

Gerard W. Ostheimer "What's New in Obstetric Anesthesia" Lecture

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BEGINNING in 1975, a review of the preceding year's medical literature relevant to obstetric anesthesiologists has been presented at the Annual Meeting of the Society of Obstetric Anesthesia and Perinatology. In 1995, the lecture was renamed in honor of Dr. Gerald Ostheimer. Dr. Ostheimer was a Boston obstetric anesthesiologist known for considerable contributions to research and education. The 2007 Ostheimer lecture was based on a review of medical literature published between January and December 2006, with the goal of identifying articles relevant to obstetric anesthesia practice. This year's review identified 1,637 articles in 52 journals in the field of anesthesiology and obstetrics (appendix).

The content areas covered by these articles included obstetric complications (25% of total), maternal coexisting disease (20%), fetal and neonatal disease (17%), labor analgesia (14%), anesthetic complications (4%), cesarean delivery anesthesia (3%), and miscellaneous topics (18%). Topical areas presented in 2006 included morbidity related to inflammation during pregnancy, genetic polymorphisms and outcomes, primary elective cesarean delivery and vaginal birth after cesarean trials, maternal obesity, global maternal health, reduction of multiple gestations with assisted reproductive technologies, and the recurring themes of preterm delivery and preeclampsia. The objective of this review of the 2006 literature was to present key articles published in the areas of maternal coexisting disease, labor analgesia, anesthesia for operative delivery, obstetric complications, anesthetic complications, and postpartum issues.

Maternal Coexisting Disease

Obesity

Obesity is now a public health issue in most developed countries. Ogden *et al.*,¹ in the *Journal of the American*

Medical Association, reported on obesity incidence among women of reproductive years. In this study by the Centers for Disease Control and Prevention, three biannual results between 1999 and 2004 of the National Health and Nutrition Examination Survey were compared. This population-based survey examines the health of a randomly sampled group of children between the ages of 2 and 19 yr and adults aged 20 yr and older, which represent the US population. Information was extracted from the study on women during reproductive years (12 yr and older). A graphic illustration of this data is presented in figure 1 and illustrates the impressive proportion of the female population within each age group who are defined as overweight or obese. Almost 30% of women 20 yr or older are obese, defined as a body mass index (BMI) of greater than 30 kg/m^2 . This proportion of the female population has seemed to stabilize during the 6 most recent years of survey examination. Perhaps the recent media attention on this disorder has increased the population's awareness to a level that will prevent further increases.

A study that specifically addressed the issue of obesity among the pregnant population was from Helms *et al.*² These investigators retrospectively studied the weight gain of almost 1.5 million parturients in North Carolina with singleton, term gestations between the years of 1988 and 2003. Excessive weight gain was defined as more than 40 lb gained during pregnancy. During the time period studied, the proportion gaining excessive weight increased from 15.5% in 1988 to 19.5% in 2003. A goal of the 2010 Healthy People Report, specifically goal 16-12, is to "increase the proportion of mothers who achieve a recommended weight gain during their pregnancies."† This study would suggest that this goal has not been achieved. Women with excessive weight gain were more likely to have macrosomic babies than the rest of the population (adjusted odds ratio, 1.9; 95% confidence interval [CI], 1.85–1.93) and had an increased risk of primary cesarean delivery (adjusted odds ratio, 1.5; 95% CI, 1.45–1.51).

Obese parturients are at increased risk for medical and obstetric complications during pregnancy, and there is evidence that anesthetic difficulties can arise for these patients as well. Technical difficulties with provision of neuraxial anesthetic techniques are well known, as are problems with ventilation after induction of general anesthesia. Recent research has focused on differences in anesthetic requirements for the obese population. In a study of analgesic requirements during labor, Panni and

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Received from the Department of Anesthesia, University of Toronto, Toronto, Ontario, Canada. Submitted for publication August 7, 2007. Accepted for publication January 11, 2008. Supported by the Department of Anesthesia, University of Toronto, Toronto, Ontario, Canada, and the Department of Anesthesia, University Health Network, Toronto, Ontario, Canada. Presented at the Gerald Ostheimer Lecture, Annual Meeting of the Society for Obstetric Anesthesia and Perinatology, Banff, Alberta, Canada, May 19, 2007.

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† US Department of Health and Human Services: Maternal, infant, and child health, Healthy People 2010. Washington, DC, US Government Printing Office, 2000:16.36. Available at: <http://www.healthypeople.gov/>. Accessed September 24, 2007.

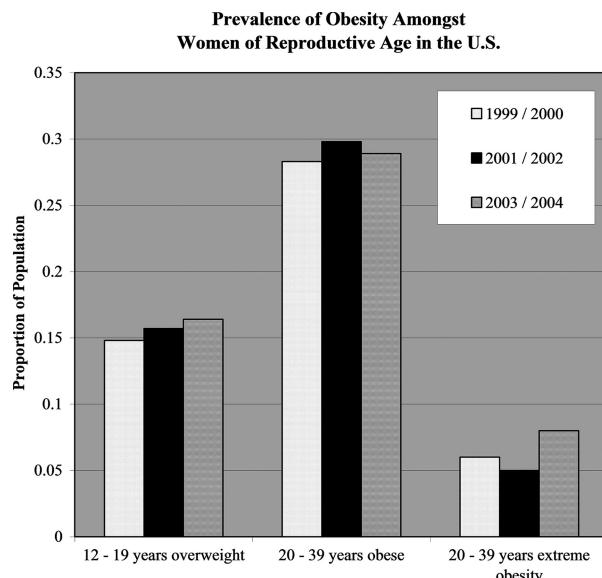


Fig. 1. The proportion of women in the US population who are overweight in teenage years (women between 12 and 20 yr of age with body mass index \geq sex-specific 95th percentile), adult women older than 20 yr who are obese (body mass index $\geq 30 \text{ kg/m}^2$), and adult women older than 20 yr who are extremely obese (body mass index $\geq 40 \text{ kg/m}^2$) during each National Health and Nutrition Examination Survey between 1999 and 2004. Data are from Ogden *et al.*¹

Columb³ determined the minimum local anesthetic concentration (MLAC) of bupivacaine. Women were placed into one of two groups based on BMI: a BMI of 30 kg/m^2 or less or a BMI of greater than 30 kg/m^2 . The women studied were at term gestation, in established labor, requesting labor epidural analgesia. They received a specific bupivacaine concentration for initiation of labor analgesia depending on the previous woman's success. Success was defined as a reduction of visual analog pain score of 10 mm or less (out of 100 mm) within 30 min of epidural initiation. The study used an up-down sequential allocation technique to determine the MLAC of bupivacaine for both groups. The MLAC for obese women was reduced by 41% compared with women with a BMI of 30 kg/m^2 or less (bupivacaine MLAC BMI $>30 \text{ kg/m}^2$: 0.067% [95% CI, 0.048–0.086%]; bupivacaine MLAC BMI $\leq 30 \text{ kg/m}^2$: 0.113% [0.108–0.118%]). Despite a reduction in local anesthetic concentrations, the upper extent of sensory block to ice was found to be higher in the obese group (BMI $>30 \text{ kg/m}^2$: T8 [25th–75th quartile, T6–T10]; BMI $\leq 30 \text{ kg/m}^2$: T10 [T10–T12]). It seems that there is a greater distribution of epidural local anesthetic in the obese parturient, because the pain scores at time of request were no different between the groups. The appreciation of altered epidural anesthetic requirements for labor in the obese parturient needs to be incorporated into our clinical plan for this group.

Cardiac Disease

The latest Confidential Enquiries into Maternal Deaths has reported that cardiac disease is now the most com-

monest cause of maternal death.⁴ Ischemic heart disease has been responsible for approximately 30% of Confidential Enquiries cardiac deaths reported between 1991 and 2002. Two studies, one from the United States and one from Canada, report on population-based estimates of the incidence of myocardial ischemic disease among pregnant women.^{5,6} The incidence rate for this disease was described as 6.2 per 100,000 deliveries in the United States and 1.1 per 100,000 women delivering in Canada. The difference between each country's rates may be attributable to differences in ascertainment of cases. The American study identified myocardial ischemic disease into the postpartum period, whereas the Canadian study only identified cases among women admitted to hospital for delivery. Both studies documented similar maternal case fatality rates (United States: 6.2%; Canada: 1.8%) and identified similar maternal factors associated with ischemic events (maternal age >30 yr, hypertension, and diabetes). Although this disease is a rare event, the combined number of maternal deaths from arterial events, including ischemic heart disease and aortic dissection, almost exceed that of maternal deaths due to venous thromboembolism. In the latest Confidential Enquiries into Maternal Deaths in the United Kingdom, 31 women died due to myocardial ischemia, cerebral ischemia, or aortic dissection, compared with 33 women with deaths from pulmonary embolism.⁴ Considerable attention has been given to reducing deaths due to venous causes, and the same initiative should be applied to the early recognition and therapy for arterial events.

Peripartum cardiomyopathy developing within the last months of pregnancy or within the first 6 months after delivery has been closely studied in a unique population on the island of Haiti.⁷ Fett *et al.*⁷ prospectively followed up 99 women with peripartum cardiomyopathy and documented the effect of further pregnancies on their cardiac function. Fifteen of 99 women became pregnant again, with only 1 of the 15 women regaining normal ventricular function before the subsequent pregnancy. More than 50% of the women (8/15) had a decline of ventricular function during the subsequent pregnancy. Within this group, mean estimates of left ventricular ejection fraction at 1 yr from the index pregnancy were 38% and declined to less than 30% at 4 yr. However, the 7 of 15 women who did not have a deterioration of heart function in the subsequent pregnancy eventually regained normal left ventricular function after delivery. The time to normal ventricular function was not limited to the first 6–12 months but continued out for several years. Although these findings are in contrast to previous descriptions of the natural order of the disease, their generalization to populations outside Haiti needs to be confirmed.

Labor and Analgesia

Complementary Medicine Techniques

Labor analgesia was the most common topic studied in 2006 in obstetric anesthesia literature. There were contributions that refined systemic, neuraxial, and nonpharmaceutical techniques of labor analgesia. Published in the Cochrane Library collection of evidence-based literature was a systematic review of complementary and alternative therapies for pain management in labor.⁸ This meta-analysis of 14 studies evaluated the efficacy of acupuncture, acupressure, audioanalgesia, aromatherapy, hypnosis, massage, and relaxation for labor analgesia. Only two therapies were found to be beneficial, acupuncture and hypnosis. Two randomized studies involving acupuncture compared with no treatment found a 30% reduction (95% CI, 0–51%) in the use of further pharmacologic therapies, but maternal satisfaction seemed to be no different. Hypnosis was shown to reduce use of epidural analgesia by 70% among 520 women randomly assigned to hypnosis or supportive psychotherapy in the United States. These two particular therapies require advance planning for parturients to make them available at the time of their labor and delivery.

Epidural Analgesia for Labor

Discussion of epidural analgesia for labor often takes place with patients in the antenatal setting; however, the consent for the procedure is obtained just before administration in labor. Anesthesiologists with an interest in obstetric anesthesia were surveyed about the risks they discussed with patients in the antenatal setting compared with during labor.⁹ Approximately 60% of the Obstetric Anesthesia Special Interest Group of the Australian and New Zealand College of Anesthetists responded to the survey, and the top five risks presented before or during labor respectively were post-dural puncture headache (96/86%), epidural block failure (93/78%), permanent neurologic injury (90/78%), leg weakness (79/68%), and hypotension (78/63%). The survey also included questions on the complication rates quoted to the patient, and these were often inaccurate compared with the published rates. An excellent summary table is included in the article, which incorporated the published rates of the 20 mentioned possible anesthetic risks.

Several articles addressed technical aspects of neuraxial anesthetic delivery systems. Wong *et al.*¹⁰ evaluated the differences between administering the hourly background epidural solution as a continuous infusion or as two quick boluses during the same time period, among multiparous women undergoing induction of labor in a randomized, double-blind study. The primary outcome was the dose of bupivacaine consumed per hour, as well as secondary outcomes of patient satisfaction, labor pain

scores, number of and delivery of patient-controlled epidural analgesia (PCEA) requests. After the initiation of analgesia with a combined spinal–epidural technique (CSE), parturients receiving epidural boluses of 6 ml every 30 min consumed less bupivacaine (median, 10.5 mg/h; 95% CI, 9.5–11.8 mg/h) than women receiving a background bupivacaine infusion of 12 ml/h (median, 12.3 mg/h; 95% CI, 10.5–14.0 mg/h). Of interest, this increase in consumption was most significant among women with longer labors. Patient satisfaction was higher with the scheduled boluses and perhaps reflected the ability of this technique to better distribute the solution through the epidural space. Unfortunately, at the current time, pump technology cannot provide scheduled intermittent boluses in addition to the patient-controlled demand bolus.

Lim *et al.*¹¹ reported another adaptation of epidural delivery pump technology. Their center has developed a computer-integrated PCEA system (CI-PCEA) that controls background infusion rates depending on the previous hour's demand boluses. This randomized trial compared a standard PCEA technique of 0.1% ropivacaine with fentanyl administered as bolus-only by patient demand to the CI-PCEA technique that initiated an infusion algorithm with changing infusion rates depending on demand boluses. Despite patients with the CI-PCEA technique receiving background infusions, the hourly consumption of ropivacaine was no different from that of the standard group (mean PCEA bupivacaine consumption of 7.2 [SD 2.6] mg/h compared with mean CI-PCEA 7.9 [SD 2.9] mg/h). Patient satisfaction was statistically greater using the CI-PCEA system; however, both groups seemed satisfied with their experience (mean visual analog scale for satisfaction with PCEA 86 [SD 11] compared with CI-PCEA 93 [SD 7]). These two studies illustrate that there is room for improvement in administering epidural medication, especially for women with prolonged labors.

Finally, to add to the literature of epidural analgesia and its effect on the progress of labor is a randomized trial by Ohel *et al.*,¹² who evaluated 449 nulliparous term women in early labor. These women, at the time of request for epidural analgesia, were assigned to either immediate initiation of epidural analgesia or a delay until cervical dilatation of 4 cm. The method of delivery was not different between the groups, with the incidence of spontaneous delivery being 70% in both, instrumental vaginal delivery being 17% (early epidural) and 19% (late epidural), and cesarean delivery being 13% (early) and 11% (late). The question is whether this population's results are generalizable to North America, where the cesarean delivery rates for nulliparous women in spontaneous labor are greater than 10–20%. Differences may exist between the study population and North America on variables such as the mean age of the study population (which was not given), mean fetal weights (ex-

Table 1. Maximal Sensory Block Using Ice

Study Population	Anesthetic Technique	
	Combined Spinal-Epidural	Single-shot Spinal
Median (interquartile range) sensory block of cold using ice in women for elective cesarean delivery not in labor	C6 (C5–C8)	T3 (T2–T4)
Median (minimum–maximum) sensory block of cold using ice in women for emergency cesarean delivery in labor	T3 (C7–T4)	T3 (T1–T6)

Data are from Lim *et al.*¹⁴ and Bray *et al.*¹⁵

cluded from the study were individuals with a fetal weight estimated greater than 4.0 kg), and incidence of high-risk pregnancies. The potential interaction between these variables and epidurals and cesarean delivery rates is not known.

Anesthesia for Cesarean Delivery

Combined Spinal-Epidural Technique

Several articles addressed the use of CSE for cesarean delivery anesthesia.^{13–15} Two randomized trials examined the anesthetic sensory spread of intrathecal local anesthesia when given through a CSE needle as compared with a single-shot spinal technique.^{13,14} One of two randomized trials examined women not in labor¹³ and the other women in labor.¹⁴ In both studies parturients received intrathecal 10 mg hyperbaric 0.5% bupivacaine in the lateral position through either a CSE technique using loss of resistance to air and immediate removal of needles or a single-shot spinal technique. The maximal sensory level was determined using loss of cold to ice with results for both studies, shown in table 1.

The investigators discovered that block height differed between the two needle techniques only among women not in labor. For women not in labor, the CSE technique's final block height was almost five segment levels higher than the single-shot spinal. The time taken to reach the maximal sensory block height was also longer in the CSE group (mean 7.5 ± 4.5 min compared with 4.6 ± 2.8 min in the single-shot spinal group). Among laboring women, the two anesthetic techniques did not demonstrate a difference in block levels. The authors postulated that labor increases the epidural space pressure above atmospheric pressure and minimizes the effect the loss of resistance technique has on changing intrathecal spread of local anesthetic drugs. The CSE technique is particularly useful when difficulties are anticipated in finding the epidural or spinal space; however, it seems that anesthesiologists must take into account whether a woman is in labor to determine the dose of local anesthetic chosen.

In another study, Bray *et al.*¹⁵ examined the hypothesis that sequential CSE anesthesia for cesarean delivery is a superior method to maintain cardiovascular stability

than single-shot CSE anesthesia. Sequential CSE anesthesia is the administration of a small dose of intrathecal drug, followed by epidural top-ups until adequate block levels are achieved. The degree of cardiovascular stability was studied in 49 women scheduled to undergo elective cesarean delivery using a suprasternal Doppler estimate of cardiac output. The Doppler estimate is based on evaluation of ascending aortic blood flow. Women who were randomly assigned to the sequential CSE group had lower median maximum sensory levels than women with the standard CSE technique (T5 compared with T3); however, there were no differences in the cardiac output, stroke volume, or systolic blood pressures between the two groups. In both groups, mean systolic blood pressure was reduced from baseline after 20 min, and cardiac output increased 10 min after introduction of spinal anesthesia. The time taken to achieve satisfactory anesthesia was longer in the group receiving sequential CSE anesthesia, and this group required more epidural top-ups.

Spinal Anesthesia

Spinal anesthesia-induced hypotension during cesarean anesthesia is a frequent topic of research because of its predictable occurrence and ever-increasing cesarean delivery rates. Advances in the understanding of autonomic nervous system function, specifically the balance between sympathetic and parasympathetic functions, has led to using heart rate variability analysis to predict the development of spinal induced hypotension. Differences between individuals' autonomic nervous systems may explain the variability in the incidence of hypotension and may highlight individuals at increased risk for hypotension. In a randomized study using preoperative heart rate variability analysis before elective cesarean delivery, Hanss *et al.*¹⁶ hypothesized that women with increased low-to-high frequency (LF/HF) ratios would benefit from preoperative prehydration or prophylactic vasopressors before spinal anesthesia.

Sixty-three women with LF/HF ratios of greater than 2.5 received either a standard anesthetic or prophylactic fluid or vasopressor around administration of spinal anesthesia for elective cesarean delivery. Fluid therapy consisted of a variable amount of 6% 130/0.4 hydroxyethyl starch up to 1,500 ml before spinal anesthesia or infu-

sion of vasopressor therapy immediately after induction of spinal anesthesia. Ninety percent of women receiving standard anesthetic care with high LF/HF ratios had hypotensive episodes, compared with 15% receiving colloid therapy prespinal and 5% receiving prophylactic vasopressor therapy. Interestingly, the group receiving prespinal colloid therapy had their LF/HF ratios reduced to a target ratio of less than 2.5. This particular technology required 5-min recordings around each event and was analyzed using fast Fourier transformation. Assessment of an individual's LF/HF ratio seems to be an increasingly feasible preoperative test, especially for delivery units with high cesarean delivery rates and spinal anesthesia.

General Anesthesia

Although the frequency of use of general anesthesia for cesarean delivery is diminishing, the patients who require or receive general anesthesia tend to be those with significant medical issues. Several articles provided evidence for managing the rapid-sequence induction technique, with particular attention toward those with hypertension. Among a nonpregnant hypertensive study population, Alanoglu *et al.*¹⁷ examined the hemodynamic effect of modifying induction agents used for rapid sequence induction. The agents that were evaluated were lidocaine or remifentanil, which were given in addition to the standard thiopental and succinylcholine induction technique. The use of 1.5 mg/kg lidocaine in addition to thiopental and succinylcholine did not prevent increases in mean arterial blood pressure or heart rate at intubation and 3 min after intubation. However, the addition of 1 µg/kg remifentanil did prevent the hemodynamic changes at intubation and for the following 3 min.

The use of remifentanil in obstetrics has been expanding, including its use for intravenous patient-controlled analgesia during labor and anecdotal reports of its use during general anesthesia. In a randomized, double-blind study by Ngan Kee *et al.*,¹⁸ an intravenous remifentanil bolus was compared with placebo during general anesthesia induction for elective cesarean delivery in 40 women. The standard induction group received 4 mg/kg thiopental, succinylcholine, and placebo, whereas the remifentanil group received 1 µg/kg remifentanil in addition to the thiopental and succinylcholine. Serial changes in mean arterial pressure, systolic blood pressure, and heart rate were greater in the standard therapy group, especially between 0 and 7 min after induction. An important concern was raised regarding the effect of remifentanil on the fetus and neonate because it readily crosses the placenta. Two neonates in the remifentanil group required naloxone administration because of poor respiratory effort at birth, as compared with none in the standard induction group. It seems that remifentanil may

be useful to maintain maternal cardiovascular stability at induction and intubation, but individuals should be immediately available to provide neonatal resuscitation therapy at delivery.

Obstetric Complications

Hemorrhage

Approximately 4% of all reviewed articles in 2006 were concerned with maternal hemorrhage, a problem of maternal morbidity in developed countries, and maternal mortality in developing countries. Two articles specifically dealt with improving hospital systems' handling of obstetric hemorrhage.^{19,20} In one of the most thoughtful examinations of hospital system issues after two maternal deaths due to hemorrhage, Skupski *et al.*¹⁹ instituted a multidisciplinary approach to hemorrhage including seven system changes. Their changes included establishment of an obstetric rapid response team that has quarterly drills, implementation of clinical pathways to identify patients at high risk early and protocols to streamline care during emergencies, separating duties of obstetrics and gynecologic emergencies to avoid neglect of either patient, increased responsibilities of in-house obstetricians for all patients, improved lines of communication between all levels of providers, and involvement of trauma team members in cases of severe hemorrhage. Many of their system changes could be incorporated into current labor and delivery units to improve coordination of involvement between obstetric, anesthesia, nursing, and critical care services.

A unique study quantified the inaccuracies in our estimation of obstetric blood loss.²⁰ Bose *et al.*²⁰ recreated 12 common obstetric hemorrhage scenarios using out-of-date packed erythrocyte units and assessed the accuracy of anesthesia providers, obstetricians, nurses, midwives, and healthcare assistants in estimating the blood volume. All types of healthcare providers tended to underestimate the blood loss of the scenarios (5 of 12 stations with statistical underestimates), and no scenario was consistently overestimated. Anesthesiologists were the most accurate estimators of all providers, but were more likely to overestimate loss by 4%. Visual depiction of the 12 scenarios were thought to be helpful reminders to healthcare providers in estimating overall blood loss and were recommended for posting within labor and delivery units.

With the introduction of factor VIIA into clinical use, anecdotal reports have arisen with its use during catastrophic obstetric hemorrhage. Sobieszczyk *et al.*²¹ report on the use of factor VIIA in 25 obstetric cases as reported to a European Internet-based registry between 2001 and 2003. This collection represents the largest series to date in obstetric patients. The majority of the cases followed cesarean delivery, and the use of factor VIIA often accompanied other lifesaving therapies, in-

cluding surgical vessel ligation and antifibrinolytic medications. The median dose used was 32 µg/kg (range, 10–137 µg/kg), and most women (20/25) received a single dose. The morbidity associated with factor VIIA use could not be quantified from the limited number of patients exposed, and only 1 patient had an increase in bleeding after its use. This patient was significantly acidotic at the time of its administration, a condition that is reported to reduce the effectiveness of factor VIIA. Two of the 25 patients died of multiple organ failure, neither directly related to the use of factor VIIA. This particular series provided detailed information on the 25 cases and would be an excellent reference for units considering making this product available as a “last-resort” therapy.

Preeclampsia

Pregnancy induced hypertension was the content topic of approximately 7% of the 2006 articles. Three well-known authors in the field, Belfort, Clark, and Sibai,²² collaborated on an excellent review of the cerebral consequences of preeclampsia. The normal physiologic changes of the cerebral circulation during pregnancy include an increase in cerebral perfusion pressure through the gestational period, but with minimal increases in cerebral blood flow. Cerebral autoregulation is an important factor in maintaining cerebral blood flow in a narrow range despite increases in cerebral perfusion pressure. However, with preeclampsia, the increase in cerebral perfusion pressure requires increasing cerebral resistance to protect against overperfusion. Autoregulation in preeclamptics is generally intact; however, the shear force on proximal cerebral vasculature can lead to development of vasogenic edema, failure of cerebral autoregulation, and overperfusion of distal capillaries. Any one of these abnormalities can be associated with the development of eclampsia. Rarely will vasospasm result before development of seizure; however, it is always present after seizures. Therefore, the authors concluded that most preeclamptic women would benefit from agents that reduce cerebral perfusion pressure and maintain cerebral flow. A small subset of preeclamptic patients with cerebral ischemia will require cerebral vasodilators, such as calcium channel blockers.

The authors discuss the merits of two agents, magnesium sulfate and labetalol, in reducing cerebral perfusion pressure. Magnesium sulfate was shown in the Magpie study to reduce the incidence of seizure activity among preeclamptics from 3% to 1%.²³ However, magnesium sulfate requires parenteral administration and has significant toxicities and side effects that require logistical planning to ensure safe administration. Labetalol is available in an oral formulation, making it potentially more available to developing countries. It seems, in preliminary studies, to be effective in reducing cerebral perfusion pressure by decreasing systemic arterial pressures,

and yet will maintain cerebral perfusion and uteroplacental perfusion. The authors are attempting to clarify differences between the two agents with the conduct of a multicenter, randomized study (Labetalol vs. Magnesium Sulfate for the Prevention of Eclampsia Trial [LAMPET]). Anesthesiologists await the final choice of prevention therapy. Magnesium sulfate is associated with numerous side effects and interactions with anesthetic agents. Labetalol is a familiar agent to anesthesiologists and should be easy to adopt into practice.

Anesthetic Complications

Anesthetic complications in obstetrics can occur with the use of conscious sedation, regional anesthetic, or general anesthetic techniques. Three articles were pertinent to our practice in obstetric anesthesia, that involving regional anesthesia and the use of local anesthetics. Ruppen *et al.*²⁴ from the United Kingdom reported on neurologic complications of obstetric epidural anesthesia after a systematic review of observational studies. This article provides a succinct estimation of risk for obstetric anesthetic providers, with the information summarized in table 2. More than 1.37 million women were included in the 27 studies, with some variability in results depending on the size of the study (> or <10,000 women studied) and the year of publication (before or after 1990).

Although case reports and animal scientific studies are considered less significant evidence on which to base changes in clinical practice, two of these articles provided valuable information on the use of lipid emulsion to treat bupivacaine-induced cardiac arrest.^{25,26} Despite the increasing use of low-concentration local anesthetics for labor analgesia, the majority of cesarean deliveries are still performed during epidural anesthesia and therefore require large volumes of high-concentration local anesthetics. Rosenblatt *et al.*²⁵ reported on the first successful resuscitation of a nonobstetric patient from bupivacaine/mepivacaine toxicity secondary to an interscalene block injection. The patient received immediate advanced cardiac life support efforts, including intubation, epinephrine, amiodarone, vasopressin, and multi-

Table 2. Incidence of Neurologic Complications in Obstetric Patients

Outcome	No. of Studies	Individual Risk, 1 in	Per 1,000,000
Epidural hematoma	8	183,383	5
Deep epidural infection	13	109,882	9
Persistent neurologic injury	9	256,979	4
Transient neurologic injury	15	3,887	257
Transient + unknown injury	21	4,343	230

Data are from Ruppen *et al.*²⁴

ple defibrillation attempts. While preparing for the institution of cardiopulmonary bypass, 100 ml lipid emulsion, 20%, was administered through a peripheral intravenous catheter, followed by a lipid emulsion infusion. The patient had return of a perfusing sinus rhythm and experienced no permanent neurologic sequelae.

The postulated mechanism of lipid emulsion's protection includes removal of bupivacaine into the lipid phase or inhibition of bupivacaine's interruption of fatty acid transport into cardiac mitochondria. Weinberg *et al.*²⁶ examined the reduction of bupivacaine concentrations in rat cardiac tissue with the administration of lipid. Two series of isolated rat hearts were exposed to toxic bupivacaine infusions, with predictable development of asystole, and then followed until recovery of normal function. The rat hearts that received lipid emulsion had 30% faster recovery to time to first heartbeat compared with controls. As well, bupivacaine washout times were increased in the lipid group compared with controls, and cardiac bupivacaine content was one third of controls. The recommendation by Weinberg, the current leading expert in the field, is to treat bupivacaine toxicity events with supportive care as well as to administer 1 ml/kg lipid emulsion intravenous bolus, 20%, followed by $0.25 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ infusion until hemodynamic stability returns.

Postpartum Issues

Analgesia

The involvement of obstetric anesthesiologists in the postdelivery period began with the addition of long-lasting, hydrophilic narcotics such as morphine and hydromorphone to our operative neuraxial anesthetics. The interest in postpartum analgesia has further developed with novel analgesic techniques being investigated and researchers evaluating preoperative predictors for severe postdelivery pain. The use of analgesia techniques other than regional after cesarean delivery has been largely confined to local anesthetic infiltration of the wound, patient-controlled intravenous analgesia, and oral analgesics including nonsteroidal inflammatories. Ranta *et al.*²⁷ introduced another analgesic technique, that of an incisional, subfascial catheter with intermittent local anesthetic boluses. In this randomized, double-blind study, analgesia provided by a subfascial catheter was compared with intermittent epidural local anesthetic boluses in 40 low-risk women after cesarean delivery. In the initial hours after surgery, women in the epidural group had average numerical pain scores less than the subfascial group (1.8 vs. 3 out of 10), but after this point, the two groups were no different with regard to pain scores at rest and at walking and total narcotic rescue doses used. This 22-gauge multiorifice catheter

can be placed by obstetric staff at the conclusion of surgery and is indicated when epidural or spinal postpartum analgesia is unavailable.

Severe postoperative pain has been associated with the development of chronic pain, and thus identifying the individual at risk for severe pain or increased analgesic requirements preoperatively would be particularly attractive. Pan *et al.*²⁸ have contributed to our understanding of predicting post-cesarean delivery pain and analgesic drug use in examining physical and psychological traits of individuals before surgery. The women enrolled in this prospective study were evaluated 2 weeks before cesarean delivery for six potential predictive factors, including thermal pain and unpleasantness ratings, preoperative blood pressure, preexisting pain during pregnancy, expectation of postoperative pain, thermal pain threshold, and intraoperative surgical conditions. The different pain outcomes, including resting pain, pain on movement, composite pain score, intraoperative analgesia, recovery room analgesia, and total analgesia, were best predicted by a combination of factors rather than any single factor. However, less than 30% of variability in pain outcomes was explained by the predictive factors. It will be interesting to follow these researchers in their refinement of these techniques, which may become part of future preoperative evaluation techniques.

Postpartum Problems in the Developing World

This year contained an extraordinary number of articles devoted to improving health for pregnant women throughout the world.²⁹⁻³³ Although many women in developing countries still die during labor and delivery, their plight often does not end with delivery. In a moving article by Lewis Wall,³⁴ the problem of obstetric vesicovaginal fistulas was described. The burden is overwhelming with as many as 130,000 new cases predicted to occur annually in the developing world. The development of an obstetric fistula is related to an obstructed labor in a woman without access to emergency obstetric services. However, lack of access to services is only one of many factors contributing to this problem. In many developing countries, the low socioeconomic position of women in society encourages their early marriage, before the completion of pelvic growth. With the increased incidence of cephalopelvic disproportion during pregnancies occurring at young ages, the women are left after an obstructed labor with the consequences of fetal death, urinary and fecal incontinence, and isolation from family and community, which all spiral into continuing poverty and premature death. The challenges are to initiate changes at the many levels that this problem occurs, and to not turn our back on this part of the world.

The authors thank their research coordinators for their invaluable assistance: Kristi Downey, B.Sc., M.Sc., and Leda Weiss, B.Sc., M.Sc. (Anesthesia Research Coordinators, Department of Anesthesia, Mount Sinai Hospital, Toronto, Ontario, Canada).

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Appendix: Journals Searched for Ostheimer "What's New in Obstetric Anesthesia" Lecture

Anesthesia Journals

- Acta Anaesthesiologica Belgica
- Acta Anaesthesiologica Scandinavica
- Anaesthesia
- Anaesthesia and Intensive Care
- Anesthesia & Analgesia
- ANESTHESIOLOGY
- Anesthesiology Clinics of North America
- ASA Newsletter
- British Journal of Anaesthesia
- Canadian Journal of Anesthesia
- Current Opinion in Anaesthesiology
- European Journal of Anaesthesiology
- International Journal of Obstetric Anesthesia
- Journal of Clinical Anesthesia
- Obstetric Anesthesia Digest
- Regional Anesthesia and Pain Medicine

Obstetric Journals

- Acta Obstetrica et Gynecologica Scandinavica
- American Journal of Obstetrics and Gynecology
- Australian and New Zealand Journal of Obstetrics and Gynaecology
- Clinical Obstetrics and Gynecology
- Current Obstetrics and Gynecology
- Current Opinion in Obstetrics and Gynecology
- European Journal of Obstetrics & Gynecology and Reproductive Biology
- Fertility and Sterility
- Gynecologic and Obstetrical Investigation
- International Journal of Gynecology and Obstetrics
- Journal of Maternal-Fetal and Neonatal Medicine
- Journal of Perinatology
- Obstetrical and Gynecological Survey
- Obstetrics and Gynecology
- Obstetrics and Gynecology Clinics of North America

Pediatric Journals

1. Journal of Pediatrics and Child Health
2. Journal of Pediatrics
3. Pediatrics

General Journals

1. American Journal of Epidemiology
2. Annals of Internal Medicine
3. BMJ
4. British Journal of Haematology
5. Circulation

6. Cochrane database
7. Critical Care Medicine
8. European Heart Journal
9. Heart
10. Journal of the American Medical Association
11. Journal of American College of Cardiology
12. Journal of Clinical Epidemiology
13. The Lancet
14. Morbidity and Mortality Weekly Report
15. Nature
16. New England Journal of Medicine
17. Science