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Review of Postoperative Delirium in Geriatric Patients Undergoing Hip Surgery

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Abstract

Postoperative delirium is a serious complication following hip surgery in elderly patients that can adversely affect outcomes in both hip fracture and arthroplasty surgery. Recently, the incidence of hip fracture in the Medicare population was estimated at approximately 500 000 patients per year, with the majority treated surgically. The annual volume of total hip arthroplasty is nearly 450 000 patients and is projected to increase over the next 15 to 20 years. Subsequently, the incidence of postoperative delirium will rise. The incidence of postoperative delirium after hip surgery in the elderly patients ranges between 4% and 53%, and it is identified as the most common surgical complication of older patients. The most common risk factors include advanced age, hip fracture surgery (vs elective hip surgery), and preoperative delirium/cognitive impairment. Exact pathophysiology has not been fully defined. It is hypothesized that imbalances in cortical neurotransmitters or inflammatory cytokine pathway mechanisms contribute to delirium. Development of postoperative delirium is associated with longer hospital stay, increased medical complications, and poorer short-term functional outcome. Patients who develop postoperative delirium are also at increased risk for cognitive decline beyond the acute phase. Following acute care, postoperative delirium is associated with the need for a higher level of care, an additional cost. Management of postoperative delirium centers on prevention and early recognition. Medical prophylaxis has been demonstrated to have limited utility. Utilization of delirium detection methods contributed to early recognition. The most effective means of prevention involved a multidisciplinary team focused on adequate hydration, optimization of analgesia, reduction in polypharmacy, aggressive physiotherapy, and early recognition of the delirium symptoms.

Keywords

adult reconstructive surgery, Confusion Assessment Method, delirium, geriatric medicine

Introduction

Currently, nearly 450 000 patients undergo hip arthroplasty surgeries in the United States each year. The volume is expected to increase by 174% by 2030.[1] Recently, the incidence of hip fracture in the Medicare population was estimated at approximately 500 000 patients per year,[2] of whom the vast majority are treated surgically. Complications from these procedures persist, despite the improvements in patient selection, surgical and anesthetic techniques during surgery, postoperative pain management, and rehabilitation. Among these complications, postoperative delirium (POD) can adversely affect the clinical and functional outcome of the patients including cognitive performance, functional independence, and overall quality of life. In fact, delirium has been reported as the most common complication following the surgical treatment of hip fractures.[3] This complication can lead to prolonged hospital stays and increases in health-care costs. The estimated cost increase has been reported to be nearly 2.5-fold greater for patients with delirium in comparison with the cost for those without such complication. Leslie et al reported that the additional costs range from $16 000 to $64 000 per patient-year.[4] If these figures are extrapolated to the overall number of patients with POD, the total national cost is estimated to be from $38 billion to more than $150 billion annually. Furthermore, delirium is cited as preventable in 40% of patients, making prevention an attractive, attainable goal.[5]

The purpose of this review is to examine the incidence, risk factors, prognosis, and management of POD in the patients undergoing orthopedic hip surgery.

Incidence and Risk Factors for POD

There is no consensus among researchers with regard to the incidence of POD following hip surgery. Bruce et al conducted

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Table 1. Risk Factors for Developing Postoperative Delirium.

	Odds Ratio	95% Confidence Interval
Age >65	3.03	1.19-7.71
Chronic cognitive decline/ dementia	6.3	2.89-13.74
Poor vision/hearing	1.7	1.01-2.85
Severe illness	3.49	1.48-8.23
Presence of infection	2.96	1.42-6.16

a meta-analysis of 26 studies that focused on POD.[6] These studies reported incidence ranging from 4% to 53%. They cited several reasons for this wide variation of incidence: (1) variability in the screening tools for establishing the diagnosis of delirium (*Diagnostic and Statistical Manual of Mental Disorders* [*DSM*] *IV*, Confusion Assessment Method [CAM] criteria), (2) the timing of patient examination for screening as delirium may present even weeks after the acute perioperative phase, and (3) multiple other clinical factors were generally not controlled (eg, advanced age, medication effects, etc). According to the UK National Institute for Health and Care Excellence, the 5 major risk factors that have been correlated with delirium include (1) advanced age (>65), (2) dementia, (3) poor vision/hearing, (4) severe illness (affects activity of daily living [ADL]), and (5) presence of infection (see Table 1).[5] Among these, age is the most significant predictor. Further risk factors include functional dependence, hip fracture, dehydration, polypharmacy, inadequately controlled pain, excessive alcohol use, and electrolyte imbalance. Studies by Galanakis et al and Duppils and Wikblad have both demonstrated the correlation between significantly increased risk ($P < .001$) and incremental increases in the patient's age.[7,8] Bruce et al reported that POD would persist or worsen in 46% to 100% of those patients with preoperative delirium. To further specify risk within the umbrella term of hip surgery, patients undergoing hip fracture surgery consistently had greater risk than patients undergoing elective total hip replacement surgery in every study comparing these 2 different patient populations.[6-8]

Pathophysiology Mechanisms

The exact pathophysiology of POD is not fully defined. One hypothesized mechanism is that there is a relative decrease in acetylcholine and a relative increase in dopamine levels in the brain. These changes disrupt the cortical neurotransmitter interactions.[9,10] This imbalance results in decreases in the alertness and wakefulness of the patients. Structural and functional neuroimaging show that the prefrontal cortices, anterior and right thalamus, and right basilar mesial temporoparietal cortex may play a significant role in subserving delirium symptoms and may be the "final common pathway" for delirium from a variety of etiologies including the aforementioned imbalance in neurotransmitters.

Another hypothesis involves serum cholinesterase activity and the incidence of delirium postoperatively. Cerejeira et al investigated this relationship and measured preoperative and postoperative cholinesterase activity in 101 consecutive patients over 60 years of age undergoing elective total hip arthroplasty. Although a direct, causal relationship has not been proven, they reported that while patients who developed delirium had a similar drop in cholinesterase activity postoperatively as patients who did not develop delirium, the affected patients arrived preoperatively with significantly decreased levels of serum cholinesterase activity. This decrease in cholinesterase activity is an independent marker that may reflect vulnerability to developing delirium. Predisposition to delirium may be indicated because patients with decreased cholinesterase activity have less homeostatic reserve.[11] There are no defined mechanisms identified with regard to why hip surgery in particular would subject the patients to an increased risk for this complication. One cited proposed mechanism is systemic cytokine release.

Elevated Systemic Cytokines

One proposed mechanism for POD is elevated cytokines that are commonly associated with physiological stresses such as cortisol, interleukin 6, interleukin 8, S100B, and C-reactive protein (CRP). van Munster et al identified a group of 120 consecutive patients at least 65 years of age who underwent hip fracture surgeries and examined the levels of these cytokines prior to and during episodes of POD. They demonstrated that the cytokines were elevated in those patients with delirium. Interleukin 8 and cortisol levels were the highest just prior to the clinical diagnosis of delirium. Interleukin 6 and S100B reach their highest levels during the clinical course of delirium. In multivariate analysis, S100B was found to be the most predictive of POD.[12-14] C-reactive protein has been studied as well. Studies by Lemstra et al, Beloosesky et al, and Lee et al examined CRP levels in groups of 68, 32, and 65 elderly hip surgery patients, respectively. They compared the CRP levels in those patients with POD to those who did not have delirium. Neither Beloosesky et al nor Lemstra et al found the CRP levels to be a meaningful predictor of POD.[15,16] However, Lee et al found that CRP levels measured at 24 and at 48 to 72 hours postoperatively were significantly higher in the group that developed delirium, suggesting the marker may be useful for confirmation of a clinical diagnosis of delirium.[17]

Clinical Outcome and Prognosis

The clinical effects of POD in the elderly patient have been studied with regard to functional outcome, cognitive decline, and mortality. Studies[18-23] have consistently demonstrated that the immediate effects of POD include (1) longer hospital length of stay, (2) decreased independence in the ADLs, (3) increased medical complications, and (4) poorer overall functional outcome. These studies differ, however, on the duration of these functional declines. Edelstein et al identified 921 elderly patients undergoing hip fracture repair and reported that the 47 patients with POD had relatively decreased ADLs and were

Table 2. Effects of Postoperative Delirium.

Effects of POD	
Immediate	Long term
Decreased independence in ADLs	Deterioration of cognitive capacity
Increased medical complications	Increased risk of developing dementia
Long-term hospital stay	Mortality (1 and 5 years)
Nursing home placement	
Poorer overall functional outcome	

Abbreviations: ADLs, activities of daily living; POD, postoperative delirium.

less likely to return to baseline ambulation at 1 year postoperatively.[19] Givens et al identified a group of 126 patients older than 65 years undergoing hip fracture repair and similarly reported that the 52 patients with POD demonstrated a reduction in the independent ADLs and ambulation at 1 month after surgery. However, this reduction was no longer present at 6 months after surgery, suggesting that POD affected only short-term rehabilitation outcomes.[21] Marcantonio et al report that the severity of the delirium also affected the functional outcome and mortality. In a study of 122 patients older than 65 years with hip fracture, they reported that severe delirium (as determined by their Memorial Delirium Assessment Scale score) resulted in an increased risk of nursing home placement or mortality at 6 months (52% vs 19%, $P = .009$).[23]

Most of the studies focusing on the long-term effects of POD demonstrated deterioration of cognitive capacity and increased risk for the development of dementia when compared to those patients who did not develop POD.[20,24-27] Bickel et al identified 200 hip surgery patients older than 60 years who were without known neurological impairment at baseline. They assessed their cognitive status at 8 and 38 months after discharge using the telephone Mini-Mental State Examination (MMSE). Of the surviving patients with POD, 53.8% had cognitive impairment, compared with only 4.4% of the nondelirious patients.[20] Kat et al identified 112 hip surgery patients over 70 years of age and followed them for an average of 30 months to assess their cognitive status using the MMSE and the Informant Questionnaire on Cognitive Decline in the Elderly tests. Of the surviving patients in the delirium group, 77.8% had dementia or mild cognitive impairment, compared to 40.9% of the control patients.[26] There are no specific pathophysiologic mechanisms identified with regard to the relationship between POD and later dementia (see Table 2).

Controversies exist with regard to whether POD increases perioperative mortality. Lundstrom et al and Edelstein et al have reported increased mortality in hip fracture patients with POD in contrast to those without such complication.[19,28] Lundstrom et al identified 78 patients older than 65 years who underwent hip fracture repair and reported increased 5-year mortality in those patients who had POD (72.4%) compared to those who did not (34.7%).[28] Edelstein et al identified 921 elderly patients undergoing hip surgery and reported increased 1-year mortality in patients who had POD (odds ratio [OR]: 2.4, $P = .02$). They suggested the increase in the mortality rate could be due to medical comorbidities, and perhaps also from the extended hospital stay.[19] Juliebo et al, Bickel et al, and Kat et al conducted similar studies to assess the mortality in the elderly hip surgery patients in large populations of 331, 200, and 603 hip surgery patients, respectively. They all initially noted an increased mortality in patients who had POD; however, there was no increased risk once adjustments were made for preoperative cognitive impairment, age, illness severity, and other medical comorbidities[20,29,30] (see Table 2).

Detection

Typically, delirium is diagnosed by examining history, physical examination, and review of medical records. However, studies have shown that nurses and physicians often miss diagnoses of delirium when relying on bedside examination alone. A diagnostic test is crucial for detecting POD early in order to diagnose and treat. Hypoactive delirium is also a serious concern that can be easily overlooked by bedside examination without any diagnostic test or tools. This type of delirium also often has the worst outcomes. The most common criteria to recognize patients with delirium are *DSM* or CAM diagnostic algorithm. The reason to implement early diagnosis is that a late or missed diagnosis of POD leads to increased mortality. Todd et al implemented a delirium protocol for 33 elderly postoperative hip fracture patients and compared outcomes with a historical control from the same unit. Delirium was detected in 18% of the patients, with detection reducing the length of stay by 22% ($P < .001$). Upon discharge, patient disposition showed a 13% ($P < .17$) improvement and satisfaction scores showed a 15% ($P < 0.15$) increase. The nursing staff utilized CAM and documented a positive or negative result. Upon negative result, the test was readministered at regular intervals. Upon positive result, nurses identified possible causes of delirium and initiated the interdisciplinary plan of care for delirium. This included evidence-based interventions such as initiating the sleep protocol, which consists of a back rub, warm drink, and relaxation tapes. Furthermore, nurses notified the physician of the newly positive CAM patient. This illustrates the feasibility and efficacy of delirium detection and treatment programs.[31] This study also highlights that one of the most effective methods for early detection of delirium may be training nurses to properly utilize delirium screening tools during the perioperative period. Additionally, shortened screening tools are also available and include Delirium-O-Meter, CAM short form, Delirium Observation Screening, and Nursing Delirium Screening Scale.[5]

Cost

Lack of diagnosis presents not only a clinical impact but a financial impact as well. Cost is a significant consideration when dealing with hip fracture patients and delirium. With an increasing push toward preventative medicine and movement to decrease overall health-care costs, the need to track health-care spending is becoming more and more important and may shed light on where cost can be reduced. A study conducted at a single facility by Zywiel et al prospectively analyzed the increased cost due to delirium in hip fracture patients. The study included a total of 242 patients 65 years of age or older (mean age, 82 years; range, 65-103 years) who were screened using the CAM following surgical treatment of a fragility hip fracture in order to detect perioperative delirium. Of the 242 patients who were screened, 116 (48%) were diagnosed with perioperative delirium (according to their CAM results) during their stay in the hospital. Upon analyzing outcomes, compared with patients with no delirium, delirium was associated with a mean incremental total length of hospital stay of 7.4 days (95% confidence interval [CI] = 3.7-11.2 days; $P < .001$) and a mean incremental length of stay following surgery of 7.4 days (95% CI = 3.8-11.1 days; $P < .001$). Furthermore, a financial analysis done at the facility showed a mean incremental episode-of-care cost (in 2012 Canadian dollars) attributable to delirium of $8286 (95% CI = $3690 to $12 881; $P < .001$) per patient and a total incremental episode-of-care cost over the study period of $961 131 in 2012 Canadian dollars.[32] Figures such as these illustrate the significance of POD and justify the need to divert attention to increasing the speed of detection and intervention. If the time patients spend in the hospital can be decreased, by any margin across the board, this can have huge effects on health-care spending.

At a possibly greater cost, patients who developed POD had a much higher rate of new admission to a skilled care facility following the acute care hospital stay (8% vs 0% $P = .002$).[32] The need for long-term care following POD is likely due to decreased functionality and required aid in ADLs. This increased rate of transfer to care facility represents a preventable cost. One must also take into consideration the cost of transferring patients from acute care facilities to skilled care facilities, another accumulation of expense that can be avoided by early screening and diagnosis of POD.

Management of POD

The most important clinical management strategy is prevention. Nonpharmacologic intervention shows the most promise. A set of 10 studies show that nonpharmacologic approaches for POD intervention, implemented and monitored by an interdisciplinary team, successfully reduced POD between 30% and 40%.[28,33-40] Early mobilization and aggressive physiotherapy protocols are integral to successful patient management. In a retrospective review of 131 patients who underwent hip fracture surgery, Kamel et al found an increased risk of developing POD with each day in which the patients did not ambulate (1.72 OR/day).[41] Nonpharmacologic strategies for delirium prevention include sensory enhancement (glasses, hearing aid, or listening amplifier maintenance), mobility enhancement (ambulation at least twice per day), cognitive orientation and therapeutic activities, cognitive stimulation, simple communication standards, nutritional and fluid replacement enhancement, sleep enhancement (nonpharmacologic sleep protocol/sleep routine), proper medication management, and daily rounding by interdisciplinary team to reinforce interventions (see Table 3).[5]

Table 3. Non-pharmacological Strategies to Prevent Postoperative Delirium.

Nonpharmacologic Strategies to Prevent POD
Early mobilization
Sensory enhancement (glasses, hearing aid, etc)
Cognitive orientation/stimulation
Nutritional and fluid replacement enhancement
Sleep enhancement
Daily rounding

Abbreviation: POD, postoperative delirium.

Two major advances in the prevention of POD are the limitation of sedation depth intraoperatively and the administration of adequate analgesia before and after surgery. In some cases, regional anesthesia is not appropriate. For such cases, depth of anesthesia can be modulated to reduce the incidence of POD. One study discovered that deep sedation was associated with increased rates of POD when compared with lighter sedation during surgery.[42] Furthermore, 2 trials showed that anesthesiologists who were randomized to use bispectral index data to guide anesthesia had a lower incidence of delirium. Bispectral index utilization is important because a priori use of light anesthesia introduces risk of intraoperative recall, patient movement, and excessive sympathetic stimulation leading to hypertension and tachycardia.[43,44] Morrison et al report that improved analgesia decreased the risk for POD. In a study of 541 patients who underwent surgery for hip fracture, they found that those who received less than 10 mg/d of parenteral morphine sulfate were more likely to develop POD than those who received 10 to 30 mg/d (relative risk [RR]: 5.4, 95% CI: 2.4-12.3).[45] Mouzopoulos et al recommend using regional blocks as another method for improved pain management. In a study of 219 patients aged 70 or older undergoing hip fracture surgery, they reported that those randomized to receive fascia iliaca blocks were less likely to have POD (RR: 0.45, 95% CI: 0.23-0.87).[46]

A multidisciplinary team consisting of the surgeons, the geriatric medicine specialists, nursing managers, social workers, physiotherapists, and the pain management service is critical in optimizing the patient outcome. The geriatric medicine or hospitalist consultant(s) would oversee medication interactions, reduction in polypharmacy, proper fluid management, and management of multimodal pain protocols.[47] Marcantonio et al utilized this approach in 126 elderly patients admitted for surgical repair of a hip fracture. The group randomized to receiving the proactive geriatrics consultation experienced fewer episodes of POD and less severe POD (RR: 0.64 and 0.40, respectively). Björkelund et al identified a group of 263 patients over 65 years of age who underwent hip fracture repair and randomized them to receive either multidisciplinary care plan or normal unit care. They demonstrated a reduction in the incidence of POD (34% vs 22%, $P = .031$) using a multimodal intervention protocol including (1) optimization of medical risk factors (increased O_2 supplementation before and after surgery, increased IV fluid administration preoperatively, and reduction in unnecessary medications including antiemetics and anticholinergics), (2) reduction in the time interval from admission to arrival on the orthopedic ward (4.6-2.7 hours), and (3) effective pain management before and after surgery (intervention group received significantly more analgesics directly after surgery).[33] Lundstrom et al randomized 199 elderly hip fracture surgery patients to postoperative care on either a geriatric unit or a conventional orthopedic ward and demonstrated an effective reduction in the incidence of delirium ($P = .003$) in those patients randomized to the geriatric unit. Moreover, the duration of delirium was shorter (5 vs 10 days), the overall medical complications were lower, and the length of hospital stay was shorter (28 vs 38 days).[28] A multidisciplinary team is also useful in monitoring the onset of delirium in patients. Milisen et al utilized this multidisciplinary approach to screen 120 elderly hip fracture patients for the development of delirium. The data demonstrated no reduction in the incidence of POD in those patients. However, the severity and duration of the delirium were both lowered.[48] Aside from the improved clinical outcomes, Pretto et al also demonstrated increased efficiency in reducing nursing workload using these multidisciplinary management protocols.[49]

Summary

Postoperative delirium is a common and serious complication following hip surgeries. The most significant risks are advanced age, hip fracture surgery, and preoperative cognitive impairment. Current research data support an increase in the stress cytokines to be the potential mechanisms of pathogenesis. The short-term implications of POD include longer hospital length of stay, medical comorbidities, and possible increased mortality. The long-term sequelae include potential increased risk of developing dementia. The most effective management strategy is screening and prevention with a focus on nonpharmacologic intervention. Multidisciplinary screening and management teams and protocols are critical to reduce this complication and to optimize patient outcome.

Declaration of Conflicting Interests

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