Aims and objectives. To examine whether interprofessional simulation training on management of postpartum haemorrhage enhances self-efficacy and collective efficacy and reduces the blood transfusion rate after birth.

Background. Postpartum haemorrhage is a leading cause of maternal morbidity and mortality worldwide, although it is preventable in most cases. Interprofessional simulation training might help improve the competence of health professionals dealing with postpartum haemorrhage, and more information is needed to determine its potential.


Methods. Interprofessional simulation training on postpartum haemorrhage was implemented for midwives, obstetricians and auxiliary nurses in a university hospital. Training included realistic scenarios and debriefing, and a measurement scale for perceived postpartum haemorrhage-specific self-efficacy, and collective efficacy was developed and implemented. Red blood cell transfusion was used as the dependent variable for improved patient outcome pre–post intervention.

Results. Self-efficacy and collective efficacy levels were significantly increased after training. The overall red blood cell transfusion rate did not change, but there was a significant reduction in the use of ≥5 units of blood products related to severe bleeding after birth.

Conclusion. The study contributes to new knowledge on how simulation training through mastery and vicarious experiences, verbal persuasion and psychophysiological state might enhance postpartum haemorrhage-specific self-efficacy and collective efficacy levels and thereby predict team performance. The significant reduction in severe postpartum haemorrhage after training, indicated by reduction in ≥5 units of blood transfusions, corresponds well with the improvement in collective efficacy, and might reflect the emphasis on collective efforts to counteract severe cases of postpartum haemorrhage.

What does this paper contribute to the wider global clinical community?

- Research supports future team training on postpartum haemorrhage. Faculty should be aware of the importance of mastery and vicarious experiences, verbal persuasion and psychophysiological state for increased efficacy.
- Simulation training can prepare staff to handle clinical emergencies and follow-up after experienced emergencies. Full participation of all staff is likely to be crucial for improved patient outcomes.
- Future research should evaluate interprofessional simulation training programmes to identify the crucial factors for improved outcomes related to prevention, identification and treatment of postpartum haemorrhage.

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Relevance to clinical practice. Interprofessional simulation training in teams may contribute to enhanced prevention and management of postpartum haemorrhage, shown by a significant increase in perceived efficacy levels combined with an indicated reduction of severe postpartum haemorrhage after training.

Key words: midwifery, patient safety, postpartum haemorrhage, self-efficacy, simulation training, teamwork, transfusion

Accepted for publication: 12 November 2016

Introduction

Most births are expected to be uncomplicated, and keeping the birthing process normal is essential for good maternity care. However, every skilled birth attendant must be aware of and be prepared for complications that threaten the mother and/or child. Postpartum haemorrhage (PPH) is defined as blood loss >500 ml within 24 hours after vaginal birth and blood loss >1000 ml after Caesarean section (CS) (Mousa et al. 2014). Along with pre-existing medical conditions, PPH is a leading cause of maternal morbidity and mortality worldwide (Say et al. 2014). PPH is preventable in most cases (PATH 2011), but it can develop rapidly. Notably, two-thirds of women with PPH have no known risk factors (POPPHI 2007).

Interprofessional simulation training is increasingly recognised as a way to enhance learning and performance in order to improve patient safety (Bergh et al. 2015). To reduce the gap between simulation and reality, the simulation teams should reflect real-life teams and should represent different medical specialities and levels of expertise (Stocker et al. 2014).

Background

In more than 70% of cases, bleeding after birth is caused by poor uterine contractions (POPPHI 2007). PPH can also be caused by trauma to the genital tract, by retained tissue and sometimes by coagulation abnormalities. The PPH rate is increasing in high-income countries and is tied to labour induction and augmentation and to previous Caesarean section (CS) (Kramer et al. 2011, Lutomski et al. 2012). In a study of the Medical Birth Registry of Norway, severe obstetric PPH, defined as blood loss >1500 ml or blood transfusion, was identified in 1-1% of the mothers (Al-Zirqi et al. 2008). In a Danish study, abnormal invasive placenta was the strongest explanatory factor for the need for blood transfusion in vaginal births (Wikkelso et al. 2014).

Active Management of Third Stage of Labour (AMTSL) implementation is now widespread and is empirically recognised as the most important way to prevent PPH (Abdul-Kadir et al. 2014, Gulmezoglu et al. 2012, Hofmeyr et al. 2015). Oxytocin is a cornerstone of the PPH management package along with controlled cord traction and uterine massage (Gulmezoglu et al. 2012, POPPHI 2007). Uterine massage remains the preferred procedure, although solid empirical evidence of its effect is scarce (Abdul-Kadir et al. 2014, Hofmeyr et al. 2013, Schott & Anderson 2008). Pregnant women are physiologically able to compensate for heavy blood loss without affecting the circulation until they suddenly decompensate with circulatory collapse (NGF 2014). PPH protocols mainly involve technical skills such as AMTSL, urine catheterisation, repair of lacerations, fluid replacement and bimanual compression (UNN 2012). Key nontechnical skills, although not explicitly listed in protocols, include efficient communication: closed-loop communication, decision-making skills, patient handover and teamwork are all important elements in scenarios for improved patient safety (Budin et al. 2014).

Obstetric emergencies require proper and timely management in demanding working conditions. In an emergency, psychological arousal might interfere with the ability of medical personnel to perform effectively. Accordingly, relevant skills should be rehearsed in a naturalistic acute setting that includes induced stress responses. Practicing relatively complex skills in a realistic simulation can enable participants to recall these skills and perform them effectively in demanding situations when psychological arousal is high (Keitel et al. 2011, Sorensen et al. 2015). Realistic simulations might function as systematic desensitisation experiences (Triscari et al. 2015).

Debriefing is an important part of simulation training (Buckley & Gordon 2011). Medical-surgical nurses perceived debriefing to be the most useful part of simulation training, both immediately after the training and three months later (Gordon & Buckley 2009). Reflective
practitioners who examined their own assumptions and mental frames were able to self-correct and improve clinical practice (Rudolph et al. 2007). According to experiential learning theory, debriefing enhances learning when it is used to analyse a concrete experience after scenario-based training (Stocker et al. 2014).

Self-efficacy, that is the belief in one’s capability to perform tasks or actions, is likely to increase after constructive and emphatic feedback during debriefing (Rudolph et al. 2013). Participants might find it difficult to judge their own performances after a scenario, and evaluative feedback can influence self-efficacy through the mechanism of verbal persuasion (Maibach & Schieber 1996). Self-efficacy is influenced by four main sources, the most important of which is mastery experience, as successes strengthen beliefs in personal efficacy. Vicarious experiences, such as observing role models, manage a specific task, bolster one’s belief in one’s own ability to do the same. Social or verbal persuasion helps people believe in their own mastery. If the physiological state during stress, which is understood to be how one perceives one’s own anxiety level, is perceived as an energising boost, it will enhance self-efficacy (Bandura 1994). In contrast, if a recent experience triggers arousal that is perceived as anxiety, it can negatively affect self-efficacy. Supported by debriefing, arousal can be interpreted as excitement, positively loaded as a normal reaction and enhancing future performance (Maibach & Schieber 1996).

The ability to manage an obstetric emergency such as PPH is closely associated with teamwork (Siassakos et al. 2011). The quality of the PPH response is thus likely to depend on both perceived individual efficacy and on perceived collective efficacy. Collective efficacy concerns the belief in the ability to solve a problem through unified effort, which can influence the quality of team performance (Bandura 1997, 2008). Collective efficacy motivates stronger team member behaviour. Team members who receive performance feedback at the team level gain a stronger shared sense of collective efficacy than if performance feedback is given at the individual level (Tasa et al. 2007). A facilitator leading a group reflection should aim for honest consideration of performance without harming the facilitator–trainee relationship. Facilitators who give rigorous feedback in an emphatic manner can strengthen collective efficacy and teamwork (Rudolph et al. 2013). Repetition of the scenario and applying new frames of understanding allow participants to optimise their performance based on recent feedback (Stocker et al. 2014). Simulation training can be used to detect latent system errors and to identify knowledge gaps/performance deficits for enhanced patient safety (Daniels & Augustine 2013).

Simulation training is generally used to improve self-efficacy related to the handling of a medical emergency (Stocker et al. 2014, Zimmermann et al. 2015). The influence of simulation training on collective efficacy and perceived team functioning is less documented. Additional research is needed to determine whether simulation training is likely to improve collective efficacy related to medical emergencies. In this context, PPH-related self-efficacy and collective efficacy refers to health professionals’ beliefs about their individual and collective ability to master PPH emergencies.

Recent studies suggest that simulation training might be associated with positive patient outcomes (Bergh et al. 2015, Draycott et al. 2015). Yet, reviews of multidisciplinary simulation-based team training note that more research is needed to investigate how and why simulation training can improve patient outcomes (Bergh et al. 2015, Daniels & Auguste 2013). There are some indications that simulation training has positive influences in maternity care. A retrospective observational cohort study of the effects of mandatory interprofessional simulation training on shoulder dystocia found a reduced rate of hypoxic ischaemic encephalopathy in newborns (Draycott et al. 2006), improved management of shoulder dystocia and reduction in the proportion of newborns with brachial plexus injury (Draycott et al. 2008). Moreover, interprofessional PPH-specific simulation training was retrospectively associated with a significant drop in the blood transfusion rate after birth ($p < 0.01$) (Egenberg et al. 2015). It is unknown whether simulation training on PPH management investigated prospectively can contribute to reduced bleeding after birth. The purpose of this quasi-experimental study was to examine whether interprofessional training would result in changes in trainees’ efficacy levels, and patient outcome, regarding PPH with a need for blood transfusions after birth.

**Methods**

**Aims**

To investigate whether interprofessional simulation training on management of PPH is associated with perceived changes in self-efficacy and collective efficacy. We hypothesised that such training would be associated with positive changes in perceived efficacy and to test whether interprofessional simulation training on PPH is associated with a reduced blood transfusion rate after birth. We hypothesised that it would be associated with an overall reduction in blood transfusion rates.
Design

The study had a multimethod, quasi-experimental pre-post design that combined patient outcome with survey measures. A questionnaire was distributed to all trainees just before the initial training, three months later and three months after the second training, which was carried out a year after the initial training. Data on patient outcome were collected 24 months pretraining (2011–2012) and 24 months postinitial training (June 2013–May 2015). The self-report questionnaires and patient outcome added to the validity of the study by triangulating quantitative data from different sources. No other interventions to reduce transfusion rates were implemented during the study period.

Simulation training

The intervention in terms of mandatory annual interprofessional simulation training was implemented at the Obstetric Department, University Hospital of North Norway (UNN), Tromsø in 2013. A senior midwife was appointed by the management to coordinate the training. The maternity ward had previously conducted skills training on technical procedures for shoulder dystocia, operative vaginal deliveries and neonatal resuscitation.

The implementation of simulation training on PPH was carried out at a learning centre within the hospital premises. A group of eight fellow midwives/doctors prepared themselves to act as facilitators and operators during a two-day facilitation course. They created realistic scenarios on obstetric emergencies such as neonatal asphyxia, shoulder dystocia and PPH. During an eight-hour training day, two of the five scenarios focused on PPH, in accordance with the PPH protocol for the hospital and based on national guidelines. According to the PPH protocol, the first steps to be made were as follows: call for help, give additional oxytocin, secure IV access, empty urine bladder, give misoprostol and perform bimanual uterine compression. In case of PPH and retained placenta, manual removal was to be performed in the operating theatre. The PPH scenario used the MamaNatalie® birthing simulator, which includes a baby, a uterus, a urine bladder, a placenta and a blood tank containing up to 1500 ml of artificial blood (LGH 2015). The birthing simulator is strapped onto the operator, who acts as the labouring woman. The operator responds to the actions during the simulation, providing a high degree of realism. The PPH scenario requires technical skills such as uterine massage and bimanual compression, and uterine contractility and blood loss are adjusted according to the team’s actions. Teams comprised four to five midwives/doctors/auxiliary nurses who were engaged in the scenario, plus two to three colleagues acting as observers; roles were swapped for repeats of the scenario (Fig. 1). Before the scenario, the facilitator briefly described the frames of the simulation training and presented the local PPH guidelines, the basic features of MamaNatalie®, learning goals for technical and nontechnical skills and the importance of a safe environment for the simulation. There were four learning goals for the team in the PPH scenario: (1) treat PPH according to guidelines, (2) develop communication skills (e.g. closed-loop communication), (3) perform uterine massage and (4) exercise clear leadership. In the actual PPH scenario, the bleeding was caused by uterine atony, and the facilitator provided information on request that could not be obtained by examination of MamaNatalie®, such as blood pressure, pulse and whether the skin was cold and clammy. Additionally, the team had to treat the operator as an anxious mother who required attention, using nontechnical skills such as communication, leadership and teamwork. The scenario ended when the team controlled the bleeding and stabilised the mother or decided to transfer her to the operating theatre. The facilitator debriefed the team with a ‘good judgement approach’ that used her/his expert opinion while valuing the unique perspective of each participant (Rudolph et al. 2007). During rigorous reflection, every trainee was challenged on his/her understanding of the PPH case and how it was managed, perception of individual and team achievements and preferable future actions. There were two PPH scenarios per training session; the second one was similar to the first, but the faculty and the participants changed roles. A second training was carried out 12 months after the first training, in May of 2014.

Figure 1 Postpartum haemorrhage simulation training at UNN, Tromsø.
Participants

Simulation training and survey participants

The study was performed at the University Hospital of North Norway in Tromsø, being a tertiary university hospital which serves the counties of Finnmark, Troms and Nordland, and provides highly specialised treatment for citizens in the North Norway region. The hospital has approximately 1400 births/year, and the staff include around 100 midwives, obstetricians and auxiliary nurses. Midwives conduct births autonomously, assisted by auxiliary nurses. The doctor on duty is called in case of complications, like PPH, and medical interventions requiring a doctor’s attendance or for advice.

Of a total of 104 staff members, 82 (79%) attended the first eight-hour simulation training in May 2013, while 85 (80%) of a total of 106 staff members participated in the second training in May 2014; just 53% of staff participated in both training sessions. The employees were informed in advance and allocated for training on one of two training days. The absence of staff at the training session was partly due to maternity leave absences and residents’ rotation schedules combined with a relatively high turnover.

Of the employees who participated in the survey by responding to the pretest, post-test, and/or follow-up test, 66% participated in the simulation training twice. While approximately 80% of the staff participated in each of the trainings, 53% participated in the training twice. Of the employees, 28% had 0–5 years of working experience, 30% had 6–15 years, and 42% had >15 years.

Only people who participated in the training were eligible to complete the surveys. The same questionnaire was used at all three time points. Of a total number of 104 employees, 82 participated in the initial training, and among the participants, 88% (n = 72) answered the pretest questionnaire. The post-test was distributed three months after the first training; of a total number of 82 employees who had participated, 62% of them responded (n = 51, of whom eight had not answered the pretest). The follow-up test was distributed three months after the second training; of a total number of 106 employees, 85 participated in the second training and the response rate among them was 72% (n = 61, 20 of whom had not answered the pre- or post-tests). Among the participants, an average of 79% of the midwives answered the pretest, post-test and follow-up test, while 81% of the auxiliary nurses and 56% of the obstetricians did the same (Tables 1 and 2).

Birth cohort

The study population comprised all women who gave birth with gestational age ≥23 weeks at UNN, Tromsø, over four years: 2011 (n = 1419) and 2012 (n = 1284) births were the baseline (before implementation of training), and June 2013–May 2014 (n = 1382) and June 2014–May 2015 (n = 1361) births were used for patient outcome after training.

Data collection

Measurements questionnaires

A literature search performed in September 2013 revealed no published self-efficacy measurements related to PPH management. A measurement of PPH self-efficacy (PPHSE) was thus developed for this specific study. SE and LEB developed items to assess PPHSE, discussed the items with an expert group of midwives and obstetricians and revised the items according to their recommendations. A preliminary PPHSE scale was pilot-tested among 59 midwives, 16 obstetricians and four auxiliary nurses employed at a
Changes following simulation training

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Different Norwegian university hospital, and minor adjustments were made. Questions on self-efficacy focused on individual perception of control. Items on PPH self-efficacy used an 8-point Likert scale that ranged from always (1 point) to never (8 points). The final PPHSE scale included eight items (Appendix 1 shows item wording and Cronbach’s alphas for the self-report scales).

In health facilities, PPH is usually handled by a team of health workers. This study included two measurements related to the collective handling of PPH. The Team Emergency Assessment Measure (TEAM) scale (Cooper & Cant 2014) is an established measure of team functioning in medical emergencies. The scale consists of eleven items with a five-step scoring format that ranges from ‘Never/Hardly ever’ to ‘Always/Nearly always’.

The first author performed the forward translation of the scale from English to Norwegian, and an expert group of native English-speaking colleagues assured the quality of the translation before pretesting. The scale was finalised based on the pretesting results. The factor analysis also served to validate the scales.

The TEAM scale is not PPH specific; thus, a scale for perceived PPH collective efficacy (PPHCE) was developed following the same procedures as for the PPHSE. The PPHCE included 13 items and used the same scoring format as the PPHSE. Information about the validity and reliability of the survey measures is in the Results section.

Measurements and patient outcome

There are indications that visual estimation of blood loss after birth is an unreliable measurement (Al-Kadri et al. 2014, Bose et al. 2006, Hancock et al. 2015), and number of units of blood products given to mothers after birth can indicate quantity of blood loss. We used the RBC transfusion rate as the dependent variable for mothers giving birth in UNN, Tromso, two years before vs. after the first simulation training, distinguishing between the overall rate of RBC transfusion and severe PPH needing ≥5 units of RBCs, platelet concentrate and/or FFP. The Department of Laboratory Medicine at UNN, Tromso, provided information about the total number of units of red blood cells (RBCs), platelet concentrate and/or FFP, while the obstetric department provided data on each mother who received blood products throughout the study period, identified by the procedural code of transfusion, type of blood products and number of units. Severe PPH was in this study defined as needing ≥5 units of blood products (RBCs, platelet concentrate and/or FFP).

Data were also collected for maternal and labour characteristics for all mothers who received RBCs during their admission, to investigate whether changes in transfusion rates could be explained by these characteristics (e.g. parity, gestational age, unplanned or planned CS, placenta praevia/accreta/percreta, haemoglobin (Hb) level at discharge and hysterectomy). Data were extracted from the hospital’s electronic birth registration system, the hospital’s electronic patient record system and the registry of the Department of Laboratory Medicine. The birth cohort visitations did not change during the two periods.

Data analysis

All analyses, except for the computation of Cohen’s d, were performed using IBM SPSS Statistics v.22 (IBM SPSS, Armonk, NY, IMB Corp, USA). The dimensionality of items assessing perceived PPH-specific self-efficacy and collective efficacy, as well as team emergency functioning, was tested by factor analysis. The factor analysis implemented principal axis factoring and a minimum eigenvalue set to 1. Internal consistency for these scales was tested by Cronbach’s alpha, and Pearson product–moment correlations were used to assess associations between index scores for these three scales.

The percentage of items with missing data was very low for items assessing perceived PPH-specific self-efficacy and collective efficacy (≤2.2%). The percentage of missing item responses for the TEAM scale was somewhat higher (7.6–9.8%). Missing data were replaced with the mean scores for the item. Cases with data for more than 50% of items were included.

The significance of changes in scores for survey measures between measurement times was determined using multivariate repeated measures analysis. The results in Tables 3 and 4 are based on multivariate analyses of variance (MANOVA) for data from independent samples. This was performed because parts of the samples were replaced between the measurements (39% of those participating in the pretest did not participate in the post-test, and 43% of those participating in the pretest did not participate in the follow-up test). Follow-up analyses with dependent samples were conducted using multivariate repeated measures analyses. These analyses compared results for identical pre–post (n = 43) and pre–follow-up samples (n = 41). The groups of professionals were too small (with eight gynaecologists responding to post-test and follow-up test), to perform differences between cadres.

Categorical variables for patient outcome were analysed using the chi-square test or Fisher’s exact test, whereas pre–post changes in continuous patient outcome variables were tested using the Mann–Whitney U-test.
Validity and reliability

Survey measure validity and reliability

A factor analysis was conducted to investigate the validity of the scales constructed for this study (the PPHSE and PPHCE). This yielded a three-factor solution that was in accordance with the expected dimensions of (1) PPH-related self-efficacy, (2) PHH-related collective efficacy and (3) team emergency functioning. The TEAM scale was computed to further explore the construct validity of the PPHE and PPHCE correlations with the Norwegian version of the General Perceived Self-Efficacy scale (GSE) (Røysamb et al. 1998). The GSE yielded an α of 0.87 in this study. The correlation between the PPHE and the GSE was 0.53 (p < 0.01). These findings support the construct validity of the PPHE. Scores for the TEAM and the PPHCE yielded a Pearson product—moment coefficient of .60, which supports the construct validity of the PPHCE. Cronbach’s alpha for the three included scales ranged from 0.90–0.96, indicating good reliability for the three scales.

Ethical considerations

All employees were allocated for training, while participation in the study was voluntary. A consent form with a description of the study was provided for them to sign on the beginning of the day of training. All staff members chose to participate in the survey and provided informed consent before answering the questionnaire. The questionnaires were printed and the participants coded for confidentiality. Information about the study was made available to women giving birth at the hospital on the hospital’s webpage.

Ethics committee approval was obtained from The Regional Committee for Medical and Health Research Ethics (2013/116 REC West, with modifications approved 17-07-2015). Approvals for access to and analyses of patient data were granted by the hospital’s Research Department and the Data Protection Officer in 2014 and again in 2015.

Results

Changes in scores for survey measures

The multivariate analysis of questionnaire scores showed that the overall change for all three dependent variables, that is self-efficacy, collective efficacy and team functioning, was significant (df = 6/360, F = 5.70, p < 0.001).

The overall changes for the three dependent variables were also significant: PPH self-efficacy (df = 2/181, F = 10.59, p < 0.001); PPH collective efficacy (df = 2/181, F = 12.27, p < 0.001); team functioning (df = 2/181, F = 7.57, p = 0.001). Post hoc analysis of changes between each measurement time for the three dependent variables showed significant changes from pre- to post-test and from pre- to follow-up test (p < 0.001). Changes from the post-test to the follow-up test were nonsignificant for all dependent variables. Cohen’s d was computed to estimate the effect sizes of the changes and indicated improvement from
pretest to post- and follow-up tests for all dependent variables. The largest improvement was found between the pretest and follow-up test for PPH collective efficacy (Table 4). However, there was also a large improvement from pre- to post-test according to the criteria for Cohen’s d (Cohen 1977). The improvement in scores for team functioning was considered medium according to the same criteria. Follow-up multivariate repeated measures analyses for dependent samples that assessed within-subject changes for staff participating in both pre- and post-test (n = 43) or pre- and follow-up test (n = 41) yielded results similar to those for independent samples given in Tables 3 and 4, based on multivariate analyses of variance (MANOVA) (Table 5).

Changes in patient outcome

The birth cohorts comprised 2703 mothers in 2011–2012 and 2743 mothers in June 2013–May 2015. In the baseline group before training (24 months: 2011–2012), 123 mothers (4.6% of a total of 2703 mothers) received transfusions; in the outcome group (24 months: June 2013–May 2015), 121 mothers (4.4% of a total of 2743 mothers) received transfusions. We found no significant change in the overall RBC transfusion rate between the periods (p = 0.8), but there was a significant reduction in blood products used for severe PPH (p = 0.04).

Follow-up analyses comparing maternal and labour characteristics were performed to investigate whether the changes in the transfusion rates could be explained by differences in these characteristics. The overall frequency of Caesarean section in the study population was 18.5% before intervention and 20.9% after intervention (NIPH 2015). Besides the significant increase in the CS rate in the birth cohort (p = 0.02) and a tendency towards an increased rate of forceps deliveries among mothers who got blood transfusion, no other significant differences in maternal characteristics were found (Table 6).

Discussion

The purpose of this quasi-experimental, pre–post intervention study was to investigate changes in perceived self-efficacy and collective efficacy and in patient outcome following interprofessional simulation training on PPH. There were significant overall changes in self-efficacy and collective efficacy (p < 0.001) (Tables 1 and 2). According to the criteria for Cohen’s d (Cohen 1977), the change in participants’ perceived ability to master PPH was medium from pre- to post-test and large from the pre- to the follow-up test 15 months later. Although the response rates for the post- and follow-up tests were somewhat low, the results suggest that the simulation training was followed by a lasting, marked enhancement in participants’ beliefs in their own ability to master PPH situations.

Hands-on training helped familiarise trainees with each step of the current PPH procedure, which may explain the positive change in perceived PPH-related self-efficacy. Training enables them to retrieve skills automatically in a demanding emergency. Moreover, every scenario was followed by a team debriefing in which a faculty member discussed the participants’ frames of understanding and supported participants’ mastery experiences. According to Bandura, self-efficacy is influenced by mastery experiences, vicarious experiences, verbal persuasion and physiological states (Bandura 1982). The PPH simulation training gave participants the opportunity to improve self-efficacy by impacting all of these factors. The simulation lets participants practice PPH management without harming patients, allowing participants to act without the fear of negative consequences. Mastery experience can be obtained by ‘artificial success’ in performance, such as controlling bleeding through uterine massage or bimanual compression. Watching colleagues manage a simulated emergency is a vicarious experience, and the maternity staff identify with colleagues who are trying to control PPH, which is a common clinical challenge. The trainees, while emotionally affected by the

| Table 5 Transfusion rates before and after interprofessional simulation training on postpartum haemorrhage |
|-------------------------------------------------|------------------|------------------|------------------|------------------|
| Pretraining                                      | Post-training    |
| Number of patients                              | Percentage of patients | Number of patients | Percentage of patients | p-value |
| RBC transfusion ≥1 unit                         | 123              | 5                | 121              | 4                | 0.80   |
| RBC transfusion ≥5 units                        | 14               | 11               | 7                | 6                | 0.39   |
| Platelet concentrate ≥1 unit                    | 3                | 2                | 2                | 2                | 0.66   |
| FFP ≥1 unit                                     | 11               | 9                | 4                | 3                | 0.07   |
| RBC, platelet concentrate, and/or FFP ≥5 units  | 17               | 14               | 7                | 6                | 0.04   |

RBC, red blood cell; FFP, fresh frozen plasma.

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Journal of Clinical Nursing, 26, 3174–3187
simulated emergency and by their own performance, do not necessarily identify with their own achievements. It is important for the facilitator to emphasise correct actions and to provide individual encouragement. Debriefing is an opportunity to focus on the participant’s psychophysiological state. Being open about one’s arousal state during debriefing, for example stress or anxiety, can serve to systematically desensitise participants and make these types of emergencies less emotionally demanding (Triscari et al. 2015). While anxiety can be counterproductive, a certain arousal level raises the level of alertness and can be an important coping strategy.

There was also a positive change in perceived PPH-related collective efficacy, with participants reporting a medium-level positive change in perceived team emergency functioning. In Norwegian health services, midwives work autonomously during normal births. When complications are anticipated or when they occur, the doctor on duty is called and is in charge of nonroutine medical treatment. Optimal communication, leadership, decision-making and task sharing during a PPH-related emergency depend on factors such as team competence and the urgency of the situation. Our results suggest that the experience of participating in and observing realistic PPH scenarios followed by team reflection strengthened perceptions of the team’s ability to manage PPH. This corresponds with findings from an observational study that a one-day simulation training strengthened professional competency (Monod et al. 2014).

Having an experience of team capability during real PPH emergencies after simulation training is also likely to have strengthened collective efficacy. Seeing the correct actions carried out by colleagues in a working relationship is likely to strengthen one’s beliefs in the team’s ability to cope and to reassure members that the team can handle PPH. Likewise, inadequate management leading to deterioration of the patient’s condition is likely to lower the collective efficacy level within the team. Debriefing during simulation training and providing feedback on the team level seems to have contributed to a strong and shared sense of collective efficacy among training participants.

Despite the significant positive change in perceived efficacy \((p < 0.001)\), we found no significant reduction in the overall RBC transfusion rate \((p = 0.8)\). On the other hand,
severe PPH needing treatment with >4 blood products dropped significantly ($p = 0.04$) during the study period, which corresponds well with the improvement in collective efficacy 15 months after initial training. This may reflect the strong emphasis of the simulation training on collective efforts to counteract PPH, especially in severe cases of PPH. Moreover, multiple staff are called to help when there is excessive bleeding. When calling for help, the chance of involvement of staff who fully participated in the training increased markedly. The attendance and involvement of trained staff with a high degree of PPH-specific self-efficacy and collective efficacy could boost the competence and skill level needed to resolve the PPH emergency effectively. Significantly fewer mothers with severe PPH after training might indicate that the staff had improved their ability to implement a faster and more coordinated response to severe PPH.

This finding contrasts with a previous retrospective study involving the same kind of simulation training (Egenberg et al. 2015), which found a 41% reduction in overall blood transfusions. The discrepancy in findings may be partly due to different study designs. A quasi-experimental pre–post study like this could be considered to have better internal validity than a retrospective study as it provides information about other measures that could affect results. In the study period, no other intervention to reduce transfusion rates was implemented. In a retrospective study, it is more difficult to rule out the possibility that other efforts may have contributed to the reduction in blood transfusions.

Another explanation for the lack of a significant change in the overall blood transfusion rate is the fact that a substantial number of employees did not complete both simulation training sessions. Of the total number of midwives, obstetricians and auxiliary nurses, 79% participated in the first training and 80% in the second training; just 53% of staff participated in both training sessions. At the time point of the follow-up test, 78% of the midwives, 79% of the auxiliary nurses and 47% of the obstetricians had participated at least once in the training. Immediate PPH management depends on the attendants’ competence and preparedness. The fact that only about half of the staff attended the intended two sessions of simulation training may have influenced the overall probability of optimal PPH management in the maternity wards. Accordingly, achieving a significant reduction in the overall RBC transfusion rate, as hypothesised, was unlikely.

The implementation of simulation training at UNN, Tromsø, did not include clinical supervision of PPH management as a follow-up after training, which could have been beneficial. A multicentre intervention study including the same hospital, combining continuous training, clinical supervision and reassessment of all midwives and obstetricians on manual protection of the perineum during childbirth, showed significant results on patient outcomes (Hals et al. 2010).

Emphasising transfer of reflective learning from simulation training to clinical work might have strengthened our study but was not included in the protocol. Feedback exchange and error recognition after daily events can strengthen team efficiency (Salas et al. 2008).

**Limitations**

This study had some limitations. A randomised controlled design would have improved the internal validity of the study but would be difficult to carry out due to practical and ethical considerations. In 2010, Norwegian health authorities directed all maternity clinics to perform practical training for obstetric emergencies (NDH 2010). This project is in line with those guidelines. We considered it unethical to recruit health facilities for randomisation of interprofessional training.

The samples in pre-, post- and follow-up tests were partially different. This may have affected the results. However, follow-up analyses with identical or dependent samples, testing within subject changes, yielded results very similar to those of the independent samples. Thus, it is unlikely that the differences between samples have had a significant impact on the survey results.

The difficulty of implementing simulation which involved all employees eligible for training turned out to be a limitation of the study, and might have reduced effects of the intervention. Full participation was not possible during the two days that were allocated for training both years. The study could have profited from training days being disseminated over a longer period of time to include all eligible employees.

**Conclusion**

This study investigated the use of simulation training to improve PPH-related efficacy and skills. The results suggest that simulation training emphasising mastery and vicarious experience, verbal persuasion and physiological state, could improve perceived PPH-related self-efficacy and collective efficacy considerably. The results also gave some support to our hypothesis that such training could have clinical effects in this study by reduction in severe postpartum haemorrhage indicated by reduced rate of $\geq 5$ units of blood transfusions. In the future, research on interprofessional simulation training programmes should evaluate factors
that might be crucial for improved maternal outcomes related to prevention, identification and treatment of postpartum haemorrhage.

Relevance to clinical practice

These findings contribute to new knowledge about how interprofessional simulation training can strengthen self-efficacy and collective efficacy levels related to PPH and thereby improve team performance. The significant increase in perceived efficacy levels and the indicated reduction in severe postpartum haemorrhage suggest that this kind of interprofessional simulation training may enhance maternity staff’s ability to prevent and manage severe postpartum haemorrhage. Universal participation is likely to be of major importance for sustainability of the training and for important impact on overall patient outcomes.

Acknowledgements

The authors would like to thank the faculty and the maternity staff at the Obstetric Department, University Hospital North Norway (UNN), Tromsø, for participating in the study, Jorunn Toften for coordinating the simulation training and Gunnel Axelsø and the management at UNN, Tromsø, for their cooperation. Thanks to Stig Pedersen, Agnethe Hennie Olsen, Lill Irene Hind and Bente Helene Johnsen for providing support for the data sampling part of the study. We thank the experts who helped develop the questionnaire, Inger Helen Berge, who assisted in the electronic distribution/sampling of the questionnaires in the pilot testing, and our colleagues at Stavanger University Hospital for participating in the pilot testing. Finally, thanks to Michael Sautter, who mentored the implementation of the simulation training at UNN, Tromsø.

Contributions

Study design: SE, PØ, TME and LEB; provided data: SE, PØ, MGA and LEB; data analysis and data preparation: SE, TME and LEB; co-wrote the paper: SE and LEB. All authors contributed to the interpretations of the results, commented on drafts and approved the final version of the manuscript.

Funding

Signe Egenberg is a registered nurse, midwife and PhD candidate who receives funding from the Laerdal Foundation for Acute Medicine.

Conflict of interest

SE has funding as PhD candidate through Laerdal Foundation for Acute Medicine. Laerdal Global Health is the producer of the birthing simulator MamaNatalie used for this study. SE has no financial relations with Laerdal Global Health. PØ, TME, MGA and LEB declare no conflict of interest.

References


Budin WC, Gennaro S, O’Connor C & Contratti F (2014) Sustainability of Improvements in Perinatal Teamwork


Appendix 1: Factor analysis of items that assessed self-efficacy, collective efficacy and team functioning related to a postpartum haemorrhage (PPH) emergency (n = 184)

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-efficacy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I remain calm when handling PPH</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have experienced being able to act in situations with PPH</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can handle PPH whenever it happens</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can carry out the necessary actions to handle PPH</td>
<td>0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am confident in how to handle PPH</td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to stay calm in emergency situations</td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to identify PPH at an early stage</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPH will make me feel paralysed/unable to act</td>
<td>-0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Collective efficacy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a team, we help each other prevent excessive PPH</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a team, we are able to carry out the necessary actions to treat PPH</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think the team will share tasks in an appropriate way during PPH</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The team can handle PPH</td>
<td>0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think that every member of the team will express themselves clearly during PPH</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a team, we can cope with PPH</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The team usually has clear leadership in emergency situations like PPH</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When PPH arises, our team is able to take action</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a team, we communicate clearly and efficiently whenever PPH arises</td>
<td>0.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Everyone knows what to do during an ongoing PPH situation</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We are able to identify PPH at an early stage</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Appendix 1  (continued)

<table>
<thead>
<tr>
<th>Functioning as a team during an emergency</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>We as a team remain calm during situations involving PPH</td>
<td>0.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We are supportive of each other when we are in high-pressure situations</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The team monitored and reassessed the situation</td>
<td></td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>The team anticipated potential actions</td>
<td></td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>The team adapted to changes in the situation</td>
<td></td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>The team morale was positive</td>
<td></td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>The team prioritised tasks</td>
<td></td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>The team acted with composure and control</td>
<td></td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>The team worked together to complete tasks in a timely manner</td>
<td></td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>The team communicated effectively</td>
<td></td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>The team followed approved standards/guidelines</td>
<td></td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>The team leader maintained a global perspective</td>
<td></td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>The team leader let the team know what was expected of them through directions and commands</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eigenvalues</th>
<th>14.0</th>
<th>4.6</th>
<th>1.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total variance explained:</td>
<td>43.8%</td>
<td>14.4%</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correlations between factor-based indexes:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlations with factor 1</td>
<td>0.37**</td>
<td>0.40**</td>
<td></td>
</tr>
<tr>
<td>Correlations with factor 2</td>
<td>0.59**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cronbach’s alphas for factor-based indexes</td>
<td>0.95</td>
<td>0.96</td>
<td>0.90</td>
</tr>
</tbody>
</table>

*p < 0.01.*