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Original Research

The predictors of postoperative delirium at surgical units in Sudan: A multicenter, cross-sectional, prospective study

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Abstract

Background: Knowledge of potential and amenable risk factors involved in the development of postoperative delirium (POD) is imperative for successful prevention and subsequent management. **Objective:** The current study objective was to delineate the risk factors associated with the occurrence of POD among patients undergoing surgical procedures. **Methods:** This multi-center (6 hospitals), cross-sectional prospective hospital-based study recruited 415 subjects aged ≥50 years who were scheduled to undergo different types of surgery. Delirium Observational Screening Scale used for the diagnosis of POD. Short Nutritional Assessment Questionnaire used for assessing the nutritional and the hydration status of patients. Pre and postoperative risk factors analyzed by univariate (chi square) and then multivariate analyses and the incidence rate of POD, was reported. **Results:** The main outcome measure was the development of POD. Out of the 385, only 43 subjects (11.2%) developed POD. High American Society of Anesthesiologists score (OR: 10.76, 95% CI: 1.379-83.99, P =0.023), duration of surgery (OR: 5.426, 95% CI: [2.249-13.092]; P =0.0001), were the strongest independent risk factors for the development of POD. Katz Index of Independence in Activities of Daily Living score (OR: 3.227, 95% CI: [1.177-8.844], P =0.023), and age ≥ 70 years (OR: 1.174, 95% CI: [1.015-1.359]; P =0.027) were additional strongest independent risk factors for the development of POD. **Conclusion:** Based on analysis or study, we found High American Society of Anesthesiologist sore, Katz-ADL, duration of surgery, and advanced age were predictors of POD. Our findings suggest preventive measures initiated in subjects identified at risk of developing POD. These results support the healthcare providers in the early prevention, diagnosis, and timely management of POD.

Keywords: delirium; multicenter; postoperative; postoperative delirium (POD); predictors; surgical units

INTRODUCTION

Delirium is an acute and fluctuating mental status, altered consciousness with reduced ability to focus, maintain, or shift attention, accompanied by cognitive changes and perceptual disturbances secondary to a general medical condition.[1]

Postoperative delirium (POD) is a form of delirium that manifests in subjects who have undergone surgical procedures and anesthesia. POD is very common in hospitalized subjects; its prevalence in the adult general medicine population is 10.0-24.0% and it affects 37.0-46.0% of the general surgical population. In the intensive care unit (ICU) setting, delirium has been reported in up to 87.0% of subjects. POD rates vary widely, ranging from 9.0 to 87.0% depending on the age of subjects and the type of surgery.[2]

POD is associated with increased days of mechanical ventilation, ICU length of stay,[3] increased hospital length of stay,[4] and subjects' functional decline.[5] Furthermore, all-cause mortality increases by at least 10.0-20.0% for every 48 hours of delirium,[6,7] and in-hospital delirium costs are doubled.[8]

A recent (2020) systematic review and meta-analysis of 11 studies, reported 8.0-54.0% of POD incidents. The authors revealed 19 risk factors for the development of POD classified as patient-related and treatment-related.[9] A 2016 a systematic review of 24 studies including 5364 patients with hip fracture reported an accumulated incidence of 24.0% POD. Elderly patients with preoperative cognitive impairment (odds ratio (OR) 3.21), advanced age (standardized mean difference 0.50), multiple comorbidities (OR 1.37) were identified among risk factors to sustain delirium after hip surgery. Females were less likely to develop delirium after hip surgery (OR 0.83).[10] POD is often an unrecognized complication that has unfavorable consequences for the individuals and health care organizations such as long hospital stay, poor clinical outcomes, and mortality.[11]

OBJECTIVE

The specific objective of this study was to predict the risk

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factors associated with POD.

METHODS AND ANALYSIS

This was a multi-center cross-sectional hospital-based study, targeted subjects undergoing surgical procedures for the development of POD in selected hospitals at Khartoum State-Sudan. The study conducted by the clinical pharmacist at six major hospitals at Khartoum City-Sudan. These are major hospitals with diverse surgical procedures serving both the Khartoum city, capital of Sudan as well as the rest of the country as well.

Subjects scheduled for elective or emergency surgery were eligible to participate in the study. The sample size was derived by computing the minimum number required for accuracy in estimating proportions by considering the standard normal deviation set at 95% confidence level (1.96, Z score) percentage picking a choice or response (50.0% = 0.5) and the confidence interval (0.05= ± 5). The formula $n = z^2 (p) (1-p)/c^2$ was used, where: z is standard normal deviation set at 95% confidence level, p is the estimated proportion of the population that presents the characteristic (when unknown we use p = 0.5), c is the margin of error interval. Accordingly, the sample size was estimated to be 385 subjects. We recruited 415 eligible subjects to account for any missing data in some patients.

The inclusion criteria were: surgical candidates ≥ 50 years of age, and positive with at least one of the criteria of Delirium Elderly at Risk (DEAR) score. Subjects excluded if they were unable to communicate, understand, complete the data, have refused to participate in the study or their relatives did not permit the study. The purpose of the study was explained to participants during the structured interview and consented subjects (or next kin) were invited to complete the study questionnaire. The study followed Helsinki as a statement of ethical principles for medical research involving human subjects, including research on identifiable human material and data.

Based on the literature review and data available from our hospitals'; we used the following data collection validated tools: Short Nutritional Assessment Questionnaire (SNAQ) for assessment of nutritional and hydration status of patients. In addition, we used Katz Index of Independence in Activities of Daily Living (KATZ-ADL score) for functional and fitness status; American Society of Anesthesiologists (ASA) score for perioperative risk assessment (physical status classification system perioperative).

As a pretest, we used DEAR to assess the risk of developing POD. Delirium Observational Screening Scale (DOSS) was used as a post-test for the diagnosis of POD. We targeted the recruited subjects admitted for surgeries and evaluated them primarily by using the DEAR instrument to identify subjects with high risk for developing POD (including clock drawing test) to assess cognition of the patient. The detailed information about the above-mentioned data tools was presented on the appendices [Appendices 1-5, supplementary materials].

We used specific tools to include pre-, intra-, and post-operative predisposing factors for developing POD.

Preoperatively, baseline characteristic data collected from the medical records of all subjects included in the study: demographic data (e.g. age, gender), social history (e.g. smoking, social drinking), comorbidities (hypertension, acute coronary syndrome, heart failure, diabetes, other endocrine diseases, hepatic diseases, renal diseases, and pulmonary diseases. Preoperative baseline characteristics collected from the patients' medical records and included: diabetes or other endocrine disorders; hepatic, renal, pulmonary or neurological diseases (co-existing dementia); CNS disorders, sensory impairment (includes visual and hearing loss), presence of tremor, and preoperative drug use. Laboratory data included: albumin level and blood urea nitrogen [BUN]), blood or plasma transfusions, and past surgical history. Preoperatively, all subjects assessed for functional and cognitive status by the anesthesiologist and/or the nurse. The respective relevant assessment of POD conducted using validated tools. Intraoperative data collected by the clinical pharmacist (principal investigator) from the recovery room nursing sheet nursing records, and included: type of anesthesia (including nitrous gases), duration of surgery, other medications, and incidence of any complications during surgery.

Postoperative data included measures of blood pressure, blood sugar, electrolytes, presence of infection, patient pain intensity, and any used analgesics. We have observed the general patient status before surgery, perioperative, during the recovery period, and postoperative period. Current medications therapy recorded. Furthermore, we reported the non-pharmacological therapies applied by nurses and respective hospital protocols to evaluate the general practice used to manage the subjects with POD.

The main outcome measure was the development of POD as per the specified diagnostic tools and its significant association with risk factors. Statistical Package for Social Sciences software (SPSS), version 21.0 (IBM SPSS Inc., Chicago, IL) and STATA 11 was used for data analysis. Initially, all information gathered via the questionnaire and the validated tools were labeled and coded into respective variables. The data pertinent to risk factors were analyzed by univariate (chi-square or fisher's exact test) followed with multivariate analyses and the incidence rate of POD was reported. A *P*-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 415 subjects were recruited from the six hospital surgical settings. from different hospital surgical settings had met the inclusion criteria and recruited. We excluded 15 subjects due to incomplete data, 9 subjects were lost to follow-up and 6 subjects were considered to have inaccurate delirium diagnoses by the researchers. A total of 385 subjects completed the study. Most of the subjects 247, (64.0%) had ages ranged between 50-59 years (55 mean age ±4.2 SD). There

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were (10.1%) aged above 70 years and (54.0%) were females. The different age groups listed in (Table 1). The baseline characteristics of the patients shown in Table 1.

Table 1. The demographic, anthropometric and other characteristics of the study population (N= 385)

Parameter	Frequency (%)
Age (years)	
50 - 59	246 (64.0)
60 - 69	100 (26.0)
≥ 70	39 (10.0)
Gender	
Female	208 (54.0)
Male	177 (46.0)
Co-morbidities	
No comorbidities	61 (15.8)
One comorbidity	193 (50.1)
Two comorbidities	88 (22.9)
≥ 3 comorbidities	43 (11.2)
BMI	
Below the normal	38 (09.9)
Normal	271 (70.4)
Abnormal	76 (19.7)
Preoperative hospital stay (days)	
1	316 (82.1)
2	36 (09.4)
≥ 3	33 (08.5)
Total per each parameter in row	385 (100.0)

(%): percent; BMI: body mass index.

Of the total surgical procedures, (81.0%) were elective and (19%) were emergency. Abdominal (19.7%) and orthopedic (18.2%) surgeries reported more frequently. Slightly more than half (50.1%) of subjects had at least one comorbid condition compared to (11.2%) with multiple comorbidities (high-risk patients). Common comorbidities included diabetes, hypertension, endocrine disorder, and cardiac and pulmonary disease.

There were (17.0%) using more than three medications and (7.3%) had used anticholinergics. There were (3.6%) alcoholics and (4.0%) had a history of delirium after previous surgery. Details of type of surgeries for patients involved in the study and preoperative data were shown in Table 2. Majority of the patients (83.2%) had KATZ-ADL score of zero (entirely dependent). About three quarter (75%) of the surgical procedures were 2-5 hours long. General anesthesia was more commonly used (69.0%) followed by spinal or local anesthesia (31.0%) and nitrous gases (44.0%). Majority of the subjects (91.0%) had no surgical complication. Using DOSS (to differentiate between the delirious and normal patient), 43 subjects developed delirium with an incidence rate of (11.2%).

Table 2. The type of surgery in the study population (N= 385)

The surgeries	Frequency (%)
Type of surgery	
Emergency surgery	73 (19.0)
Elective surgery	312 (81.0)
Total	**385 (100.0)**
The specific type of surgery	
Abdominal	76 (19.7)
Orthopedic	70 (18.2)
Cardiac	47 (12.2)
Trauma	45 (11.7)
Tumor	35 (9.1)
Urological	34 (8.8)
Thoracic	30 (7.8)
Colorectal	18 (7.8)
Endocrine	19 (4.9)
Gynecological	11 (2.9)
Total	**385 (100.0)**

(%): percent; N: The number of the subjects in the study population.

The majority of subjects (60.4%) had developed delirium on day 1, followed by (37.2%) on day 2, and only (2.4%) on day 3. The incidence of delirium was (77.0%) in ICU, (21.0%) in the surgical ward, and (2.0%) in the post-anesthesia care unit (PACU).

More than half of the subjects (51.0%) had their symptoms resolved after three days. Subjects who developed delirium were much older, had a history of alcohol, illicit drug, and smoking history, and received general anesthesia and nitrous derivatives ($P < 0.001$). Additional risks associated with the development of delirium included: subjects who had lower Katz-ADL score, higher ASA score, increased surgery complications, long surgical procedure, comorbid diseases, blood or plasma transfusion, low albumin level, high urea nitrogen, and low body mass index (BMI) were more significantly associated with the development of delirium ($P <0.001$; [Table 3A and 3B)].

Postoperatively, (88.8%) normal blood pressure, (89.6%) normal blood sugar, and (84.7%) no electrolyte imbalance. Only (15.0%) developed a postoperative infection and (7.5%) uncontrolled pain. Comparing physical and functional status among subjects with delirium versus those without delirium revealed significant differences ($P <0.001$). Meperidine (pethidine) was the most widely used analgesic; either alone or in combination with other analgesics. Other drugs used were: diclofenac sodium (35.3%), paracetamol (33.5%), nefopam injection (22.6%), fentanyl (14.8%), propofol (9.6%), and morphine (3.9%). More subjects with a history of polypharmacy (including sedative hypnotics or illicit drug use) developed delirium ($P < 0.05$). There was no significant difference between subjects taking anticholinergics drugs and who were not ($P= 0.109$). For delirium management, (7%) received not therapy vs. (93%) who were treated with multiple agents. Treatments included: midazolam for sedation (60.4%);

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Table 3A. The association between the perioperative data of the study population characteristics and the POD (N= 385)

Parameter **Positive** 43 (11.2)		**The DOSS frequency (%)**		
		Negative 342 (88.8)	**Fisher's exact test P value**	
Gender	Male	26 (6.8)	151 (39.2)	0.054
	Female	17 (4.4)	191 (49.6)	
Occurrence of delirium after a pervious surgery	Yes	7 (1.8)	8 (2.1)	< 0.001*
	No	36 (9.4)	334 (86.8)	
Previous incidence of stroke	Yes	17 (4.4)	36 (9.4)	< 0.001*
	No	26 (6.8)	306 (79.5)	
Preoperative anemia	Yes	11 (2.9)	14 (3.6)	< 0.001*
	No	32 (8.3)	328 (85.2)	
Poly-pharmacy	Yes	35 (9.8)	31 (8.05)	< 0.001*
	No	8 (2.1)	11 (80.7)	
Anticholinergic drugs	Yes	6 (1.6)	22 (5.7)	0.109
	No	37 (9.6)	320 (83.1)	
Sedatives/hypnotics	Yes	5 (1.3)	3 (0.8)	0.001*
	No	38 (9.9)	339 (88.1)	
Drug abuse /sudden withdrawal	Yes	2 (0.5)	0 (0.00)	0.012*
	No	41 (10.6)	342 (88.8)	
Alcohol	Yes	6 (1.6)	8 (2.1)	0.002*
	No	37(9.6)	334 (86.8)	
Smoking	Yes	25 (6.5)	79 (20.5)	0.001*
	No	18 (4.7)	263 (68.3)	
Alcohol	Yes	6 (1.6)	8 (2.1)	0.002*
	No	37(9.6)	334 (86.8)	
Blood or plasma transfusions	Yes	21 (5.5)	18 (4.7)	< 0.001*
	No	22 (5.7)	324 (84.2)	
Albumin level	Low	12 (3.1)	8 (2.1)	< 0. 001*
	Normal	31 (8.1)	334 (86.8)	
BUN	Normal	30 (7.8)	317 (82.3)	< 0. 001*
	High	13 (3.4)	25 (6.5)	
BMI	Below the normal	18 (4.7)	20 (5.2)	< < 0.001* 0.001*
	Normal	20 (5.2)	251 (65.2)	
	Abnormal	5 (1.3)	71 (18.4)	

Keys. BMI: body mass index; BUN: Blood urea nitrogen; DOSS: Delirium Observational Screening Scale; (%): percent; N: The number of the subjects in the study population; POD: postoperative delirium; **P* value: statistically significant

Table 3B. The association between the perioperative data of the study population characteristics and the POD (N=385)

Parameter **Positive** 43 (11.2)		**The DOSS frequency (%)**		
		Negative 342 (88.8)	**Fisher's exact test *P* value**	
Comorbidities	Two	12 (3.1)	76 (19.7)	< 0.001*
	≥ 3	31 (8.1)	12 (3.1)	
Hypertension	Yes	30 (7.8)	124 (32.2)	< 0.001*
	No	13 (3.4)	218 (56.6)	

Cardiovascular diseases	Yes	23 (6.0)	38 (9.9)	< 0.001*
	No	20 (5.2)	304 (79.0)	
Diabetes	Yes	27 (7.0)	83 (21.6)	< 0.001*
	No	16 (4.2)	259 (67.3)	
Endocrine diseases	Yes	2 (0.5)	39 (10.1)	0.290
	No	41 (10.6)	303 (78.7)	
Hepatic diseases	Yes	3 (0.8)	5 (1.3)	0.049*
	No	40 (10.4)	337 (87.5)	
Renal diseases	Yes	4 (1.0)	11 (2.9)	0.074
	No	39 (10.1)	331 (86.0)	
Pulmonary diseases	Yes	18 (4.7)	64 (16.6)	0.001*
	No	25 (6.5)	278 (72.2)	
Neurological diseases	Yes	4 (1.0)	1 (0.3)	0.001*
	No	39 (10.1)	341 (88.6)	
Central nervous system diseases	Yes	3 (0.8)	3 (0.8)	0.020*
	No	40 (10.4)	339 (88.1)	
Co- existing dementia	Yes	2 (0.5)	3 (0.8)	0.039*
	No	41 ((10.6)	339 (88.1)	
Visual impairment	Yes	6 (1.6)	11 (2.9)	0.007*
	No	37 (9.6)	331 (86.0)	
Hearing impairment	Yes	4 (1.0)	2 (0.5)	0.002*
	No	39 (10.1)	340 (88.3)	
Presence of tumor	Yes	6 (1.6)	41 (10.6)	0.629
	No	37 (9.6)	301 (78.2)	

Keys. DOSS: Delirium Observational Screening Scale; (%): percent; N: The number of the subjects in the study population; POD: postoperative delirium; *P value= statistically significant.

benzodiazepines (16.2%), and /haloperidol for delirium (7.0%). Only (9.4%) received atypical antipsychotics either alone or in combination with benzodiazepines (4.7%). Delirium improved in (81.0%) of the patients post management.

Logistic regression analysis performed to identify independent predictors for increased risk associated with POD. Univariate analysis has shown that age ≥70 years, low KATZ-ADL scores ≤2, high ASA scores, increased duration of surgical procedure, high blood urea nitrogen, pre-existing co-morbidities, low albumin, and low BMI to be significantly associated with POD. The variables with a *P*-value <0.05 were further included in the multivariate model to determine the strength of the association.

The following four independent risk factors were identified for the development of POD in order of strength of association: ASA high scores, longer duration of surgery, Katz ADL low scores, and higher age. Multivariate logistic regression analysis revealed that high ASA scores (adjusted OR: 10.76, 95% CI: [1.379-8.399]; *P*< 0.023), duration of surgery (OR: 5.426, 95% CI: [2.249-13.092]; *P* =0.0001), KATZ-ADL score (OR: 3.227, 95% CI: [1.177-8.844]; *P* =0.023), age ≥ 70 years (OR: 1.174, 95% CI: [1.015-1.359]; *P* =0.027) to be the strongest independent risk factors for POD, (Table 4). There were (29, 67.4%) delirious subjects that had a hyperactive subtype of delirium (9, 20.9%) had hypoactive and (5, 11.7%) had a mixed subtype of delirium.

DISCUSSION

Our study identified four risk factors as the independent predictors of POD occurrence (high ASA score, longer duration of surgery, low KATZ ADL score, and age ≥ 70 years). The incidence of POD was 11.2% with hyperactive being the most frequent, followed by hypoactive and finally the mixed type. Previous studies have reported similar predictive risk factors, but related to non-abdominal surgical procedures.[12] However, the current research has explored the POD in a diverse population with various type of surgeries. We detected that high ASA scores were the most important risk factor contributing to the development of POD (OR =10.76). A one-point increase in the ASA score was associated with a 10X increase in POD occurrence. This incidence reported in similar prospective studies.[13,14] Therefore, postoperatively take a slight change in ASA score seriously.

The duration of the surgery was the second most important factor associated with a higher incidence of POD (OR =5.426).

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Table 4. The final model of multivariate logistic regression analyses for prediction of POD

Variables	Odd ratio	95% CI	*P*-value
ASA score	10.763	(1.379 - 8.399)	0.023*
Duration of Surgery (hours)	5.426	(2.249 -13.092)	0.0001*
Katz - ADL score	3.227	(1.177 - 8.844)	0.023*
Age (years)	1.174	(1.015 - 1.359)	0.031*
Numbers of co-morbidities	0.851	(22.457 - 67.232)	0.365
Blood or plasma transfusion	0.569	(13.218 - 84.915)	0.512
Albumin level	0.241	(11.365 – 37.841)	0.678
Blood urea nitrogen	0.158	(17.617 – 45.619)	0.698
BMI	0.127	(23.248 – 67.259)	0.751

Keys: ASA score: American Society of Anesthesiologists score; BMI: body mass index; CI: confidence interval; Katz - ADL score: Katz Index of Independence in Activities of Daily Living score; POD: postoperative delirium; **P*-value: statistically significant.

A recent study reported longer surgical procedures are associated with increased risk of delirium.[15] Previous studies have reported specific age groups and the physical impairment rather than just advanced age. One study reported only (22.0%) POD in subjects <60 years of age, but the incidence increased to (42.0%), (72.0%), and (92.0%) for every additional decade of age.[16] Although age is a non-modifiable risk factor, prevention and management strategies considered due to the negative impact of intensity and duration of delirium. Although in our study the incidence of POD was (11.2%), an overall incidence of (17.0% - 51.0%) reported in previous studies.[17-20] This reflects how the POD prevalence may vary among the studies and it may depend on the patient population, timing of assessment, experience of the investigator, and the assessment tools.

From the overall incidence of POD, the incidence rate after elective surgery was higher than that occurs after emergency surgery (7.3% versus 3.9%; *P* <0.05) respectively.[21,22] This might be due to the large heterogeneity of included populations and different surgical procedures studied. However, the study conducted by Yu and colleagues[6] found that an incidence rate of delirium after major emergency surgery was lower than elective.[6] POD is prevalent in surgical patients and increases the risk of PO cognitive dysfunction which may extend beyond the surgical recovery leading to short- and long term clinical sequalae.[23,24] In a recent prospective observational study, of 946 elderly patients undergoing elective urological surgery, the rate of POD observed in 32 (3.4%). The history of cerebrovascular disease (OR 5.24), low Hasegawa Dementia Scale-Revised score <20 points (OR 3.50), low serum albumin level <3.5 g/dL (OR 3.12) and long surgery >4 h (OR 4.94) identified as independent risk factors for the development of POD.[25] A recent small study of 138 subject (> 65 years of age) undergoing spinal surgery reported older age, preoperative low cognitive function, long duration of surgery, and transfusions were important POD risk factors particularly with spinal surgery.[26]

POD is a common complication that exerts an enormous burden on patients, their families, hospitals, and public resources. The current study has identified the risk factors and determinants contributing to POD, the findings of which may support the healthcare providers for early prevention, diagnosis, and timely management of POD. The increased incidence of POD has an enormous impact on the population health outcomes such as quality of life and substantial cost to the healthcare system. The role of the clinical pharmacist in the identification, assessment, and prevention of POD was well recognized. Future research is to be directed towards interventions to prevent the development of POD.

Generally, the variability in risk factors and the incidence rate of POD is due to different in the assessment tools used to identify POD, the type of surgery and the potential surgical risk. Therefore, future research studies warranted to explore the diversity of POD in different populations.

The strengths of our study include prospective design, DOSS diagnostic tool, and involvement of experienced anesthesiologist who diagnosed the delirium. We also studied various confounders from heterogonous hospital settings. The limitation of our study was mainly about the relatively small sample size recruited from the six different hospitals. Therefore, our results may not be generalizable to each selected care setting. Secondly, the inability to cover all shifts of DOSS score when it's related to subjects with sub-syndromal or hypoactive type, hence the incidence of POD may have been underestimated besides unsuitability and difficulty to perform all pre-tests within emergency surgery. There was wide variation in some of the reported 95% CI in our study, which might raise some concern about the selection of patients in such a diverse population with different surgical procedures.

CONCLUSION

Based on analysis or study, we found High ASA sore, Katz-ADL, duration of surgery, and advanced age were predictors of POD. Our findings suggest preventive measures initiated in subjects identified at risk of developing POD. These results support the healthcare providers in the early prevention, diagnosis, and timely management of POD.

KEY MESSAGES

What is already known on this subject?

The increased incidence of POD has negative impact on the population health as well as considerable healthcare costs.

The role of the clinical pharmacist in the identification of the risk factors for the occurrence of POD is not well defined.

What our article adds to the literature?

Although POD is a common and important complication in the elderly it has been neglected by healthcare professionals including clinical pharmacist.

This study has identified risk factors contributing for POD.

The findings may support early diagnosis, prevention, and timely management of POD by healthcare professionals.

The role of the clinical pharmacist in the identification, assessment, and prevention of POD was recognized/identified.

Impact on clinical practice

The predictors of POD may facilitate the development of risk-factor model that can be emulated by similar health care settings.

Understanding modifiable and non-modifiable risk factors for POD can improve prevention and management of POD.

ETHICS APPROVAL

Ethics approval was granted by the Ethics Committee of the Graduated College of National University, Khartoum-Sudan. Written approval for conduction of the study was obtained from the Ministry of Health in Khartoum State-Research Administration and Private Hospital Research Administration (20180512).

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DECLARATIONS

Declaration of interest statement

'Declarations of interest: none'.

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Conflicts of interest/Competing interests (include appropriate disclosures)

All authors declare no conflicts of interest.

Consent to participate

Participant has consented to participate in the study prior to start of the research.

Consent for publication

All author consent to the manuscript publication.

Availability of data and material (data transparency)

Data was not available.

Code availability (software application or custom code)

Not applicable.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis performed by [Asim Ahmed Elnour], [Sara Babikr] and Al-Kubaissi, Khalid A. The first draft of the manuscript was written by [Sara Babikr] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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APPENDICES

Appendix 1. Delirium Elderly at Risk (DEAR) instrument[26]

We have evaluated all surgical subjects for the development of postoperative delirium (POD) by using the Delirium Elderly at Risk (DEAR) instrument. The DEAR score has included a clock drawing test (CDT) to inform the cognition of patient. This score is used as pre-test preoperatively to identify patient with high risk for POD.

In our study we have launched the DEAR for all patients within the surgical wards. The DEAR score relies on baseline information to know about the delirium risk factors. It contains 5 questions (patient age, sensory impermanent, functional dependence, any substance use (alcohol or drugs like benzodiazepines), patient cognition status (ask about any history of delirium occurs in previous surgery or by doing a cognition test (clock drawing test).

Patient age	Age 80 or more than 65 put a patient on a risk	YES NO
Sensory impairment	Patient use hearing aids and/or very low vision	YES NO
Functional dependence	Patient requires assistance with bathing, dressing, toiling and feeding.	YES NO
Substance use	Patient drinks alcohol 3or more per week ,or patient on chronic use of benzodiazepines three times per week	YES NO
Cognition	Ask about history of occurrence of delirium state in previous surgery or by failed on doing clock drawing test	YES NO

Keys:

YES: 1; NO: 0; *A score of one or more places the patient at higher risk to developing postoperative delirium; DEAR: Delirium Elderly at Risk; POD: postoperative delirium;

Clock Drawing Test (CDT)

The CDT is a part from DEAR used to identify the cognition status, as a nonverbal screening tool where the patient is asked to draw a clock. Placement of the numbers around the circle requires visual-spatial, numerical sequencing, and planning abilities. The patient is then asked to draw the hands on the clock to indicate “ten minutes past 11 o’clock.” The test also assesses long-term attention, memory, auditory processing and motor programming.

CDT has been proposed as a quick screening test for cognitive dysfunction secondary to dementia, delirium, or a range of neurological and psychiatric illnesses. It can be effectively administered to resistant and non-compliant older persons.[27]

How: -

Provide patient with a piece of paper with a pre-drawn circle of approximately 10 cm in diameter.

Indicate that the circle represents the face of a clock and ask the patient to put in the numbers so that it looks like a clock.

Ask the patient to add arms so that the clock indicates the time “ten minutes after eleven.”

Scoring: -

The choice of a scoring system ultimately depends on the specific needs and goals of the clinician or researcher. The clock is divided into eighths, beginning with a line through the number 12 and the center of the circle.

If the 12 is missing, its position is assumed to be counterclockwise from the 1 at a distance equal to that between the 1 and 2. Any straight edge may be used to divide the clock into eighths.

The scoring template shows the clock circle, already divided in to eighths. A scoring template, drawn on a see-through sheet of plastic, is placed over the patient’s drawing.

Alternatively, a scoring template drawn on paper, is placed under the patient’s drawing so that the scoring template clock shows through the patient’s drawing paper above it.

One point each is given for the numbers 1, 2, 4, 5, 7, 8, 10, and 11 if at least half the area of the number is in the proper octant of the circle relative to the number 12.

One point each is given for an obvious short hand pointing at the 11 and an obvious long hand pointing to the 2. The difference in the length of the hands must be obvious at a glance.

A score of 10 suggest that cognitive impairment (CI) is unlikely. 8 or 9 must be interpreted clinically. < 8 indicates CI and < 5 indicates prominent impairment.

Appendix 2. Short Nutritional Assessment Questionnaire (SNAQ)

In our study, SNAQ is classified as a pre-test, it was used for assessing the nutritional and the dehydration status of patients. SNAQ combines body mass index (BMI) by three questions related to: -

- did you lose weight unintentionally? (more than 6 kg in the last 6 month=3 points and more than 3 kg in the last month) = 2 points.

- did you experience a decreased appetite over the last month? = 1 point

- did you use supplemental drinks or tube feeding over the last month? = 1 point[28]

Meaning of points score: -

0 of one point (normal or near to normal nourished and no intervention)

2 points moderately malnourished

3 points and more severely malnourished

Or by

1- Nourished those with (<5% weight loss in the last 6 month and BMI >18.5)

2- Moderately malnourished (5-10% weight loss in the 6 month and the BMI >18.5)

3- Severely malnourished (>10% weight loss in the last 6 month or >5% in the last month or BMI <18.5)

Appendix 3. American Society of Anesthesiologists (ASA) score

The ASA Physical Status Classification System has been in use for over 60 years. The purpose of the system is to assess and communicate a patient's pre-anesthesia medical co-morbidities. The classification system alone does not predict the perioperative risks, but used with other factors (e.g., type of surgery, frailty, level of deconditioning), it can be helpful in predicting perioperative risks. We have used the ASA score to assess and predict the perioperative risks of the fitness of patient before surgery.[29-32]

ASA direction of use

ASA Physical Status Classification	Definitions	ASA Physical Status
ASA I	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use.
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well controlled DM/HTN, mild lung disease.
ASA III	A patient with severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA < 60 weeks, history (>3 months) of MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis.

ASA V	A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction.
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	
*****The addition of "E" denotes Emergency surgery: (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part)		

Appendix 4. Katz Index of Independence Activity of Daily Living (KATZ-ADL)

The KATZ-ADL score is used for functional impairment to assess functional impairment and person limits. It consists of 6 items that assess self-care abilities, including feeding, bathing, dressing, toilet use, continence, and transferring from bed to chair.[33]

Activities Points (1 or 0)	**Independence (1 point) NO supervision, direction or personal assistance**	**Dependence (0 points) WITH supervision, direction, personal assistance or total care**
BATHING Points:	(1 POINT) Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity	(0 point) need help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
DRESSING Points:	(1 point) get cloth from closets and drawers and puts on clothes and outer garments complete with fasteners may have help tying shoes	(0 points) needs help with dressing self or needs to be completely dressed
TOILETING Points:	(1 point) goes to toilet ,gets on and off, arranges clothes, cleans genital area without help	(0 point) needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING Points	(1 point) moves in and out of bed or chair unassisted. Mechanical transfer aids are acceptable	(0 point) needs help in moving from bed to chair or requires a complete
CONTINENCE Points:	(1 point) exercises complete self-control over urination and defection	(0 point) is partial or totally incontinent of bowel or bladder
FEEDING Points:	(1 point) gets food from plate into mouth without help, preparation of food may be done by another person	(0 point) needs partial or total help with feeding or requires parenteral feeding

Total points: 6 points, Scoring: [6 = High (patient independent), 0 = Low (patient very dependent)]

Appendix 5. The Delirium Observation Screening scale (DOSS)

The DOSS scale was developed to facilitate early recognition of delirium, according to the Diagnostic and Statistical Manual-IV criteria, based on nurses' observations during regular care.

Directions for use

The DOSS is a 13-item observational scale of verbal and nonverbal behavior. The observations can be conducted during regular care. To optimize recognition of delirium, recording of observations per shift is important.[34]

Rating (tick as appropriate)

Never: during this shift, contacts with the patient the described behavior was not observed

Sometimes: during this shift, in contacts with the patient the described behavior was always observed once, or a few times or even all the time

Unable: during this shift, in contacts with the patient the described behavior was not observed since the patient was asleep or did not give necessary verbal responses OR the rater does not find he/she competent to observe the absence or presence of the behavior**.**

Directions for scoring

For each shift the total score is calculated by counting the circled ratings.

Adding the total scores per shift gives the total score for today.

The DOSS Scale final score is calculated by dividing the total score for today by 3.

For the version with 13 items, two score are allotted:

Never = 0 point; Sometimes or always = 1 point

The Delirium Observation Screening scale (DOSS)

Observing the patient	Day shift: never =0 sometimes/always=1 unable= -			Evening shift: never =0 sometimes \always=1 unable= -			Night shift: never =0 sometimes \always=1 unable= -		
1. Dozes of during conversation or activities	0	1	-	0	1	-	0	1	-
2. Is easy distracted by stimuli from the environment	0	1	-	0	1	-	0	1	-
3. Maintains attention to conversation or action	1	0	-	1	0	-	1	0	-
4. Does not finish question or answer	0	1	-	0	1	-	0	1	-
5. Gives answers that do not fit the question	0	1	-	0	1	-	0	1	-
6. Reacts slowly to instructions	0	1	-	0	1	-	0	1	-
7. Thinks to be somewhere else	0	1	-	0	1	-	0	1	-
8. Knows which part of the day it is	1	0	-	1	0	-	1	0	-
9. Remembers recent event	1	0	-	1	0	-	1	0	-
10. Is picking, disorderly, restless	0	1	-	0	1	-	0	1	-
11. Pulls iv tubes, feeding tubes ,catheters	0	1	-	0	1	-	0	1	-
12. Is easy or sudden emotional	0	1	-	0	1	-	0	1	-
13. Sees/hears things which are not there	0	1	-	0	1	-	0	1	-

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