**101**:97-101.
18. Bergh AM, Baloyi S, Pattinson RC. What is the impact of multi-professional emergency obstetric and neonatal care training? Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1028-43.
19. Ameh CA, Van Den Broek N. Making It Happen: Training health-care providers in emergency obstetric and newborn care. Best Pract Res Clin Obstet Gynaecol 2015;**29**(8):1077-91.
20. Weiner CP, Collins L, Bentley S, et al. Multi-professional training for obstetric emergencies in a US hospital over a 7-year interval: An observational study. Journal of Perinatology 2016;**36**(1):19-24.

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21. Bajaj K, Rivera-Chiauzzi EY, Lee C, et al. Validating Obstetric Emergency Checklists using Simulation: A Randomized Controlled Trial. American Journal of Perinatology 2016.
22. Crofts JF, Winter C, Sowter MC. Practical simulation training for maternity care-where we are and where next. BJOG Int J Obstet Gynaecol 2011;**118**(SUPPL. 3):11-16.
23. Gillan C, Lovrics E, Halpern E, et al. The evaluation of learner outcomes in interprofessional continuing education: A literature review and an analysis of survey instruments. Med Teach 2011;**33**(9):e461-e70.
24. Calvert KL, McGurgan PM, Debenham EM, et al. Emergency obstetric simulation training: How do we know where we are going, if we don't know where we have been? Aust New Zealand J Obstet Gynaecol 2013;**53**(6):509-16.
25. Draycott T, Crofts J. Structured team training in obstetrics and its impact on outcome. Fetal Matern Med Rev 2006;**17**(3):229-37.
26. Freeth D, Hammick M, Reeves S, et al. *Effective Interprofessional Education: Development, Delivery and Evaluation*: Blackwell Publishing Ltd, 2008.

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Table 1: Modified Kirkpatrick's framework (adapted from Barr's six level classification)

Level 1	Participant reaction	Learners' views on the learning experience and its interprofessional nature
Level 2a	Change in attitudes	Changes in attitudes towards team members of the interprofessional groups
Level 2b	Change in knowledge or skills	Including knowledge and skills related to the interprofessional activity
Level 3	Behavioural change	Identify individual transfer of interprofessional learning
Level 4a	Change in organizational practice	Wider change in organisational practice and delivery of care
Level 4b	Change in clinical outcome	Improvement in change in patient care

* Adapted with permission from Barr *et al* [2]

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Table 2: Learning acquired from the PROMPT program

Theme	Responses	Comments
Communication	87	*"Allocating task to a certain individual and not to someone!"* *"Use closed loop communication"* *"Use team members' names"* *"Use specific terminology"* *"Effective communication between team members leads to effective management"* *"Communication becomes even more important in an emergency situation"* *"Asking who is in charge (of the situation)"* *"To ask what's happening for documentation, to tell when observations/anything is to be done"*
Knowledge of equipment and procedure	78	*"I learnt where things are kept so they can be accessed immediately in an emergency"* *"Familiarity with the ward and procedures to initiate emergency responses"* *"Need to spend time learning to hook up the resuscitation cot to the gases in birth rooms"* *"Using the resuscitaire, turning it on"* *"Familiarise yourself with the content of the emergency boxes"* "*It was difficult to find the equipment like the IV pump for the simulation. I understand we need to know where these*

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		things are."
Learning leadership and followership	**73**	*"Put hand up if free when already completed a task in an emergency situation"* *"It's ok to not have a job and wait"* *"Learned to identify the importance of clarifying leadership role in every scenario"* *"Step in with a helicopter leader role"* *"Ask who is the leader/what is going on/what can I do?"* *"I needed to be more assertive as team leader"* *"Clear instructions and explicitly determining who the emergency leader is"*
Supportive learning environment	**68**	*"Useful to practise these things in team prior to the real deal"* *"It consolidated training/knowledge that I have come across in pieces"* *"It identifies my weaknesses so I can work on them"* *"Learning about eclampsia and PPH in a relaxed environment"*
Realism in simulation	**48**	*"Having a serious actress helped to keep it real"* *"Stay calm in a stressful emergency"* *"Practical experience of emergencies we don't normally get to manage"*
Interprofessional roles and teamwork	**46**	*"Teamwork improves working together"* *"My specific role as a RMO (junior doctor) in an emergency situation…."*

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		"….taking on roles/tasks that I can do instead of RMO" *"That you could have a small role that makes up effective care"*
Prioritisation	**33**	*"(checking) Fetal heart rate during eclamptic fit is not a priority"* *"Think of first line of management in a maternity emergency"* *"IV fluids very important in PPH, possibly more than drugs"* *"The importance of airway and fluid resuscitation"* *"The first steps in managing an eclamptic woman"*

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Table 3: Shoulder dystocia

	2011-2012	**2014-2015**	***p-value***
Cases	268 (1.7%)	290 (2.3%)	**0.001**
Live born	268 (100%)	290 (100%)	1.00
Internal manoeuvres	51 (19%)	54 (19%)	0.91
Interval between head and body	2.0 (IQR 1-3)	2.0 (IQR 1-2)	**0.04**
Brachial plexus injury	17 (6%)	10 (3%)	0.12
Fracture*	14 (5%)	7 (2%)	0.12
Apgar <7 @ 5min	21 (8%)	15 (5%)	0.31
Lactate >8 mg/dL	12 (4%)	22 (8%)	0.16
Admission SCN/NICU	87 (32%)	74 (26%)	0.08
Major perineal trauma	31 (12%)	27 (9%)	0.41
3rd degree tear	28 (10%)	26 (9%)	0.48
4th degree tear	3 (1%)	1 (0.3%)	0.36
Management sheet completed	63 (24%)	48 (17%)	**0.04**

* Humerus or clavicle

SCN: special care nursery; NICU: neonatal intensive care unit

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Table 4: Postpartum haemorrhage 1000-1499 mL

	2011-2012	**2014-2015**	***p-value***
Cases	561 (3.7%)	511 (4.1%)	0.09
CS	196 (35%)	176 (34%)	0.90
Transfer to theatre after vaginal birth	65 (12%)	76 (15%)	0.12
IV access before theatre	260 (99.6%)	252 (100%)	1.00
Bakri balloon	2 (0.4%)	6 (1%)	0.16
ICU admission	0	3 (0.6%)	0.12
RBC transfusion	65 (12%)	75 (15%)	0.15

CS: caesarean section; ICU: intensive care unit; RBC: red blood cells

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Table 5: Postpartum haemorrhage >1500mL

	2011-2012	**2014-2015**	***p-value***
Cases	329 (2.2%)	287 (2.3%)	0.48
CS	101 (31%)	64 (22%)	**0.03**
Transfer to theatre after vaginal birth	99 (30%)	108 (38%)	**0.049**
IV access before theatre	199 (99.5%)	171 (99.4%)	1.00
Bakri balloon	21 (6%)	34 (12%)	**0.02**
ICU admission	23 (7%)	24 (8.3%)	0.55
RBC transfusion	156 (47%)	149 (52%)	0.29

CS: caesarean section; ICU: intensive care unit; RBC: red blood cells

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Figure Legend

Figure 1: Bar diagrams showing level of knowledge (Q1), confidence (Q2) or prior experience (Q3) of medical staff (top panel) and midwifery staff (bottom panel) in dealing with eclampsia, shoulder dystocia, neonatal resuscitation (NLS) and postpartum haemorrhage (PPH).

1-5 on the y- axis denotes likert scale rating, where 5 is the highest rating.

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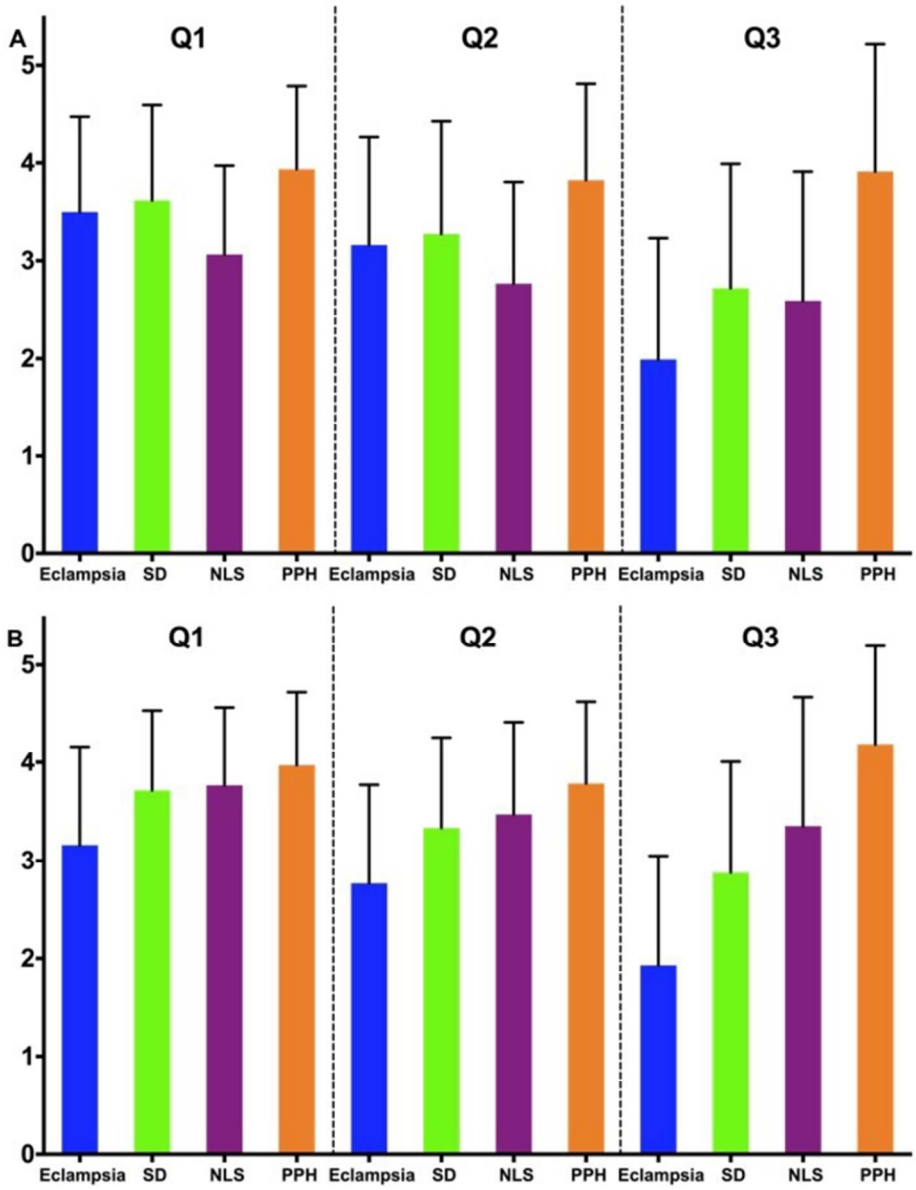

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