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A BRIEF EXIT BEFORE A GRAND ENTRANCE

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ABSTRACT:

Well-known historian Winston Churchill has been quoted as stating "He who fails to plan, plans to fail." Significant planning and collaboration were necessary to prepare for the first Ex-utero Intrapartum Treatment (EXIT) procedure in the IWK Health Centre in Halifax, NS. EXIT is a life-saving technique used to secure a fetal airway when there is some type of airway compression involved. The procedure is done while oxygenation and perfusion are maintained through utero-placental circulation.[1] The IWK's obstetrical team followed a mother whose fetus was diagnosed in utero with a high airway anomaly/obstruction.

The EXIT procedure involved inter-professional collaboration with the following teams: pre-natal care; obstetrics; paediatric and adult anesthesia; otolaryngology; neonatology; respiratory therapy; and the paediatric Operating Room (OR). This article will review the steps taken to prepare for this elective procedure and the measures undertaken in preparation for the possibility of emergency surgery due to early labour. It will also describe the intraoperative experience and the post-operative debriefing session.

INTRODUCTION

Four surgical/neonatal services and four pediatric perioperative nurses at the IWK had the opportunity to be involved in a procedure that was being performed for the first time at this health centre. It was an exciting opportunity to learn this approach. The case required a great deal of planning to ensure it was executed properly and with the best possible patient outcomes. This article will review the steps involved in preparing for this surgical procedure as well as the specific case history. The team conferences and simulation done in

To better understand the goals and maternal risks of the EXIT procedure it can be compared to a caesarean section.

preparation for this case will also be discussed. And the authors will review the intraoperative experience as well as the post-operative debriefing process.

Definition and Indications for EXIT procedure

Stefini, S., et al (2012) offered the following definition: "Ex-utero intrapartum treatment (EXIT) is a technique used to secure the fetal airway while oxygenation is maintained through utero-placental circulation."[1] This is accomplished by partially delivering the baby through a traditional caesarean section type incision. Only the head, upper part of the torso, and one arm are initially delivered so as leave the lower part of the body in the uterus.[2] Procedures essential for the survival of the fetus are then performed. These procedures may consist of direct laryngoscopy, rigid or flexible bronchoscopy, tumour decompression and resection, intubation, tracheostomy, and initiation of extracorporeal membranous oxygenation (ECMO).[3]

These procedures can be life-saving for a baby with an unsecure airway. After an adequate airway is secured, the fetus is then completely delivered and the umbilical cord is clamped.[3] The benefit of the EXIT procedure for the baby has to, however, be balanced with the risk to the mother. Marwan, A. & Crombleholme, T. (2006) noted "The physiology of pregnancy itself contributes to a number of maternal and fetal anaesthetic risks."[4]

To better understand the goals and maternal risks of the EXIT procedure it can be compared to a caesarean section.

The goal of a caesarean section is for rapid delivery of the fetus, with minimal relaxation of the uterus, and then quick return of uterine tone after the delivery to prevent hemorrhage. A regional anaesthetic is preferred with a minimal anesthetic plane in order to avoid neonatal depression upon delivery.[4,5] The goal of the EXIT procedure is, on the other hand, uterine relaxation. This allows for partial delivery of the fetus and gives the otolaryngologist prolonged intra-uterine access for the surgical intervention. A high concentration of anaesthetic gas allows uterine relaxation which decreases uterine vascular tone and, therefore, puts the mother at an increased risk of bleeding. Maternal safety is of major importance so if there is a chance the procedure will negatively affect maternal safety the EXIT procedure is stopped and the delivery is completed. Close monitoring of the mother takes place throughout the entire procedure.[5]

It is also worth noting that the EXIT procedure involves anaesthesia of two patients: both the mother and the fetus. The anaesthetic goal for the mother is to achieve a deep plane of general anaesthesia while maintaining a normal blood pressure and uterine volume. Normal blood pressure helps with fetal oxygenation during the EXIT procedure. Adequate uterine volume is also required to prevent placental abruption. The anaesthetic goal for the fetus is to achieve a surgical anaesthesia level without causing cardiac depression. The fetal anaesthesia is mainly provided through the trans-placental passage of inhalational agents. Additional intramuscular medications may, however, be given to the fetus to enhance anaesthesia. A pulse oximeter is placed on the fetal hand to monitor fetal oxygenation throughout the procedure.[4,5]

Current indications for the EXIT procedure include in-utero diagnoses of large fetal neck masses (which distort the airway anatomy and result in difficult laryngoscopy), large lung and mediastinal masses (which can result in cardiac compression leading to cardiac arrest), severe congenital diaphragmatic hernia (which requires initiation of ECMO), congenital high-airway obstruction syndrome (CHAOS) (such as laryngeal atresia, tracheal atresia, laryngeal web, and a laryngeal cyst).[3,4] Specifically, the IWK Health Centre followed a mother whose baby was diagnosed in utero with a congenital high airway anomaly or obstruction (CHAOS).

It would involve synchronized multi-discipline team work.

Case History

The mother was a young woman in her mid-twenties. It was her 5th pregnancy and she'd had one live birth. Due to her prenatal history she had multiple ultrasounds and MRIs done, during this pregnancy, with findings of fetal Congenital High Airway Obstruction and Intrauterine Growth Restriction (estimated wt. 2500 gms). The Otolaryngology surgeon consulted in the case reported the possibility of a normal trachea but the need to anticipate a high risk of respiratory distress at birth with possible death from asphyxia.

The family did not reside locally. The plan, therefore, was to admit the mother to the prenatal unit at 36½ weeks gestation (9 days prior to the planned EXIT procedure). An ultrasound was done, on admission, to further estimate the fetus' weight and airway status. Prior to this the involved staff received informative emails regarding this case that included information about those involved, plans for delivery, and the schedule of team conferences. They also contained information about the EXIT procedure itself including what it is, its' principles, and why its necessary to preserve uteroplacental gas exchange. Those involved were encouraged to educate themselves with a provided list of further references.

Team conferences, that included all medical staff, began several days prior to the mother's planned admission. Contingency plans were made, at that time, should an emergency delivery occur sooner than the planned procedure. There were staff on call leading up to the scheduled delivery date, and plans & equipment were arranged so that a speedy transfer of essential items could be made should the mother go in to labour before the procedure. All staff were informed of the whereabouts of these items.

To ensure maternal and fetal stability and safety, to minimize delay in care during and immediately following the EXIT procedure, and to maximize contingency preparedness, it was decided that the procedure would take place in the Paediatric OR rather than the Birth Unit or the Women's OR. Contingency items for the procedure would be close at hand and advanced neonatal acute care supplies and surroundings would be nearby. It would involve synchronized multi-discipline team work.

Teams Involved

Two anaesthesia teams were involved – one for mother and one for the fetus. The anaesthesia team for the mother included an Anaesthetist and an Anaesthesia Assistant. It would be necessary for them to start an intravenous and arterial line, administer regional anaesthesia, and finally administer a general anaesthesia to mother only after any pre-scrub positioning and preparations were complete. The anaesthesia team for the fetus included a separate Anaesthetist and Anaesthesia Assistant.

There were two surgical teams as well – an Obstetrical team and a Paediatric Otolaryngology team. The Obstetrical team comprised a surgeon, a resident, fellow, one scrub nurse, and two circulating nurses. They would prepare a sterile set-up for the delivery and for any potential related problems. A perinatal Clinical Nurse Specialist was present with the father in the OR during induction and stayed with him in a private waiting room during the procedure. An Ultrasound Sonographer was also present pre-op to assess fetal heart rate and placental placement.

The paediatric team comprised two Otolaryngology surgeons, two scrub nurses, two circulating nurses, and a surgical liaison nurse. They prepared two sterile set-ups for the fetus (one for the initial completion of a Laryngoscopy and/or Bronchoscopy and one for the potential Tracheostomy).

Immediately following the delivery of all or part of the baby the coordination between anaesthesia and surgical teams would be crucial to preventing uterine atony and excessive maternal bleeding.[4] The uterus must be relaxed enough to

allow removal of all or part of the fetus and to prevent expulsion of the placenta but not relaxed enough to encourage uterine hemorrhage.[4]

A neonatal team was present to attend to the baby once fully delivered. It comprised a Neonatologist, Neonatal Nurse Practitioner, Neonatal Fellow, Respiratory Therapist and three Neonatal Intensive Care Nurses. Once a patent airway was established the baby would be handed over to this team. A cozy cot would be in the OR for baby care and to possibly be used as a work surface while establishing the baby's airway if it could not be established in the designated area of the sterile field. Following establishment of a patient airway the neonatal team would assess the baby and treat her accordingly.

Special Preparation

A simulation/walk took place on the day prior to the planned EXIT procedure. It was held in the OR in which the EXIT procedure would be performed. It included all team members noted above. At this time the delivery plan was discussed and practiced. It began with an outline of the time and route of maternal delivery to the OR. The plan was for the patient to be brought to the OR at approximately 0700 for a scheduled 0800 start time.

Due to the large volume of necessary staff, expected to be present in the OR for the procedure, the placement of people and equipment were vital. Discussions and a simulation took place focusing on optimal positioning of the OR bed and the patient's placement on it, the various staff teams to be in the OR and at the OR bed at different stages of the surgical procedure, the sterile case tables for both teams, the equipment boom containing most of the electronic equipment, suction, etc., and the cozy cot for baby and its proximity to the OR bed. Each team was aware of which

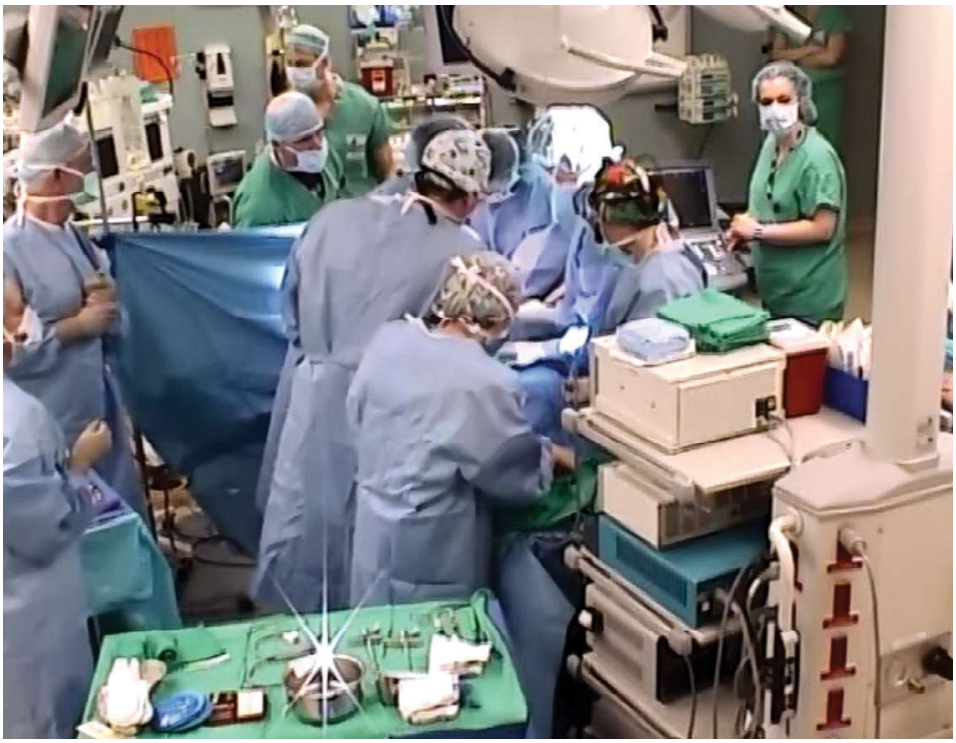
The EXIT procedure would be performed on the OR table in the area of the maternal incision.

essential items to bring to the OR the next day.

Some special concerns arose from this meeting. One was the need for a solid surface on which to operate on the fetus. This would need to be strong, flat, immobile, and soft, proximal to mother's perineum/incision, and would need to allow enough space to allow the surgeons to function and maneuver around it. This resulted in the decision to use a sterile covered mayo tray with the grounding pad on top of it, sitting atop the mother's upper thighs. Padding with green towels, between the mayo tray and the grounding pad, would provide a firmer surface and protect the mother. The tray would be taped securely to the mother and to the bed. The company representative for the grounding pad was contacted to ensure the pad would remain effective when used under a wet fetus.

Another concern was the need for smaller equipment given the expected size of the baby and the diminished room available in the patient's airway, based on the expected size. Options were discussed regarding the use of urology scopes as well as otolaryngology's flexible and rigid bronchoscopes. There were deliberations as to whether the light cords for the scopes and head lamps were long enough to reach the surgical site given that they had to be plugged into the equipment boxes on the boom and the surgical site was further away than in our usual practice. There were also discussions regarding the placement of the viewing screens. The plan for audiovisual recording of the scopes and the overall procedure was discussed.

The EXIT procedure would be performed on the OR table in the area of the maternal incision. Consequently, a number of unsterile, but necessary, upper airway items, such as the oxygen saturation probe, ambu bag, inhalation circuit, light cords, telescope, prism, laryngoscope handle & blade, and other bronchoscopy equipment for ventilation/oxygenation of the fetus would need to be sterilized prior to the planned surgery. In the OR the bronchoscopy equipment is cleaned and sterilized after use but not wrapped in sterile packaging. It is, instead, stored in the emergency airway cart. There is the potential for this equipment to be needed on other cases and therefore this equipment could not be sterilized until immediately prior to the planned event. This was done on the day of surgery to ensure that all items were sterile and available for surgery.



Courtesy K. MacDonald

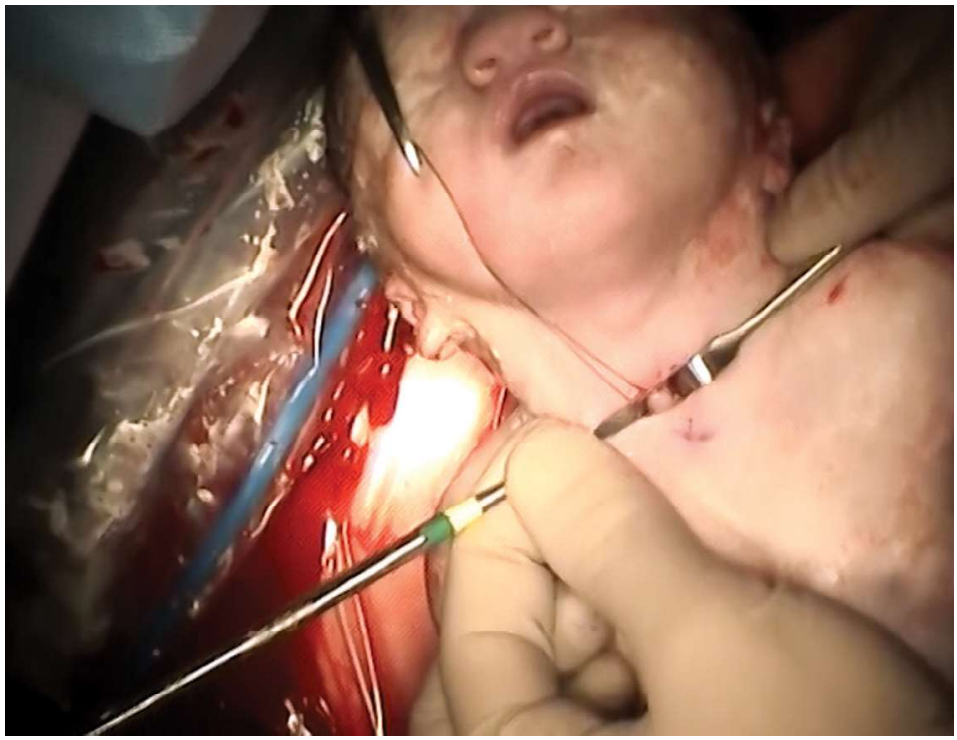
Obstetrical, otolaryngology and anaesthesia perioperative teams working on EXIT procedure.

During the simulation a list was generated of all the specific individuals who would be present at the case the following day. It was decided that if any extra staff/learners arrived they would be directed to the OR conference room where a video feed of the case was being directed.

By the end of the walk through many issues had been resolved. All staff agreed it was an important and informative session.

Intraoperative Experience

The perioperative nurses were nervous and excited the night before and the



Courtesy K. MacDonald

Tracheostomy being completed during EXIT procedure.

morning of the procedure. They were early to work and worked out their roles for the day. They checked to make sure all equipment was sterile or being sterilized and put the equipment in the correct location for surgery.

At 0700 the room was buzzing. Birth unit nurses, neonatal intensive care unit (NICU), and anaesthesiology were all setting up. The otolaryngology surgeons were present and rechecking all equipment. The surgical liaison nurse (SLN) was present and in contact with the parents.

The room was ready at 0720. The OR conference room was set up for observers via the audio-visual integration system. Even though the IWK is a teaching hospital no one was to enter the room unless they were on the official day of surgery list. No otolaryngology residents, med students etc. were present for surgery but were encouraged to observe in the conference room. Other nurses, the nurse manager, and other surgeons were also present in the conference room to observe.

At 0735 the mother and father entered the OR theatre. The mother was smiling and both parents waved to the nurses and made jokes. The sterile members of the team were scrubbed and in the correct locations ready to proceed. The anaesthesia team had asked for minimal talking once the mother and father entered the OR. The OR conference room was full of staff and learners who would watch the procedure.

The anaesthesiologist was ready to begin at 0740. The mother was awake for her regional anaesthetic, intravenous, arterial catheter placement and positioning for her procedure. She was awake for the positioning and securing of the mayo stand on her legs. The father stood in a far corner of the room and took pictures of all teams in their positions to document the journey. The time out portion of the surgical safety checklist was initiated by the obstetrical team. Every person said their name and their team while the parents acknowledged team members while they spoke. The father was escorted out of the theatre before induction.

Maternal induction took place at 0832. The mother's position was re-checked and surgery was ready to begin. The obstetrical team immediately prepped and draped. The otolaryngology team was positioned in close for the bronchoscopy. The neonatal team was in position away from the sterile field. The anaesthesia staff responsible for the mother were monitoring her closely. The anaesthesiologist for the baby was ready with the obstetrical nurses having meds drawn up for intramuscular injection for the fetus if necessary.

0845 was surgery start time. Before the incision the entire team was aware there would be quiet in the theatre for each team to concentrate. The otolaryngology team watched the procedure and awaited their part to begin. While rechecking the equipment they realized that some of the non-radiopaque equipment must be counted due to the

Courtesy K. MacDonald

Participants involved in debriefing event.

proximity of the sterile field to the mother's uterus.

At 0856 the baby's head and left arm were delivered while the right arm remained tucked inside the uterus. The obstetrical nurses pulled back to allow the otolaryngology surgeon to the bedside and the circulating nurse room to assist. This team immediately began with the bronchoscopy procedure. Other team members simultaneously hooked up a sterile saturation probe on the baby's left hand for the readings to be monitored. One obstetric surgeon called out perfusion from the cord to reassure the team. There were two quick looks with the bronchoscope to see if there was a small airway opening. There was none just tissue covering the airway.

The otolaryngology team proceeded to the tracheostomy procedure and worked quickly. The tracheostomy tube was placed and secured. Ventilations were performed for the baby with a sterile ambu bag as the trach was secured. The Obstetric team finished delivery of the baby at 0904 and baby was handed over to the neonatologist and the NICU team.

From 0905 newborn assessment and care took place on an over bed warmer. The baby was stabilized and otolaryngology continued their assessment with a flexible bronchoscope to visualize more of the airway defect. The tracheostomy table remained sterile in case any other intervention was required. The baby was transported to the NICU at 0930.

The obstetric team finished the required post-delivery procedure with the mother. Due to the inclusion of multidisciplinary surgical teams, and the EXIT procedure occurring in close proximity to the mother's incision, an x-ray was performed before transferring the mother to the stretcher. The mother emerged from anaesthesia and was extubated in the OR. She was speaking as she was transported to the Birth Unit for recovery. Everyone left the room, let out a huge sigh, and was so happy and excited to have performed a successful procedure.

Post Procedure Debrief

Debriefing offers an avenue for reflection, recognizing gaps in care, and giving clear feedback to the team.6 Approximately one week following the procedure the entire team met in the OR conference room to debrief this case. Following team introductions, the following videos from the OR camera were shown to the group:

1. Obstetrical team: Surgery up until the baby's upper body delivery;
2. Otolaryngology team: the bronchoscopy and the tracheostomy; and
3. Neonatal team: neonatal assessment.

Discussions at the debriefing session centered on these questions: How did the case go, how successful was the team, and were the directions clear?

The general consensus was that the case went well. Only two physicians had been involved with cases similar to this in other teaching centers. Both individuals stated it was when they were residents – one in otolaryngology and the other in anaesthesiology. Both individuals expressed that they felt the procedure at the IWK ran smoother and with a better outcome for the patient than the previous case on which they had worked. The team discussed that they believed the success of the

procedure was directly related to the preparations that had been made. Specifically, they felt the simulation, which took place the day before and involved all teams, was very beneficial in allowing the teams to work through many issues in advance.

The otolaryngology team was very happy reviewing the timing of the videos. It had taken less than 2 minutes to perform the bronchoscopy and less than 6 minutes to perform the tracheostomy. It was, needless to say, important to complete the procedures in a timely manner. The obstetrical team was pleased that they were able to control the bleeding from the uterus. The neonatal team was pleased that the baby stayed well perfused while the procedures were being performed. There were several teams involved and as each had their turn they had clearly been in charge and others gave them space and quiet.

Further discussion questions at the debriefing session included:
1. What were some of the challenges;
2. How could the team have been more effective; and
3. What were the favourite/least favourite aspects

Challenges discussed included the short light cord for the bronchoscopy. It was disappointing that the telescopic view from the bronchoscopy had not been recorded. This view had been broadcast to the conference room but was not recorded at that time. The biomedical team had been consulted during the simulation but were not asked to record the bronchoscopy intraoperatively. The team also felt there were too many people present on the neonatal team. Even though there were many people in the room there were many more staff/learners in the conference room so having someone designated to direct traffic in the OR had been a good plan.

Discussions on team function was positive as well. The team felt roles were very clear, each individual team worked well when it was their turn, and other teams respected the expertise of others, and everyone acted very professionally. There were leaders for each team and information was clearly stated and shared with all teams.

Feedback on favourite aspects from the otolaryngology team included the speed with which they were able to get the airway established. This team was, however, very disappointed not to have recorded video of the initial bronchoscopy. The anaesthesia and obstetrical teams cited their favourite aspect as how well the mother responded to required medication and how quickly she stabilized. The neonatal team was pleased with the baby's perfusion and glad that they were able to do their assessment so quickly. The neonatal team felt they had too many people on their team and would change that for future procedures.

CONCLUSION

This case provided an exceptional learning experience for four surgical teams that included more than 20 health care professionals at the IWK Health Centre. It was a unique learning opportunity as this was the first time the procedure had been performed at this centre. The team members' learning began when the proposed procedure was presented to the group

Courtesy K. MacDonald

Additional participants involved in debriefing event.

The steps involved to prepare for this case were extensive and included the sharing of literature with all involved.

and continued throughout the simulation, the procedure, and in to the debrief.

Marwan, A. & Crombleholme, T. (2006) noted "The EXIT procedure provides the surgeon with the luxury of transforming a potentially fatal neonatal emergency to a controlled clinical environment that is more likely to result in a better outcome"4

Former British Prime Minister and historian Sir Winston Churchill has been quoted as saying: "He who fails to plan, plans to fail". The planning required for this case was extraordinary and time consuming. It included multiple multidisciplinary team conferences and a simulation of the planned procedure.

The steps involved to prepare for this case were extensive and included the sharing of literature with all involved. The intraoperative experience, through the eyes of perioperative nurses at the IWK, was examined. The multidisciplinary debriefing session, which occurred days after the procedure, brought forward some very valuable information from and for all team members. Lessons learned from this debrief were also explored. If a case similar to this one comes up, in the future, the team felt it was extremely important to have pre-planning sessions including a simulation. Next steps discussed for other cases also included the importance of recording the bronchoscopy procedure.

Everyone involved was pleased to have been part of this team. Team members expressed that it was the planning and the inter-professional collaboration that led to the successful outcome for this mother and baby. The success of the procedure was measured by many factors such as the ability to control the mother's bleeding intraoperatively; the establishing of the airway in a very timely fashion; the ability of the neonatal team to assess the baby thoroughly and promptly; and the authority each team lead felt when it was their time to be in control in the Operating Room.

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