An Electronic Alert to Reduce Postoperative Delirium in the Older Adult

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Abstract

Older adults frequently experience delirium after surgery, contributing to a decline in quality of life, increasing morbidity and mortality rates, and adding significant costs to the healthcare system. The Beers Criteria was developed by the American Geriatrics Society and lists medications correlated with a decline in cognition among older adults. These medications are commonly administered in the perioperative period by anesthesia practitioners. At a large university hospital, an educational video was distributed, followed by the launch of an electronic health record alert advising over 300 anesthesia practitioners to reduce dosing or omit Beers Criteria medications in patients aged 70 or older. The total administration and total mean dosage of Beers Criteria medications administered were measured across four study periods: pre-educational video/pre-alert, post-education/pre-alert, and at two post-education/post-alert time points in select surgeries. This quality improvement project demonstrated significant reduction in Beers Criteria medications administered to patients 70 years or older to reduce rates of cognitive decline.

Keywords: electronic alert, educational video, postoperative delirium, Beers Criteria

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Postoperative delirium (POD), defined as delirium following surgery, is a common and preventable complication in older adults associated with increased mortality and morbidity, prolonged length of hospitalization, and increased healthcare costs (Berian et al., 2017; Samuel, 2014). Delirium is a devastating condition that can affect all aspects of a patient's life. Characterized by a rapid decline in cognition that can wax and wane over hours or days, delirium often impairs the attention, memory, executive function, visuospatial tasks, and language of older adults. Other mental status symptoms can include sleep-wake cycle disturbances, hallucinations, delusions, affect changes, and autonomic dysfunction (Trabold & Metterlein, 2014; Josephson & Miller, 2014). The high incidence of cognitive alterations occurring during the postoperative period have directed researchers to identify its causative factors. One of the risk factors of delirium in older adults is medication administration (Mohanty, Rosenthal, Russell, Neuman, Ko, & Esnaola, 2016). The American Geriatrics Society developed the Beers Criteria as a medication prescribing guideline to encourage safety and prevent complications in older adults. Drug classes such as benzodiazepines, anticholinergics, antihistamines, and antipsychotics have been identified as risk factors for postoperative delirium and are included among other medications on the Beers Criteria (Samuel, 2014). Anesthesia providers often administer these medications in the perioperative period, which may contribute to delirium in older adults (Needham, Webb & Bryden, 2017).

Problem Description

One in three inpatient operations are being performed on patients over 65 years of age (Wanderer & Rathmell, 2017). This population is expected to double by 2050 and will likely constitute approximately 21 percent of America's total population (U.S. Census Bureau, 2014). As humans age, cellular physiology changes, leading to increased health problems and a

continued need for surgery due to advanced age and comorbid conditions (Kanonidou & Karystianou, 2007). With the large number of older patients undergoing surgery, POD is found to be the most common surgical complication among this population with an incidence of up to 50% (Samuel, 2014). POD can continue past the immediate postoperative period, causing further cognitive and functional decline with reported occurrences lasting up to 36 months (Hebert, 2018). These implications are not benign and in the United States alone, treatment related to delirium costs an estimated $150 billion dollars annually (Josephson & Miller, 2014). Anesthesia practitioners must be diligent in preventing POD due to the growing older adult population and the implications of this complication.

Rationale

There is reassuring research championing the use of education and clinical decision support tools. After conducting a literature review, studies demonstrated that utilizing a computerized alert was linked to a statistically significant decrease in inappropriate medication prescribing, especially with added education and training (Smith et al., 2014; Faine et al., 2015; Lau et al., 2014; Gupta, 2014; Niehoff et al., 2016). Evidence suggests that tailoring the electronic alert to a specific audience and allowing users to provide feedback improves overall compliance and effectiveness (Niehoff et al., 2016). To deliver content, using an educational video has been shown to be effective in increasing provider adherence to protocols (Kandler et al., 2016). The authors utilized clinical informatics in conjunction with electronic media to implement a quality improvement (QI) project with the aim of reducing Beers Criteria medication administration in the older adult population. At the site where the project was implemented, there have been over 5,700 surgical procedures performed on older adults per year since 2013.

Specific Aims

The aim of this QI project was to reduce the mean dosage in milligrams and overall administration of Beers Criteria medications given by anesthesia practitioners to adults aged 70 years or older over a six-month period.

Methods

Context

The Institutional Review Board of both the site and school's institution approved this QI project as exempt. An interdisciplinary team initiated this QI project at an urban 776-bed academic teaching hospital. The 317 anesthesia practitioners at this hospital include anesthesiologists, certified registered nurse anesthetists, residents, and student registered nurse anesthetists.

Inclusion criteria were patients aged 70 years and older undergoing inpatient and outpatient surgery between February 3, 2019 and October 2, 2019. Exclusion criteria included emergent, ocular, cardiac and off-site gastrointestinal procedures.

Intervention

The authors developed an educational video to increase awareness among anesthesia practitioners about medications associated with postoperative delirium. In addition, an electronic alert was released with the purpose of notifying anesthesia staff to omit or reduce dosages of Beers Criteria medications in the perioperative period to patients over the age of 70 years. The interdisciplinary team chose the age of 70 years due to uniform hospital views of this population being the most appropriate to apply the intervention with the possibility of increasing provider compliance.

This pre-test/post-test design involved a video released to anesthesia staff via email and an in-person presentation educating providers about postoperative delirium, including

background information and a description of Beers Criteria medications to avoid. The video was created using the Vyond platform and introduced the best practice advisory (BPA) electronic alert in Epic Systems Corporation (EPIC) (see Figure I). In the event that a patient was 70 years or older, a BPA alert was displayed in the upper left-hand corner of the electronic anesthesia record that notified the anesthesia practitioner that this patient was part of the initiative: "Delirium Prevention in Older Patients." Upon clicking on the alert, the BPA listed the following medications in accordance with the 2019 Beers Criteria guidelines to avoid or reduce in dosage: benzodiazepines, anticholinergics, H2 receptor-antagonists, corticosteroids, antipsychotics, chlorpromazine and meperidine. The BPA also linked to a fact sheet with more information regarding delirium prevention in older adults, discussing implications for healthcare professionals and patients. This alert was specific to anesthesia practitioners accessing intraoperative health records starting in June 2019. To prevent disruption and loss of productivity, this alert occurred one time for each provider accessing the same patient's chart.

Measures

Data was collected on Beers Criteria medications administered during the following study periods: the first study period was February 3, 2019 to April 3, 2019 (pre-education/pre-alert); the second study period was April 4, 2019 to June 4, 2019 (post-education/pre-alert); the third and fourth study periods were June 5, 2019 to August 5, 2019 and August 6, 2019 to October 2, 2019 (post-education/post-alert). The purpose of collecting data across study periods was to determine whether the educational video, electronic alert, or both impacted the amount of Beers Criteria medications administered. The specific Beers Criteria medications that were measured included: dexamethasone, diphenhydramine, famotidine, haloperidol, lorazepam, meperidine, midazolam, promethazine, and scopolamine.

Analysis

Sample characteristics included number of patients, type of surgery, patient age, and duration of surgery from time in room to time out of room. The sample was grouped by the four study periods as described above. An analysis of variance (ANOVA) was conducted to compare continuous variables with a subsequent post-hoc analysis using Tukey's test to examine the mean dosage of Beers Criteria medication administered across study periods, with dosage reported as means and standard deviations. A Chi Square test was conducted to compare changes in the proportion of categorical variables over study periods, determining whether the proportion of each Beers Criteria medication decreased, with a Bonferroni correction applied. Statistical significance was set to $p < 0.05$ unless otherwise specified to adjust for multiple post-hoc comparisons. All analyses were conducted using R Studio (Boston, MA).

Ethical Considerations

In the event of reducing or omitting a Beers Criteria medication, certain medications that are prescribed to treat preoperative anxiety may have been withheld for this study population. The Beers Criteria list is a guideline and clinical decision skills should be utilized foremost.

Results

Between February 3, 2019 and October 2, 2019, there was a total of 2,210 surgical procedures performed on patients aged 70 years or older. A total of 1,934 Beers Criteria medications were administered during the intraoperative period, defined as time in room to time out of room. Beers Criteria medications were administered in 934 of the 2,210 cases. There was no statistically significant difference in number of patients across study periods. The mean age was 76 ($\pm$5) years with no statistically significant difference found in age ($p = 0.051$). Post-hoc pairwise comparisons found that the proportion of surgical patients across study periods was not significant ($p = 0.007$) based on the Bonferroni adjusted p-value ($p = 0.0009$). The largest

proportion of patients were seen in the endocrine service, followed by the pulmonary and urology services. The mean in room to out of room time was 152 (±112) minutes with no statistical difference in length of time by study period ($p = 0.914$). These results indicate that the study periods were well-balanced in clinical and demographic characteristics (see Table 1).

In addressing the aim of decreasing overall administration of Beers Criteria medications, the authors measured the proportion of cases in which Beers Criteria medications were administered across study periods. There was no statistically significant difference in proportion of total cases where Beers Criteria medications were administered across study periods ($p = 0.2018$) (see Table 2).

The results of overall Beers Criteria medication administration analysis included statistically significant changes in the administration of dexamethasone, lorazepam, meperidine, midazolam, and promethazine. There was a statistically significant decrease in the proportion of dexamethasone administered, from 6.8% at Study Period 1 to 4.1% at Study Period 4 ($p = 0.005$). The mean dosage of lorazepam decreased significantly from 1.11 milligrams (mg) at Study Period 1 to 0.45 mg at Study Period 2 ($p = 0.019$). Meperidine administration decreased in proportion from 4.7% in Study Period 2 to 1.1% in Study Period 4 ($p = 0.001$). A statistically significant reduction was seen in both the proportion of midazolam administered and mean dosage, where the proportion decreased from 21.3% in Study Period 1 to 13.8% in Study Period 4 ($p = 0.001$); the mean dosage decreased from 2.03 mg in Study Period 1 to 1.61 mg in Study Period 4 ($p < 0.001$). There was a statistically significant increase in the proportion of promethazine administered ($p < 0.024$) across all study periods. All other medications did not show a statistically significant change in dosage or proportion administered (see Table 3).

Discussion

To the authors' knowledge, this quality improvement project implemented the first BPA alert on reducing the administration of Beers Criteria medications in conjunction with an educational video. The project demonstrated that a simple alert and a supplemental educational video had the potential to decrease Beers Criteria medication administration, ultimately reducing rates of postoperative cognitive decline.

Limitations of this project may include alert fatigue, staff turnover or non-compliance. A new cohort of anesthesia residents started in July; however, this cohort viewed the educational video and was educated on the purpose of the alert. Staff turnover and clinicians new to the institution could have also impacted the results, especially with floating anesthesia providers or those who may not have seen the educational video. Further limitations include the intervention being deployed at a single institution, as well as challenges in communication with data personnel during various time points across the study.

In addition, the data findings showed an increase in promethazine administration. This was the most commonly administered Beers Criteria medication given across all study periods. This medication is used for postoperative nausea and vomiting (PONV), which is another common complication of anesthesia. Education on other medications to treat PONV that are not included on the Beers Criteria should be provided to clinicians. In turn, clinicians would be able to administer other medications, such as ondansetron, to treat PONV without the risk of delirium. The older adult population is also not considered to be a population at high risk for PONV.

The administration of dexamethasone is indicated for various procedures as well as in the instance of a difficult intubation to reduce airway edema or in neurologic procedures to reduce swelling or inflammation. The authors chose to omit dexamethasone given in neurologic procedures due to a surgical necessity for this medication that could skew results. In these cases,

critical decision making should always be utilized by each provider. The risks and benefits of administering a Beers Criteria medication should be weighed in terms of patient health condition, situational circumstances, and as an overall guideline for practice.

Furthermore, there was no change in famotidine administration practices, and it was found to be largely administered in gastrointestinal procedures. Alternatives could be considered to this medication in the future. Also, because dosages of scopolamine are available as a single patch, the dosage is rarely decreased. In addition, during the administration of regional anesthesia, it is common practice to administer a sedative, usually a benzodiazepine such as midazolam, to alleviate anxiety during the procedure.

Knowing this information, the authors recommend furthering education to all providers who care for patients in the perioperative period, not exclusively anesthesia personnel. These providers include preoperative nurses, post-anesthesia care unit nurses, operating room nurses, pharmacists, surgeons, and rotating residents and students. In a previous data analysis, a total of 5,612 Beers Criteria medications were administered in the entire perioperative period, compared to 1,934 Beers Criteria medications administered in just the intraoperative period alone, defined as time in operating room to time out of room. This data validates that clinicians outside of the anesthesia department administered a majority of Beers Criteria medications to older adults. There were oral forms of these medications administered as well, validating the need for broadening education.

The authors could target specific surgical specialties with a high volume of older adult patients (such as the endocrine, pulmonary and urology services) with all staff under these specialties involved in the initiative. Targeting other fields with the electronic alert specifically, such as pharmacy, could ensure providers be notified in real time at the moment of prescribing or administration of a Beers Criteria medication in all patient locations. The most important aspect

for success is educating all clinicians in the perioperative period on the importance of this intervention because anesthesia practitioners are only a fraction of those who provide care during this crucial time period. Staff buy-in and willingness to work as a team are important aspects in the success of an intervention.

Anesthesia practitioners have a unique role in the medication-use process; assessing, selecting an optimal regimen, dispensing, administering, and monitoring the patient. These processes are generally performed by the same provider with little safety interventions. The unique role of the anesthesia professional demands great responsibility to protect and mitigate the occurrence of cognitive decline in patients under their care. This quality improvement project demonstrated a change in practice through education and real-time electronic alerts. Educating and alerting clinicians with clinical decision support tools are strategies that can be implemented to protect patients from cognitive decline in the postoperative period.

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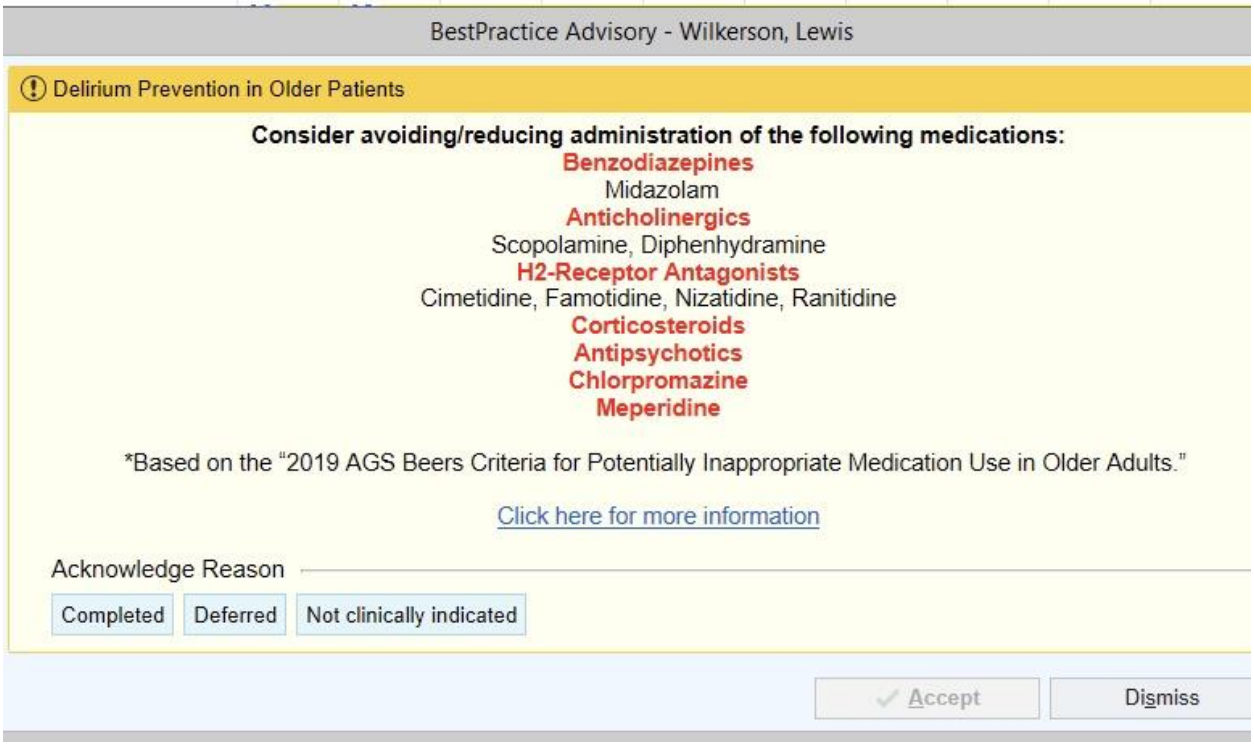

Figure I. Best-practice advisory (BPA) alert to notify anesthesia practitioners of medications to omit or reduce in dosage. This message is displayed upon clicking on the yellow tab titled "Delirium Prevention in Older Adults" in the upper left-hand corner of the electronic chart.

Table 1

Perioperative Patient and Surgical Data at UPHS

Variables	Study Period 1	Study Period 2	Study Period 3	Study Period 4	Overall	p[a]
Number of subjects, n	563	529	581	537	2210	0.249
Age (mean (SD))	75.83 (5.15)	76.51 (5.47)	76.45 (5.42)	75.88 (5.03)	76.17 (5.28)	0.051
Primary Procedure Service (%)						0.026[b]
Endocrine Oncologic	93 (16.5)	97 (18.3)	120 (20.7)	117 (21.7)	427 (19.3)	
Gastrointestinal Surgery	42 (7.5)	45 (8.5)	60 (10.3)	38 (7.1)	185 (8.4)	
Gynecological Surgery	19 (3.4)	8 (1.5)	17 (2.9)	23 (4.3)	67 (3.0)	
Neurosurgery	80 (14.2)	77 (14.6)	66 (11.4)	51 (9.5)	274 (12.4)	
Otorhinolaryngology	45 (8.0)	50 (9.5)	39 (6.7)	38 (7.1)	172 (7.8)	
Orthopedic Surgery	3 (0.5)	5 (0.9)	4 (0.7)	8 (1.5)	20 (0.9)	
Plastic Surgery	31 (5.5)	19 (3.6)	25 (4.3)	23 (4.3)	98 (4.4)	
Pulmonary	90 (16.0)	77 (14.6)	93 (16.0)	77 (14.3)	337 (15.2)	
Thoracic Surgery	30 (5.3)	19 (3.6)	29 (5.0)	21 (3.9)	99 (4.5)	
Transplant Surgery	4 (0.7)	4 (0.8)	1 (0.2)	3 (0.6)	12 (0.5)	
Urology	78 (13.9)	74 (14.0)	73 (12.6)	102 (19.0)	327 (14.8)	
Vascular Surgery	48 (8.5)	54 (10.2)	54 (9.3)	36 (6.7)	192 (8.7)	
In Room to Out of Room (minutes) (mean (SD))	154.45 (120.56)	153.86 (105.48)	150.03 (109.60)	153.19 (111.24)	152.85 (111.88)	0.914

Note. n = number. SD = standard deviation. UPHS = University of Pennsylvania Health System

[a]p < 0.05 set as statistical significance unless otherwise noted

Statistical significance for Number of Subjects was defined using the Chi-Square.

Statistical significance for age and In Room to Out of Room was defined using the Analysis of Variance (ANOVA).

[b]Post-hoc pairwise comparisons found that the proportion of surgical patients differed between time 2 and 4 but was not significant at p = 0.007 based on the Bonferroni adjusted p-value (p = 0.0009). Statistical significance was then defined as a p-value < 0.0009.

Table 2

Proportion of Patients Administered Beers Criteria Medications Across Study Periods

Study Periods	Number of Cases Beers Criteria Medications Administered (n)	Proportion of Total Cases Administered Medications (%)	p[a]
Study Period 1	308	55	
Study Period 2	321	61	
Study Period 3	330	57	
Study Period 4	318	58	
			0.2018

Note. n = number.
[a]Statistical significance for Proportion of Total Cases Administered Medications was defined using the Chi-Square. Statistical significance was defined as $p < 0.05$.
X-squared = 4.621, df = 3, p-value = 0.2018

Table 3

Subjects Given Beers Criteria Medications and the Distribution of Beers Criteria Medications Given (percentages refer to the proportion of medication administered in study period out of all Beers Criteria medications)

Variable	Study Period 1	Study Period 2	Study Period 3	Study Period 4	p[a]
Number of subjects given Beers Criteria medications (n)	308	321	330	318	
Number of Beers Criteria medications given (n)	511	473	509	441	
dexamethasone (%)	35 (6.8)	34 (7.2)	15 (2.9)	18 (4.1)	**0.005**
dexamethasone dose (mean (SD))	4.80 (1.95)	5.29 (2.36)	6.27 (3.20)	4.67 (2.06)	0.166
diphenhydramine (%)	16 (3.1)	14 (3.0)	18 (3.5)	16 (3.6)	0.929
diphenhydramine dose (mean (SD))	34.38 (12.50)	38.39 (14.26)	36.11 (16.54)	42.97 (12.88)	0.354
famotidine (%)	38 (7.4)	50 (10.6)	56 (11.0)	43 (9.8)	0.222
famotidine dose (mean (SD))	20.53 (3.24)	20.60 (4.24)	20.54 (4.01)	21.63 (6.15)	0.601
haloperidol (%)	3 (0.6)	1 (0.2)	0 (0.0)	1 (0.2)	0.319
haloperidol dose (mean (SD))	2.33 (2.31)	1.00 (-)	-	0.50 (-)	0.999
lorazepam (%)	19 (3.7)	12 (2.5)	12 (2.4)	10 (2.3)	0.465
lorazepam dose (mean (SD))	1.11 (0.66)	0.69 (0.47)	0.88 (0.57)	0.45 (0.23)	**0.019**
meperidine (%)	24 (4.7)	26 (5.5)	14 (2.8)	5 (1.1)	**0.001**
meperidine dose (mean (SD))	13.54 (3.53)	12.73 (2.81)	16.07 (10.32)	15.00 (5.59)	0.316
midazolam (%)	109 (21.3)	62 (13.1)	97 (19.1)	61 (13.8)	**0.001**
midazolam dose (mean (SD))	2.03 (0.44)	1.95 (0.52)	1.92 (0.48)	1.61 (0.53)	**<0.001**
promethazine (%)	254 (49.7)	261 (55.2)	282 (55.4)	272 (61.7)	**0.003**
promethazine dose (mean (SD))	6.42 (1.03)	6.94 (3.19)	6.65 (2.38)	6.43 (1.69)	**0.024**
scopolamine (%)	6 (1.2)	6 (1.3)	8 (1.6)	3 (0.7)	0.652
scopolamine dose (mean (SD))	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	0.999

Note. n = number. Dose in milligrams. Percentage is defined as number of specific medications given divided by number of total Beers Criteria medications given (in line 2).

[a]An Analysis of Variance (ANOVA) of all continuous variables (number of subjects given Beers Criteria medications, number of Beers Criteria medications given, and dose) yielded significant variations. A post-hoc Tukey Test was conducted for adjusted statistical significance (p) for pairwise comparisons of the continuous variables.
A Chi-Square of categorical values (specified Beers Criteria medication given as a proportion of total Beers Criteria medication within the given study period), also yielded significant variations. A Bonferroni correction was conducted for adjusted statistical significance (p) for categorical values.