**Implementing military aviation debriefing methods to improve outcome of peripartum interventional procedures**

Gali Garmi, MD,1,2 Michael Pollig, MBA,3 Noah Zafran, MD,1,2 Sivan Zuarez-Easton, MD,1,2 Shabtai Romano, MD,1,2 Raed Salim, MD,1,2

1Department of Obstetrics and Gynecology, Emek Medical Center, Afula, Israel

2The Ruth and Bruce Rappaport Faculty of Medicine, Technion, Haifa, Israel

3Shamayim Social business, Hospital & Health Care division, Tel Aviv, Israel

**Corresponding author**

Raed Salim, MD

Department of Obstetrics and Gynecology

Emek Medical Center

Afula 18101, Israel

Phone: +972-4-6494031

E. Mail: [salim\_ra@clalit.org.il](mailto:salim_ra@clalit.org.il)

**Abstract**

**Objective**

Debriefing is widely used as a mean to improve motivation, learning, and performance. We aimed to examine trend in maternal and perinatal outcomes over time following implementing the Israeli Air Force's (IAF's) debriefing methods.

**Methods**

In 2016, the delivery ward was part of the "Shamayim" (or sky in English) project. Shamayim, a social business organization managed by former IAF's pilots, specializes in implementing an inquiry-based learning model in different organizations that aim for better achievements. Following the training period, an online mobile application was developed to investigate two peripartum interventions: vacuum deliveries and genital tract examinations performed in cases of postpartum hemorrhage (PPH) or retained placental products. The application was downloaded to smart phones of all physicians that were in charge any time during the study period. After each procedure, physicians answered an application designed 3 questions, regardless of outcome within 24 from the procedure: What happened? Why did it happen? How can I improve? Same form was completed regarding equipment used. Once in 3 to 4 months, forms were presented anonymously to delivery ward team. Conclusions were recorded and implemented as possible. Outcome examined included trend over time in maternal and neonatal outcomes related to the 2 interventions examined as well as rate of equipment faults. The Cochran-Armitage test for trend and the Spearman’s correlation test were utilized, in the case of dichotomous and continuous variables respectively.

**Results**

Between November 2016 and May 2018, 308 vacuum deliveries and 219 genital tract examinations were performed. In vacuum deliveries, a decreasing trend over time was observed in the rates of vacuum cup detachments (*p*<0.001), PPH (*p*=0.019), cord artery pH<7.1 (*p*<0.001), NICU admission (*p*=0.048) photo therapy (*p*<0.001) and in maternal length of stay (*p*=0.003). No significant change in the procedure related neonatal trauma rate was noted. In the second intervention, a decreasing trend over time was observed in the rates of blood transfusion (*p*<0.001), Hb drop >2gr% (*p*<0.001), and systolic BP<70 mmHg (*p*=0.042). Additionally a decreasing trend over time was observedin equipment faults rate according to the 206 forms submitted *(p* <0.001).

**Conclusion**

IAF's debriefing method used in the delivery ward led to improve maternal and neonatal outcomes resulting from the two interventional procedures examined.

**Introduction**

Analysis of adverse events involving hospitalized patients showed that about 70% of all accidental injuries are caused by errors or failure to follow accepted practices (1-3). Additionally, half of all surgical complications are thought to be avoidable, and most are the result of communication failures (4).

Debriefing is used in medical environments as a mean of learning from daily practice and is widely used as a mean to improve performance (1). Furthermore, a growing body of evidence also links debriefing and teamwork in surgery to improve outcomes and reduced rates of adverse events (5-17). A meta-analysis showed that organizations can improve individual and team performance by approximately 25% by using properly conducted debriefs (1).

Much of what is known about debriefing and teamwork has been generated from the products of many years of research in aviation and military settings (18). Pilots debrief allows team members to discuss the various decisions that were made, things that could have been done differently, any potential need for rehabilitation or training, and what was successfully accomplished (18). Aviation debriefing concepts have been found simple, inexpensive and suitable for adaptation to hospital emergency departments and operating rooms (2,19).

Delivery ward is a complex, multifaceted setting in which effective communication and coordination of team members can be vital for safe and robust functioning. Team members need to share information rapidly when responding to expected and unexpected events. In this study we aimed to examine the impact of implementation of the Israeli Air Force's (IAF's) debriefing methods on maternal and neonatal outcomes on two peripartum interventions: vacuum deliveries and genital tract examinations performed immediately postpartum under anesthesia.

**Methods**

Retrospective study conducted at a single teaching hospital using data collected between November 2016 and May 2018. In 2016, the delivery ward in Emek Medical Center was part of the "Shamayim" (or sky in English) debriefing program. Shamayim is a social business organization managed by former IAF's pilots. The principles of the "Shamayim" methodology is based on simplicity and efficiency in debriefing as a learning routine. The concept is based on moving from blaming to taking personal responsibility, personal learning that leads to group learning, drawing conclusions and quick results. The concept is based on the IAF's method of debriefing that includes three key questions: What happened? Identifying the outcome to debrief; why did it happen? Describing the essential reasons and system failures that led to the specific outcome; how can I improve? Suggestions to prevent reoccurrence or to preserve, in cases of uneventful outcome. These three questions are employed in each minor and major action and procedure in cases of unfavorable outcome (in order to improve) and in cases of favorable outcome (in order to replicate). This method allows debriefing on an individual basis and within the context of a team since it includes all team members involved.

The "Shamayim" program began at our institution with weekly meetings of a designated medical staff group that was led by the chief of the delivery ward, and included senior obstetricians, residents, chief, senior and junior midwifes.

Each session was steered by the same instructor, a former IAF's pilot. Briefing and debriefing included lectures, case studies on daily medical events and procedures that took place during the previous week, role playing, video-recorded simulation, and training in briefing and debriefing methods based on the 3 key questions.

This period lasted three months. In the following nine months, monthly meetings aimed at transferring the stick from the "Shamayim" instructor to the medical staff.

The instructor accompanied this period most of the time. During this period, medical staff implemented methods of debriefing based on the 3 key questions. Throughout this period of training, an online debriefing tool (smartphone application) was developed by the head of the delivery ward (R.S.) that participated in the project together with the head of "Shamayim" instructor (M.P.), to investigate two peripartum interventions: vacuum deliveries and genital tract examinations performed in cases of postpartum hemorrhage (PPH) or retained placental products under regional or general anesthesia. At our institution when instrumentalvaginal delivery is indicated, only vacuum extraction is used. These interventions are performed by the physician in charge and require multiple teamwork and designated equipment. The application was downloaded to the smart phones of all physicians that work in the delivery ward.

Based on this conception, after each intervention, physician in charge answered the application designed 3 questions form, regardless of outcome: What happened? Why did it happen? How can I improve? The same form was also completed regarding the equipment used. In order to focus on specific outcomes (what happened?), a number of adverse outcomes that may result following the two procedures were pre-prepared focusing on the process that led to the event rather than on the etiology (Table 1). For example, performing a vacuum extraction and delivery of a neonate with a cord artery pH less than 7.1 (a pre-prepared outcome) was the answer to the first key question, "what happened?" the involved physician needed to mark (Table 1). This was the issue to debrief in the next two key questions (Why did it happen? and, how can I improve?). Physicians referred among others, to possible delay in timing of intervention and reasons for that, and to ineffective utilization of all potential team communication. The involved physician completed the form, usually within several minutes and e-mailed it to the head of the delivery ward within 24 hours from the event. Forms were received anonymously.

Once in 3 to 4 months, the received forms were presented anonymously to all obstetric team during staff meeting. Rates of favorable and unfavorable outcomes were presented. Conclusions were recorded and implemented as possible.

Data for the present study was collected from computerized labor files, electronic medical records at discharge, and the application forms. Data included maternal demographic and obstetric variables. Outcomes examined were those that occurred before discharge and that were related to the procedures including number of vacuum cup detachments, PPH, perineal tear grade 3 and 4, and length of maternal stay after delivery. Neonatal outcome included shoulder dystocia, Apgar score, umbilical cord artery pH, intensive care unit (NICU) admission, photo therapy, and rate of fetal trauma including clavicular fracture, Erb's palsy and cefalohematoma. For the genital tract examination, outcomes examined included also hemoglobin (Hb) drop, systolic blood pressure (BP) <70 mmHg, and need for blood transfusion.

Among the equipment faults that were examined (in both procedures) were electrical outlet faults, technical errors in activating the operating theater bed, elementary equipment not found in the designated place and equipment malfunction as in the case of blunt blades of the episiotomy scissors.

Primary outcome was trend in the occurrence of maternal and neonatal outcomes examined during the study period (time from application use) related to the two interventions as well as trend in rate of equipment faults.

**Statistical analysis**

Statistical analysis was conducted using the IBM SPSS 23 program and the R programming language. Spearman's correlations were calculated to determine the presence, direction and strength of correlations between the time index and continuous variables such as BMI, and gestational age while the analogous values were tested via the Cochran-Armitage trend test in the case of dichotomous variables such as diabetes, low levels of HB, and other outcomes. Descriptive statistics and calculation of means and standard deviations were performed via SPSS while Spearman correlations and Cochran-Armitage tests for trend estimation were performed via R. Meta-analytic results from 46 independent samples and from other reports show that debriefs improve performance of teams and individuals (1,16,17). For that reason, all applied tests were one tailed as the underlining assumption was that as the treating unit improves as time goes by, the frequency of unfavorable outcomes and errors will decrease.

**Results**

Data from all 308 vacuum deliveries and 219 genital tract examination that occurred between November 2016 and May 2018 were collected. The medical staff at our institution comprised of 15 physicians that were in charge at any time during the study period and were supposed to complete the forms following the procedures. The compliance rate in cases of vacuum delivery was 43.2% (133 forms were completed out of total 308 procedures) and 35.2% in genital tract examination (77 forms were completed out of total 219 procedures).

Maternal demographic and obstetric variables of women who had vacuum deliveries during the study period are presented in Table 2. No statistically significant correlations were detected between time (study period) and maternal demographic and obstetric variables, based on spearman’s correlation coefficient. In vacuum deliveries, a decreasing trend over time was observed in the rates of vacuum cup detachments based on 17 (5.5%) reported cases (*p*<0.001), and in the rate of PPH, based on 28 (9.1%) cases reported following the procedure, (p=0.019). There was one case of tear grade 3 or 4 during the study period. Regarding shoulder dystocia, while the trend was significant (p<0.001) the calculation was based only on 5 cases (1.6%) out of 308 vacuum deliveries. As such, the test might not be as powerful as its significance implies. A significant decrease over time was also detected in length of maternal stay using Spearman’s correlation coefficient (p=0.003). Regarding neonatal outcome, a significant decrease was detected over time in cases of Apgar score <7 at 1 minute (p=0.006), based on 20 (6.5%) reported cases. In contrast, no significant trend was detected in the frequency of Apgar score <7 at 5 minutes (p=0.2686). Additionally, a significant and decreasing trend over time was detected in the frequency of cord artery pH lower than 7.1 (p<0.001) based on 36 (11.7%) reported cases, and similarly, for cord artery pH <7.0 (p=0.0064). Additionally, based on 13 cases (4.2%), a significant decrease in trend (p=0.048) was detected in the frequency of NICU admission. A significant and decreasing trend was detected in the frequency of photo therapy (p<0.001) based on 57 (18.5%) reported cases. In general the frequency of any of the above neonatal outcomes tended to decrease over time (p<0.001). No significant trend was detected in the frequency of cephalohematoma (p=0.426) or clavicular fracture (p=0.104). There was one case erb's palsy during the study period. There was no decrease in the frequency of any neonatal trauma related to vacuum extraction (p=0.132). Additionally no decrease was detected in the length of neonatal stay (p=0.99), (Table 2).

Maternal demographic and obstetric variables of the 219 women who had genital tract examinations during the study period are presented in Table 3. No significant correlations were detected between time (study period) and maternal demographic and obstetric variables, based on spearman’s correlation coefficient. A significant and decreasing trend was detected in the frequency of blood transfusions based on 57 (26%) reported cases (*p*<0.001), however, no significant trend was detected in the number of blood transfusions given (*p*=0.506). Based on 148 (67.6%), 122 (55.7%) and 84 (38.4%) reported cases, a decreasing trend in the frequency of HB drop >2mg%, frequency of HB levels <9mg% and <8mg% respectively were detected (*p*<0.001 for the three trends). The frequency of systolic BP <70mmHg decreased over time *(p*=0.042), however, as there were only 10 observed cases of BP <70 mmHg, this decrease in trend should be interpreted with caution. No trend was detected in length of maternal stay (*p*=0.637) (Table 3).

Regarding equipment faults, 203 forms (39% of both procedures) were filled and completed; 130 (42.2%) in the vacuum extraction procedure and 73 (33.3%) in the genital tract examination procedure. Based on 47 (23.2%) reported faults (23 with vacuum and 24 with genital tract examination) a decreasing trend over time was observedin the equipment faults rate *(p* <0.001) (Figure 1).

**Discussion**

The results of the current study showed that the military aviation debriefing methods used in the delivery ward led to a trend of improved maternal and neonatal outcomes when implemented in vacuum deliveries and postpartum genital tract examinations performed in cases of PPH or retained placental products. Errors identified were mainly related to the process of care, such as delayed intervention or delay until consulting with a specialist, and inappropriate performance of a procedure. Additionally, errors of judgement, e.g. underestimation or failure to interpret adequately the implication of the fetal heart rate tracing were also observed.

Furthermore, equipment errors found during the study period were reduced significantly over time. A number of issues were identified and handled, including equipment adjustments, ordering additional equipment to prevent immediate shortage, and rearranging equipment and medications in the delivery and the operative suits.

Similar results of 24% equipment errors were reported by Wolf et al, who examined the effect of debriefing on operating room team function and equipment issues. The authors stated that equipment issues that include delay, availability, and malfunction decreased significantly owing to debriefing from 24% to 6.8% (6).

Data suggest that at least half of all surgical complications are avoidable (20,21).

Bhasale et al analyzed 805 incident reports completed by general practitioners in Australia and found that 76% of events were preventable (22). There have been a number of reports of increased safety-related practices and improved communication after team training (23), and preoperative debriefings (17,24,25), that led to improved performance (24,25). In high-risk settings other than the operating room, such as emergency departments (26), labor and delivery units (27), neonatal suites (28), there is evidence that clinical errors (26) and adverse outcomes were decreased (24,25,27), and debriefing led to decreased rates of morbidity and mortality (10,25). Findings from meta-analysis (*N* = 2,136) on team and individual level debriefs showed that organizations can improve individual and team performance by approximately 25% by using properly conducted debriefs. The results were similar across teams and individuals, and for medical and nonmedical participants. Moreover, there was no relationship between effect size and publication year, gender mix, time spent debriefing, or team size. The authors stated that improvement of 20% or more is quite encouraging for an inexpensive intervention that requires little time to conduct (1).

Still, evidence for the effectiveness of peripartum debriefing programs in improving women safety, and their impact on overall delivery ward function (delays in action, misjudgment, and equipment errors) has not been thoroughly studied. In the current study we adopted debriefing methods of military aviation practice that was established among fighter pilots several decades ago (29). Aviation teamwork concepts have been found suitable for adaptation to hospital emergency departments and operating rooms (10). Additionally, the educational and implementation process employed was based on 3 questions used to brief and debrief events in the IFA. In order to implement this simple and inexpensive method in the delivery ward we chose smartphone application, an easy and cheap electronic modality as a means for the process of debriefing. Electronic integration has been shown to increase compliance in debriefing implementation and has the potential to extremely improve practice (10,30). Additionally, discomfort of individuals involved was avoided due to anonymously sharing. As in the case of IFAs debriefing method, the focus was on learning and looking forward to the next opportunity to excel and improve performance.

**Limitations**

This study has a number of limitations. The design, involving a comparison of data over time, led to lack of a control group. Another limitation is that our program was planned to meet the needs of the medical staff operating within the delivery ward and may not likely to be applicable “as is” to other healthcare providers. However, major elements of the approach used can serve other several hospital settings. Additionally the improvement observed may be related, at least in part to another mechanism, the Hawthorne effect, i.e. an improvement in performance due to subjects’ knowledge of being observed (31). Moreover, compliance rate for briefings/debriefings was not monitored on a regular basis for each procedure and not all procedures in the study period were followed by a debriefing form. Nevertheless, with increased awareness a gradual change took place. We decided to include data from all procedures during the study period since all physicians attended the feedback meetings during the study period and all physicians had the opportunity to learn and improve from the debriefing process. Compliance with debriefing has been reported to be difficult by others who at the same times reported improving outcomes regardless of the compliance rate (1,2,32-34).

**Conclusion**

Intrapartum complications are a substantial cause of morbidity and occasionally mortality. They may be devastating to women and her child and costly to health care systems. Some are preventable, though their prevention may require a change in systems and individual behavior. The aviation debriefing concept and tools performed via a smartphone application in the current study, can be successfully adapted to other delivery wards, may decrease errors and was proved neither costly nor lengthy.

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**Table 1:** Application for post-procedure debriefing.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vacuum delivery debriefing form** | | | | | | | | | | | | | |
| 1. What happened? (mark the relevant space) | | | | | | | | | | | | | |
| other | Uneventful | | Failed | | Tear grade 3/4 | | PPH | Shoulder dystocia | | Cord pH<7.1 | Neonatal trauma | |  |
|  |  | |  | |  | |  |  | |  |  | | NRFHR |
|  |  | |  | |  | |  |  | |  |  | | Prolonged second stage |
|  |  | |  | |  | |  |  | |  |  | | Woman exhaustion |
|  |  | |  | |  | |  |  | |  |  | | NRHFR + Prolonged second stage |
| **Uterine revision debriefing form** | | | | | | | | | | | | | |
| 1. What happened? (mark the relevant space) | | | | | | | | | | | | | |
|  | |  | |  | Other | Uneventful | | | Systolic blood pressure < 70 mmHg | | | PPH |  |
|  | |  | |  |  |  | | |  | | |  | Retained placenta |
|  | |  | |  |  |  | | |  | | |  | Retained membranes |
|  | |  | |  |  |  | | |  | | |  | Retained cotyledon |
|  | |  | |  |  |  | | |  | | |  | PPH |
|  | |  | |  |  |  | | |  | | |  | Complicated suturing |

NRFHR, non-reassuring fetal heart rate; PPH Postpartum Hemorrhage

2. Why did it happen? ...................................

3. How can I improve? ..................................

**Equipment faults related to the distinctive procedure**

1. Were there equipment problems? Yes/No

2. Why did it happen? .................................

3. How can I improve? .................................

**Table 2. Maternal demographic and obstetric variables and outcomes of vacuum delivery over time**

|  |  |  |  |
| --- | --- | --- | --- |
| **Demographic and obstetric variables** | | **Maternal outcomes** | |
| **Variables** **(N=308)** | **Mean ± SD or N (%)** | **Outcome** | ***P*-value** |
| Maternal age, years | 28.3±5.4 | Tear grade 3 or 4\* | ….. |
| Maternal age >35 years | 30 (9.7) | Vacuum cup detachments | <0.001 |
| Smoking status | 21 (6.8) | Shoulder dystocia | <0.001 |
| Ethnicity  Arabs  Jews | 128 (41.6) 180 (58.4) | PPH | 0.019 |
| Pregestational BMI (kg/m2) | 23.0±4.3) | Length of stay, days | 0.003 |
| Pregestational BMI >30 (kg/m2) | 20 (6.5) | **Neonatal outcomes** | |
| Primiparous (1st birth) | 223 (72.4) | **Outcome** | ***P*-value** |
| Maternal diseases | 39 (12.7) | Apgar<7 at 1 min | 0.006 |
| Diabetes in pregnancy | 28(9.1) | Apgar<7 at 5 min | 0.2686 |
| Hypertension | 5 (1.6) | Cord artery PH<7.1 | <0.001 |
| Gestational age at delivery | 39.5±1.0 | Cord artery PH<7.0 | 0.0064 |
| Reason for vacuum  Prolonged second stage Non-reassuring fetal FHR Combined | 103 (33.4) 187 (60.7) 18 (5.8) | Photo therapy | <0.001 |
| **Neonatal variables during the study period** | | NICU admission | 0.048 |
| **Variables** **(N=308)** | **Mean ± SD or N (%)** | Any of the above | <0.001 |
| Neonatal birthweight, grams | 3188.7±421.2 | Neonatal trauma  Cefalohematoma  Clavicular fracture  Erb's palsy\*  Any | 0.426  0.104  …..  0.132 |
| Neonatal gender (male) | 154 (50) | Length of stay | 0.99 |

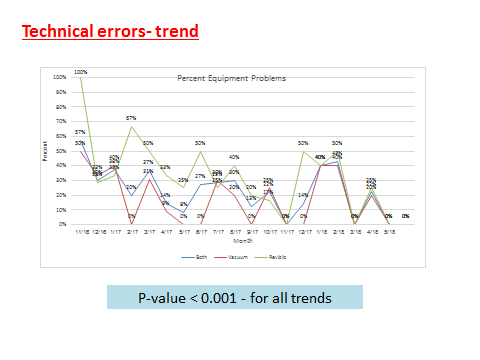
\*Only one case was identified during the study period

**Table 3. Maternal demographic and obstetric variables and outcomes of genital tract examination over time**

|  |  |  |  |
| --- | --- | --- | --- |
| **Demographic and obstetric variables** | | **Maternal outcomes** | |
| **Variables** **(N=219)** | **Mean ± SD or N (%)** | **Outcome** | ***P*-value** |
| Maternal age, years | 28.88±5.93 | Blood transfusion | >0.001 |
| Maternal age >35 years | 32 (14.6) | Number of blood units transfused | 0.506 |
| Ethnicity  Arabs  Jews | 105 (47.9) 114 (52.1) | Postpartum hemoglobin drop >2 gr% | >0.001 |
| Pregestational BMI (kg/m2) | 24.066±4.53 | Postpartum hemoglobin <9 gr% | >0.001 |
| Pregestational BMI >30 (kg/m2) | 33.150 (2.58) | Postpartum hemoglobin <8 gr% | >0.001 |
| Smoking | 11 (5.0) | Systolic blood pressure <70 mmHg | 0.042 |
| Primiparous (1st birth) | 86 (39.3) | Length of stay, days | 0.637 |
| Maternal diseases | 29 (13.2) |  |  |
| Diabetes in pregnancy | 12 (5.5%) |  |  |
| Hypertension | 10 (4.6) |  |  |
| Gestational age at delivery | 39.229±2.01 |  |  |
| Mode of delivery  Spontaneous vaginal  Vacuum extraction | 208 (95.0) 11 (5.0) |  |  |
| Reasons for revision\*  PPH  Retained placental products  Complicated tears\*\* | 108 (48.2) 44 (19.6) 72 (32.1) |  |  |
| Tear grade 3 or 4 | 1 (0.5) |  |  |

\*N=224, due to overlap reasons.

\*\*Complicated tears were those who required general or regional anesthesia for repair and included tears in the cervix, proximal part of the vagina, grade 3 or 4 and tears that were repaired under anesthesia upon women request.



**Figure 1**