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Low postoperative delirium rates at an urban academic hospital

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LOW POSTOPERATIVE DELIRIUM RATES

AT AN URBAN ACADEMIC HOSPITAL

by

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DEDICATION

I would like to dedicate this work to my mother, Addis, and my father, Marlon.

ACKNOWLEDGMENTS

I would like to give a special thank you to Dr. Ala Nozari, Dr. Robert Canelli, Dr. Jean Spencer, Shivali Murkerji, and Dayessi Rivero for their contribution to this study, support, and overall insight throughout this year. They have truly made this a heartening and motivational experience for me.

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ABSTRACT

Introduction: Postoperative delirium (POD) is defined as an acute change in the state of mind that is associated with memory loss and behavioral changes after an operation. Although the pathophysiology of postoperative delirium is not fully understood, there are many established factors associated with this altered mental state such as older age, prior history of drug or alcohol abuse, and pre-existing cognitive impairment. Previous literature has reported the rate of POD to be 10% to 15%. Boston Medical Center (Boston, Massachusetts) is an urban accountable care organization (ACO) that provides healthcare for an underserved and often uninsured population, many of whom have chronic disease and substance use disorders and other risk factors for POD. This study aimed to determine the rate of POD at this safety net hospital, anticipating that the rate might be higher than the reported national average.

Methods: This study had both a prospective arm and a retrospective arm. In the prospective arm, patients were screened (June 2021–December 2021) for eligibility prior to their surgery. On the day of the surgery, eligible patients were approached, and consent was obtained. Inclusion criteria were all patients between the ages of 65 and 89 who presented for surgery (non-cardiac, non-neuro) under general anesthesia and required a minimum hospital stay of 3 days. Chart reviews were performed, and Confusion Assessment Method (CAM) scores were recorded by nurses and collected for 3 postoperative days. The retrospective arm of the study analyzed patients who met the same inclusion criteria between the years of 2018 and 2019. CAM scores were collected, and rates of POD were determined for both arms of the study.

Results: A total of 52 patients were enrolled in the prospective arm of the study. Two patients were found to be CAM positive at some point in their postoperative course, giving a rate of POD of 3.85%. The mean age (SD) of CAM-negative patients was 72.0 (5.4) years, whereas the mean age (SD) of CAM-positive patients was 71.2 (3.0) years. The male and female participants were equally represented in both the CAM-positive and CAM-negative cohorts. The only statistically significant finding in the prospective arm was whether the patient was hypernatremic ($p = .015$). For the retrospective arm of the study, there were a total of 244 patients who fit the same inclusion criteria as used for the prospective arm. Two patients tested positive for delirium, making the rate of POD at 0.82% for this period. The statistically significant variable in the retrospective arm was the hospital length of stay ($p = .026$).

Discussion: The rate of POD at this urban safety net hospital appears to be much lower than the cited average of 10%–15%. It is possible that POD rates have improved dramatically since the cited averages because of enhanced recovery after surgery (ERAS) protocols and delirium prevention measures. It is also possible that POD is underdiagnosed, especially in non-intensive care unit (non-ICU) settings, where bedside nurses are less familiar with the POD scoring systems. Further research is needed to assess the accuracy of delirium scoring in non-ICU settings.

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LIST OF ABBREVIATIONS

ACO .... accountable care organization

ASA .... American Society of Anesthesiologists

BMC .... Boston Medical Center

BMI .... body mass index

CAM .... Confusion Assessment Method

CDC .... Centers for Disease Control and Prevention

COPD .... chronic obstructive pulmonary disease

DSM .... *Diagnostic and Statistical Manual of Mental Disorders*

DVT .... deep vein thrombosis

ERAS .... enhanced recovery after surgery

EHR .... electronic health record

GCS .... Glasgow Coma Scale

GERD .... gastroesophageal reflux disease

HIPAA .... Health Insurance Portability and Accountability Act

ICDSC .... Intensive Care Delirium Screening Checklist

ICU .... intensive care unit

IL-6 .... interleukin 6

IRB .... Institutional Review Board

LOS .... length of stay

MAC .... monitored anesthesia care

NCCDPHP .... National Center for Chronic Disease Prevention and Health Promotion

POD .... postoperative delirium

RA ....research assistant

RASS ....Richmond Agitation-Sedation Scale

REDCap .... Research Electronic Data Capture

SAS ....Riker Sedation-Agitation Scale

SDC.. surgical day care

STAMP .... surgical trauma-associated molecular patterns

TIVA .... total intravenous anesthesia

INTRODUCTION

Delirium is an acute disturbance in a patient's mental state that results in confusion, changes of state of mind, or memory loss. This change of state of mind can persist from days to weeks and could eventually lead to death (Gogia & Fang, 2022). There are specifically three forms of delirium: hyperactive, hypoactive, and mixed delirium. Hyperactive delirium is easily recognizable by rapid mood changes, uncooperativeness, and hallucinations. Hypoactive delirium is a bit harder to recognize because of its "silent nature" characterized by restlessness, unresponsiveness, and psychomotor retardation (Whitlock et al., 2013). Mixed delirium has a mixture of both hyperactive and hypoactive forms that can vary throughout the day (van Velthuijsen, 2018).

Risk Factors for Delirium

The pathophysiology of delirium is poorly understood. Delirium is caused by the impairment of receiving and/or sending signals from the brain (Hála, 2007). Recent published research has shown that acetylcholine deficiency and decreased oxidative metabolism in the brain play a major role in the pathophysiology of delirium, but how this condition develops postoperatively has yet to be well understood (Hála, 2007). There have been identified risk factors that increase a patient's chances of developing delirium. Some of those risk factors include age >65 years, metabolic imbalances, medical procedures that use anesthesia, history of drug or alcohol abuse, cognitive disorders, visual or hearing impairment, history of delirium, malnutrition, and any medical illnesses

(Robinson et al., 2009). Patients presenting with more than one of these predisposing risk factors are more prone to develop delirium.

Elderly Population

The Urban Institute (Washington, D.C.) reports that the American population over the age of 65 has been increasing quickly within the last century. Figure 1 shows from the years of 2000 to 2020, the number of people ages 65–84 increased from 31 million to 47 million, and ages 85 and older increased from 4 million to 7 million. It is estimated that these numbers will continue increasing, and by 2040, roughly 20% of the U.S. population will be ages 65 and older (Urban Institute, 2015).

Delirium disproportionately affects the elderly population. Although just a small percentage of the general population is affected (1%–2%), it is believed to occur in up to 14% of those over the age of 85 (Inouye et al., 2014). Furthermore, it has been reported that 8%–17% of older patients requiring emergency care develop delirium. This percentage increases in the nursing home setting where it has been reported that as many as 40% of older patients have presented with delirium (Inouye et al., 2014).

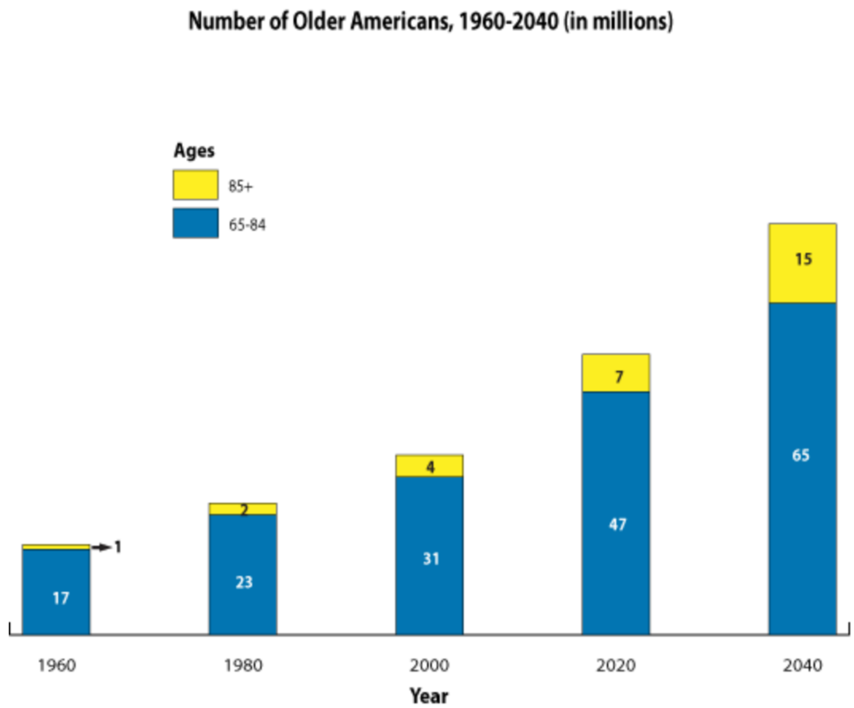

Figure 1. Number of Older Americans. This graph shows the rapid increase of the elderly population in the United States reported by the U.S. Census Bureau. By the year 2040, the elderly population will double from the reported number in 2000. From (Urban Institute, 2015).

Interrelationship Between Delirium and Dementia

According to the Centers for Disease Control and Prevention (Atlanta, Georgia), dementia is defined as the "impaired ability to remember, think and make decisions" and is not normal for aging (Centers for Disease Control and Prevention [CDC], 2019). In 2014, reports found that an estimated 5 million adults ages 65 years and older in the United States have dementia. It has been estimated that by 2060, 14 million Americans ages 65 years and older will have dementia (CDC, 2019). As the population of older adults grows in the United States, so does the percentage of those affected by dementia. It is important to underscore the relationship between dementia and delirium, given the importance of dementia as a risk factor that almost directly correlates with delirium. Figure 2 depicts the direct and indirect mechanisms by which delirium and dementia have an interrelationship. Direct factors such as hypoxia, drugs, and stroke can cause delirium and increase the chances of developing dementia. Figure 2 emphasizes the possibility of accelerating pre-existing dementia as a result of the development of delirium. The use of anesthesia in patients 60 years and older has been associated with postoperative cognitive decline, which impacts a patient's ability to conduct daily tasks. As shown in Figure 2, the use of anesthesia is strongly associated with the development of both delirium and dementia.

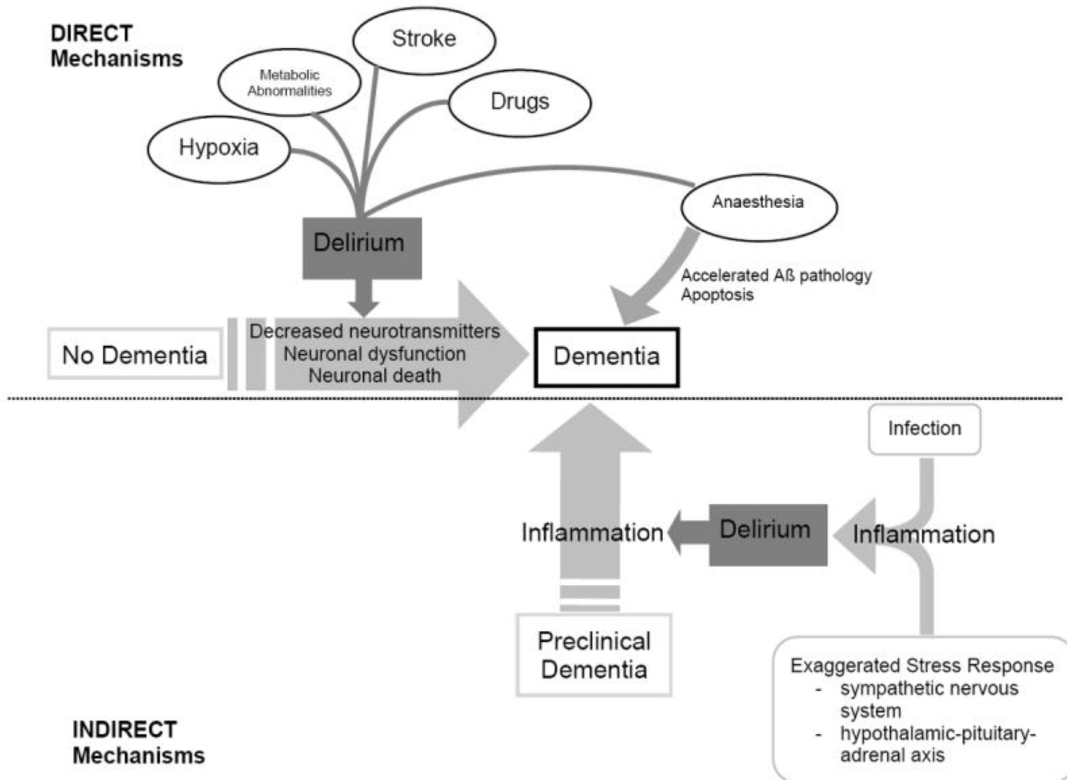

Figure 2. Interrelationship Between Delirium and Dementia. This model emphasizes the pathophysiologic interrelationship between delirium and dementia. It highlights direct mechanisms such as hypoxia, anesthetics, and drugs, which are established risk factors for delirium, and how they can possibly cause dementia. The development of delirium, causing an acceleration of pre-existing dementia in patients, highlights why recognition and treatment of delirium are important factors in preventing other neurocognitive disorders from developing. From (Fong et al., 2015).

Accountable Care Organization in an Urban City

An accountable care organization (ACO) is a group of doctors and healthcare facilities that come together to give coordinated high-quality care to patients while avoiding unnecessary and duplicated services. An ACO has a specific goal to improve the health of an entire population by focusing on disease prevention and treating patients with chronic disease while controlling healthcare costs for those patients (National Center for Chronic Disease Prevention and Health Promotion [NCCDPHP], 2016). As many as

20% of hospitals in the United States participate in ACOs since 2014 (NCCDPHP, 2016). ACOs are usually located in urban cities in the United States. Researchers have found that as many as 13% of patients who belong to an ACO are below the federal poverty line (Lewis et al., 2017). Many of these patients are immigrants and uninsured, and they have many comorbidities. In a research study that investigated ACOs serving a high proportion of racial and ethnic minorities compared with ACOs that do not, the results emphasized the difference in quality care (Lewis et al., 2017). The study showed that ACOs that serve a high minority population were less likely to offer services such as outpatient rehabilitation and hospice care. The study also indicated that ACOs serving a high minority population performed worse in clinical and process measures compared with ACOs serving low minority populations (Lewis, 2017).

Boston Medical Center

Boston Medical Center (BMC) is an urban, academic hospital located in the South End of Boston, Massachusetts. BMC is one of the few ACOs in the city of Boston. There are over one million patient visits every year. About 72% of these visits are from a patient population mostly made up of underserved, uninsured, low-income families. BMC provides healthcare to a large number of patients with chronic illnesses such as obesity, cancer, and cardiovascular diseases. They also provide healthcare to many patients with substance use disorders. More than 50% of the patient population at BMC are ethnic and racial minorities, and over 30% of the patients do not speak English. Many of the patients at BMC are elders and immigrants. BMC is also a Level 1 adult trauma center, a designation which means there are many high-risk surgeries daily. The elderly population makes up many of these high-risk surgeries, which are most commonly abdominal, thoracic, and spinal surgeries. The average length of stay at BMC after a surgery is 6.35 days.

Patients presenting for surgery at Boston Medical Center generally have many risk factors for postoperative delirium (POD), including advanced age, chronic medical conditions, dementia, and substance use disorder. Therefore, one could expect a higher rate of POD when compared with the general population.

Postoperative Delirium

Postoperative delirium (POD) is a form of delirium after an operation that includes anesthesia. It usually presents in the first 3 days after the surgical procedure (Whitlock et al., 2011). Postoperative delirium can happen to any person of any age, but the likelihood of having POD increases as one gets older (Neufeld, 2013). POD is a known complication after surgery for older patients, with 15%–25% of patients developing delirium after elective surgery. The incidence of POD in older patients increases to 50% when they undergo a high-risk surgery, such as hip fracture repair (Ramírez Echeverría & Paul, 2021). Symptoms of POD include agitation, fatigue, hallucination, slurred speech, rapid mood swings, uncooperative or aggressive behavior, and difficulty focusing (Wingfield, 2020).

Consequences of Postoperative Delirium

There are many implications for patients who develop POD, including increased hospital length of stay, increased need for mechanical ventilation, increased mortality, increased risk of cognitive decline, and increased associated medical costs (Pisani et al., 2009). A study that investigated the impact that delirium had on mortality rates in a general medical ward reported that "mortality significantly increased 11% for every 48 hours of delirium" (González et al., 2009).

Based on one investigation of healthcare spending in the United States, POD costs roughly $32.9 billion per year to manage, an amount which rivals the costs of diabetes and cardiovascular disease healthcare treatments (Gou et al., 2021). The study claimed that POD should be addressed as a public health issue affecting the elderly population. It was also noted that as the severity of delirium increases, the cost of treatment increases as well. Mild delirium healthcare costs started at $83,534, whereas severe delirium healthcare costs were at $140,008. The findings of this study emphasized that delirium is indeed a public health crisis for the elderly population and has severe economic consequences for both the patient and the hospital (Gou et al., 2021).

Confusion Assessment Method

There are only a handful of validated screening tools to identify delirium. One of these tools is the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) score. The CAM-ICU scoring system is a diagnostic tool used to identify the development as well as the resolution of delirium in the clinical setting. Although this tool was developed for use with critically ill patients in the intensive care unit (ICU), its' use has been extended to medical and surgical floors as well. This assessment was designed to be used by providers without any psychiatric background and takes less than one minute to complete (Gusmao-Flores et al., 2012). There are four features assessed by

CAM-ICU: (1) mental status, (2) inattention, (3) altered level of consciousness, and (4) disorganized thinking (see Figure 3).

To assess for acute onset of mental status change or fluctuating mental status (feature 1), the bedside nurse tries to determine if there has been a change from the patient's baseline mental status. An accurate assessment requires that the patient's baseline mental status be known. If the patient is assessed to have no changes from baseline ("No"), then the patient is CAM negative, and delirium is absent. However, if the patient has changes ("Yes"), then the assessment proceeds to the second feature.

Feature 2 assesses inattention which is done by testing the patient's alertness through responses to stimuli from the environment. This stimulus can be sound, movement, or events occurring in the environment. For example, the nurse spells a word or phrase, such as "C-A-S-A-B-L-A-N-C-A," and instructs the patient to squeeze the nurse's hand when the letter "A" is spoken. An error occurs when the patient squeezes without an "A" or fails to squeeze when "A" is spoken. If the patient makes no more than 1 error, the individual is CAM negative and delirium is absent. If the patient commits 2 or more errors, the assessment proceeds to the third feature.

Feature 3 evaluates the level of consciousness which is measured by using the Richmond Agitation-Sedation Scale (RASS). RASS is a method that assesses a patient's level of sedation in the ICU through a 10-point scale. Table 1 depicts RASS with four levels of agitation which scale from +1 to +4, five levels of sedation which scale from –1 to –5, and one level of alert and calm at 0 (Trivedi & Iyer, 2016). If the patient's RASS level is anything other than 0 (alert and calm), the patient is CAM positive and delirium is present. If the patient's RASS level is 0, the clinician then proceeds to the fourth feature.

Feature 4 assesses disorganized thinking in which the patient uses verbal or written words and/or uses movement to respond. Feature 4 asks four questions such as "Does one pound weigh more than two pounds?" and asks a two-step command such as "Hold up 1 finger and do the same with your other hand." The questions and commands are done to accurately identify if the patient has any disorganized thinking. If the patient has more than 1 error, then the individual is CAM positive, and delirium is present. If the patient commits 0–1 errors, the patient is considered CAM negative, and delirium is absent. Feature 4 presents a problem with patients who are nonverbal and/or have lost motor abilities. It is important to emphasize that according to the CAM-ICU tool, if features 1 plus 2 and either feature 3 or feature 4 are present, delirium is present (Ely, 2016).

CAM-ICU Worksheet

Feature 1: Acute Onset or Fluctuating Course	Score	Check here if Present
Is the patient different than his/her baseline mental status? OR Has the patient had any fluctuation in mental status in the past 24 hours as evidenced by fluctuation on a sedation/level of consciousness scale (i.e., RASS/SAS), GCS, or previous delirium assessment?	Either question Yes →	☐
Feature 2: Inattention		
<u>Letters Attention Test</u> (See training manual for alternate **Pictures**) <u>Directions</u>: Say to the patient, *"I am going to read you a series of 10 letters. Whenever you hear the letter 'A,' indicate by squeezing my hand."* Read letters from the following letter list in a normal tone 3 seconds apart. **S A V E A H A A R T** or **C A S A B L A N C A** or **A B A D B A D A A Y** **Errors are counted when patient fails to squeeze on the letter "A" and when the patient squeezes on any letter other than "A."**	Number of Errors >2 →	☐
Feature 3: Altered Level of Consciousness		
Present if the Actual RASS score is anything other than alert and calm (zero)	RASS anything other than zero →	☐
Feature 4:Disorganized Thinking		
<u>Yes/No Questions</u> (See training manual for alternate set of questions) 1. Will a stone float on water? 2. Are there fish in the sea? 3. Does one pound weigh more than two pounds? 4. Can you use a hammer to pound a nail? **Errors are counted when the patient incorrectly answers a question.** **<u>Command</u>** Say to patient: "Hold up this many fingers" (Hold 2 fingers in front of patient) "Now do the same thing with the other hand" (Do not repeat number of fingers) *If the patient is unable to move both arms, for 2nd part of command ask patient to "Add one more finger" **An error is counted if patient is unable to complete the entire command.**	Combined number of errors >1→	☐

Overall CAM-ICU **Feature 1 <u>plus</u> 2 <u>and</u> either 3 <u>or</u> 4 present = CAM-ICU positive**	**Criteria Met →**	☐ **CAM-ICU Positive** **(Delirium Present)**
	Criteria Not Met →	☐ **CAM-ICU Negative** **(No Delirium)**

Figure 3. Confusion Assessment Method Worksheet. This worksheet depicts the four features of the CAM method that nurses and other health professions use to evaluate a patient's cognitive status after a procedure. The purpose of this worksheet is to have a step-by-step process to identify delirium in a patient in less than one minute. CAM = Confusion Assessment Method; GCS = Glasgow Coma Scale. ICU = intensive care unit; RASS = Richmond Agitation-Sedation Scale; SAS = Riker Sedation-Agitation Scale. From (Ely, 2016).

Table 1. Richmond Agitation-Sedation Scale. The Richmond Agitation-Sedation Scale (RASS) is a scale that is part of the CAM method and specifically used to detect the level of consciousness in a patient.

+4	**Combative**	Combative, violent, danger to others
+3	**Very Agitated**	Pulls or removes tube(s) or catheter(s), aggressive
+2	**Agitated**	Frequent non-purposeful movement, fights ventilator
+1	**Restless**	Anxious, apprehensive, but movements not aggressive or vigorous
0	**Alert & Calm**	
-1	**Drowsy**	Not fully alert, but has sustained awakening to voice (eye opening & contact >10 sec)
-2	**Light Sedation**	Briefly awakens to voice (eye opening & contact <10 sec)
-3	**Moderate Sedation**	Movements or eye opening to voice (but no eye contact)
-4	**Deep Sedation**	No response to voice, but movement or eye opening to physical stimulation
-5	**Unarousable**	No response to voice or physical stimulation

Note. CAM = Confusion Assessment Method. Adapted from (Sessler et al., 2002).

Preventions and Interventions of POD

POD is not well understood, but prevention strategies to decrease a patient's risk of developing delirium postoperatively have been established and implemented in many institutions. A study in Madrid analyzed the effectiveness of a multicomponent intervention implemented into daily practice to prevent POD in older patients (Vidán et al., 2009). This multicomponent intervention included daily monitoring of orientation, sensory impairment, sleep, mobility, hydration, drug use, and nutrition. The findings emphasized that nonpharmacological interventions reduced POD in older patients and improved the quality of care that the patients received (Vidán et al., 2009).

Preventative strategies, specifically the non-pharmacological interventions that are done to prevent POD, include regulating the sleep-wake cycle, getting patients their glasses and hearing aids once they wake up from their procedure, and limiting vital signs and lab draws during nighttime hours. Based on Figure 4, box B considers the preventative measures that could be done to avoid postoperative delirium (Robinson & Eiseman, 2008). At BMC, there is a delirium precautions order set in the computerized provider order entry system (Epic Systems, Verona, Wisconsin) that can be used to assist the healthcare team with assuring that all applicable delirium preventive strategies are ordered.

A pharmacological approach to prevent POD in older patients includes the use of antipsychotics for prophylaxis as well as management. Some studies investigating the use of prophylactic antipsychotics, such as haloperidol, for the prevention of delirium have suggested that perioperative use of prophylactic antipsychotics can reduce POD in older patients (Janssen et al., 2019). Notably, antipsychotic medications are also used for the treatment of POD. One study evaluating the effectiveness of haloperidol as prophylaxis for POD was done in patients age 70 years and older having hip surgery (Kalisvaart et al., 2005). The patients were given either haloperidol (1.5 mg per day) or a placebo postoperatively for 3 days. The study concluded that the use of haloperidol reduced the duration of delirium and the hospital length of stay for the patients (Kalisvaart et al., 2005). Quetiapine is another antipsychotic agent that is used for treatment of POD, and it is reported to resolve delirium 3.5 days faster than haloperidol (Nazemi et al., 2017).

Dexmedetomidine is a sedative that could be used as a preventative pharmacological measure for POD in the appropriate clinical setting. A clinical study investigating POD in elderly patients undergoing esophagectomy concluded that adding perioperative dexmedetomidine to an intravenous anesthesia lowers POD (Hu et al., 2021). This is supported by a decrease in circulating levels of pro-inflammatory cytokine interleukin 6 (IL-6) which has previously been related to the immunology of POD (Hu et al., 2021). Other studies have shown that intraoperative use of dexmedetomidine may be a viable strategy for POD prophylaxis (Liu et al., 2016).

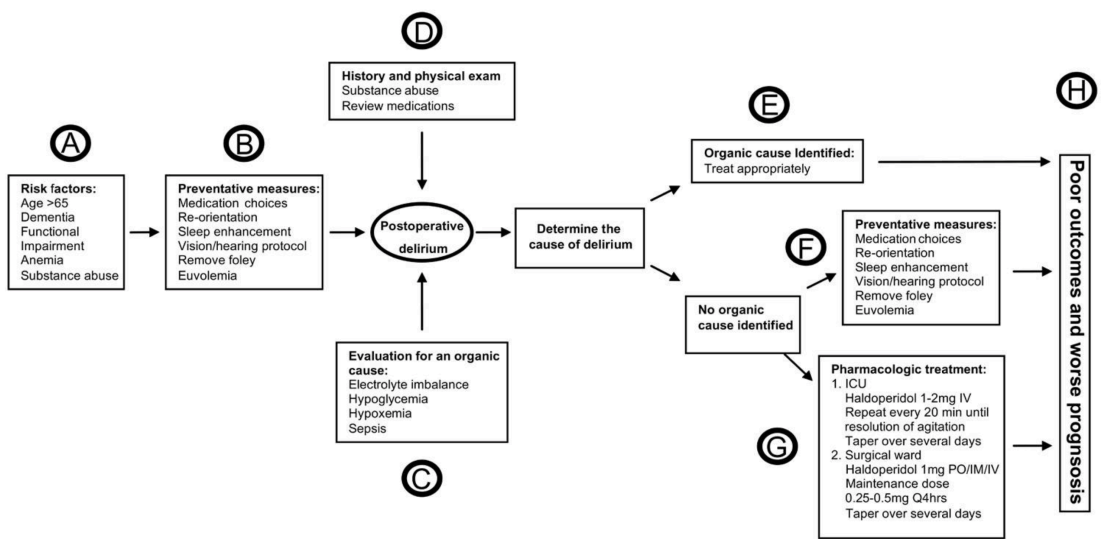

Figure 4. A Diagnostic and Treatment Algorithm for Postoperative Delirium. This flow chart emphasizes the preventative measures (boxes B and F) that should be considered for averting the development of POD in older patients. ICU = intensive care unit; POD = postoperative delirium. From (Robinson & Eiseman, 2008).

SPECIFIC AIMS

Risk factors that contribute to the development of POD have been established by previous studies and include advanced age, history of drug or alcohol abuse, and pre-existing cognitive impairment or dementia. The rate of POD after a surgical procedure under general anesthesia was found to be about 10%–15% for most of these studies. POD was measured by CAM score or another validated measurement tool.

Because Boston Medical Center is an urban ACO that provides healthcare to a major metropolitan uninsured population that includes a large proportion of patients with chronic disease and substance use disorders, the hypothesis is proposed that rates of POD at BMC may be higher than previous studies.

The first aim of this clinical research study is to report the rate of POD at BMC. This will be done by both a prospective and a retrospective chart review analysis by obtaining the necessary information from participants to analyze the development of postoperative delirium.

The second aim of this clinical research study is to discuss alternative ways to assess POD and evaluate the BMC's use of the CAM scoring system to diagnose delirium in patients outside of the intensive care unit. This will be done by reviewing other tools used to assess POD and evaluating the way clinicians are diagnosing POD.

METHODS

Prospective Study

The prospective study was approved by the Institutional Review Board (IRB) at Boston University School of Medicine on March 21, 2021 (IRB protocol number H #41378).

To screen patients that were eligible for the study, trained research assistants (RAs) checked the operation room schedule the day before procedures were scheduled. This was done through chart review of the BMC electronic health record (EHR) system (Epic Systems). Inclusion and exclusion criteria used to assess eligibility are described in Table 2.

Table 2. Inclusion and Exclusion Criteria for Postoperative Delirium Study. This table summarizes the four inclusion criteria and the five exclusion criteria for assessing eligibility of a patient for the study.

Inclusion Criteria	Exclusion Criteria
• Age 65-89 years • Surgery must use general anesthesia. • Patient must be admitted in the hospital for at least 3 days following procedure. • Patient class for procedures must be inpatient or surgical admit.	• Cardiac surgery • Neurosurgery • CAM scores are not recorded. • Anesthesia type is spinal or MAC. • Patient class for procedures is SDC, bedded outpatient, or emergency.

Note. CAM = Confusion Assessment Method; MAC = monitored anesthesia care; SDC = surgical day care.

Trained research assistants approached eligible patients for Health Insurance Portability and Accountability Act (HIPAA) authorization on the day of the procedure in the pre-operative area. HIPAA authorizations were obtained for patients who fit the eligibility criteria for the study and agreed to participate. Patients who were discharged prior to the 3-day post-surgery mark were excluded. For patients who met all eligibility criteria, research assistants reviewed their medical records, and the information listed in Table 3 was collected. Each enrolled patient had to have a minimum of 6 CAM-ICU scores (2 CAM-ICU scores recorded per day). CAM-ICU scores were performed by the patient's nursing team and recorded in the patient's medical record. All study variables were recorded in a Research Electronic Data Capture (REDCap) database.

Table 3. REDCap Data Collection. Variables collected on REDCap highlight the most common and known risk factors for POD in the prospective cohort.

Demographics	• REDCap ID • Age at date of surgery • Patient pace • Surgery name • Patient biological sex • Patient height • Patient weight • Patient BMI
Comorbidities/ Risk Factors	• What is the patient's frequency of alcohol use? • What is the history of tobacco use? • Does the patient have a history of drug use? • Does the patient have any of the following health comorbidities? • Check of all comorbidities: - Asthma - Bipolar disorder - COPD - Coronary disease - Coagulopathy bleeding disorder

	- DVT - Fibromyalgia - GERD - Gynecomastia /hyperprolactinemia - Hypertension - Low back pain - Malignant hyperthermia - Motion sickness - Pulmonary embolus - Sleep apnea
Surgical Data	• Patient ASA status • Albumin pre-op • Anesthesia start time • Anesthesia end time • Induction time • Emergence time • Extubation time • Estimated blood loss • Estimated blood transfusion • Anesthesia: inhaled, inhaled with propofol infusion, inhaled with remifentanil infusion, or TIVA? Yes/No based on the surgery: • Emergency surgery? • Abdominal surgery? • Thoracic surgery? • Hydroxyethyl starch intraoperative administration • Ketamine intraoperative administration • Opioids intraoperative administration • Increased blood pressure fluctuation (not absolute hypotension-noncardiac surgery: changes >20%)
Post-Op	• CAM scores day 1 through 5 (2 scores per day) Yes/No based on the post-op care: • Ketamine postoperative administration • Benzodiazepines postoperative administration • Opioids postoperative administration • ICU admission • Hypothermia on admission to the recovery room (<35 degrees) • Postoperative pain at rest • Melatonin administration

	Which of the following was administrated (could be more than one): ○ Haloperidol ○ Quetiapine ○ Olanzapine ○ Risperidone ○ Dexmedetomidine ○ Other ○ None

Note. ASA = American Society of Anesthesiologists; BMI = body mass index; CAM= Confusion Assessment Method; COPD= chronic obstructive pulmonary disease; DVT= deep vein thrombosis; GERD = gastroesophageal reflux disease; ICU = intensive care unit; REDCap = Research Electronic Data Capture; TIVA = total intravenous anesthesia.

Retrospective Study

The retrospective study was approved by the Institutional Review Board at Boston University School of Medicine on December 7, 2021 (H #42074). The use of the retrospective data was to expand on the data from the prospective study H #41378. The retrospective arm of the study followed the same inclusion criteria as the prospective aspect of the study as seen on Table 2. The time range investigated for this retrospective study was from January 1, 2018, to December 31, 2019.

The retrospective part of the study helped to generate a more powerful data set by allowing the analysis of a larger population. The retrospective data provided information to answer the second aim of this study and identified methods to improve the assessment. The analysis also helped to better identify factors that might affect the incidence of POD in older patients. Comparing data from two arms of the study allowed validation of the findings through inclusion of a larger sample size.

Statistical Analysis

The data were calculated and analyzed using Microsoft Excel and R statistical software. Categorical variables were presented as counts and percentages and were compared using a chi-square test. Continuous variables (e.g., hospital length of stay, ICU length of stay, age, height, and weight) were presented as mean $\pm$ SD and were compared using a *t*-test. A *p*-value $\leq .05$ was considered statistically significant. Univariate regression analysis was done to examine the effect of age, hospital length of stay, and ICU length of stay on the incidence of postoperative delirium.

RESULTS

Retrospective Cohort

Figure 5 shows the flowchart for subject enrollment in the retrospective study. Of the 20,075 total procedures between 2018 and 2019, 16,942 were excluded because the patients were either under the age of 65 or over the age of 89. 187 of the surgeries were cardiac or neurological in nature, and these were also excluded. There were 2,946 procedures that met inclusion criteria for surgery type, although 1,886 were subsequently excluded because the hospital stay was less than 3 days. From the 1,060 eligible procedures with at least 3 days in the hospital, 816 were excluded because no CAM-ICU scores were recorded in the medical record. The final cohort included 244 procedures. Of the 244 procedures, 242 patients did not develop POD and 2 patients experienced POD. As shown in Figure 6, the rate of POD in the retrospective cohort was 0.82%.

Retrospective Univariate Analysis

The results of univariate analysis on the effects of age, hospital length of stay, and ICU length of stay on the incidence of postoperative delirium are summarized in Table 4. Hospital length of stay was the only variable that had a statistically significant association ($p \leq .05$) with POD in the data.

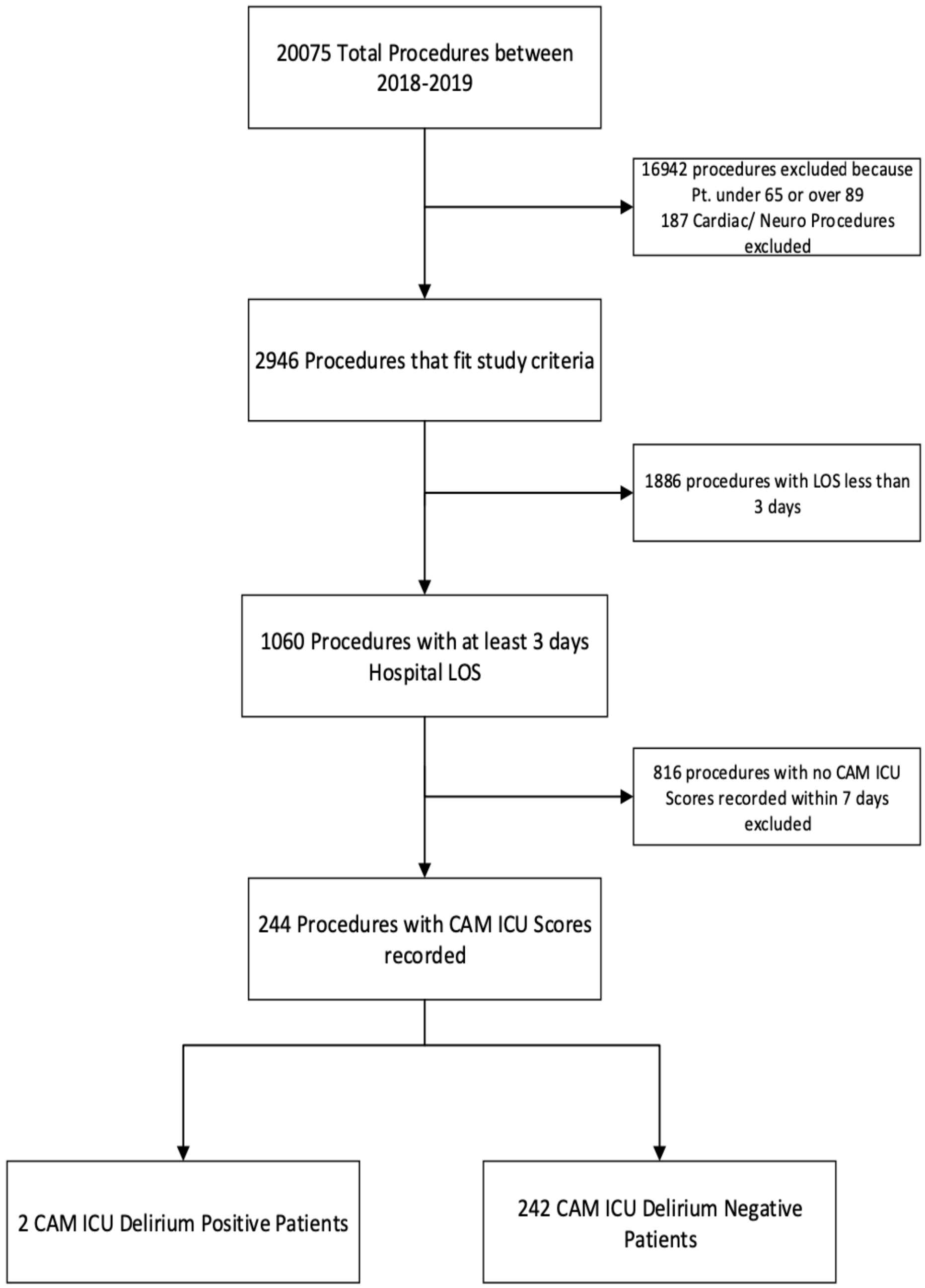

Figure 5. Summary of Subject Enrollment for Retrospective Participants. This flowchart shows the process of selection for the final cohort of 244 total patients. CAM = Confusion Assessment Method; ICU = intensive care unit; LOS = length of stay.

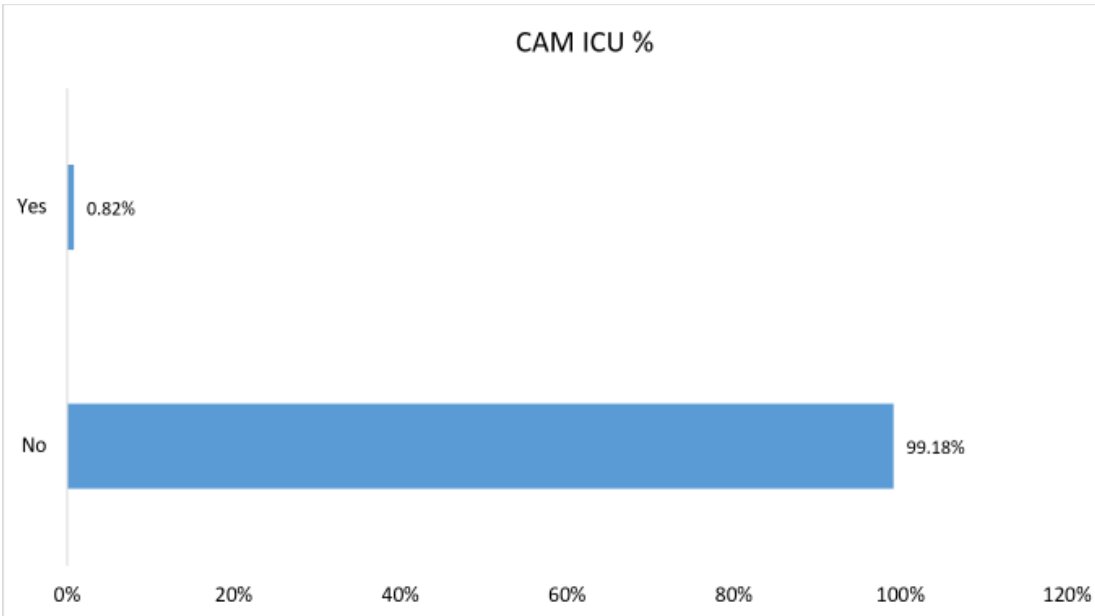

Figure 6. Positive for POD in Retrospective Participants. This bar graph represents the percentage of patients who tested positive for POD. Only 2 out of 244 patients had POD, so 0.82% represents the rate in the retrospective cohort. CAM = Confusion Assessment Method; ICU = intensive care unit; POD = postoperative delirium.

Table 4. Characteristics of Retrospective Population. The results of univariate analysis are shown for patients who tested either negative (n = 242) or positive (n = 2) for postoperative delirium. The age, hospital length of stay, and ICU length of stay are reported as values of the mean (SD) for these normal continuous variables.

Characteristic	Negative for POD (n = 242)	Positive for POD (n = 2)	*p*-Value
Age - year, mean (SD)	73.1 (6.3)	71.0 (4.2)	.642
Hospital Length of Stay - day, mean (SD)	9.6 (8.1)	22 (13)	.026
ICU Length of Stay - day, mean (SD)	2.4 (2.9)	3 (0)	.779

Note. ICU = intensive care unit; POD = postoperative care unit. Statistical significance: $p \leq .05$.

Prospective Cohort

Between June 2021 and December 2021, there were a total of 218 eligible patients who met the inclusion criteria for procedure type. As demonstrated in Figure 7, 115 patients were excluded, and a total of 103 patients were enrolled. Subsequently, 51 were excluded for being discharged before 3 days post-op, having a second procedure within 3 days post-op, or having an insufficient number of recorded CAM scores. There were a total of 52 participants in the final cohort. Only 2 patients were positive for postoperative delirium, and the remaining 50 patients tested negative (see Figure 7). The rate of POD in the prospective cohort was 3.85%.

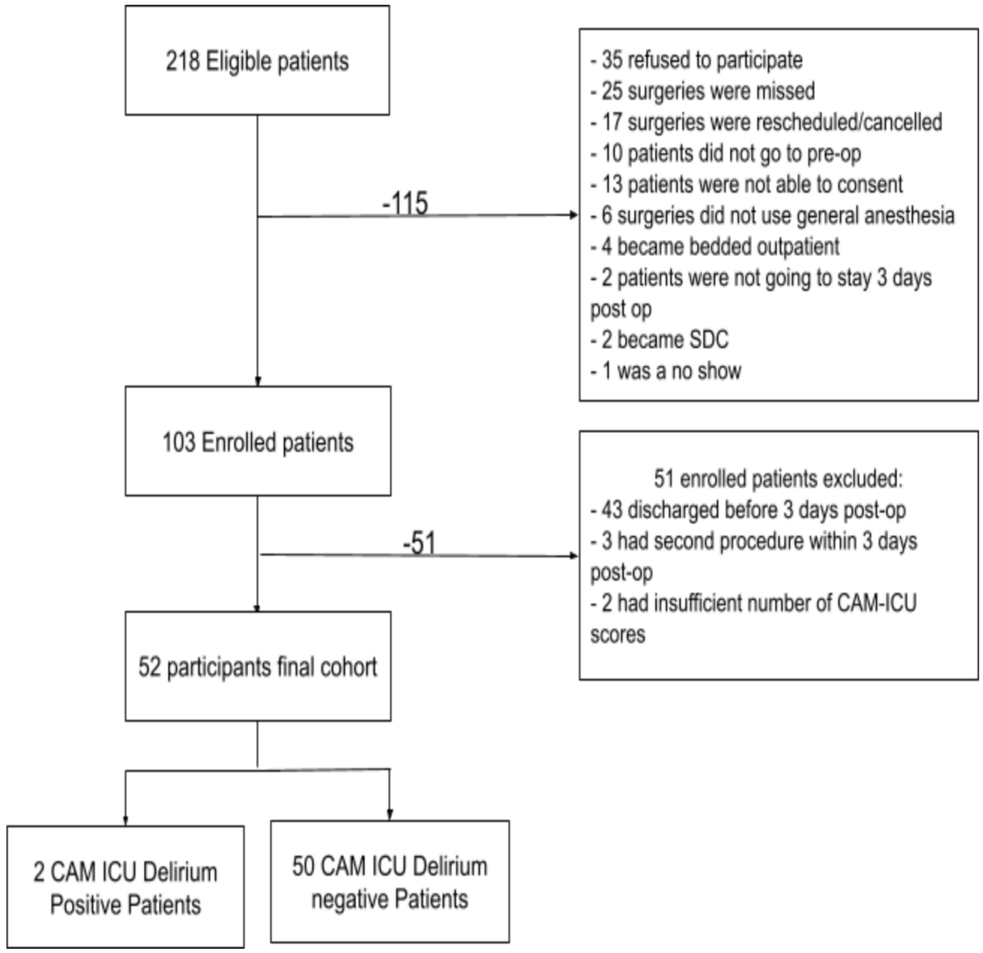

Figure 7. Summary of Subject Enrollment for Prospective Participants. This flowchart shows the process of selection for the final cohort of 52 total patients. CAM = Confusion Assessment Method; ICU = intensive care unit; SDC = surgical day care.

Prospective Univariate Analysis

Univariate analysis was done to compare and identify the demographics and risk factors between patients who tested positive for postoperative delirium and patients who tested negative for postoperative delirium (Table 5). There were no variables in Table 5 that had $p \leq .05$. As a result, there were no statistically significant predictors of postoperative delirium identified in the cohort.

Univariate analysis was also done for postoperative medication administration between patients who tested positive and those who tested negative for postoperative delirium (Table 6). Again, there were not any variables in Table 6 that had $p \leq .05$. Variables with insufficient patients were not tested.

Table 5. Demographics and Comorbidities of Prospective Study Population. The results of univariate analysis are shown for demographics, comorbidities, and any medical history involving medications with anticholinergic effects for patients who tested either negative (n = 50) or positive (n = 2) for POD. Values of the mean (SD) are reported for normal continuous variables. Counts and percentages are reported for categorical variables.

Characteristic	Negative for POD (n = 50)	Positive for POD (n = 2)	*p*-Value
Age - year, mean (SD)	72.0 (5.4)	71.2 (3.0)	.850
Female Sex, n (%)	25 (50%)	1 (50%)	NS
Race			.991
Asian, n (%)	1 (2%)	0	
Native American/Alaska Native, n (%)	1 (2%)	0	
Black or African American, n (%)	18 (36%)	1 (50%)	
White, n (%)	28 (56%)	1 (50%)	
Two or more races, n (%)	2 (4%)	0	
Type of Surgery			.416
Abdominal, n (%)	16 (32%)	2 (100%)	

Oral/Head/Neck, n (%)	6 (12%)	0	
Ortho Non Spine, n (%)	8 (16%)	0	
Ortho Spine, n (%)	10 (20%)	0	
Thoracic, n (%)	10 (20%)	0	
Height - meter, mean (SD)	1.66 (0.11)	1.65	.875
Weight - kilogram, mean (SD)	80 (20)	78	.883
BMI, mean (SD)	28.8 (6.6)	29.8	.845
Comorbidities			
Hearing Loss, n (%)	2 (4%)	1 (50%)	.234
Visual Impairment, n (%)	19 (38%)	0	.730
Hyponatremia <135 mmol/L, n (%)	9 (18%)	0	NS
Hypernatremia >145 mmol/L, n (%)	0 (0)	1 (50%)	.015
No Parkinson's Disease, n (%)	50 (100%)	2 (100%)	NA
Diabetes Mellitus, n (%)	22 (44%)	2 (100%)	.404
Chronic Pain, n (%)	34 (68%)	0	.221
Cardiovascular Disease, n (%)	24 (48%)	1 (50%)	NS
Frailty, n (%)	16 (32%)	1 (50%)	NS
GERD, n (%)	21 (42%)	0	.651
Hypertension, n (%)	38 (76%)	2 (100%)	NS
Prescription of Drugs with Anticholinergic Effects	10 (20%)	0	NS

Note. BMI = body mass index; GERD = gastroesophageal reflux disease; NA = not applicable; NS = not significant; POD = postoperative delirium. Statistical significance: $p \leq .05$.

Table 6. Postoperative Medication Administration for Prospective Study Population. The results of univariate analysis are shown for postoperative medications associated with patients who tested either negative (n = 50) or positive (n = 2) for POD. Counts and percentages are reported for the categorical variables.

Characteristic	Negative for POD (n = 50)	Positive for POD (n = 2)	*p*-Value
Ketamine administration, n (%)	1 (2%)	0	NS
Benzodiazepine administration, n (%)	6 (12%)	1 (50%)	.626
Opioid administration, n (%)	45 (90%)	1 (50%)	.543
ICU admission, n (%)	7 (14%)	0	NS
No hypothermia on admission to the recovery room, n (%)	50 (100%)	2 (100%)	NA
Postoperative pain at rest, n (%)	12 (24%)	0	NS

Note. ICU = intensive care unit; NA = not applicable; NS = not significant; POD = postoperative delirium. Statistical significance: $p \leq .05$.

DISCUSSION

Retrospective Data:

Findings

From Figure 5, the original cohort of 1,060 patients yielded a total of 244 patients who had recorded CAM-ICU scores from 2018 to 2019. Figure 6 depicts that only 2 patients in this group were positive for postoperative delirium, making the retrospective rate of POD 0.82%. This finding confirms that the rate of delirium at BMC is significantly lower than the previously reported national and international averages of 10%–13%. The CAM-ICU scores were performed by nurses without RA involvement. These retrospective data point out a perceived lack of urgency and importance among healthcare providers to take a cognitive assessment of patients after surgery in a non-ICU setting. In Table 4, the hospital length of stay variable was statistically significant with $p = .026$. Comparison of the hospital length of stay showed a mean of 22.5 days for patients who tested positive for POD and a mean of 9.6 days for patients who tested negative. A longer length of stay is a known risk factor for POD (Inouye et al., 2005), which likely explains the statistical significance in this variable. The ICU length of stay and patient age were statistically insignificant with $p > .05$. Having a small sample size for patients that tested positive for POD does not allow for proper analysis of whether these characteristics have a relationship with the development of postoperative delirium.

Limitations

A limitation of the retrospective study was the constraint from the small quantity of data that was gathered. There was no information collected on the drugs administered intraoperatively and postoperatively during the hospital stay. Based on past research, which has linked certain medications to the onset and prevention of delirium (Inouye et al., 2014), it is possible that more granular data on postoperative medications could help in understanding why some patients did or did not develop POD after surgery.

Another limitation of the retrospective arm of the study was the finding that CAM-ICU scores were not taken regularly for most patients after their surgical procedure. Out of the 1,060 eligible patients who stayed 3 days or longer after their surgery, only 244 patients had recorded CAM-ICU scores for each of those days. Thus, only about 23% of the eligible patients were assessed for delirium. This raises a concern about whether healthcare providers are correctly assessing the cognitive status of a patient after surgery. The lack of CAM-ICU scores does not give an accurate retrospective rate for POD during the years from 2018 to 2019.

Prospective Data

Findings

Based on Figure 7, there were a total of 218 eligible patients who met the inclusion criteria for the study. The exclusion of 115 of these eligible patients resulted from changes in their anesthetic approach, admission type, surgery schedule, or consent to participate in the study. From a total of 103 enrolled patients in the study, an additional 51 were excluded because their length of stay was less than 3 days after surgery or there was an absence of CAM score recordings. With the final cohort having a total of 52 patients, only 2 patients had positive CAM scores, whereas 50 patients had negative CAM scores. Thus, the prospective arm of the study had a POD rate of 3.85%, significantly lower than the reported national and international POD averages of other institutions.

In the final cohort of 52 patients, the mean age (SD) for the participants who did not develop POD was 72.0 (5.4) years compared with the mean age (SD) of 71.2 (3.0) years for the 2 participants who did develop delirium. Table 5 highlights that abdominal surgery was the most common surgery in this cohort, and it was the type of surgery that both of the POD patients received.

As seen in Table 7, none of the participants had an American Society of Anesthesiologists (ASA) status of 1, 11 participants had an ASA status of 2, 34 participants had an ASA status of 3, and 7 participants had an ASA status of 4 (see Table 8 for status descriptions). This highlights the fact that the entire cohort had a systematic disease. A majority (78%) of the final cohort had an ASA status of 3 or higher, signifying that they suffered from a severe systematic disease.

Table 7. American Society of Anesthesiologists (ASA) Status of Prospective Study Population. The results of univariate analysis are shown for the ASA status of the prospective cohort (n = 52). ASA status descriptions are summarized in Table 8. Counts and percentages are reported for the categorical variables.

ASA Status	Total Study Population (n = 52)
1, n (%)	0 (0%)
2, n (%)	11 (21%)
3, n (%)	34 (65%)
4, n (%)	7 (13%)

Table 8. American Society of Anesthesiologists (ASA) Status Description. This provides a description of each status and what it means. From (Doyle et al., 2021).

ASA Status	Description
1	Patient is healthy.
2	Patient has a mild systemic disease.
3	Patient has a severe systemic disease.
4	Patient has a severe systemic disease that is a constant threat to life.
5	Moribund patient not expected to survive without an operation.

In this cohort, the most common comorbidity (see Table 5) was hypertension, a condition affecting a total of 40 patients, including the 2 patients who tested positive for POD. Nineteen of the participants in the cohort had a form of visual impairment. Diabetes mellitus was another common comorbidity present in a total of 24 participants, including the 2 participants who tested positive for POD. One of the two POD-positive participants also had hearing loss, cardiovascular disease, frailty, and hypernatremia.

As shown in Table 5, the prevalence of hypernatremia (sodium levels above 145 mmol/L) was statistically significant in the POD-positive patients (p = .015). One of two POD-positive patients (50%) was hypernatremic compared with no patients in the non-delirious group. Imbalances in electrolytes, such as hypernatremia, are among known risk factors for POD. All other characteristics had $p > 0.05$, a likely result because of the small sample size (only 2 POD-positive patients in 52 total patients). Hence the study was underpowered to detect differences in most variables.

Postoperative medication administration (benzodiazepines and opioids), summarized in Table 6, did not differ statistically between the two groups. Postoperative pain at rest, ketamine administration, and ICU admission could not be compared because they were not present in the POD-positive patients. More important, even though opioid administration and benzodiazepine administration are known risk factors for POD, there was no difference in their dosing between the two groups. Again, the small sample size might have rendered the study underpowered for identification of all potential risk factors.

Figure 8 depicts the CAM scores for the two patients who tested positive for POD. Two scores were taken per day for each patient. One patient tested positive for POD for the entire 3 postoperative days, yielding a total of 6 positive scores. The other patient tested positive for POD on the second postoperative day, yielding 2 positive CAM scores.

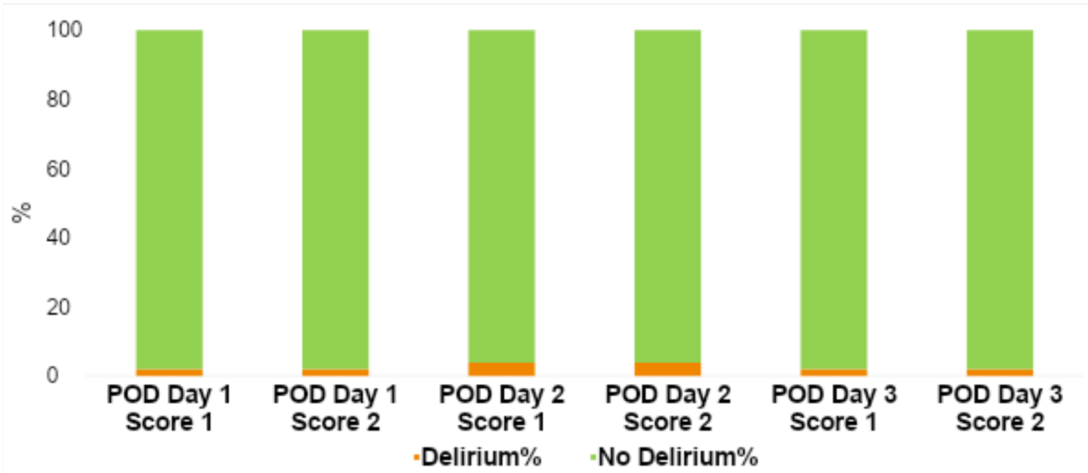

Figure 8. Delirium Scores for Prospective Participants. Postoperative delirium (POD) scores for prospective participants enrolled in the study are represented as % total scores for each day. Two scores are collected from each individual in the group of 52 for each of the 3 postoperative days. Orange represents percentage of scores indicating delirium; green represents percentage of scores indicating no delirium.

These prospective data showed a slightly higher rate of POD than the retrospective data. This result seems likely because the nurses were actively asked to take CAM-ICU scores daily for a minimum of 3 days in the prospective study. The high number of participants who were excluded from the data analysis because of missing CAM scores in the retrospective study confirms that CAM-ICU scores are not obtained in most patients outside the ICU and may be considered of lower clinical value by the providers. In contrast, patients who did require ICU admission after their surgical procedure had at least 2 CAM scores taken per day as per institutional guidelines. Revising nursing assessment guidelines to mandate delirium assessment every shift regardless of patient location (intensive care unit or surgical floor) may raise the awareness of postoperative delirium, help identify the incidence of POD more accurately, and allow for the implementation of tools to treat or prevent its occurrence.

Limitations

The observational nature of this study was a limitation for this investigation. The idea of the prospective study was to determine the rate of POD at BMC, an institution that cares for patients with many POD risk factors. However, the low postoperative delirium rates at an institution serving people with many of these risk factors suggests that an interventional study might more accurately uncover the true POD rates. Assessment by skilled providers and study staff could help improve the quality and quantity of collected data in an interventional prospective study. Training a research assistant to properly take a CAM score and perform these assessments on the participants would not only prevent the number of patients who were excluded because of missing scores but also identify delirium in patients who might have been missed. In addition, many of these healthcare professionals who cared for the study participants had more than 1 patient to oversee at a time. Having additional staff with appropriate training would further improve patient enrollment, data acquisition and accuracy.

The use of the CAM-ICU tool is also a drawback of the prospective arm of this study. A quick start or fluctuation of symptoms is required for a valid diagnosis of delirium. Even if inattention with disordered thinking or altered level of awareness is found, the CAM-ICU tool is unable to categorize the patient as delirious if the healthcare professional does not witness variation of symptoms. With this tool, even if one of the symptoms is present, it does not automatically rate positive for delirium. For the future of this study, the CAM-ICU tool should be preferentially used in the ICU, and for a daily clinical setting, a more accurate tool should be considered such as the 3D- CAM method.

Why Does the Postoperative Delirium Rate Appear So Low at BMC?

There are a few potential explanations for the low POD rate at BMC when compared to published data. One theory is that the low POD rate reflects the advancements made in perioperative medicine, including the optimization of patients' clinical status prior to surgery as well as the utilization of newer enhanced recovery after surgery (ERAS) protocols. The optimization and improvement of a patient's clinical status before surgery, known as "prehab", is a fairly new concept that aims to get a patient ready for surgery both physically and mentally, rather than the older ways of solely focusing on postoperative rehabilitation. Additionally, an ERAS protocol is a multimodal perioperative treatment regimen meant to facilitate faster recovery after surgical procedures by optimizing preoperative organ function and decreasing the profound stress response from surgery (Feldheiser et al., 2016). In this protocol, pharmacologic agents such as nervous system depressant are avoided in elderly patients. Benzodiazepines, one such agent that is typically used to treat anxiety before a surgery, are avoided. The use of short-acting benzodiazepines is known to be an independent risk factor for delirium. Additionally, the protocol also emphasizes that long-acting sedatives and opioids should not be used in patients because they can hinder postoperative movement and lengthen a patient's recovery time, and consequently, hospital stay. Guidelines on how to optimize a patient's clinical status before anesthesia and surgery could be helpful in reducing the incidence of POD.

A second theory as to why the BMC POD rate is low when compared to published data is that the low rate is due to an under-diagnosis of POD at the institution. Supported by the retrospective results of this study, CAM scores were verified as not being routinely recorded for many postoperative patients, especially when the patients are not in the intensive care unit. The CAM-ICU score was developed for the critical care setting and has since been applied for use outside of the ICU. It is plausible that nurses without ICU level training are not competent at using the CAM-ICU scoring system to detect delirium.

Although BMC does have a geriatrics team, they are not always consulted to older patients compared to most institutions. These patients are more susceptible to develop POD and are therefore routinely screened and followed by dedicated teams in some institutions. Although a tremendous amount of research has emphasized how prevalent POD is in certain demographics, its incidence is underestimated in many institutions and clinical settings. The unique demographic group served at the Boston Medical Center requires diversion of resources to optimize other aspects of care, including psychiatric care, nutrition, and social care of many patients. Providers are therefore likely to not prioritize systematic assessment of POD in many of these patients. However, assessing a patient's postoperative mental function is critical in determining any mental status fluctuations that could significantly affect recovery, hospital length of stay, and morbidity after surgery and anesthesia. Failure to appropriately assess and treat POD could also put the patient at risk for development of other possible cognitive changes such as dementia (Lingehall et al., 2017).

According to a study by Kjorven et al. (2011), some providers confuse delirium with personality rather than an illness-based condition. As a result, with inadequate education and insufficient support from management and administration, these providers might be biased toward the elderly population. Healthcare providers in this study also expressed that they see POD as a “normal symptom” for older individuals after surgery. Inadequate delirium recognition by healthcare providers following surgical procedures allows the development of POD, which hinders the post-surgical recovery, primarily in the aging population (Kjorven et al., 2011).

Regular training and implementation of POD diagnostic and prevention protocols could potentially reduce the incidence and duration of POD, leading to improved patient outcome, shorter hospital length of stay, and lower healthcare expenses.

Alternatives to CAM Method

Although CAM scores are used globally to detect delirium in medical patients, there has been a debate over its efficiency and accuracy to identify POD. In favor of the CAM-ICU tool, a study focused on estimating the development of delirium based on risk factors using CAM scores (Koskderelioglu et al., 2017). They found that 18.3% of 109 participants developed delirium. Interestingly, the CAM-ICU tool was found to have a specificity of 98.9% and a sensitivity of 80% for diagnosing delirium, making this method more accurate than other tools in the detection of delirium (Koskderelioglu et al., 2017).

There are newer diagnostic tools that have been developed to diagnose delirium. A 2016 study compared the effectiveness of the CAM-ICU tool with the 3-minute diagnostic assessment for delirium using the Confusion Assessment Method (3D-CAM) in patients over the age of 75 in a general inpatient setting (Kuczmarska et al., 2016). Based on their results, Kuczmarska and colleagues (2016) determined that the 3D-CAM tool had higher sensitivity compared with the CAM-ICU assessment. Using an alternative method to CAM-ICU after surgery that is more sensitive could enable better detection and management of POD in non-ICU patients.

Another alternative would be to use the gold standard diagnostic tool of evaluating postoperative delirium in patients, the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, text revision (DSM-IV-TR) criteria (American Psychiatric Association, 2000). A prospective study compared the DSM-IV-TR with the CAM-ICU and the Intensive Care Delirium Screening Checklist (ICDSC) to evaluate their validity and psychometric properties (Boettger et al., 2017). These researchers used all three diagnostic tools on 210 participants to detect delirium, and their results showed an incidence of 23.3% with the CAM-ICU, 30.5% with the ICDSC, and 43.8% with the DSM-IV-TR criteria. Hence, neither the CAM-ICU nor the ICDSC surpassed the diagnostic discrimination of the DSM-IV-TR for diagnosing delirium on a daily clinical routine. The DSM-IV-TR also performed better in terms of predicting the occurrence of delirium (Boettger et al., 2017).

Every hospital, including Boston Medical Center, has required routine checks for delirium. BMC uses the CAM score system, but these findings from Boettger et al. (2017) demonstrated that this tool may not accurately detect delirium in patients compared with other diagnostic tools. This reason could explain that the BMC POD rate is so low because it does not accurately detect POD in patients outside the ICU. Implementation of these other assessment tools that are as efficient and sensitive but perform with higher accuracy should be considered in enhancing the diagnosis and treatment of POD.

Future Research

This study considered some of the more established risk factors for POD, but based on recent publications, there are some non-established risk factors that could be analyzed for future research. An observational study tracking cholinesterase activity in patients after non-cardiac surgery concluded that cholinesterase activity could be used as a biomarker for POD (Zhao et al., 2019). This is a possible risk factor that could be checked in elderly patients or those with significant risk factors preoperatively. If the patient has impaired cholinesterase activity, the individual might benefit from careful observation and POD assessment after surgery.

A recent study analyzing postoperative delirium in orthopedic surgeries both retrospectively and prospectively in older patients concluded that there were three other risk variables for POD that should be carefully examined (Wang et al., 2021). These variables were elevated postoperative creatinine, electrolyte abnormalities, and reduced fluid infusion during fasting. Creatinine was seen as a possible biomarker because recent studies showed a strong association between renal dysfunction and psychiatric disorders such as POD. The researchers also stated that decreasing the fasting period and increasing perioperative rehydration could decrease POD (Wang et al., 2021). Applying these recent biomarkers to the list of established risk factors list could help identify patients at risk for POD preoperatively.

Conclusion

Postoperative delirium is a complication that frequently affects the most vulnerable demographic—the elderly population. This study aimed to report the rate of POD at Boston Medical Center, to find possible solutions to better assess POD, and to examine POD diagnostic tools in this vulnerable group of patients. The prospective arm of this study identified a POD rate of 3.85% at Boston Medical Center. This rate was significantly lower than previously published studies and might be related to the small sample size and timing of the study. However, a larger cohort studied in the retrospective arm showed a similar incidence of POD between 2018 and 2019. In fact, the retrospective arm of the study reported an even smaller POD rate of 0.82%.

It is possible that this low incidence of POD at Boston Medical Center, relative to previously published data, is either a result of perioperative patient optimization and implementation of the ERAS protocol and postoperative delirium precautions or a wider limitation in the clinician’s ability to identify and treat this important postoperative complication.

The development and use of better and more discriminative POD diagnostic tools for patients outside of the ICU are needed. Programs should be developed to train clinicians in POD diagnosis and treatment in the recovery room and in the surgical and medical wards. Quality improvement projects should be initiated to examine the effects of environmental and pharmacological delirium precaution measures on the incidence of POD and patient outcome after surgery.

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CURRICULUM VITAE

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