

# Delirium after cardiac surgery: A retrospective case-control study of incidence and risk factors in a Canadian sample

Alcohol use in the week before surgery was identified as the risk factor most strongly associated with postoperative delirium in a recent study at St. Paul's Hospital.

## ABSTRACT:

**Background:** Postoperative delirium is a major complication of cardiac surgery. A pilot study was proposed to determine the incidence of delirium and identify risk factors for delirium in patients undergoing elective heart surgery in a Canadian hospital.

**Methods:** Charts of 38 patients admitted for heart surgery were reviewed retrospectively. Variables related to delirium were characterized as being present before, during, or after cardiac surgery. Logistic regression was used to calculate odds ratios for risk factors.

**Results:** After cardiac surgery 11 of 38 patients developed delirium. The risk factor associated most strongly with delirium was recent alcohol use (OR 6.11), followed by intubation time (OR 1.20), time spent in intensive care (OR 1.11), and postoperative creatinine levels (OR 1.03).

**Conclusions:** The incidence of delirium following cardiac surgery is considerable, with almost one-third of patients becoming delirious. Special attention should be paid to alcohol use in the period preceding surgery and future studies should look specifically at alcohol use and dependence as risk factors for delirium after cardiac surgery.

## Background

Postoperative delirium is a common complication of cardiac surgery.<sup>1</sup> Episodes of delirium are associated with increased morbidity, mortality, and a longer hospital stay<sup>2,3</sup> and can be distressing for patients, their families, and nursing staff.<sup>4</sup> Recognizing delirium and those at risk can reduce the impact of delirium through targeted interventions and risk reduction.<sup>5,6</sup> Understanding the frequency of delirium and the complications associated with it can help guide future research and resource allocation.

Historically, a number of psychiatric symptoms have been identified following heart surgery: confusion, agitation, and hallucinations have been labeled postcardiotomy delirium,<sup>1</sup> postoperative psychosis,<sup>7</sup> and acute brain syndrome.<sup>8</sup> Earlier studies of postoperative patients did not define delirium in a consistent way because a standard definition has only been available since the publication of the DSM-III.<sup>9</sup>

Most of the surgeries described in the earliest reports involved repairing valves and congenital anomalies.<sup>8</sup> Coronary artery bypass graft (CABG) is now the most common type of cardiac surgery<sup>10,11</sup> and may have lower rates of delirium than valve surgery.<sup>8</sup>

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Nevertheless, in Canada, bypass grafts and other types of cardiac surgery are increasingly being performed on patients who are older and have a greater number of comorbid medical conditions,<sup>12</sup> which may make them more at risk for delirium. While the mortality from cardiac operations in British Columbia is decreasing,<sup>12</sup> it is unclear whether the incidence of delirium is as well. Despite the development of a consistent definition of delirium and standardized measurements for it, there are significant discrepancies between studies on the incidence of delirium,<sup>11</sup> making it difficult to predict what rates of delirium will occur in a given population.

The study described here was designed to determine the incidence of postoperative delirium and to identify risk factors by taking advantage of the extensive data collected on cardiac surgery patients in British Columbia. These patients receive preoperative screening by anesthesiologists and nurses. Data about each case—including variables that have been identified as risk factors for delirium in other studies—are gathered from the preoperative, intraoperative, and postoperative period and entered into a provincial health database.

## Methods

### Patients

Study subjects were chosen by reviewing a consecutive series of charts for patients undergoing elective heart surgery during a 2-week period in 2007 at St. Paul's Hospital, a tertiary care facility in Vancouver, BC. Thirty-eight patients were selected for the study. All procedures were approved by the University of British Columbia Clinical Research Ethics Board.

### Data input and gathering

Before surgery, a preoperative assessment of each patient was performed

by an anesthesiologist and cardiac nurse. The assessment involved the use of standardized screening questionnaires that included a number of questions about risk factors for delirium, as well as standardized questions about regular alcohol consumption and consumption during the week before surgery. Intraoperative data were gathered along with postoperative data recorded by nursing staff in the cardiac intensive care unit and the

ing was positive, or if the diagnosis was made by a physician involved in the patient's care.

### Statistics

Group differences comparing variables between patients with or without delirium were analyzed with independent-means *t* tests for continuous variables and the chi-square test for dichotomous variables. Because of the relatively small sample size,

## Recognizing delirium and those at risk can reduce the impact of delirium through targeted interventions and risk reduction.

postoperative medical unit. Following the presentation of delirium, additional variables that were of clinical interest, such as frequency of psychiatrist consultation, were also recorded even though these could not have contributed to the onset of delirium. The data gathered are displayed in **Table 1**.

### Delirium assessment

The diagnosis of delirium was based on DSM-IV-TR<sup>13</sup> criteria and was made retrospectively using progress notes. The nurses had been trained in using the confusion assessment method (CAM)<sup>14</sup> to screen for and diagnose delirium. A patient was deemed to have delirium if the DSM-IV-TR criteria were met according to the progress notes, if the patient's CAM rat-

risk factors for delirium at the preoperative, intraoperative, or postoperative stages were selected from **Table 1** only if there was a significant between-group difference ( $P < .05$ ) as determined by forward stepwise logistic regression analysis. SPSS software was used for all analyses.

### Results

The majority of patients undergoing surgery were male (78.9%) and the mean age was 67 years. The surgical interventions included CABG alone in 22 cases, valve surgery in 9 cases, and combined CABG and valve surgery in 7 cases. Three of 38 cases had "off pump" procedures. Patients became delirious in 11 of 38 cases (28.9%). Separate preoperative, intra-

**Table 1. Data gathered during study of 38 patients undergoing elective heart surgery at St. Paul's Hospital in Vancouver, BC, during a 2-week period in 2007.**

Variables	No delirium (n = 27)	Delirium (n = 11)
<b>Preoperative</b>		
Age (years)	64.6 (SD 12.0)	72.5 (SD 8.7)
Gender (M / F)	21 (78%) / 6 (22%)	9 (82%) / 2 (18%)
ASA* score of 4 or 5 (Y / N)	16 (59%) / 11 (41%)	8 (73%) / 3 (27%)
Diabetes mellitus (Y / N)	21 (78%) / 6 (22%)	8 (73%) / 3 (27%)
Hypertension (Y / N)	21 (78%) / 6 (22%)	10 (91%) / 1 (9%)
Prior stroke (Y / N)	0 (0%) / 27 (100%)	1 (9%) / 10 (91%)
Atrial fibrillation (Y / N)	1 (4%) / 26 (96%)	2 (18%) / 9 (82%)
Peripheral vascular disease (Y / N)	4 (15%) / 23 (85%)	1 (9%) / 10 (91%)
Hearing impairment (Y / N)	3 (11%) / 24 (89%)	2 (18%) / 9 (82%)
Vision impairment (Y / N)	11 (41%) / 16 (59%)	8 (73%) / 3 (27%)
Alcohol consumption, regular (Y / N)	12 (44%) / 15 (56%)	6 (55%) / 5 (45%)
Alcohol consumption, recent (Y / N)	3 (11%) / 24 (89%)	6 (55%) / 5 (45%)
Smoking (Y / N)	6 (22%) / 21 (78%)	2 (18%) / 9 (82%)
Current psychiatric medication (Y / N)	2 (7%) / 25 (93%)	0 (0%) / 11 (100%)
Urgency of surgery (score?)	2.04 (SD 0.44)	2.09 (SD 0.70)
Ejection fraction (%)	51.0 (SD 11.5)	47.3 (SD 12.7)
Pre-op hemoglobin (g/dL)	13.9 (SD 1.4)	13.2 (SD 1.3)
Pre-op white blood cell count (cells/nL)	7.67 (SD 2.48)	8.77 (SD 3.24)
Pre-op creatinine (μmol/L)	89.7 (SD 28.7)	110.7 (SD 34.5)
<b>Intraoperative</b>		
CABG† / AVR‡	17 CABG / 10 AVR	6 CABG / 5 AVR
Number of vessels grafted	2.33 (SD 1.62)	2.27 (SD 1.56)
Surgical complications (Y / N)	0 (0%) Y / 25 (100%)	3 (27%) / 8 (73%)
Cross-clamp time (minutes)	74.0 (SD 24.3)	68.0 (SD 20.8)
Pump time (minutes)	88.5 (SD 29.2)	88.0 (SD 21.8)
Blood transfused (units)	0.59 (SD 1.22)	1.64 (SD 2.91)
Intubation time (hours)	6.92 (SD 2.82)	18.6 (SD 15.5)
Cardiopulmonary bypass (Y / N)	24 (89%) / 3 (11%)	11 (100%) / 0 (0%)
<b>Postoperative</b>		
Post-op hemoglobin (g/dL)	11.3 (SD 1.3)	10.4 (SD 1.8)
Post-op white blood cell count (cells/nL)	11.80 (SD 3.91)	14.51 (SD 6.47)
Post-op creatinine (μmol/L)	84.5 (SD 25.5)	112.7 (SD 34.9)
Morphine IV in first 24 h (mg)	32.1 (SD 18.1)	36.3 (SD 21.3)
Hydromorphone in first 24 h (mg)	6.19 (SD 4.32)	4.89 (SD 5.20)
Fentanyl in first 24 h (μg)	0.93 (SD 4.81)	0.0 (SD 0.0)
Combined opioid equivalent dose	33.3 (SD 51.5)	29.9 (SD 20.5)
Lorazepam (mg)	0.389 (SD 0.902)	0.091 (SD 0.301)
Midazolam (mg)	4.57 (SD 3.52)	7.18 (SD 5.56)
Time in cardiac surgery ICU (hours)	25.0 (SD 11.0)	55.8 (SD 39.5)

\*ASA: American Society of Anesthesiologists  
 †CABG: coronary artery bypass graft  
 ‡AVR: aortic valve replacement

operative, and postoperative variables were included in the analysis to determine risk factors for delirium. After logistic regression, four factors were identified as significant predictors of delirium. Alcohol use in the week before surgery, intubation time, time spent in the cardiac surgery intensive care unit, and postoperative creatinine levels were all independently associated with delirium (Table 2).

The risk factor associated most strongly with delirium was alcohol use in the week preceding admission (OR 6.11). Alcohol use was reported on a standardized questionnaire given to all patients prior to surgery; regular alcohol consumption, irrespective of use in the week preceding admission, was not associated with delirium. Psychiatrists were consulted for 9 of the 11 patients with delirium (82%) and only 2 of the 27 patients without delirium (7%) ( $\chi^2 = 20.3$ ;  $P < .001$ ). The postoperative stay was significantly longer for patients with delirium—a mean of 9.7 days versus 6.2 days for patients without delirium ( $t = 2.64$ ;  $P = .01$ ). Restraints were used for only 3 of the 11 delirious patients and there were no reported behavioral disturbances or reports of violence toward staff in any of the charts that were reviewed.

## Conclusions

Slightly under one-third of the patients in this retrospective case-control study developed delirium after cardiac surgery. Because delirium was diagnosed retrospectively, we may have underestimated its incidence since delirium often goes unrecognized and unrecorded, particularly in cases involving the hypoactive subtype.<sup>15</sup> Nevertheless, the incidence in our study falls well within the range of incidence reported in prospective studies,<sup>3,6,16,17</sup> and is consistent with an incidence of 32% recorded in the only previous

prospective study that assessed risk factors for delirium and CABG in a Canadian sample.<sup>18</sup> The rate of psychiatric consultation was high (82%) in the delirious patients, which we believe reflects the awareness of delirium and its impact in our centre.

The factors most strongly associated with delirium were recent alcohol use, intubation time, time spent in the ICU, and postoperative creatinine levels. We suspect that recent alcohol use may precipitate a withdrawal-related delirium, and we believe that ours is the first study to identify recent alcohol use as a strong risk factor specifically for delirium associated with cardiac surgery. A previous major study reported that a history of excessive alcohol use (defined as including “hospitalization resulting from alcohol consumption or withdrawal”) was a risk factor for postcardiac surgery type II cerebral outcome.<sup>19</sup> That study did not assess recent alcohol use, however, and was not specific to delirium, as it included any type of cognitive deterioration, including memory impairment and seizures. All patients at our centre who are considered to be at risk of withdrawal are put on a protocol that includes using the revised Clinical Institute Withdrawal Assessment for Alcohol (CIWA-Ar) scale.<sup>20</sup> Given the relative risk for delirium in recent drinkers, future studies should assess the amount, duration, and regularity of alcohol use, as well as any history of withdrawal symptoms.

We did not find a significant association with a number of factors that we anticipated would be associated with delirium. We reviewed postoperative doses of opioids and benzodiazepines, suspecting that these medications might be associated with delirium,<sup>21</sup> but we did not find evidence for this. We were also interested in “code white” calls and violent incidents, as these are particularly

**Table 2. Risk factors for delirium after cardiac surgery, identified using logistic regression analysis.**

Factor	Odds ratio	95% confidence interval
<b>Preoperative</b>		
Recent alcohol use ( <i>P</i> = .03)	6.11	(1.13–33.19)
<b>Intraoperative</b>		
Intubation time ( <i>P</i> = .001)	1.20	(1.00–1.43)
<b>Postoperative</b>		
Time in cardiac surgery ICU ( <i>P</i> = .001)	1.11	(1.03–1.20)
Creatinine levels ( <i>P</i> = .009)	1.03	(1.00– 1.58)

concerning events for staff and patients: no calls or incidents were reported with any of the patients.

Caution should be made when attributing cause to associated factors. Because delirium results from a complex interaction of factors, it is difficult to determine which of the factors are causal and which are a result of confounding common underlying pathology. For example, longer intubation time will predispose an individual to a respiratory infection<sup>22</sup> that can then contribute to delirium.<sup>23</sup> It is also possible that the more severely ill patients and those with more complications in surgery would be likely to have both longer intubation times and higher rates of delirium with no connection between the two.

As this pilot study involved only 38 patients, the statistical power to detect differences between those who developed delirium and those who did not was modest. This may account for the study’s inability to identify previously reported risk factors, such as age<sup>24</sup> or prior stroke.<sup>18</sup> However, a study with a small sample size also offers some benefits, including the strength of the association in those variables that are identified, highlighting risk factors for delirium that are clinically relevant. Future

prospective studies that consider larger numbers of subjects, that use standardized measures, and that take into account the severity and consequences of delirium are warranted. Additionally it may be useful to conduct studies that look specifically at alcohol consumption and dependence as risk factors.

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**Competing interests**

None declared.

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