Predictive value of frailty on postoperative complications in elderly patients with major abdominal surgery.

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Abstract

Aims: To investigate the predictive value of frailty on postoperative complications in elderly patients undergoing major abdominal surgery.

Study design: This was a prospective cohort study.

Methods: Frailty phenotype assessment instruments were applied to evaluate the frailty of patients, and a self-designed questionnaire was employed to collect disease related data, including general demographics, a physiological index POSSUM score and an operative severity index. Postoperative complications were recorded during clinical follow-up. Differences in complications between groups were analysed to determine whether frailty was an independent influencing factor for postoperative complications in elderly patients undergoing abdominal surgery and to determine the predictive value of frailty.

Results: The incidence of frailty in elderly patients undergoing abdominal surgery was 23.74% (n=176). The incidence of postoperative complications in the frailty group was 50% (n=32), significantly higher than that in the non-frailty group (7.64%, n=144; p<0.0001). Frailty was an independent influencing factor for postoperative complications in elderly patients undergoing major abdominal surgery. The area under the curve of frailty in the prediction of postoperative complications in elderly patients with major abdominal surgery was 0.757, indicating that frailty had the same predictive value as POSSUM.

Conclusion: Frailty is an effective predictor for the occurrence of postoperative complications in elderly patients undergoing major abdominal surgery.

Relevance to clinical practice: Frailty is related to the occurrence of postoperative complications to assess the surgical risk of patients. Frailty assessment provides a new tool for nurses involved with the preoperative care and risk assessment of elderly patients with surgical risk.

Introduction

Surgical intervention is a conventional treatment method. According to annual statistical data from the National Bureau of Statistics, 43,829,200 inpatients underwent surgical treatment in hospitals and medical institutions in 2014, accounting for 21.44% of all inpatients that year [1]. With the growth of aging populations throughout the world, the elderly have become the main population admitted to medical institutions. Medical statistics from the USA indicate that more than 1/3 of the patients who undergo surgical treatment are over 65 y old [2]. Overall adaptation and tolerance in elderly patients are decreased because of higher levels of complications and delayed onset of disease. The organs of the elderly are susceptible to decompensation during emergencies, especially when combined with stress events, such as hospitalization or surgery, which leads to postoperative complications. Postoperative complication is the main factor influencing postoperative prognosis. Therefore, a comprehensive and accurate preoperative risk assessment for patients plays an important role in the prediction of adverse outcomes and in the decision-making process.

Background

Major abdominal surgery is a significant stressor for the elderly, leading to endocrine, metabolic and immune dysfunction, subsequent physiological changes and a decreased quality of life [3]. Approximately 35% of patients experience postoperative complications and the 30 d case fatality rate is approximately 10% [4]. Postoperative complications may initiate cascading reactions, such as disability, inability to manage self-care, decreased quality of life, increased medical costs and other adverse outcomes [5]. The existing clinical preoperative risk assessment instruments, such as Glasgow, POSSUM (the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity), ASA (American Association of Anesthesiologists) and other assessment tools for specific organs or systems (such as Goldman), are aimed at the characteristics of the operation or the disease itself and fail

to take the physical condition of the patients into account. With increasing gage, the probability of body abnormalities increases due to age-related changes [6]. However, individual aging is characterized by heterogeneity [7], necessitating health assessment methods designed specifically for elderly patients, such as the CGA (comprehensive geriatric assessment) and assessments of sarcopenia and frailty [8]. The CGA assessment requires multidisciplinary teams and multi-dimensional evaluations [9], which are significant obstacles in clinical practice. In 2012, experts from six international professional associations reached a consensus definition of frailty, i.e., frailty is a clinical syndrome caused by multiple factors, with the main characteristics of decreased strength and endurance and reduced physiological tolerance. Frailty in individuals enhances their susceptibility to disability or death, and frailty screening is recommended for all individuals over 70 y old [10]. The American College of Surgeons recommends that frailty assessment be implemented in preoperative risk evaluations [11]. Researchers believe that physiological status is more related to the occurrence of postoperative death than surgery [12]. Therefore, this prospective cohort study was designed to investigate the effects of frailty on postoperative complications in elderly patients undergoing major abdominal surgery to provide a new method of clinical care for preoperative risk management.

Methods

Participants

Our study was approved by the Xuanwu Hospital Capital Medical University medical quality and safety management in January 2015. A prospective cohort from February-October 2015 was used to investigate the predictive value of frailty on postoperative complications in elderly patients undergoing major abdominal surgery. The survey data were provided anonymous codes to ensure that identifying information remained confidential. A total of 176 patients were enrolled in the study.

The inclusion and exclusion criteria for recruiting the participants

Inclusion criteria: 1. Age ≥ 60 y; 2. being admitted to department of surgery due to abdominal digestive diseases; stable disease; 3. being scheduled for elective surgery; 4. willingness to participate in this study.

Exclusion criteria: 1. History of Parkinson's disease or stroke; currently taking carbidopa, levodopa, donepezil hydrochloride and/or antidepressants, as they may produce the symptoms similar to emaciation; 2. cognitive impairments or psychiatric disorders; 3. having not undergone any major abdominal surgeries; 4. hypothyroidism; 5. language impairments preventing the patient from understanding the questions asked.

Investigative tool

General information: General information including age, sex, BMI, smoking and drinking history, comorbidity and laboratory indexes was recorded. BMI was calculated as height/body weight^2, and comorbidity was assessed using the CCI scale.

Frailty assessment: The frailty phenotype proposed by Dr. Fried following the cardiovascular health study includes five indicators: unintentional weight loss, self-reported exhaustion, low activity level, slow walking speed and weak grip strength. One point is scored for each indicator when a specific target is reached. Subjects scoring 0 were classified as robust, 1-2 as pre-frail and 3-5 as frail.

The five indicators were operationalized as follows:

1. "Weight loss" was defined as self-reported un-intentional weight loss of more than 3kg or greater than 5% of body weight during the previous year.

2. "Exhaustion" was indicated by a self-response as "a moderate amount the time" or "most of the time" to either of the following statements: "I felt everything I did was an effort" or "I could not get going" based on the Center for Epidemiological Studies-Depression Scale.

3. "Low physical activity" was defined by gender specific low weekly energy expenditures measured by the IPAQ-SF (International Physical Activity Questionnaire-Short Form).

4. "Slow walking speed" was defined as a usual walking speed below the criterion-specific thresholds adjusting for gender and height from the Cardiovascular Health Study Group.

5. "Weakness" was defined as mean grip strength of the dominant hand that was three times below the criterion-specific thresholds adjusting for gender and body mass index (BMI) defined in the Cardiovascular Health Study Group.

POSSUM scoring system: POSSUM was proposed by the British scholar Copeland [13], in 1991 based on data from general surgical operation cases. It can be used to predict the incidence of postoperative complications and death. This system includes twelve independent preoperative physiological factors (age, heart signs, respiratory signs, systolic blood pressure, pulse rate, Glasgow coma score, hemoglobin, white blood cells, blood urea nitrogen, sodium, potassium and ECG) and six operative severity indexes (surgical margin, operation number, total blood loss, abdominal contamination and malignant tumor). It is mainly applicable to general surgery.

Postoperative complications

Postoperative complications that occurred in patients during hospitalization were used to measure out comes in this study. Complications were categorized according to the common postoperative complications defined in the National Surgical Quality Improvement Program (NSQIP) by the American College of Surgeons (ACS) [14].

Statistical analysis

Data were recorded using Epidata 3.1 and statistically analysed by SPSS 17.0 software. Measurement data were expressed as the mean ± standard deviation or median and four percentile. Comparisons between two in dependent samples used at-test and the Mann-Whitney U test was used for comparisons between two groups. Enumeration data were presented as percentages, and the chi squared test/continuous correction chi squared test/Fisher exact probability test was applied for comparisons between the two groups. A CMH stratified chi squared test was employed to adjust for confounding factors. Factors influencing postoperative complications were analysed by a logistic regression based on the maximum likelihood method. The Receiver Operator Characteristic curve (ROC) was plotted, and the Area under the Curve (AUC) was calculated to determine the predictive values of frailty and POSSUM for postoperative complications. A P-value of <0.05 was considered statistically significant, and any missing data were deleted from the analysis.

Results

Of the 287 patients enrolled in this study, 176 met the inclusion criteria for this study. The mean age was 69.50 ± 7.55 y. The frailty group included 32 patients and the non-frailty group included 144 patients.

Of the176 patients that underwent major surgery, there were 32 cases with frailty and 144 without frailty (including 92 cases with pre-frailty, accounting for 52.27% of all patients). The incidence rate of frailty in patients with major abdominal surgery was 18.18%. Postoperative complications occurred in 27 patients (15.34%). There was a statistically significant difference in the incidence of postoperative complications between the frailty group (50%) and the non-frailty group (7.64%) (RR=12.091, 95% CI: 4.768-0.536, Table 1).

A univariate analysis of the basic characteristics of the two groups was conducted to adjust for confounding factors. Results showed statistically significant differences between the two groups in age, CCI, preoperative ALB, HB, WBC, and Na^+ levels (Table 2). When these variables were used for stratification, differences in the rates of postoperative complications between the two groups remained statistically significant as determined by a stratified chi squared test (RR=6.625-12.955) (Table 3).

Relationships between frailty and postoperative complications in elderly patients undergoing major abdominal surgery

Using the physiological index from POSSUM and the surgical invasion index, postoperative complications were compared between the complication group and the non-complication group by univariate analysis (Table 4). Using variables that showed significant differences between the two groups (age, pulse rate, hemoglobin, Na^+, the extent of surgery, blood loss, abdominal contamination and malignant tumor),frailty as an independent variable and postoperative complications as the

dependent variable, logistic (maximum likelihood) regression analysis showed that frailty was an independent risk factor for postoperative complications in elderly patients that had undergone major abdominal surgery (adjusted RR=6.415, Tables 5 and 6).
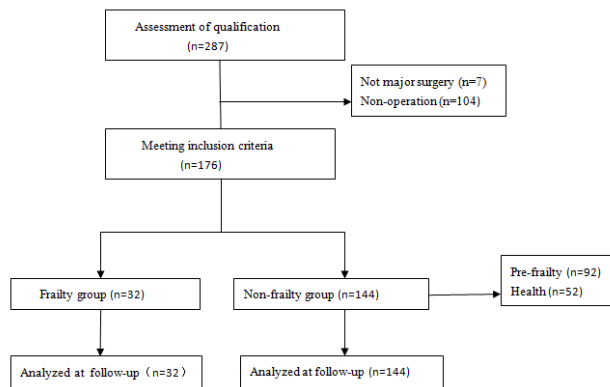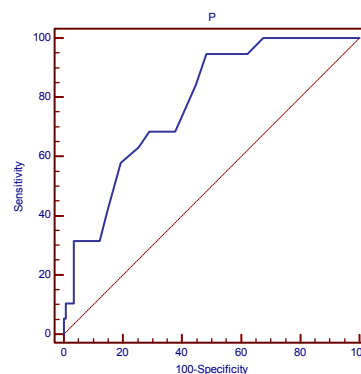

Figure 1. Prospective cohort trial design.

Figure 2. ROC curves of POSSUM for postoperative complications.
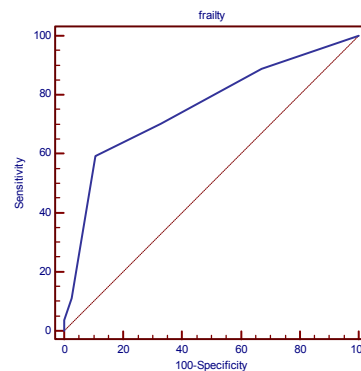

Figure 3. ROC curves of frailty for postoperative complications.

The predictive value of frailty for postoperative complications in elderly patients that underwent major abdominal surgery

The ROC curve was used to determine the predictive value of frailty for postoperative complications after major abdominal surgery. Results show that the AUCs for frailty and POSSUM

were 0.757 and 0.777, respectively, which are medium-level predictive values. The AUCs of the two factors were compared (Z=1.226, P=0.2203>0.05), and the difference was not statistically significant (Table 7, Figures 1-3). Therefore, our conclusion was that frailty and POSSUM shared the same predictive values.

Table 1. *Comparison of postoperative complications in elderly patients undergoing major abdominal surgery between the two groups (n=176).*

Frailty level	Case number/proportion	Postoperative complications/incidence	χ^2	p
Non-frailty	144 (81.82%)	11 (7.64%)	32.987 [1]	<0.0001
Frailty	32 (18.18%)	16 (50%)		
Health	52(29.55%)	3 (5.77%)	24.324 [2]	<0.0001
Pre-frailty	92(52.27%)	8 (8.93%)		
Frailty	32 (18.18%)	16 (50%)		

Table 2. *Comparison of basic data between the frailty group and the non-frailty group.*

Item	Frailty group(n=32)	Non-frailty group(n=144)	Statistics	P
Age (year)	76 (68, 82)	66 (63,72.75)	-4.857	<0.0001
Sex				
Male	13 (40.63%)	69 (47.92%)	0.559	0.454
Female	19 (59.37%)	75 (52.08%)		
BMI (kg/m^2)	24.43 ± 3.89	24.71 ± 3.88	0.474	0.636
Smoking history	9 (32.14%)	37 (26.24%)	0.411	0.522
Drinking history	7 (25%)	22 (15.60%)	0.865	0.352
CCI	2 (1.5,4.5)	2 (0,3)	-2.155	0.031
Operation level				
Level 3	16 (50%)	89 (63.12%)	1.882	0.17
Level 4	16 (50%)	52 (36.88%)		
Affected sites				
Liver and gall	18	73	1.95	0.404
Stomach and intestines	11	64		
Pancreas	3	7		
Preoperative peripheral blood examination				
ALB (g/L)	34.41 ± 5.32	37.81 ± 5.75	3.011	0.003
HB (g/L)	109.84 ± 21.72	129.36 ± 17.79	4.661	<0.0001
WBC^2 (× 10^{12}/L)	6.8 (5.55, 9.69)	5.94 (4.51,7.72)	-2.076	0.038
Serum urea (mmol/L)	5.11 ± 2.35	5.21 ± 1.82	0.22	0.827
Serum K$^+$ (mmol/L)	4.02 ± 0.48	3.95 ± 0.35	-0.814	0.421
Serum Na$^+$ (mmol/L)	141 (138, 142.4)	142.3 (140, 143.9)	2.716	0.007

Table 3. *Comparison of postoperative complications in elderly patients undergoing major abdominal surgery between the two groups-adjusted (n=176).*

Adjustment/stratification factors	RRCMH (95% CI)	χ^2	p
Age	8.973 (3.336, 24.136)	23.794	<0.0001
CCI	6.625 (2.472, 17.752)	19.116	<0.0001
Preoperative ALB	8.259 (3.076, 22.173)	19.826	<0.0001
Preoperative HB	7.595 (2.789, 20.683)	21.339	<0.0001

Preoperative WBC	12.955 (4.981, 33.695) 36.692 <0.0001	Preoperative Na$^+$	10.725 (3.948, 29.139) 26.742 <0.0001

Table 4. *Data comparison between the complication group and the non-complication group.*

Variables	Complication group	Non-complication group	Statistics	p
Age	75 (65, 82)	67 (63, 73)	-3.137	0.002
Cardiac sign				
No	12	68	0.055	0.815
Abnormal	15	77		
Respiratory sign[4]				
No shortness of breath	24	129	<0.0001	0.991
Abnormal	3	16		
Systolic pressure (mmHg)				
110-130	16	97	0.066	0.798
Other	8	43		
Pulse rate				
50-80	17	128	7.371	0.007
Other	7	11		
HB[2] (g/L)				
13-16	8	57	16.018	0.001
11.5-12.9/16.1-17.0	5	54		
10.1-11.4/17.1-18.0	5	24		
≤ 9.9/≥ 18.1	8	6		
WBC[5] (× 10^{12}/L)				
4-10	19	124	2.478	0.115
Other	8	25		
Blood urea nitrogen	4.33 (3.08, 7.25)	4.89 (4.17, 6.00)	-0.916	0.359
Na$^+$	138 ± 4.44	141.76 ± 2.75	3.219	0.003
K$^+$				
3.5-5.0	23	142	2.453	0.117
Other	4	7		
ECG				
Normal	18	108	2.569	0.261
Atrial fibrillation, HR 60-90	3	6		
Abnormal rhythm, premature beat ≥ 5/min, abnormal Q wave and ST/T wave	6	28		
Extent of operation				
Level 3	9	99	10.569	0.001
Level 4	18	50		
Total blood loss (ml)	50 (25, 200)	10 (5, 30)	-4.376	<0.0001
Abdominal contamination				

No	20	139	5.303	0.021
Yes	6	20		
Malignancy				
No	7	98	15.528	0.001
Single focus only	9	27		
With lymph node metastasis	6	11		
With distant metastasis	4	12		

Table 5. Assignment of categorical variables in logistic regression analysis for factors influencing postoperative complications after major abdominal surgery.

Variables	Variable assignment
Age	0=≤ 60, 1=61-70, 2=71-85
Pulse rate	0=50-80, 1=other
Hemoglobin	0=13-16, 1=11.5-12.9/16.1-17.0, 2=10.1-11.4/17.1-18.0, 3=≤ 9.9/≥ 18.1
Malignant tumor	0=no, 1=single focus only 2=with lymphatic metastasis, 3=with distant metastasis
Blood loss	0=<100, 1=101-500, 2=501-999, 3=≥ 1000
Extent of operation	0=level 3, 1=level 4
Abdominal contaminate	0=no, 1=yes

Table 6. Logistic regression analysis of influencing factors for postoperative complications after major abdominal surgery.

Variables	B	S.E.	Wald statistics	p	OR	95% CI
Frailty	1.859	0.696	7.133	0.008	6.415	1.640, 25.095
Blood loss	2.53	0.715	12.523	0	12.553	3.092, 50.969
Malignant tumor	0.652	0.302	4.645	0.031	1.918	1.061, 3.470
Pulse rate	2.201	0.941	5.465	0.019	9.03	1.427, 57.141
Age	1.669	0.717	5.419	0.02	5.308	1.302, 21.644
Constant	-4.786	0.854	31.42	0	0.008	

Note 1. Model χ^2=53.371, p ≤ 0.000. 2. Cox and Snell R^2=0.317, Nagelkerke R^2=0.546. 3. Hosmer-Lemeshow test: χ^2=7.791, p=0.254>0.05 is the model that best fit the data.

Table 7. Predictive value of frailty and POSSUM for postoperative complications in patients with major abdominal surgery.

Model	AUC	Z	P	95% CI	Sensitivity	Specificity
Frailty score	0.757	4.651	<0.0001	0 0.687, 0.818	59.26	89.26
POSSUM	0.777	5.462	<0.0001	0.696, 0.844	94.74	51.75

Discussion

Previous health assessments for the elderly are largely related to comorbidity and the diagnosis of diseases, including cardiovascular disease, cancer and respiratory disorders [8]. In recent years, research on aging has begun to focus on physiological tolerance and frailty as a reflection of the internal environment and functional reserves of patients, which has become an important issue in gerontology research [15,16].

Previous studies have shown that frailty can be used to predict the incidence of adverse outcomes in community populations, and recent studies have shown that it is a good predictor of outcomes for hospitalized patients. Frailty is a useful measurement for the early identification of patients likely to experience adverse outcomes and is useful for promoting early clinical interventions. The frailty phenotype assessment is the most commonly used instrument for frailty evaluation [17].

The incidence of frailty is high in elderly patients with major abdominal surgery and frailty screening should be conducted in these patients. In this study, the incidence of frailty in elderly hospitalized patients with abdominal surgery was 18.18%, higher than in previous studies (10.4%-11.3%). Xi et al. found an 11.1% incidence of frailty in older populations in communities of Beijing and an incidence of 11.3% in Taiwan [18,19], reported an incidence of 10.4% in scheduled surgery patients. In this study, patients unsuitable for frailty assessment due to severe disease were excluded. However, the high chance of frailty in such patients suggests that the actual incidence of frailty in elderly inpatients with major abdominal surgery may be higher than reported in our study. One contribution to the high incidence of frailty in older inpatients with abdominal surgery may be low energy intake; in the elderly; approximately 60% have an inadequate intake of energy and protein [20]. Our study population included patients with chronic wasting diseases that are often associated with fasting or eating disorders, such as tumors of the digestive system. Decreased energy intake can reduce the resting metabolic rate of patients, resulting in decreased activity. Consequently, energy intake is reduced in the elderly because of energy conservation. Because of this feedback loop, the incidence of frailty in elderly inpatients with abdominal surgery was increased.

Frailty may increase the risk of postoperative complications in elderly patients undergoing major abdominal surgery. A study published in Circulation showed that the median survival rate was low in patients with frailty and that frailty was a risk factor for death during hospital stays and for postoperative complications in cardiac surgery patients [21]. Researchers at Emory University [22], conducted a correlation analysis between frailty and 1 y mortality in patients with abdominal surgery. The latest results show that the mortality of patients with frailty was 6.7 time higher than those with pre-frailty. Adjustments against related factors (age, ASA, CCI, preoperative hemoglobin concentration, GFR, creatinine and albumin concentration) revealed an OR of 3.6 (95% CI: 0.86-12.46), indicating that frailty was still a risk factor for postoperative complications. Logistic regression analyses in our study showed that frailty was an independent risk factor for postoperative complications, and the risk of postoperative complications for patients with frailty was 6.415 times higher than that of the non-frailty patients, indicating that frailty is a significant risk factor for postoperative complications in elderly patients with major abdominal surgery.

Frailty and POSSUM have the same predictive value. POSSUM is widely applied in surgical fields, and extensive studies have shown that POSSUM effectively predicts the incidence of postoperative complications and death in older patients with abdominal surgery [23-25]. In this study, frailty provided a medium-level predictive value for postoperative complications in elderly patients, comparable to that of POSSUM (p>0.05). All of the data from this study support the predictive value of frailty, suggesting that frailty assessment results can provide valuable information for clinical decision-making. In the context of developing medical technology, the physical condition of the patient is considered more relevant than the operation for the occurrence of postoperative death, after adjustment for the control of variables [12]. Therefore, we believe that frailty could be an effective instrument for preoperative risk assessment to assist in clinical decision-making and improve outcomes in elderly patients.

Conclusions

The rate of postoperative complications in frailty patients is significantly higher compared than that in non-frailty patients. Frailty is an independent risk factor for postoperative complications in elderly patients undergoing major abdominal surgery, who are at the highest relative risk. Frailty has a medium-level predictive value for postoperative complications in elderly patients undergoing major abdominal surgery. Based on the results of this study, medical staff and gerontology researchers can identify and manage frailty in elderly patients to determine risk, aid in preoperative planning and to establish the research foundation for preoperative interventions to reduce the occurrence of postoperative complications and improve outcomes in elderly patients after abdominal surgery. In addition, frailty can be used to identify elderly patients requiring a higher level of postoperative care or to increase the frequency of postoperative visits for these patients.

Relevance to Clinical Practice

Nurses are responsible for the perioperative care of patients undergoing surgery, and the prevention of postoperative complications is of great significance to patients. However, active nursing measures to prevent postoperative complications are uncommon and nursing has a limited role in the prevention of postoperative complications. Therefore, it is necessary for nurses to perform preoperative risk assessments and to utilize the results of assessments in preoperative interventions. Frailty phenotype evaluation shave many advantages, such as effective risk predictions, ease of use, fast access to data, timeliness and simple environmental requirements, which make it suitable for clinical nurses. Frailty assessment provides a new idea and tools for preoperative risk assessment and perioperative nursing of elderly patients [26].

Source of Funding

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