Background  Postoperative delirium in older patients results in worse outcomes and increased costs. The prevalence and predictors of postoperative delirium in patients undergoing major colorectal surgery are not clear.

Objectives  To determine the prevalence and predictors of postoperative delirium in older patients after major colorectal surgery.

Methods  Patients older than 50 years, without preexisting cognitive impairment, were recruited before surgery. These patients were assessed after surgery for delirium daily for 3 days by using the Confusion Assessment Method. Regression analysis was used to determine independent predictors of postoperative delirium.

Results  Patients (n=118) had a mean age of 71.81 years, and approximately half were women (54%). Most participants (64%) were married, and comorbid conditions were common. Delirium developed in 35% of the patients in the 3 days after surgery and in 21% in the first 24 hours. New cases of delirium were identified on each of the 3 days after surgery, and a few patients (7%) had delirium for the entire 3 days. Odds for delirium in the first 24 hours were increased for patients who had early admission (odds ratio [OR]=4.48; P=.06) and decreased for patients who were married (OR=0.25; P=.01). Odds for delirium in the first 3 days after surgery were increased for men (OR=4.27; P=.02), older patients (OR=1.05; P=.04), and patients who stayed overnight in the critical care unit (OR=2.97; P=.06).

Conclusions  Postoperative delirium is common and persistent in older patients in the first 3 days after colorectal surgery. (American Journal of Critical Care. 2011;20:45-55)
Delirium is a common postoperative complication in older surgical patients.\textsuperscript{1,2} It can occur in up to 37\% of all hospitalized patients, although reports vary on the prevalence.\textsuperscript{3} It is often the first, and, in some instances, the only clinical indication in older adults of a significant physiological disturbance or a complication of treatment.\textsuperscript{4}

Postoperative delirium is an acute confusional state caused by physiological abnormalities and is characterized by a rapid onset, fluctuating course, and cognitive features of inattention, disorganized thinking, and an altered level of consciousness. Importantly, delirium results in symptoms that are uncomfortable for patients and may lead to behaviors that potentially compromise patients’ safety. Such behaviors include sleep disruption, hypoactivity or hyperactivity, aggression, agitation or lethargy, and hallucinations, all of which increase the complexity of postoperative nursing care for these patients. Potential injuries due to postoperative delirium in patients include self-harm, unplanned removal of invasive catheters, and falls. In addition, postoperative delirium is associated with delayed recuperation and return to preoperative levels of cognition and function; lengthened hospital stays, resulting in increased financial cost; permanent cognitive impairment; initial nursing home placements; and increases of up to 67\% in morbidity and mortality.\textsuperscript{7-10} Fortunately, with early detection and rapid intervention, investigation, and treatment of the underlying causes, the adverse sequelae of delirium can be minimized or eliminated.\textsuperscript{11-13}

The development of postoperative delirium involves a dynamic interplay of factors, and identification of some of these may help early detection and, potentially, prevention. Although evidence suggests that impairment of the cholinergic system\textsuperscript{14} and genetic genotypes such as apolipoprotein E e4 polymorphism\textsuperscript{15,16} are predisposing factors for delirium, most likely the stress of surgery itself is a central precipitating factor.\textsuperscript{17} Postoperative delirium occurs most often in the first 3 days after surgery, and most cases develop in the first day.\textsuperscript{18,19} However, the time of onset and the duration of postoperative delirium are poorly understood; most published studies of hospitalized patients indicate the prevalence of delirium with no reference to the length of hospital stay or incidence.\textsuperscript{20}

Other than the stress of surgery, the risk factors for delirium in surgical patients most likely do not differ substantially from those in nonsurgical patients.\textsuperscript{17} However, advanced age,\textsuperscript{8,18,19,21-24} preexisting impaired cognition,\textsuperscript{8,21,22,24-26} use of psychotropic medications,\textsuperscript{22,25,26,28} and impaired functional status and sensory deficits\textsuperscript{22,24,27,29} are recognized as predisposing factors for postoperative delirium. A diverse array of precipitating factors for delirium have also been identified in surgical patients, including impaired oxygenation,\textsuperscript{26,27} abnormal hematological and/or biochemical status,\textsuperscript{25,26,30-32} blood loss and replacement,\textsuperscript{19,32} and intravenous infusions.\textsuperscript{30,32,24,31} These factors also vary according to the type of surgery undertaken. For example, precipitating factors for postoperative delirium in cardiothoracic surgical patients include admission to the intensive care unit and invasive monitoring,\textsuperscript{14,25} cardiopulmonary bypass,\textsuperscript{14,26,27} and hypothermic states.\textsuperscript{37} In patients undergoing abdominal surgery, intraoperative tachycardia,\textsuperscript{15} long duration of surgery,\textsuperscript{39} abnormal melatonin levels,\textsuperscript{34} and disturbances in the sleep-wake cycle\textsuperscript{36,37} were specific additional predictors.

Investigation of postoperative delirium in patients undergoing abdominal surgery is important because of their multiple risk factors for this complication, including older age, high rate of malignant neoplasms, relatively long duration of surgery,\textsuperscript{32} abnormal levels of electrolytes before surgery,\textsuperscript{30} concurrent illnesses such as diabetes mellitus,\textsuperscript{32,33} alcohol abuse, and functional limitations.\textsuperscript{18,40} Not surprisingly, rates of postoperative delirium in patients who have abdominal

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**About the Authors**

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surgery range from 17% to 51%. Because the number of older patients undergoing abdominal surgery, in particular, major colorectal surgery, is increasing, health professionals such as nurses need to understand the potential for postoperative delirium and the associated consequences for patients.

Nurses, particularly in critical care and acute surgical units, have the most frequent contact with postoperative patients and therefore are in the best position to detect cognitive changes associated with delirium. Unfortunately, nurses differ in their knowledge, recognition, and assessment of delirium. Without knowledge of delirium and its occurrence, nurses cannot easily ensure the safe care of patients in the early postoperative course, much less develop risk management plans. Therefore, the aims of this study were to determine the prevalence and predictors of postoperative delirium during the first 3 days after surgery in older patients undergoing major colorectal surgery.

Methods
A prospective, descriptive design was used. Delirium was assessed daily for 3 days after surgery. The study was approved by both the hospital and university human research ethics committees, that operate under the auspices of the National Health and Medical Research Council of Australia. Guidelines followed in the approval process are in keeping with the Helsinki Declaration of 1975 and the revision of 2000.

Patients and Setting
A convenience sample of patients scheduled for major colorectal surgery was recruited from Sydney Adventist Hospital, a private, 352-bed, acute-care teaching facility in Sydney, Australia. Patients were considered eligible for the study if they were admitted for an elective procedure classified in the Australian Refined Major Diagnosis Related Group 6 (major colorectal surgery), 50 years or older, and able to read and comprehend English. Informed consent to participate in the research was obtained preoperatively. Patients were excluded if they had cognitive dysfunction and/or documented substance abuse because each of these factors increases the likelihood of delirium. Likewise, patients younger than 50 years old were excluded because delirium is more likely in older patients and the majority of patients undergoing major colorectal surgery are 50 years or older.

Table 1
Confusion Assessment Method diagnostic algorithm

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Onset and fluctuating course</td>
<td>Information on onset and fluctuating course is usually obtained from a family member or nurse and is indicated by positive responses to the following questions: Is there evidence of an acute change in mental status from the patient’s baseline? Did the (abnormal) behavior fluctuate during the day, that is, tend to come and go or increase and decrease in severity?</td>
</tr>
<tr>
<td>2: Inattention</td>
<td>Inattention is indicated by a positive response to the following question: Did the patient have difficulty focusing attention, for example, being easily distractible or having difficulty keeping track of what was being said?</td>
</tr>
<tr>
<td>3: Disorganized thinking</td>
<td>Disorganized thinking is indicated by a positive response to the following question: Was the patient’s thinking disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?</td>
</tr>
<tr>
<td>4: Altered level of consciousness</td>
<td>Altered level of consciousness is indicated by any answer other than “alert” to the following question: Overall, how would you rate this patient’s level of consciousness—alert (normal), vigilant (hyperalert), lethargic (drowsy, easily aroused), stupor (difficult to arouse), or coma (unrousable)?</td>
</tr>
</tbody>
</table>

The 4 cardinal features of delirium are acute onset and fluctuating course, inattention, disorganized thinking, and altered level of consciousness.

Appendix A
A diagnosis of delirium based on the Confusion Assessment Method requires the presence of features 1 and 2, and either 3 or 4.
and a high interobserver reliability (81%-100%) and requires minimal effort by respondents.45

The clinical interview included a Mini Mental State Examination,49,50 the forward digit span test,51 and an additional 10 general questions formulated by Marcantonio et al.40 The additional questions provided consistency in building rapport with patients and supplementary information for determining orientation and attention. Findings from the interview were placed on the CAM algorithm to determine the presence or absence of delirium. The data collector/interviewer (L.T.M.) was trained and assessed in the competent use of all instruments by an experienced mental health professional (J.S.-P.).

The Mini Mental State Examination52 is a well-recognized instrument widely used to screen for global impairment in mental status.53-55 It contains 30 items and was designed for use at a patient’s bedside. Two of the items (writing and drawing tasks) were too burdensome for the postoperative patients in this study; therefore, a modified 28-item Mini Mental State Examination was used, because recall and concentration were assessed through existing aspects of the instrument. The principal author of the CAM verified that the shortened 28-item instrument provided sufficient clinical information with which to rate the CAM (S. K. Inouye, MD, e-mail communication, March 25, 2005).

Sociodemographic data, clinical history, sensory and mobility deficits, height, and weight were collected from patients during face-to-face interviews and by review of medical records. The data included age; sex; marital status (married included living in a common-law relationship); comorbid medical conditions; disturbances in vision, hearing, or mobility; and alcohol and tobacco intake. Patients were considered to have impairment in vision, hearing, or mobility if they required an aid or assistance for normal daily function. Patients whose alcohol intake exceeded the maximum recommended daily intake by the Australian National Alcohol Strategy 2006-2009 were considered to have a heavy intake. Hematocrit, hemoglobin, sodium, and potassium levels were also obtained from the medical record preoperatively and postoperatively on day 1. Finally, clinically relevant information such as earlier admission (defined as admission to the hospital at least 1 day before surgery), intravenous hydration, duration of surgery, and postoperative admission to the critical care unit were also recorded.

Procedure

Potential participants were identified from the surgical schedule and were recruited from the preadmission clinic, on early admission to the hospital, or through the day-of-surgery admission unit between March and December 2005. From a total of 177 eligible patients, 124 were recruited; 50 potential participants were fast-tracked to surgery (Figure 1). A total of 118 patients had all 3 postoperative delirium assessments completed; data for 6 patients were eliminated because of death (n = 2), prolonged admission to the critical care unit (n = 2), and change in procedure (n = 2). Patients were assessed for delirium once a day for 3 days postoperatively, because delirium tends to peak within this period.19,25,26 Delirium assessments were conducted randomly between the hours of 8 AM and 8 PM to avoid systematic circadian bias in assessment.18,25,26,39,57,58

Data Analysis

Data were summarized by using means, standard deviations, frequencies, and percentages. Delirium was categorized into 3 responses: at least 1 episode in the first postoperative day, at least 1 episode at any time during the first 3 days after surgery, or daily episodes. Univariate analyses (Pearson χ² and t tests) were used to assess differences between patients with delirium and those without. Because multiple testing was done for all variables, the level of significance used for these tests was reduced to P = .02 on the basis of Bonferroni principles.39 Because the prevalence of abnormal levels of serum electrolytes at any time was low, the sodium and potassium

Predictors of delirium within the first 24 hours and any time during the first 3 days after surgery were determined.
were female (54%; Table 2). Most (64%) were married or in a common-law relationship. Comorbid health problems were common, particularly hypertension (57%), arthritis (38%) and hypercholesterolemia (36%). Most patients had multiple comorbid conditions: 1 in 5 patients (21%) had 5 or more. Although few patients were current smokers (14%), 1 in 5 (20%) exceeded daily alcohol intake guidelines. The most common abnormality in blood or serum levels preoperatively was hemoglobin; more than 44% of the patients had an abnormal value (Table 3). Postoperatively, the most common abnormality was hematocrit level; more than 72% of the patients had abnormal values. The majority of patients (70%) had been admitted early for their surgery. The surgery was typically long (mean, 2.5 hours; SD, 62 minutes) and included a mean intravenous infusion of 3.3 L of crystalloids. More than a quarter of the patients (27%) required an overnight stay in the critical care unit.

Postoperative Delirium

More than 1 in 5 participants (21%) had delirium in the first day postoperatively and more than 1 in 3 (35%) had at least 1 episode of delirium in the first 3 days after surgery (Figure 2). A few patients had delirium the second (9%) and third (7%) days postoperatively. Although new cases of delirium continued to occur throughout the first 3 days after surgery, the number of new cases decreased dramatically after the first day ($P<.001$). However, the

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**Table 2**

Sample characteristics by occurrence of delirium

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (n=118)</th>
<th>No delirium (n=77)</th>
<th>Delirium on first day (n=25)</th>
<th>Delirium in 3 days (n=41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>71.81 (10.19)</td>
<td>70.17 (9.66)</td>
<td>76.52b (11.54)</td>
<td>74.90b (10.53)</td>
</tr>
<tr>
<td>No. of comorbid conditions, mean (SD)</td>
<td>2.64 (2.09)</td>
<td>2.51 (2.05)</td>
<td>2.76 (2.12)</td>
<td>2.88 (2.15)</td>
</tr>
<tr>
<td>Female</td>
<td>64 (54)</td>
<td>31 (40)</td>
<td>17 (68)</td>
<td>33 (80)</td>
</tr>
<tr>
<td>Married</td>
<td>76 (64)</td>
<td>52 (68)</td>
<td>10 (40)b</td>
<td>24 (59)</td>
</tr>
<tr>
<td>Functional limitations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision impairment</td>
<td>57 (48)</td>
<td>36 (47)</td>
<td>15 (60)</td>
<td>21 (51)</td>
</tr>
<tr>
<td>Hearing impairment</td>
<td>34 (29)</td>
<td>22 (29)</td>
<td>7 (28)</td>
<td>12 (29)</td>
</tr>
<tr>
<td>Mobility impairment</td>
<td>17 (14)</td>
<td>8 (10)</td>
<td>8 (32)b</td>
<td>9 (22)</td>
</tr>
<tr>
<td>Lifestyle factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy alcohol intake</td>
<td>24 (20)</td>
<td>13 (17)</td>
<td>4 (16)</td>
<td>11 (27)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>17 (14)</td>
<td>12 (16)</td>
<td>2 (8)</td>
<td>5 (12)</td>
</tr>
</tbody>
</table>

a Values are number (%) unless otherwise indicated. Pearson $\chi^2$ used for categorical data and $t$ test for all continuous data.
b $P<.02$.

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Results

Characteristics of the Sample

The mean age of the participants (n=118) was 71.81 years (SD, 10.19), and slightly more than half were female (54%; Table 2). Most (64%) were married or in a common-law relationship. Comorbid health problems were common, particularly hypertension (57%), arthritis (38%) and hypercholesterolemia (36%). Most patients had multiple comorbid conditions: 1 in 5 patients (21%) had 5 or more. Although few patients were current smokers (14%), 1 in 5 (20%) exceeded daily alcohol intake guidelines. The most common abnormality in blood or serum levels preoperatively was hemoglobin; more than 44% of the patients had an abnormal value (Table 3). Postoperatively, the most common abnormality was hematocrit level; more than 72% of the patients had abnormal values. The majority of patients (70%) had been admitted early for their surgery. The surgery was typically long (mean, 2.5 hours; SD, 62 minutes) and included a mean intravenous infusion of 3.3 L of crystalloids. More than a quarter of the patients (27%) required an overnight stay in the critical care unit.

Variables included age, sex, marital status, vision impairment, number of comorbid conditions, duration of surgery, and volume of fluids given.
Overall daily incidence was relatively stable, from 15% to 21%.

Few characteristics differed for the patients who had delirium (Table 4). However, compared with patients who did not have delirium, patients with delirium were older, both those who had delirium the first day ($P = .02$) and those who had it within the first 3 days overall after surgery ($P = .009$). In addition, patients with delirium on the first day were more likely to be unmarried ($P = .004$) and to have a mobility impairment ($P = .005$), whereas those in whom delirium developed within the first 3 days of surgery were more likely to have had an admission to the critical care unit ($P = .02$).

Predictors of Postoperative Delirium

The predictors of delirium in the first day and overall for all 3 days postoperatively were determined by using logistic regression, and 2 models were developed (Table 5). With all other variables constant, the odds of having delirium the first day postoperatively decreased by 75% for patients who were married and increased more than 4 times for patients who had an early admission. In contrast, when other variables were held steady, the odds of having delirium in the 3 days postoperatively were increased more than 4 times for patients who were male, almost 3 times for patients who had an overnight admission to a critical care unit, and by 7% for each year of age; the odds were reduced by 2% by duration of surgery. Of note, the $P$ values for 2 variables, early admission (defined as more time between hospital admission and surgery) and overnight admission to a critical care unit, were slightly greater ($P = .06$) than the critical value of $P = .05$.

Discussion

Postoperative delirium is common and persistent in patients who have colorectal surgery. At least 1 in 3 patients in our study had delirium, and this
number most likely is an underestimation of the actual proportion of patients affected. Delirium was assessed once daily, so some cases may have been missed because of the fluctuating nature of delirium. For example, in patients who have abdominal surgery, when delirium is assessed 3 times a day, the incidence increases to 51%.19 Furthermore, many patients have delirium for several days postoperatively, and new cases continue to develop, especially within the first 3 days after surgery.12 Variability in the frequency of clinical assessment is a factor that makes comparison of prevalence rates across studies difficult in delirium research.41

Regardless, these numbers are disturbing because clinical guidelines for the routine postoperative care of patients after colorectal surgery rarely include regular assessment for delirium in the early stage of recovery or subsequently. Therefore, patients may not be receiving the most safe and suitable care necessary. Because delirium is an indicator of serious physiological problems such as sepsis, myocardial infarction, and acute metabolic disorders,14 such underlying conditions probably are not detected in a timely fashion. The underrecognition of delirium and lack of understanding that delirium is a serious medical condition requiring rapid intervention are consistent themes in delirium research.12-44 Recommendations have often been made to incorporate a dedicated focus for delirium education in both undergraduate nursing programs18 and continuing professional development.45 Although nurses clearly can play a vital role in early detection of delirium, this role is of value only if they can recognize and understand the significance of the onset of delirium.39,45,46

Importantly, if postoperative delirium goes undetected, patients and their families may experience unnecessary distress because patient care will not be altered and timely treatment of the causes will not be commenced. Clearly, a minimum daily assessment for delirium is justified, yet delirium assessment or, indeed, cognitive assessment is not often a routine part of postoperative patient care.

Because of their continual contact with patients, nurses can observe fluctuations in cognition, levels of consciousness, and attention and thus are in a key position to conduct these assessments.49,67 Nurses are the health care professionals most likely to first notice a change in a patient’s cognitive functioning. Nurses are also able to liaise with a patient’s relatives and visitors who are familiar with the patient’s usual mental functioning, thus promoting early diagnosis. Timely consultation with experts such as clinicians who specialize in psychogeriatric care is associated with better outcomes for patients who have delirium while in the hospital,42,65 but such consultation can occur only if nurses recognize that a patient has delirium. Timely diagnosis also allows staff to address immediate threats to a patient’s safety.

If nurses are unaware that a patient has delirium, their expectation that the patient is able to engage in recovery behavior may further compromise the patient’s safety. Because of the fluctuating nature of delirium, many patients with this condition are able to interact normally during lucid periods. This situation may lead to faulty assumptions that the patients are retaining and understanding essential educational

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### Table 4
Perioperative characteristics for occurrence of delirium

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (n = 118)</th>
<th>No delirium (n = 77)</th>
<th>Delirium on first day (n = 25)</th>
<th>Delirium in 3 days (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early admission, No. (%)</td>
<td>83 (70)</td>
<td>49 (64)</td>
<td>22 (88)</td>
<td>34 (83)</td>
</tr>
<tr>
<td>Critical care unit overnight, No. (%)</td>
<td>32 (27)</td>
<td>15 (20)</td>
<td>10 (40)</td>
<td>17 (41)</td>
</tr>
<tr>
<td>Duration of surgery, mean (SD), minutes</td>
<td>152 (62)</td>
<td>154 (56)</td>
<td>129 (40)</td>
<td>147 (71)</td>
</tr>
<tr>
<td>Intraoperative crystalloid infusion, mean (SD), L</td>
<td>3.3 (1.6)</td>
<td>3.3 (1.6)</td>
<td>2.7 (1.1)</td>
<td>3.1 (1.5)</td>
</tr>
</tbody>
</table>

A *t* test was used for continuous data and *χ²* for categorical data.

---

### Table 5
Model statistics and predictors of delirium in the first day and 3 days overall postoperatively

<table>
<thead>
<tr>
<th>Variable</th>
<th>P</th>
<th>Exp (B)</th>
<th>95% Confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delirium in the first day postoperatively (<em>χ²</em> = 14.7, Cox and Snell <em>R²</em> = 0.12, <em>P</em> = .001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>.01</td>
<td>0.25</td>
<td>0.10 - 0.67</td>
</tr>
<tr>
<td>Early admission</td>
<td>.06</td>
<td>4.48</td>
<td>0.96 - 21.04</td>
</tr>
<tr>
<td>Delirium in 3 days overall postoperatively (<em>χ²</em> = 18.8, Cox and Snell <em>R²</em> = 0.15, <em>P</em> = .001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being male</td>
<td>.02</td>
<td>4.27</td>
<td>1.43 - 16.90</td>
</tr>
<tr>
<td>Age</td>
<td>.04</td>
<td>1.05</td>
<td>1.00 - 1.10</td>
</tr>
<tr>
<td>Duration of surgery</td>
<td>.04</td>
<td>0.98</td>
<td>0.98 - 1.00</td>
</tr>
<tr>
<td>Critical care unit overnight</td>
<td>.06</td>
<td>2.97</td>
<td>0.96 - 0.17</td>
</tr>
</tbody>
</table>
information, such as use of patient-controlled analgesia, deep breathing, and mobility exercises. However, further research is needed to determine the duration of in-hospital postoperative delirium and its continuation after discharge; the potential persistence of delirium can make patient education and discharge planning more difficult.

Involving a patient’s family members, ensuring they clearly understand what is occurring, and providing opportunities for therapeutic communication are vital components of the recovery process. Family involvement is especially important because older patients and their families often have unarticulated fears that an episode of delirium is an indication of impending or developing dementia. This problem is compounded if patients remember their delirium experience; they require further reassurance that the delirium is a transient cognitive impairment related to their physical illness.

Predictors of Postoperative Delirium

Older age has often been identified as a predisposing risk factor in surgical patients, and our findings confirm this effect in patients more than 50 years old. Older patients are thought to be more susceptible because of the association between aging and an impaired physiological ability to compensate for or adjust to the physical demands of surgery when they already have comorbid conditions; vision, mobility, and hearing deficits; and increased use of medications. Consequently, more care and vigilance are needed for older patients than for younger patients.

Our finding that being male is an independent predisposing factor for delirium confirms findings of other studies. Edlund et al reported that men were not only more vulnerable than women to delirium but also were sicker on admission, experienced more postoperative complications, and had higher long-term mortality. The greater predisposition of men to delirium may be related to a sex-related general deficit in health-seeking behavior. Further investigation is required to understand why being male is a predisposing factor.

Of note, we found that postoperative delirium was less likely in patients who were married than in those who were not. This finding has not been reported before, perhaps because few investigators included marital status in their analysis. Most likely marital status indicates the presence of social support, which can reduce the incidence of delirium by 30%. However, the support of a loved one during hospitalization, including visiting at the time of assessment, might be influential, and this possibility is worthy of further investigation.

Although clinical factors have been identified as important in the development of postoperative delirium, most of these factors were not important in our study. Instead, factors likely to indicate an overall poor physical state were important, such as early admission before surgery or admission to a critical care unit after surgery. Early admission for surgery most likely is an indicator of more severe underlying colorectal problems and/or comorbid conditions. Severity of illness and hospitalization have been acknowledged as predisposing factors in the development of delirium in older patients. Similarly, we expected that admission to a critical care unit would be linked with postoperative delirium, because these patients often have other serious comorbid conditions, including cardiac disease and chronic renal failure, or have experienced surgical complications such as hypotension, extended duration of anesthesia, or slow awakening. Furthermore, the prevalence of delirium in critical care units is high, and this is associated with the underlying condition and the severity of illness necessitating admission to a critical care unit.

Overall, the multifactorial nature of the causes of delirium is important. Inouye found that the effects of precipitating factors and baseline vulnerability are multiplicative rather than additive. In our study, being unmarried, being male, requiring an earlier hospital admission, and being admitted to the critical care unit postoperatively were predictive of postoperative delirium.

Strengths and Limitations

The major strengths of our study were the use of a prospective design and a validated delirium diagnostic instrument (CAM) based on a detailed cognitive assessment. Several studies have indicated that the effectiveness of the CAM for diagnosing delirium lies in the skills and knowledge of the administering clinician. Therefore the training before data collection began was valuable. Having a single researcher-interviewer perform all delirium assessments also ensured consistency of delirium diagnosis throughout the study phase. The interviewer also involved nursing staff and patients’ family members who were present throughout the day.
However, because delirium is a fluctuating condition, once-daily assessment may have resulted in missed cases. Because the mean length of stay of patients who do not have complications is 7 days and the duration of our study was 72 hours, we might have missed cases of delirium that developed more than 72 hours after surgery. Additionally, many potential patients were not included in the study because they were admitted on the day of surgery. Thus, the study sample may have included more patients who were in a poorer health state. Other limitations included the use of proxy measures of sensory and functional status and self-report to determine alcohol and tobacco use. Additionally, the results may not be applicable to patients less than 50 years old.

We did not investigate all of the risk factors for delirium, such as oxygenation status, blood glucose levels, blood transfusions, use of medications, vital signs at the time of the delirium episode, and analgesia. Future research should include these factors in addition to the predictors we identified.

**Conclusion**

Postoperative delirium is relatively common in patients undergoing major colorectal surgery and may occur during, and persist for, the first 3 days after surgery. These findings provide an impetus for the implementation of routine screening protocols for postoperative delirium and show that a systematic approach to assessment and monitoring of postoperative delirium is clearly justified. Systematic identification of patients most at risk is essential for delirium prevention, early recognition, and prompt treatment of delirium, particularly because delirium indicates underlying serious physical conditions that have an adverse effect on safe recovery.

**ACKNOWLEDGMENTS**

This research was conducted at Sydney Adventist Hospital while Linda Thomson Mangnall was a postgraduate student enrolled in the Faculty of Nursing, Midwifery and Health, University of Technology, Sydney (Kuring-Gai Campus), Australia. The authors offer appreciation and thanks to the staff and patients of Harrison ward, level 12, at the Sydney Adventist Hospital, for their support of, and participation in, this research.

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**eLetters**

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