

Epidural Analgesia in Cardiac Surgery: An Updated Risk Assessment

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ABSTRACT

Introduction. The use of epidural anesthesia carries risks that have been known for 50 years. The debate about the use of locoregional technique in cardiac anesthesia continues. The objective of this report is to estimate the risks and their variability of a catheter-related epidural hematoma in cardiac surgery patients and to compare it with other anesthetic and medical procedures.

Methods. Case series reporting the use of epidural anesthesia in cardiac surgery were researched through Medline. Additional references were retrieved from the bibliography of published articles and from the internet. Risks of complications in other anesthetic and medical activity were retrieved from recent reviews.

Results. Based on the present evidence, the risk of epidural hematoma in cardiac surgery is 1:12,000 (95% CI of 1:2100 to 1:68,000), which is comparable to the risk in the nonobstetrical population of 1:10,000 (95% CI 1:6700 to 1:14,900). The risk of epidural hematoma is comparable to the risk of receiving a wrong blood product or the yearly risk of having a fatal road accident in Western countries.

Conclusions. The risk of a hematoma after epidural in cardiac surgery is comparable to other nonobstetrical surgical procedures. Its routine application in a controlled setting should be encouraged.

INTRODUCTION

Recently, there has been controversy in cardiac anesthesiology literature about the use of thoracic epidural anesthesia in cardiac anesthesia [Chaney 2006a, 2006b; Hemmerling 2006; Ho 2006]. The opinions are strongly divided between the promoters of the techniques and others who think these techniques are dangerous, offer no benefits, and should be banished. Thoracic epidural anesthesia in cardiac surgery

carries risks and benefits. There are risks related to epidural anesthesia in all fields of anesthesia, as there are risks related to all medical activities. Any surgeon cutting the skin exposes the patient to a risk of infection and/or bleeding. Recently, the overall health care system has been classified as high risk with a risk comparable to bungee jumping [Lundstrom 2007]. The risk assessment in cardiac surgery is further complicated by the occurrence of neurologic or spinal pathologies not related to epidural catheter placement such as anterior spinal artery syndrome [Yoshida 2005]. Furthermore, epidural hematoma has even been reported without an epidural catheter [Case 2005; Hyderally 2005]. The aim of the present report is to estimate the risk of epidural hematoma in cardiac surgery due to intraoperative heparin administration and to compare this risk with other patient populations or techniques.

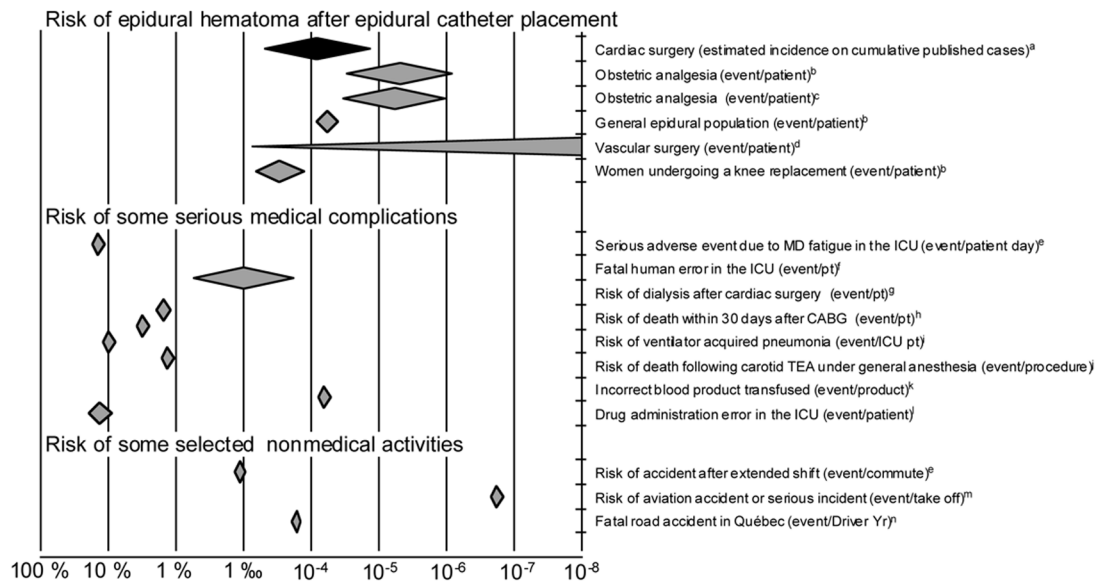
METHODS

Publications presenting patients receiving an epidural catheter and combined anesthesia for cardiac surgery were retrieved from Medline, SciSearch Embase, Google, and Google Scholar by searching the terms epidural anesthesia, epidural catheter, locoregional anesthesia, or epidural and cardiac surgery, coronary artery bypass grafting, aortic valve surgery, or mitral valve surgery. Databases were searched from 1966 to 2007. Data from the literature included randomized control trials, retrospective and prospective cohorts, and meta-analyses. The number of cases done using an epidural and the epidural-related complications were extracted, taking care to not count patients twice. Risks of catheter-related epidural hematoma in noncardiac surgery and in other procedures were extracted from large scale meta-analyses or trials.

Risk assessment for a rare event and estimation of their confidence intervals is difficult. We calculated the risk of selected events in anesthesia, critical care, medicine, and daily life. The 95% confidence intervals (CI) of a single proportion were calculated according to the method described by Wilson [Newcombe 1998b] (Figure). Risks were plotted on a logarithmic scale, the higher risks on the left of the graph. The distance between each bar toward the right represents a 10-fold decrease in the probability of the event to occur. The Wilson method was applied to compare 2 proportions [Newcombe 1998a].

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Risk of epidural hematoma, of some medical complication, and nonmedical daily activities. Risk is expressed as proportion (center of diamond) and its 2-sided 95% confidence interval (extremities of diamond). a, Estimate based on one systemic heparinization-related epidural hematoma in 12,000 published cases of cardiac surgery with an epidural in place. b, Data from [Moen 2004]. c, Data from [Ruppen 2006a]. d, Data from [Ruppen 2006b]. e, Data from [Landrigan 2004]. f, Data from [Bracco 2001]. g, Data from [Mehta et al 2006]. h, Data from [Shroyer 2003]. i, Data from [Safdar 2005]. j, Data from the Cochrane collaboration, available at: <http://www.cochrane.org/reviews/en/ab000126.html>, accessed March 29th 2006. k, Data from [Stainsby 2005]. l, Data from [Herout 2004]. m, Data from National Transport Safety Board. Available online at <http://www.nts.gov/aviation/Table5.htm>, accessed March 29th 2006. n, Data from The Société d'assurance Automobile du Québec, available online at http://www.saaq.gouv.qc.ca/prevention/bilan_routier_05/sommaire.html, accessed March 29th 2006.

RESULTS

Approximately 12,000 published cases of cardiac surgery under combined general-epidural anesthesia or sole epidural were found. One case of epidural hematoma probably related to the full heparinization that occurred in 1995 and was published in 2004 in a newsletter of the UK Medical Protection Society [Medical Protection Society UK 2004]. For the present analysis, we considered the numerator to be one event (the event presented by the Medical Protection Society) and the denominator to be 12,000.

There are other case reports of neurological events occurring in patients with an epidural catheter placed for cardiac surgery. Rosen [2004] presented a patient with an epidural placed for aortic valve replacement. An epidural catheter was placed, and the patient received 21,000 U heparin for aortic valve replacement, which was reversed. On postoperative day 2, while the patient was ambulating, he received a bolus of 4500 U heparin followed by a continuous heparin infusion. In addition, the patient received 4 mg of alteplase for a nonfunctioning PICC line, and at that point an epidural hematoma developed [Rosen 2004]. This case underlines the impressive systemic effect of “locally” administered thrombolysis in a central line. Sharma [2004] presented a case of catheter-related epidural hematoma in a patient receiving an epidural 10 hours after low molecular weight heparin on the day prior to aortic valve surgery. This case adds to the long list of catheter-related epidural

hematoma in patients receiving low molecular weight heparin. The patient required a spinal decompression for hematoma with neurologic compression. Yoshida [2005] and Bracco [2007] presented cases of anterior spinal artery stroke in postoperative cardiac surgery patients with an epidural catheter in place. The catheter was not the culprit in these cases, but the epidural analgesia/anesthesia could have made the neurological evaluation more difficult. In a recent series of more than 2000 patients receiving an epidural catheter for cardiac surgery, Chakravarthy presented 4 cases of temporary neurologic deficits, mainly upper limb monoplegia attributable to the catheter's position [Chakravarthy 2004, 2005]. These were resolved by pulling the catheter out 1 to 2 cm or by removing it. Jack [2006] also presented a series of 2837 patients with zero vertebral canal hematoma or abscess.

The risk of epidural hematoma after regional techniques for cardiac surgery is comparable to the risk in a nonobstetrical population [Moen 2004] (RR 0.83 favoring cardiac surgery; 95% CI 0.11-6.42, not significant). The risk of hematoma during cardiac surgery is comparable to the risk of receiving the wrong blood product, is 10 times lower than the risk of dying because of human error during an intensive care unit stay, and is 100 times lower than the risk of death after a carotid thrombendartectomy under general anesthesia. The risk of a systemic heparinization-related epidural hematoma is comparable to the risk of being a victim of a fatal accident while driving a car during one year.

DISCUSSION

Risk assessment in clinical practice is very complex and has to take into account several parameters. (1) What is the probability of an event to occur after an intervention? (2) What are the benefits of the intervention? (3) Prior to the intervention, are there modifiable risk factors that, if optimized, may decrease the incidence of the event? (4) Is every team member aware of the intervention, the possibility of an event, and the change in the process of care secondary to the intervention? (5) Do we put in place systems to detect and mitigate the consequence of the event? We do these analyses daily with different techniques and consequences, such as surgery and wound infection or cardiac surgery and atrial fibrillation.

The present risk update analysis has some limitations, since it includes in the denominator numerous patients from randomized controlled trials and from prospective and retrospective cohorts. They include different times of catheter placement and different perioperative heparinization protocols. We also made the assumption that no other case of heparinization-related epidural hematoma occurred. We hoped that the complication would have been reported if it had happened because it is so serious.

Ho previously published a risk estimate based on zero report of epidural hematoma in 5000 patients receiving an epidural for heart surgery. These authors used the Hanley and Lipmann-Hand method for adverse events that have not yet occurred [Hanley 1983]. For large ($n > 30$) samples, this method estimates the 95% CI upper interval at 3 divided by the sample size. Therefore Ho et al proposed an upper 95% CI for the incidence at 1/1500 epidurals. As one event occurred, the Hanley and Lipmann-Hand method could not be applied to the actual data. Applying the Wilson method to data available when Ho performed his simulation would yield an upper 95% CI of 1 in 1303 occurrences.

Based on the current data, the risk of an heparinization-associated epidural hematoma is not zero, but the mean risk is comparable to the risk of receiving the wrong blood product or the risk of an epidural in a nonobstetric population. Most of the team performing epidurals for cardiac surgery comply with the recommendation of Horlocker et al [2003], although these recommendations did not specifically address the question of patients undergoing systemic heparinization. When performed according to safe practice guidelines with proper communication between all teams involved, upgraded clinical patient tracks and proper follow-up, locoregional techniques for cardiac surgery bear an acceptable risk of complications, which compares to that of epidural applied in general surgery.

It is interesting to note that the analysis of the case report described before by 2 experts by the Medical Protection Society supported the use of epidural analgesia in cardiac surgery and both noted benefits associated with its use. However, these experts pointed out deficiencies in communication and delays when the complication occurred. These cases illustrate the importance of communication between different health care specialists whenever thoracic epidural anesthesia is used in cardiac surgery [Hemmerling 2004].

In 1994, 7% of anesthesiologists in the US were practicing locoregional techniques in cardiac surgery [Goldstein 2001]

and in 2006, 22% of Canadian cardiac surgery centers performed locoregional techniques (Nguyen et al, IARS annual meeting 2007; abstract S-53). This updated risk assessment might help to better weigh the risk-benefit ratio of using thoracic epidural anesthesia in cardiac surgery.

REFERENCES

- Bracco D, Favre JB, Bissonnette B, et al. 2001. Human errors in a multidisciplinary intensive care unit: a 1-year prospective study. *Intensive Care Med* 27:137-45.
- Bracco D, Noiseux N, Prieto I, Basile F, Hemmerling TM. 2007. Acute spinal artery syndrome after off-pump coronary artery bypass graft surgery using combined thoracic epidural and general anesthesia. *J Cardiothorac Vasc Anesth* [in press].
- Case AS, Ramsey PS. 2005. Spontaneous epidural hematoma of the spine in pregnancy. *Am J Obstet Gynecol* 193:875-7.
- Chakravarthy M, Nadiminti S, Krishnamurthy J, et al. 2004. Temporary neurologic deficits in patients undergoing cardiac surgery with thoracic epidural supplementation. *J Cardiothorac Vasc Anesth* 18:512-20.
- Chakravarthy M, Thimmangowda P, Krishnamurthy J, Nadiminti S, Jawali V. 2005. Thoracic epidural anesthesia in cardiac surgical patients: a prospective audit of 2,113 cases. *J Cardiothorac Vasc Anesth* 19:44-8.
- Chaney MA. 2006. Risk of hematoma after epidural anesthesia and analgesia for cardiac surgery. *Anesth Analg* 103:1327-8.
- Chaney MA. 2006. The use of epidural analgesia in cardiac surgery should be encouraged. *Anesth Analg* 103:1592-3.
- Goldstein S, Dean D, Kim SJ, et al. 2001. A survey of spinal and epidural techniques in adult cardiac surgery. *J Cardiothorac Vasc Anesth* 15;2:158-68.
- Hanley JA, Lipmann-Hand A. 1983. If nothing goes wrong, is everything all right? Interpreting zero numerators. *JAMA* 249:1743-5.
- Hemmerling TM, Djaiani G, Babb P, Williams JP. 2006. The use of epidural analgesia in cardiac surgery should be encouraged. *Anesth Analg* 103:1592.
- Hemmerling TM, Olivier JF, Basile F, Prieto I. 2004. Epidural hematoma after anticoagulation with a thoracic epidural catheter in place: a mere coincidence? *Anesth Analg* 99:1267-8; author reply 1268.
- Herout PM, Erstad BL. 2004. Medication errors involving continuously infused medications in a surgical intensive care unit. *Crit Care Med* 32:428-32.
- Ho AM, Li PT, Karmakar MK. 2006. Risk of hematoma after epidural anesthesia and analgesia for cardiac surgery. *Anesth Analg* 103:1327.
- Horlocker TT, Wedel DJ, Benzon H, et al. 2003. Regional anesthesia in the anticoagulated patient: defining the risks (the second ASRA consensus conference on neuraxial anesthesia and anticoagulation). *Reg Anesth Pain Med* 28:172-97.
- Hyderally HA. 2005. Epidural hematoma unrelated to combined spinal-epidural anesthesia in a patient with ankylosing spondylitis receiving aspirin after total hip replacement. *Anesth Analg* 100:882-3, table of contents.
- Jack ES, Scott NB. 2006. The risk of vertebral canal complications in 2837 cardiac surgery patients with thoracic epidurals. *Acta Anaesthesiol Scand* 2006. Online first at <http://www.blackwellsynergy.com/doi/abs/10.1111/j.1399-6576.2006.01168.x>, accessed March 29th, 2007.

- Landrigan CP, Rothschild JM, Cronin JW, et al. 2004. Effect of reducing interns' work hours on serious medical errors in intensive care units. *N Engl J Med* 351:1838-48.
- Lundstrom T. 2007. Mandatory reporting of untoward events and nosocomial infections. Presentation at the 36th Annual SCCM congress. Orlando, FL: SCCM; February 17th 2007.
- Medical Protection Society UK. 2004. Education and publications—UK casebook 2004 (3)—August: Epidural emergency. URL: <http://www.medicalprotection.org/Default.aspx?DN=f4adb0-cf77-494e-87b9-627ac967a86c>, accessed March 29th, 2007.
- Mehta RH, Grab JD, O'Brien SM, et al; Society of Thoracic Surgeons National Cardiac Surgery Database Investigators. 2006. Bedside tool for predicting the risk of postoperative dialysis in patients undergoing cardiac surgery. *Circulation* 114:2208-16.
- Moen V, Dahlgren N, Irestedt L. 2004. Severe neurological complications after central neuraxial blockades in Sweden 1990-1999. *Anesthesiology* 101:950-9.
- Newcombe RG. 1998. Interval estimation for the difference between independent proportions: comparison of eleven methods. *Stat Med* 17:873-90.
- Newcombe RG. 1998. Two-sided confidence intervals for the single proportion: comparison of seven methods. *Stat Med* 17:857-72.
- Rosen DA, Hawkinberry DW 2nd, Rosen KR, et al. 2004. An epidural hematoma in an adolescent patient after cardiac surgery. *Anesth Analg* 98:4:966-9, table of contents.
- Ruppen W, Derry S, McQuay HJ, Moore RA 2006. Incidence of epidural haematoma and neurological injury in cardiovascular patients with epidural analgesia/anaesthesia: systematic review and meta-analysis. *BMC Anesthesiol* 12;6:10.
- Ruppen W, Derry S, McQuay H, Moore RA. 2006. Incidence of epidural hematoma, infection, and neurologic injury in obstetric patients with epidural analgesia/anesthesia. *Anesthesiology* 105:394-9.
- Safdar N, Dezfulian C, Collard HR, Saint S. 2005. Clinical and economic consequences of ventilator-associated pneumonia: a systematic review. *Crit Care Med* 33:2184-93.
- Sharma S, Kapoor MC, Sharma VK, Dubey AK. 2004. Epidural hematoma complicating high thoracic epidural catheter placement intended for cardiac surgery. *J Cardiothorac Vasc Anesth* 18:6:759-62.
- Shroyer AL, Coombs LP, Peterson ED, et al; Society of Thoracic Surgeons. 2003. The Society of Thoracic Surgeons: 30-day operative mortality and morbidity risk models. *Ann Thorac Surg* 75:1856-64; discussion 1864-5.
- Stainsby D, Russell J, Cohen H, Lilleyman J. 2005. Reducing adverse events in blood transfusion. *Br J Haematol* 131:8-12.
- Yoshida S, Nitta Y, Oda K. 2005. Anterior spinal artery syndrome after minimally invasive direct coronary artery bypass grafting under general combined epidural anesthesia. *Jpn J Thorac Cardiovasc Surg* 53:230-3.