

# The risk factors of postoperative delirium in general anesthesia patients with hip fracture

## Attention needed

Zhe Chu, MD<sup>a</sup>, Yixuan Wu, MD<sup>b</sup>, Xuanhui Dai, MD<sup>c</sup>, Cuicui Zhang, MD<sup>b</sup>, Qianfeng He, MD<sup>b,\*</sup> 

### Abstract

Delirium is a common postoperative complication of patients with hip fracture, yet the risk factors for postoperative delirium in patients with hip fracture remain unclear. We aimed to evaluate the associated risk factors of postoperative delirium in patients with hip fracture, to provide evidence for formulating coping measures of postoperative delirium prevention and treatment in clinical practice.

Patients undergoing surgery for hip fracture from March 1, 2018 to September 30, 2020 in our hospital were included. The related characteristics and related lab examination results were reviewed and collected. The univariate and logistic regression analyses were performed to identify the potential risk factors.

A total of 462 patients were included, the incidence of postoperative delirium in patients with hip fracture was 16.02%. Logistic regression analyses indicated that history of delirium (OR=4.38, 1.15–9.53), diabetes mellitus (OR=5.31, 1.23–10.75), hypoalbuminemia (OR=4.97, 1.37–9.86), postoperative hypoxemia (OR=5.67, 2.24–13.42), and body mass index (BMI) (kg/m<sup>2</sup>) (OR=3.03, 1.36–6.18) were the independent risk factors for the delirium in patients with hip fracture surgery (all  $P < 0.05$ ). The cutoff value of postoperative blood sugar, albumin, and BMI for delirium prediction was 8.05 (mmol/L), 32.26 (g/L), and 19.35 (kg/m<sup>2</sup>), respectively, and the area under curve of postoperative blood sugar, albumin, and BMI was 0.792, 0.714, and 0.703, respectively.

Those patients with a history of delirium, postoperative hypoxemia, blood glucose  $\geq 8.05$  mmol/L, albumin  $\leq 32.26$  g/L, and BMI  $\leq 19.35$  kg/m<sup>2</sup> particularly need the attention of healthcare providers for the prevention of delirium.

**Abbreviations:** AUC = area under curve, BMI = body mass index, CAM = confusion assessment method, ROC = receiver operating characteristic.

**Keywords:** delirium, hip fracture, nursing, prevention, surgery

## 1. Introduction

Hip fracture is a common type of fracture in elderly patients. With the growth of the elderly population, it is expected that by 2040, the number of hip fractures in China will exceed 1 million cases per

year.<sup>[1,2]</sup> In general, the incidence of hip fractures increases with the aging of patients.<sup>[3]</sup> Some studies<sup>[4,5]</sup> have found that the incidence of hip fractures in people older than 85 years old is 10 to 15 times that of people aged 60 to 65 years old. The high incidence of hip fractures in the elderly and the physiological characteristics of the elderly make the treatment of hip fractures of the elderly a major challenge for clinical healthcare providers.

Surgeries are generally performed clinically for the treatment of the hip fracture. It is been reported that delirium has become the most important complication of hip fracture surgery due to its high incidence up to 42.65%.<sup>[6]</sup> Delirium is a kind of acute consciousness disorder characterized by a decline in patients' cognitive ability and attention deficit. With the improvement of technology related to hip fracture surgery, the elderly with hip fracture undergoing surgery treatment is greatly increased, and the incidence of delirium after surgery may also increase accordingly.<sup>[7]</sup> Patients with delirium after surgery during hospitalization are reported to have a worse prognosis and outcome than those without delirium.<sup>[8,9]</sup> Postoperative delirium can exacerbate the condition and increase the risk of pulmonary infections, electrolyte disturbances, deep vein thrombosis, and falls, thus prolonging the length of hospital stay, increasing the cost, and burdens of patients and society.<sup>[10,11]</sup> It is been reported that the mortality of patients with delirium after hip fracture surgery increased by about 3 times compared with patients without delirium in 6 months after surgery.<sup>[12]</sup> Therefore, the management of delirium after hip fracture surgery is essential to the prognosis of patients.

The pathogenesis of postoperative delirium in elderly patients currently includes inflammation, neurotransmitter, and psychosocial stress theory. However, most of the research only stays on

Editor: Bernhard Schaller.

ZC and YW contributed equally to this work.

This present study was approved by the medical ethics committee of our hospital (No. 1800233-7), and the written informed consent was obtained from all included patients.

The authors have no funding and no conflicts of interest to disclose.

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

<sup>a</sup> Department of Emergency, The First Hospital of Jilin University, Changchun 130021, <sup>b</sup> Department of Emergency, <sup>c</sup> Department of Orthopedics, Tangdu Hospital, Air Force Military Medical University, Xi'an, Shaanxi 710038, China.

\* Correspondence: Qianfeng He, Department of Emergency, Tangdu Hospital, Air Force Military Medical University, No. 569, Xinsi Road, Baqiao District, Xi'an, Shaanxi 710038, China (e-mail: qianfenghedr@yeah.net).

Copyright © 2021 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Chu Z, Wu Y, Dai X, Zhang C, He Q. The risk factors of postoperative delirium in general anesthesia patients with hip fracture: attention needed. *Medicine* 2021;100:22(e26156).

Received: 26 November 2020 / Received in final form: 8 May 2021 / Accepted: 11 May 2021

<http://dx.doi.org/10.1097/MD.00000000000026156>

theoretical speculation and lacks the support of a large amount of research evidence.<sup>[13]</sup> Most scholars<sup>[14,15]</sup> have reported that pain stimulation caused by surgical trauma, hypoxemia, and environmental disturbances in the body is associated with postoperative delirium. The incidence of delirium in hip fractures is significantly higher than that of other surgical patients.<sup>[12,16]</sup> Currently, the factors of delirium in patients after hip fracture surgery remain unclear, more studies are needed to further elucidate the potentially related factors. Therefore, we aimed to conduct this retrospective study to identify the risk factors of delirium in patients after hip fracture surgery, to provide insights into the development of measures targeted on those risk factors to reduce postoperative delirium in patients with hip fracture.

## 2. Methods

### 2.1. Ethical considerations

This present study was approved by the medical ethics committee of our hospital (No. 1800233-7), and the written informed consent had been obtained from all included patients.

### 2.2. Patients

Our study was a retrospective study design. We retrospectively selected the patients receiving surgery for hip fracture from March 1, 2018 to September 30, 2020 as the study population. The patients were included if they met the following inclusion criteria: (1) patient was older than 18 years and had a hip fracture; (2) no drugs taken that could significantly affect mental activity within a month, including antipsychotic drugs, antiepileptic drugs, and sedative and sleeping pills; (3) no mental disorder and cognitive impairment before the operation; and (4) patient was willing to participate in this study and signed the written informed consent. The patients were excluded if they met the following exclusion criteria: (1) the patients did not receive surgical treatment; (2) patients with femoral neck or intertrochanteric fractures caused by tumors; (3) patients with a history of psychotropic substance abuse (such as benzodiazepines); (4) patients who could not communicate face to face; and (5) patients who were unwilling to participate in this study.

### 2.3. The diagnostic criteria for delirium

The diagnostic criteria for delirium referred to the standards developed and recommended by the American Psychiatric Association's Diagnostic and Statistical Manual of Psychiatry, and the confusion assessment method (CAM)<sup>[17]</sup> was adopted as a diagnostic tool in this present study. It has the following main items: (1) acute onset and fluctuating course; (2) inattention; (3) incoherent thinking; and (4) change in consciousness. Having the symptoms of both (1) and (2) or 1 of (3) and (4) could make the diagnose of delirium. All evaluation processes were conducted by researchers and psychiatrically trained nursing staff, the nurses in our department had been trained in the proper usage of the CAM scale. We checked the patients for delirium every 6 hours patients for delirium until they were discharged from the hospital. Following nursing, bundles had been routinely used to prevent delirium, including early correction of dehydration and electrolyte disorders, and supplementation of nutrients, monitoring of blood oxygen saturation and oxygen partial pressure, proper pain control, active participation of family members in the

postoperative period, prevention of sleep disturbances, and overuse of sedatives if necessary.

### 2.4. Data collections

Following data were collected by 2 authors independently: patients' identity, age, body mass index (BMI), concurrent complications including hypertension, diabetes mellitus, hyperlipidemia, history of delirium, type of hip fracture, the related lab examinations including sugar, albumin level peri-surgery, duration of surgery, and estimated blood loss during surgery. Each of the 2 mentioned authors collected the data of all consecutive patients with unified forms, and the data gathered by each author had been compared to ensure accuracy. For the laboratory data we collected, we chose the detected items that presented in all patients to reduce the potential biases related to the missing data of variables.

### 2.5. Statistical analysis

The data analyses of this study were performed with SPSS 23.0 statistical software. According to whether patients had postoperative delirium, they were divided into delirium group and non-delirium group. The characteristics of patients between the 2 groups were analyzed and compared. Continuous variables were tested by *t* test, and categorical variables were tested by  $\chi^2$  test. Multivariate logistic regression analysis was conducted to screen out the independent risk factors. According to the univariate analysis, the independent variables with statistical differences were further taken into the logistic regression model for multivariate analysis. Besides, the curve on the receiver operating characteristics (ROC) was made on the related lab test results, and the area under curve (AUC) was calculated for the analysis of diagnosis value. In this study,  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. The characteristics of included participant

A total of 462 postoperative patients with hip fracture were included, of whom 74 patients had the attack of delirium, the incidence of delirium in patients with hip fracture after surgery was 16.02%. As presented in Table 1, there were no statistical differences in the gender, age, hypertension, hyperlipidemia, anemia, cognitive dysfunction, type of fracture, duration of surgery, and estimated blood loss during surgery between the delirium and non-delirium patients (all  $P > 0.05$ ), but there were statistical differences in the BMI, cases of diabetes mellitus, history of delirium, hypoalbuminemia, and postoperative hypoxemia between delirium and non-delirium patients (all  $P < 0.05$ ).

### 3.2. The potential risk analysis

We included BMI, diabetes mellitus, history of delirium, hypoalbuminemia, and postoperative hypoxemia into further logistic regression analyses to identify the potential risk factors. As Table 2 showed, logistic regression analyses indicated that the history of delirium (OR = 4.38, 1.15–9.53), diabetes mellitus (OR = 5.31, 1.23–10.75), hypoalbuminemia (OR = 4.97, 1.37–9.86), postoperative hypoxemia (OR = 5.67, 2.24–13.42), and BMI ( $\text{kg}/\text{m}^2$ ) (OR = 3.03, 1.36–6.18) were the independent risk factors for the postoperative delirium in patients with hip fracture (all  $P < 0.05$ ).

**Table 1**  
The characteristics of included participants among 2 groups.

Variables	Delirium group (n=74)	No-delirium group (n=388)	$\chi^2/t$	P
Male/female	23/41	114/274	1.108	0.093
Age (yrs)	67.9±3.95	67.4±2.57	12.252	0.179
BMI (kg/m <sup>2</sup> )	20.6±3.04	22.2±2.99	4.817	0.035
Hypertension	53 (71.62%)	280 (72.16%)	2.204	0.118
Diabetes mellitus	46 (62.16%)	75 (19.33%)	1.280	0.007
Hyperlipidemia	14 (18.92%)	71 (18.30%)	1.649	0.142
History of delirium	38 (51.35%)	19 (4.90%)	1.104	0.001
Anemia	13 (17.57%)	72 (18.56%)	1.197	0.144
Hypoalbuminemia	20 (27.03%)	44 (11.34%)	1.062	0.016
Cognitive dysfunction	1 (1.35%)	5 (1.29%)	0.977	0.204
Type of fracture			1.285	0.099
Intertrochanteric fracture	36 (48.65%)	192 (49.48%)		
Femoral neck fracture	38 (51.35%)	196 (50.52%)		
Duration of surgery (min)	127.9±13.95	119.2±12.04	18.184	0.057
Estimated Blood loss during surgery (mL)	285.3±44.28	267.18±40.92	19.106	0.061
Postoperative hypoxemia	35 (47.30%)	13 (3.35%)	1.942	0.035

**Table 2**  
Logistic regression analysis on the risk factors for delirium in patients with hip fracture surgery.

Variables	$\beta$	SE	OR	95%CI	P	Rank
History of delirium	0.89	0.29	4.38	1.15–9.53	0.048	1
Diabetes mellitus	0.92	0.31	5.31	1.23–10.75	0.031	2
Hypoalbuminemia	1.03	0.45	4.97	1.37–9.86	0.042	3
Postoperative hypoxemia	0.99	0.39	5.67	2.24–13.42	0.019	4
BMI (kg/m <sup>2</sup> )	1.74	0.22	3.03	1.36–6.18	0.046	5

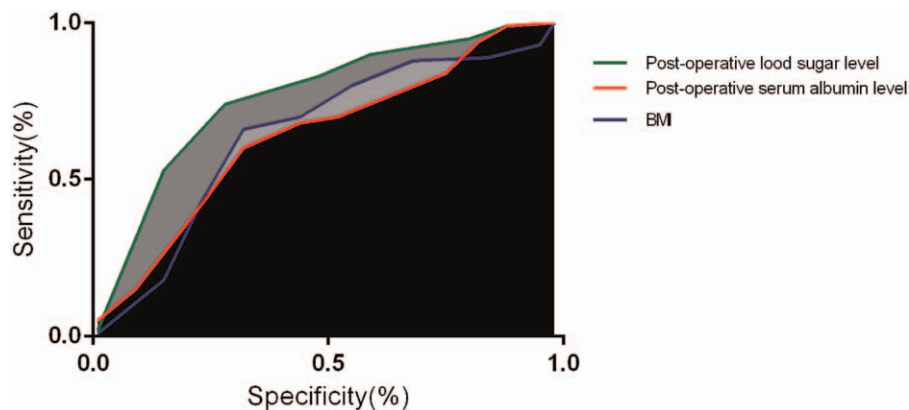
BMI=body mass index.

**3.3. The predictive value of factors for the delirium**

The curves of ROC for postoperative blood sugar, albumin, and BMI were presented in Figure 1. As showed in Table 3, the cutoff value of postoperative blood sugar, albumin, and BMI for delirium prediction was 8.05 (mmol/L), 32.26 (g/L), and 19.35 (kg/m<sup>2</sup>), respectively, indicating that postoperative blood sugar (AUC=0.792, 0.723–0.829), albumin (AUC=0.714, 0.627–0.797), and BMI (AUC=0.703, 0.664–0.738) had good predictive value for the postoperative delirium in patients with hip fracture(all  $P < 0.05$ ).

**4. Discussions**

Several previous studies<sup>[18,19]</sup> have found that elderly hip fractures are closely associated with a high incidence of delirium. The incidence of postoperative delirium in elderly patients in previous studies differs from 15% to 56%.<sup>[20–22]</sup> The incidence of delirium in patients with hip fracture after surgery was 16.02%, which is less than that of previous reports. It may be explained by the following reasons: Firstly, the sample sizes among studies have varied greatly. The sample size of 462 patients with hip fracture surgery is medium and does have certain clinical



**Figure 1.** The curve of ROC for postoperative blood sugar, albumin, and BMI. BMI=body mass index, ROC=receiver operating characteristic.

**Table 3**  
The predictive value of related factors.

Variables	Cutoff value	AUC	95%CI	Sensitivity (%)	Specificity (%)
Postoperative blood sugar level	8.05 mmol/L	0.792	0.723–0.829	72.43	80.22
Postoperative serum albumin level	32.26 g/L	0.714	0.627–0.797	68.02	83.19
BMI	19.35 kg/m <sup>2</sup>	0.703	0.664–0.738	69.50	80.74

AUC=area under curve, BMI=body mass index.

implications. Secondly, it may be related to the type of delirium.<sup>[2,3]</sup> The delirium can be divided into hyperactive, active inhibitory, or mixed type. Among them, the patients with activity-inhibited delirium are easy to miss clinically because of their indifferent clinical manifestations. Reports<sup>[24,25]</sup> have shown that the rate of missed diagnosis of delirium can be as high as 64%. Thirdly, the differences in the diagnostic criteria for delirium may be associated with the different results. The results of this present study have shown that history of delirium, diabetes mellitus, hypoalbuminemia, postoperative hypoxemia, and BMI (kg/m<sup>2</sup>) ≤19.35 were the independent risk factors for the delirium in patients with hip fracture surgery, those risks factors should be included for the evaluation clinically in the treatment of hip fracture and management of delirium.

Diabetes mellitus has been found closely associated with delirium after surgery. Feinkohl et al<sup>[26]</sup> have conducted a meta-analysis including 14 related literature, and the results have shown that the incidence of postoperative delirium in elderly patients with diabetes is significantly higher than that of patients without diabetes. Ma et al<sup>[27]</sup> have found that the glucose metabolism rate of the brain tissue of delirium patients is significantly reduced, and dexmedetomidine can reduce the incidence of postoperative delirium. Therefore, it can be inferred that postoperative delirium may be related to the disorder of sugar and nervous metabolism. Diabetes is a common disease in elderly patients.<sup>[28]</sup> The results of this study suggest that the awareness and importance of diabetes should be improved, and the impact of poor blood glucose control on postoperative complications should be fully considered during the perioperative period.<sup>[29]</sup> Strict monitoring and control of blood glucose are needed for postoperative patients.

Elderly patients with hip fractures have a high incidence of postoperative complications, which seriously endanger their lives. Previous studies<sup>[30–32]</sup> have found that about 3-quarters of hip fracture-related deaths were caused by subsequent postoperative complications. The incidence of delirium in patients undergone surgery is greatly increased. The main reason is that the delirium state is under stress, and the irritability affects the patient's eating, activity, and cardiopulmonary functions. And elderly patients often suffer from malnutrition.<sup>[33]</sup> It is reported that about 20% of patients with hip fractures suffer from malnutrition.<sup>[34]</sup> Due to the weakened function of the various organs of the elderly patients, bed rest after fractures affects gastrointestinal function and slows digestion. There are many manifestations of malnutrition, such as drowsiness, fatigue, anemia, etc. The most clinically significant is hypoalbuminemia. After the operation, the patient's albumin will be reduced to varying degrees.<sup>[35]</sup> Postoperative hypoalbuminemia is a risk factor for postoperative delirium in elderly patients with hip fractures. It may be explained that with hypoalbuminemia the wound healing is poor, patients may stay in bed for a long time.<sup>[36]</sup> And hypoalbuminemia can aggravate the symptoms of the nervous system, thereby increasing the risk of delirium.<sup>[37]</sup>

This study also has found that BMI ≤19.35 kg/m<sup>2</sup> is a risk factor for delirium after orthopedic surgery in the elderly. BMI is often used as a measure of body fat level and health index.<sup>[18]</sup> In recent years, studies<sup>[29,38,39]</sup> have shown that BMI may be a risk factor for postoperative delirium. Among the elderly patients who need long-term care of their families, those who are lean and have low body weight are more likely to have the attack of delirium.<sup>[40]</sup> The previous study<sup>[41,42]</sup> has concluded that low BMI is 1 of the risk factors for delirium after orthopedic hip surgery, which is consistent with our findings. However, the potential mechanisms remain unclear, more studies are needed to confirm the mechanisms associated with the relationship of BMI and delirium.

This present study was a retrospective design and could not avoid its limitations. Firstly, we retrospectively selected the patients receiving surgery for hip fracture from March 1, 2018 to September 30, 2020 as the study populations, and we did not calculate the sample size needed to powerful enough to detect the differences between 2 groups. And the previous comorbidities, imaging records were not detailed, thus some information was lacking. Secondly, this study did not include comprehensive risk factors for the perioperative period, the information such as the education level, marriage and childbirth, alcohol abuse history, etc. could not be included. Finally, this study used CAM for the diagnosis of delirium. There are other clinical delirium evaluation scales, there may be some deviations in the results with different delirium scales. Therefore, the causes and risk factors of delirium after hip fracture need further exploration.

### 5. Conclusions

In conclusion, history of delirium, diabetes mellitus, hypoalbuminemia, postoperative hypoxemia, and low BMI are the risk factors for delirium in patients after hip fracture surgery, and those patients with postoperative blood sugar ≥8.05 mmol/L, albumin ≤32.26 g/L and BMI ≤19.35 kg/m<sup>2</sup> particularly require the attention from the healthcare providers for the prophylaxis of delirium. The control of blood sugar and timely treatment of hypoalbuminemia and hypoxemia may be beneficial to reduce the incidence of postoperative delirium, thereby improving the prognosis of patients with hip fractures.

### Author contributions

QH designed research; ZC, YW, XD, and QH conducted research; ZC, CZ, and QH analyzed data; ZC and YW wrote the first draft of the manuscript; QH had primary responsibility for final content. All authors read and approved the final manuscript.

**Conceptualization:** Qianfeng He.

**Data curation:** Zhe Chu, Yixuan Wu.

**Formal analysis:** Zhe Chu, Yixuan Wu, Xuanhui Dai, Qianfeng He.

**Investigation:** Zhe Chu, Yixuan Wu, Qianfeng He.

**Methodology:** Zhe Chu, Cuicui Zhang, Qianfeng He.

**Resources:** Yixuan Wu, Xuanhui Dai, Cuicui Zhang.

**Software:** Cuicui Zhang.

## References

- [1] Dreinhofer K. Hip fracture in the elderly: time to act. *Dtsch Arztebl Int* 2020;117:51–2.
- [2] Wang Y, Cui H, Zhang D, Zhang P. Hospitalisation cost analysis on hip fracture in China: a multicentre study among 73 tertiary hospitals. *BMJ Open* 2018;8:e019147.
- [3] Peng K, Yao P, Yang L, et al. Parenthood and risk of hip fracture: a 10-year follow-up prospective study of middle-aged women and men in China. *Osteoporos Int* 2020;31:783–91.
- [4] Hsu CC, Ko JY, Lin CL, et al. The epidemiology of hip fracture among subjects with pyogenic liver abscess (PLA): a nationwide population-based study. *Biomed Res Int* 2020;2020:5901962.
- [5] Zhuang HF, Wang PW, Li YZ, Lin JK, Yao XD, Hu H. Analysis of related factors of brittle hip fracture in postmenopausal women with osteoporosis. *Orthop Surg* 2020;12:194–8.
- [6] Grle M, Markotic V, Prlic J, Grle I, Miljko M. Postoperative delirium in patients after hip fracture treatment. *Psychiatr Danub* 2020;32:128–9.
- [7] Urban MK, Sasaki M, Schmucker AM, Magid SK. Postoperative delirium after major orthopedic surgery. *World J Orthop* 2020;11:90–106.
- [8] Lee PJ, Shorten GD. Delirium after hip fracture surgery. *J Clin Anesth* 2019;58:119–20.
- [9] Sieber FE, Neufeld KJ, Gottschalk A, et al. Effect of depth of sedation in older patients undergoing hip fracture repair on postoperative delirium: the STRIDE randomized clinical trial. *JAMA Surg* 2018;153:987–95.
- [10] Jin Z, Hu J, Ma D. Postoperative delirium: perioperative assessment, risk reduction, and management. *Br J Anaesth* 2020;125:492–504.
- [11] Duning T, Iltting-Reuke K, Beckhuis M, Oswald D. Postoperative delirium – treatment and prevention. *Curr Opin Anaesthesiol* 2021;34:27–32.
- [12] de Jong L, van Rijkevorsel V, Raats JW, Klem TMAL, Kuijper TM, Roukema GR. Delirium after hip hemiarthroplasty for proximal femoral fractures in elderly patients: risk factors and clinical outcomes. *Clin Interv Aging* 2019;14:427–35.
- [13] Zhang X, Tong DK, Ji F, et al. Predictive nomogram for postoperative delirium in elderly patients with a hip fracture. *Injury* 2019;50:392–7.
- [14] Hecht G, Slee CA, Goodell PB, Taylor SL, Wolinsky PR. Predictive modeling for geriatric hip fracture patients: early surgery and delirium have the largest influence on length of stay. *J Am Acad Orthop Surg* 2019;27:e293–300.
- [15] Li QH, Yu L, Yu ZW, et al. Relation of postoperative serum S100A12 levels to delirium and cognitive dysfunction occurring after hip fracture surgery in elderly patients. *Brain Behav* 2019;9:e01176.
- [16] Bai J, Liang Y, Zhang P, et al. Association between postoperative delirium and mortality in elderly patients undergoing hip fractures surgery: a meta-analysis. *Osteoporos Int* 2020;31:317–26.
- [17] Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegel AP, Horwitz RI. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Ann Intern Med* 1990;113:941–8.
- [18] Oh ES, Li M, Fafowora TM, et al. Preoperative risk factors for postoperative delirium following hip fracture repair: a systematic review. *Int J Geriatr Psychiatry* 2015;30:900–10.
- [19] Wang Y, Tang J, Zhou F, Yang L, Wu J. Comprehensive geriatric care reduces acute perioperative delirium in elderly patients with hip fractures: a meta-analysis. *Medicine (Baltimore)* 2017;96:e7361.
- [20] Viveros-Garcia JC, Torres-Gutierrez JL, Alarcon-Alarcon T, et al. Fragile hip fracture in Mexico: Where are we today? Where do we want to go? *Acta Ortop Mex* 2018;32:334–41.
- [21] Li C, Bai S, Song X, Qin Y, Li N, Li H. A retrospective study on risk factors associated with postoperative delirium in elderly patients with hip fracture. *Chin J Orthop* 2018;38:250–6.
- [22] Yuan Y, Han Y, Ji X, et al. Risk factors associated with delirium for patients with hip fracture under the orthogeriatric unit mode. *Natl Med J China* 2018;98:3235–9.
- [23] Oh ES, Fong TG, Hshieh TT, Inouye SK. Delirium in older persons: advances in diagnosis and treatment. *JAMA* 2017;318:1161–74.
- [24] Burry L, Mehta S, Perreault MM, et al. Antipsychotics for treatment of delirium in hospitalised non-ICU patients. *Cochrane Database Syst Rev* 2018;6:CD005594.
- [25] Marcantonio ER. Delirium in hospitalized older adults. *N Engl J Med* 2017;377:1456–66.
- [26] Feinkohl I, Winterer G, Pischon T. Obesity and post-operative cognitive dysfunction: a systematic review and meta-analysis. *Diabetes Metab Res Rev* 2016;32:643–51.
- [27] Ma H, Ouyang W, Mo Y, et al. Changes in cerebral glucose metabolism induced by postoperative delirium in elderly patients and the effects of dexmedetomidine on it. *Chin J Anesthesiol* 2012;32:1417–20.
- [28] Wang D, Lai J, Lu S, Huang M, Hu S, Xu Y. Rapid-onset hyponatremia and delirium following duloxetine treatment for postherpetic neuralgia: case report and literature review. *Medicine (Baltimore)* 2018;97:e13178.
- [29] Galyfos GC, Geropapas GE, Sianou A, Sigala F, Filis K. Risk factors for postoperative delirium in patients undergoing vascular surgery. *J Vasc Surg* 2017;66:937–46.
- [30] Malafarina V, Reginster JY, Cabrerizo S, et al. Nutritional status and nutritional treatment are related to outcomes and mortality in older adults with hip fracture. *Nutrients* 2018;10:
- [31] Chang W, Lv H, Feng C, et al. Preventable risk factors of mortality after hip fracture surgery: systematic review and meta-analysis. *Int J Surg* 2018;52:320–8.
- [32] Sheehan KJ, Sobolev B, Chudyk A, Stephens T, Guy P. Patient and system factors of mortality after hip fracture: a scoping review. *BMC Musculoskelet Disord* 2016;17:166.
- [33] Giannoulis D, Calori GM, Giannoulis PV. Thirty-day mortality after hip fractures: has anything changed? *Eur J Orthop Surg Traumatol* 2016;26:365–70.
- [34] Ferrari S, Reginster JY, Brandi ML, et al. Unmet needs and current and future approaches for osteoporotic patients at high risk of hip fracture. *Arch Osteoporos* 2016;11:37.
- [35] Lin HS, Watts JN, Peel NM, Hubbard RE. Frailty and post-operative outcomes in older surgical patients: a systematic review. *BMC Geriatr* 2016;16:157.
- [36] Liu Z, Zhang J, He K, Zhang Y, Zhang Y. Optimized clinical practice for superaged patients with hip fracture: significance of damage control and enhanced recovery program. *Burns Trauma* 2019;7:21.
- [37] Barreiro E. Models of disuse muscle atrophy: therapeutic implications in critically ill patients. *Ann Transl Med* 2018;6:29.
- [38] Wang Y, Liu Y, Zhang M, et al. Preliminary establishment and validation of delirium prediction model in elderly orthopedic surgery patients. *Chin J Traumat Orthop* 2019;21:558–63.
- [39] Zhu G, Xiong L. Analysis of risk factors for delirium in elderly hip fracture. *Zhejiang Clin Med* 2016;18:1463–4.
- [40] Su X, Wang D, Meng Z. Low body mass index is associated with increased risk of delirium in elderly patients after surgery: a prospective cohort study. *J Clin Anesthesiol* 2015;31:421–6.
- [41] Tanaka P, Goodman S, Sommer BR, Maloney W, Huddleston J, Lemmen HJ. The effect of desflurane versus propofol anesthesia on postoperative delirium in elderly obese patients undergoing total knee replacement: a randomized, controlled, double-blinded clinical trial. *J Clin Anesth* 2017;39:17–22.
- [42] Gonzales J, Lovald ST, Lau EC, Ong KL. Risk of opioid-related adverse events after primary and revision total knee arthroplasty. *J Surg Orthop Adv* 2018;27:148–54.