Getting Good Tone: Recent Lessons From the OR
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**Objectives:** Upon completion of this presentation, participants will obtain an overview of key aspects of the oxytocin dosing for achieving adequate uterine tone for patients undergoing Cesarean delivery (CD). This presentation will focus on recent and key literature for achieving optimal oxytocin dosing in patients undergoing pre-labor CD and in laboring patients undergoing intrapartum CD.

**Summary:** Uterine atony has been identified as leading cause of postpartum hemorrhage (PPH) in women undergoing CD. Population based studies indicate an apparent increase in PPH due to uterine atony. Oxytocin exposure during labor has been shown to be a significant independent risk factor for severe PPH due to uterine atony, which supports laboratory studies of oxytocin-receptor desensitization.

Oxytocin remains the first line agent for the prevention and management of uterine atony in women undergoing CD. However, there are inconsistent practices in oxytocin dosing during CD, which is supported by data from a recent survey of 391 lead anesthesiologists and obstetricians in the UK (Sheehan et al). In this survey, the majority (88%) of respondents use a 5 IU slow bolus and 12% of respondents using a 10 IU bolus; a wide variability in oxytocin infusions rates (3-20 IU/hour) for maintaining adequate uterine tone post-delivery was also reported.

Recent studies have investigated different dosing strategies (bolus, infusion, or bolus plus infusion) for the initiation and maintenance of adequate uterine tone during elective and non-elective CD.

Results of studies investigating oxytocin bolus dosing indicate that an oxytocin bolus less than 5 IU can initiate adequate uterine tone in patients undergoing elective and non-elective CD:

- **Elective Cesarean Delivery:** Carvalho et al. determined the ED90 (minimum effective dose) of oxytocin to be 0.35 IU (95% CI = 0.18 - 0.52 IU). Butwick et al. studied the effects of four different oxytocin bolus doses (0.5, 1, 3, and 5 IU) oxytocin boluses with a placebo group. In this study, the proportion of patients with adequate uterine tone at 2min after placebo and 0.5 IU oxytocin was high (73% and 100% respectively), thus the ED50 and ED95 for oxytocin could not be derived. Sartain et al. compared a 2 IU bolus vs 5 IU bolus, and observed no differences in uterine tone at 5, 10, 15 and 20 min after oxytocin dosing. The results of these studies indicate that adequate uterine tone can be achieved with an oxytocin bolus of < 3 IU during elective CD.

- **Non-elective Cesarean Delivery:** Balki et al. determined the ED90 of oxytocin during non-elective CD for labor arrest as 2.99 IU (95% CI = 2.32 – 3.67 IU). Thus a higher dose of oxytocin is needed to achieve adequate uterine tone for non-elective CD, which is in keeping with current knowledge of oxytocin receptor desensitization associated with labor.

Few studies have investigated oxytocin infusions for initiating or maintaining adequate uterine tone during CD. George et al. determined that the ED90 of an oxytocin infusion necessary to initiate adequate uterine tone during elective CD was 0.29 IU/min (95% CI = 0.15 – 0.43 IU/min). However nearly 18% of patients required additional uterotonics for achieving adequate uterine tone. Sarna et al. studied the effect of four different oxytocin doses (5, 10, 15, 20 IU) delivered as an infusion (1 IU/min) during elective CD, and observed no differences in uterine tone (assessed on a linear scale) between oxytocin groups.

Optimal oxytocin regimens for maintaining adequate uterine tone post-CD in women undergoing elective CD and non-elective CD remain uncertain. King et al. investigated the effects of a 5 IU oxytocin bolus + infusion (1.33 IU/min for 30 min followed by 0.04 IU/min for 8 hours) versus an identical oxytocin infusion without bolus post-CD in women with ≥ 1 risk factor for PPH. In the first 24 hr post-CD, the percentage of patients requiring additional uterotonics was similar in each group (29% vs 40%). Balki et al. compared blood loss with oxytocin (3 IU loading dose + maintenance infusion [2.4 IU/hr]) versus a combined oxytocin-ergometrine maleate regimen (identical oxytocin regimen + ergometrine (0.0375 mg loading dose + maintenance infusion [0.03 mg/hr]) during non-elective CD for labor arrest. The authors observed no significant differences in blood loss between groups (1218 mL vs 1299 mL respectively), although more women required additional boluses of study drug for inadequate uterine tone following oxytocin alone compared with oxytocin-ergometrine (21% vs 57% respectively).

**Key Points:**
1. Oxytocin (with initial ‘mini’ bolus dosing [0.5 IU – 3IU]) is advocated for initiating adequate uterine tone during elective Cesarean delivery, followed by a carefully titrated oxytocin infusion for maintaining adequate uterine tone.
2. Oxytocin dosing for initiating adequate uterine tone are higher for laboring patients requiring intrapartum CD than patients undergoing pre-labor CD.
3. Further work is needed to investigate optimal oxytocin regimens for maintaining adequate uterine tone during CD, and in the use of second line uterotonics (methylene, hemabate, misoprostol) for treating refractory uterine atony.

**Key References:**