

Online Supplement to Methods Section:

The cost-analysis of providing neuraxial anesthesia for a single ECV attempt was conducted using a previously published computer simulation decision cost model.¹ This cost model was originally developed to determine the cost effectiveness of ECV for the management for breech presentation. The model was then adapted for the current study to calculate the amount (in 2010 U.S. dollars) that would be saved or further spent with neuraxial anesthesia to facilitate ECV success.

This computer-based decision tree model factors for various outcomes following ECV, and determines associated expected costs from a societal perspective. Each decision pathway incorporates further possible clinical outcomes as a result of a previous decision. Possible outcomes included in this model were probability of success of ECV, probability of spontaneous reversion to breech position prior to delivery following successful ECV, mode of delivery, need for unanticipated emergency cesarean delivery and adverse outcome from emergency cesarean delivery. Costs to society were incorporated into the model for each possible outcome following trial of ECV and therefore captured the total expected cost of delivering a term singleton breech fetus. Three modes of delivery were considered possible including vaginal, scheduled cesarean or emergency cesarean delivery (Figure 1).

Model Probabilities

Success rates of first attempt ECV with and without anesthesia were obtained from published reports identified in a systematic literature review. The literature review was undertaken in accordance with the Preferred Reporting Items for Systematic reviews and Meta-

Analyses (PRISMA) guidelines.² We identified literature written in English between January 1980 and September 2010 using the terms “anaesthesia or anesthesia or neuraxial or analgesia or extradural or spinal or epidural or intrathecal” and “external cephalic version or ECV or version” in the Cochrane, EMBASE, Medline and Web of Sciences databases. Included studies were those which examined success rates of first attempt ECV with neuraxial (spinal, epidural or combined spinal-epidural) analgesia or anesthesia. Only published randomized, controlled studies were considered and data from posters, abstracts, letters, retrospective trials, case reports, and unpublished data were not reviewed. No minimum sample sizes were required for inclusion of studies. We supplemented the search with a manual review of references from the retrieved articles. After combining the results of the electronic searches, and removing duplicate records and abstracts, each author (PS and BC) independently screened the unique records. Any disagreements about the eligibility of a study were resolved by discussion.

ECV success was defined as vertex presentation confirmed by ultrasound immediately following ECV. The quality of the studies were assessed using the Jadad Scale, a scoring system that examines the withdrawals, blinding and randomization of a study.³ Neuraxial techniques (spinal, epidural, combined spinal-epidural) were grouped into one studied intervention. We identified six randomized controlled studies (Table 4) from the systematic literature review described above.⁴⁻⁹

Other outcome probabilities included in the model in addition to ECV success were similarly determined from a review of the literature published in Medline, Cochrane and Up-to-Date, in addition to a manual review of the references. Details of outcome probabilities included in our model are previously published.¹ The probability (and ranges) of other outcomes considered in our model included spontaneous reversion to breech presentation 6% (3-10%),

requirement for cesarean delivery after successful ECV 27% (9-30%), post-dural puncture headache 1% (0-2%), successful second trial of ECV 51% (17-71%), need for emergency cesarean delivery 0.35% (0-1%) and adverse outcome from emergency cesarean delivery 1% (0-1%).^{1,10}

Cost Determinations

Costs rather than charges as they appear on a hospital bill were used for the economic modeling and analyses because charges do not capture the actual economic consequences of an event. From a societal perspective this is in accordance with recommendations by the U.S. Panel on Cost-Effectiveness in Health and Medicine.¹¹

The total cost of ECV with and without neuraxial anesthesia was determined from the sum of the hospital cost, the professional cost of the obstetrician and anesthesiologists' service, and the cost of the mother's time from a missed day of work (based on a 2010 U.S. Census Bureau's mean income for a female worker). We assumed the cost of a mother's missed day of work was an estimate of the opportunity cost of a mother participating in a procedure or hospital stay. Point estimates of expected duration of procedure and length of stay were obtained from the U.S. Department of Health and Human Services Healthcare Cost and Utilization Project data.¹² The calculated values were similar to previous studies.¹³⁻¹⁵ Cost estimates of ECV were determined by summing the cost of the individual components of the procedure. Physician professional costs were determined using the Current Procedural Terminology (CPT) codes reimbursed at the 2010 Medicare rate without geographic adjustment. Medicare rates to estimate the cost of physician services is the most common method used in health services research.^{12,14-16} The cost of obstetrician's service was determined using CPT 59412 (External Cephalic Version);

the physician service costs were obtained using CPT 59590 (routine obstetric care including antepartum care, cesarean delivery, and postpartum care); the cost of the anesthesiologist's service during ECV was derived using the American Society of Anesthesiologists Relative Value System (base of 4 units of care for the first hour and 1 unit/hr for the subsequent); and the mean cost of a mother's time for the procedure and subsequent recovery was estimated at \$115 (mother's missed day of work) using U.S. Census data.

Cost of complications due to procedures related to ECV and delivery were also incorporated into the model. Complications factored into the model included post-dural puncture headache following a neuraxial technique, need for emergency delivery following ECV and subsequent maternal and neonatal intensive care. In the event of a post-dural puncture headache, the cost for final treatment was estimated as the need for an epidural blood patch. We assumed that post-dural puncture headaches were fully resolved following a single epidural blood patch. The cost of an adverse outcome due to an emergency cesarean delivery was also included in the analysis to capture the cost of a rare but highly expensive event. The cost of complications secondary to emergency cesarean delivery was estimated as maternal hospitalization of an additional day with neonatal intensive care monitoring. Our costs, however, assumed that maternal and neonatal morbidities resulted in successful resolution without subsequent complication. One-way and multi-way sensitivity analyses were conducted on the costs for ECV with and without neuraxial anesthesia. Sensitivity analysis varied the probability of spontaneous reversion, breech vaginal delivery, emergent cesarean delivery, cesarean delivery for other indications and costs (ECV, hospital, staff, services and supplies) by $\pm 10\%$ to determine these parameters impact on our final model's ECV cost results.

Monte-Carlo Probabilistic Simulation Sampling and Cost-Analysis Modeling

Point estimates for costs described above and point estimates and ranges (i.e. minimum, likely and maximum data points) for all outcome probabilities outlined above were computed into TreeAge Pro 2010 software (*Tree Age Software, Inc., Williamstown, MA*). The base case for ECV was determined utilizing cost and probability outlined in our previously published computer simulation decision ECV cost model.¹ Point estimates (mean) and ranges for ECV with and without neuraxial anesthesia were derived from published ECV success rates (Table 4). To determine expected costs, we conducted Monte Carlo simulations using probabilistic sensitivity sampling with 1000 iterations for ECV with neuraxial anesthesia and 1000 iterations for ECV without anesthesia. We first demonstrated the distribution of costs for each strategy (ECV with or without anesthesia) separately using the TreeAge probabilistic sensitivity sampling with Monte Carlo simulations. We then used the TreeAge software with Monte Carlo simulations to do incremental outcome comparisons between each strategy (ECV with or without anesthesia) to determine the incremental cost difference and cost distribution between strategies. During each of the iterations, all samples of random variables were identical, except for whether neuraxial anesthesia was used. The cost-probability distribution derived from the modeling was graphed and the prediction intervals were computed from the 2.5 to 97.5th percentiles. Mean difference and 2.5 to 97.5th percentile prediction intervals for cost of ECV with and without neuraxial anesthesia were similarly derived from the Monte-Carlo cost-probability distribution model. To calculate the ECV success rate above baseline at which neuraxial anesthesia became cost saving (i.e. 2.5 to 97.5th percentile prediction interval no longer crossed zero), we ran further simulations increasing ECV success in 1% increments from the 38% ECV success at base case.

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