World J Surg (2020) 44:3729–3736
https://doi.org/10.1007/s00268-020-05715-8

ORIGINAL SCIENTIFIC REPORT

Does Preoperative Comprehensive Geriatric Assessment and Frailty Predict Postoperative Complications?

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Accepted: 17 July 2020 / Published online: 31 July 2020

Abstract

Background The influence of preoperative comprehensive geriatric assessment and frailty on postoperative morbidity, mortality, delirium were examined.

Methods A total of 108 patients were evaluated. The Katz Index of Independence in Activities of Daily Living (ADL), the Lawton Brody Instrumental Activities of Daily Living Scale (IADL), the Mini-Nutrition Assessment test (MNA), the Mini-Mental State Examination (MMSE), Yesavage Geriatric Depression Scale (GDS) were performed. Fried Criteria were used to assess physical frailty. We used the Physiological and Operative Severity Scores for the Enumeration of Mortality and Morbidity score (POSSUM), the American Society of Anesthesiologists Score (ASA), and the Charlson Comorbidity Index (CCI) to determine the risk of postoperative morbidity and mortality. Assessment Test for Delirium (4AT) was applied for detection of delirium.

Results The median age was 71 years (min–max: 65–84). IADL ($p = 0.032$), MNA ($p = 0.01$), MMSE scores ($p = 0.026$) were found to be significantly lower in patients with morbidity. POSSUM physiology score ($p = 0.005$), operative score ($p = 0.015$) and CCI ($p = 0.029$) were significantly higher in the patients with morbidity. Patients developed morbidity were found to be more frail ($p < 0.001$). The patients with delirium were found to have lower IADL ($p = 0.049$) and MMSE scores ($p = 0.004$), higher POSSUM physiology score ($p = 0.005$) and all of them were frail. It was found that frailty (OR = 23.695 95% CI: 6.912–81.231 $p < 0.001$), POSSUM operative score (OR:1.118 95% CI: 1.021–1.224 $p = 0.016$) and preoperative systolic blood pressure (OR:0.937%95 CI: 0.879–0.999 $p = 0.048$) were independently related factors for postoperative morbidity.

Conclusion In our study, CGA and frailty in preoperative period were found to be indicators for postoperative morbidity and delirium.

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Introduction

Advanced age may be an independent risk factor for complications, but not an obstacle for surgery [1]. Improvement in surgical and anesthesia techniques increased the expectation of long-term survival for geriatric patients [2]. However, geriatric patients are more likely to have poor health due to age-related physiological decline, multiple comorbidities, and accompanying geriatric syndromes. Postoperative complications (POCs), prolonged hospitalization, functional decline, and mortality can occur after surgery. Although there is a high postoperative complication rate in older adults, there is no suitable tool to evaluate the perioperative risks. In geriatric patients, standard preoperative evaluation, physical examination, laboratory evaluation, and imaging methods do not provide sufficient information for deciding proper treatment [3]. Therefore, a comprehensive evaluation is needed to determine and individualize risk factors preoperatively [4].

Comprehensive geriatric assessment (CGA) evaluates older adults in a holistic approach [5]. Several studies have shown that CGA has predictive effect on POCs and mortality in geriatric patients [6, 7]. In these studies, CGA, frailty and surgical risk scores were not appraised together for predicting postoperative morbidity, mortality and delirium. CGA can specify reversible terms that can improve patients' fitness before surgery. It might also assist clinicians' predictions regarding complications by predicting support needs during and after surgery.

Frailty is a condition caused by decrease in reserve capacity in various systems in older people and can be distinguished from the aging process and comorbidity [8]. Frailty predicts mortality and morbidity in the perioperative process more accurately than chronological age [9]. Frailty is shown to increase complication risk, length of hospital stay and mortality in operations. This situation is irrespective of the patient' age; therefore, higher complication rates in younger frail patients have necessitated new research into the cause [10, 11]. Evaluating frailty preoperatively in older people may give additional risk stratification to classic perioperative risk factors. Therefore, using the frailty evaluation may be helpful to check treatment options and adjust the anticipation of the surgical improvement [12]. The American College of Surgeons and the American Geriatrics Society (AGS) recommends frailty assessment as part of the preoperative evaluation of older patients [13].

Delirium develops in 30–40% of older patients after major surgery. It is associated with increased cost, prolonged hospital stay, and one-year mortality [14]. Although preoperative cognitive impairment is a leading risk factor for postoperative delirium, preoperative cognitive assessment is not routinely performed. Studies evaluating hip fractures or elective surgery, have noticed an association between CGA and postoperative delirium [15]. Multidimensional interventions that optimize mobility, vision, hearing, hydration, cognition, drugs, pain, and sleep have proven to be effective strategies to prevent delirium in medical and surgical settings. Accordingly, it is important to determine the patients who are at risk of delirium. Thereby, clinicians can improve plans to reduce risk [16].

The purpose of this study was to investigate the influence of preoperative CGA and frailty on postoperative morbidity, mortality, and delirium. To the best of our knowledge this is the first study evaluating a wide variety of CGA and surgical risk tools at the same setting.

Methods

Participants

A total of 108 patients who applied to geriatric outpatient clinic between January 2017 and August 2018 were included in the study. Patients older than 65 years and for whom elective general, orthopedic and traumatology surgery planned were evaluated. Emergency surgery, day surgery, surgery under local anesthesia, and palliative surgery were determined as exclusion criteria. Patients were assessed for delirium three times a week. Thirty-day morbidity and mortality after surgery was assessed.

Age, gender, with whom the patient lived, educational status, smoking and alcohol use, body mass index (BMI), accompanying diseases, incontinence, falls, pressure ulcer, number of drugs were recorded. Intraoperative blood loss, type of surgery and complications were provided from records.

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Dementia was diagnosed using DSM-5 criteria and patients with early stage dementia were included in the study.

Comprehensive geriatric assessment

CGA was conducted by three geriatricians. In the context of CGA, functional status assessment was performed with Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales [17–19]. Preoperative cognitive status was assessed by using the Folstein Mini-Mental State Examination (MMSE) and The Clock Drawing Test (CDT) [20, 21]. The CDT scoring ranges 0–6 points and <4 shows low cognitive performance [22]. Depressive symptoms were assessed using Yesavage Geriatric Depression Scale (GDS) short form [23]. Nutritional status was evaluated by Mini-Nutritional Assessment short form (MNA-sf) [24, 25].

The frailty phenotype was determined by measuring five domains: unintentional weight loss, self-reported exhaustion, weakness, slow walking speed and low physical activity [8]. According to these criteria, the patients having 3 or more points were reported as 'frail', 1 or 2 points as 'pre-frail' and 0 point as 'robust.'

Surgical scores and preoperative risk assessment

Surgical risk was assessed with the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM), the American Society of Anesthesiologists (ASA) and the British United Provident Association (BUPA) [26–28]. The POSSUM, which is suggested to estimate postoperative morbidity and mortality, consists of the Physiologic Severity Score (PSS) and Operative Severity Score (OSS). The PSS is based on 12 factors including preoperative measurements like laboratory measurements, age, cardiac and respiratory status. The OSS is calculated using 6 factors that define the operative severity, the number of procedures, total blood loss, peritoneal soiling, asset of malignancy, and surgery type. The ASA classification which has a well-ingrained score is used in the preoperative evaluation of the patient's compliance with surgery and predicts postoperative mortality and scored between 1and 5, worst scored by 5. BUPA is assessed according to the severity of the surgery, which varies between minor and major complex surgery.

Charlson Comorbidity Index (CCI) which has 19 categories of comorbidity was used for risk assessment of medical co-morbidity burden and risk of 1-year mortality [29].

Delirium assessment

Delirium was evaluated preoperatively and postoperatively on 3rd, 7th days by three geriatricians. Delirium was diagnosed by using the assessment test for delirium (4AT) [30].

Morbidity and mortality evaluation

A postoperative complication was stated as any case happening within 30 days of surgery. During the postoperative 30 days, surgical complications were assessed by a geriatrician and a surgeon. Complications include bleeding from the wound site, local hematoma, re-bleeding, hemorrhage, pulmonary infection, surgical site infection, urinary tract infection, septicemia, fever of unknown origin, wound dehiscence, deep vein thrombosis/pulmonary thromboembolism, congestive heart failure, worsening renal function, hypotension, respiratory failure, cardiac arrest or myocardial infarction, stroke or coma for longer than 24 h, and anastomotic leakage.

Postoperative length of stay (LOS) was defined by the number of days from surgery to discharge. Patients were followed and mortality was recorded for 30 days.

Ethics

The study protocol was evaluated and approved by the local Ethics Committee. Informed consent was obtained from each patient.

Statistical analyses

SPSS 22.0 version was used for the statistical analyses. Descriptive statistical results were offered as frequencies and percentage for categorical variables. Numerical parameters were examined with histogram and Kolmogorov–Smirnov tests for normal distribution. The continuous parameters with normal distributions were presented as mean ± SD while the skew ones as median (minimum–maximum). Comparison of categorical variables was performed by Chi-square or Fischer exact tests where convenient. Normally distributed continuous variables were compared by Student *T* test while the skew ones were assessed using Mann–Whitney *U* test. *P* value lower than 0.05 was considered as statistical significance. The parameters those had significantly differences or had *p* value lower than 0.20 in univariate analyses were included in Binary Logistic Regression analysis to detect the independently associated parameters for morbidity.

Results

Preoperative patient characteristics

One hundred and eight patients were included in this study. The median age was 71 years (65–84) and 63% was female. Most of them were living with their partners or families (69% and 17%, respectively). The three most common comorbid conditions were hypertension (59.3%), malignancy (41.7%), and diabetes mellitus (25%). The frequencies of comorbid diseases and geriatric syndromes are shown in Table 1.

Postoperative morbidity

POCs developed in 28.7% of the patients. The complicated patients were not different according to age ($p = 0.485$), gender ($p = 0.504$), number of drugs ($p = 0.591$), and comorbid diseases. Patients with complications had longer hospital stay ($p < 0.001$). When CGA was performed, it was seen that MMSE, IADL, MNA, and CDT scores were significantly worse in the complicated group ($p = 0.026$, $p = 0.032$, $p = 0.001$, $p = 0.046$, respectively). Surgical scoring showed that PSS and OSS scores were significantly higher in patients with complication compared to without (respectively, $p = 0.005$, $p = 0.015$), but ASA ($p = 0.056$) and PUBA ($p = 0.262$) scores were not related to complications. Patients with POCs had higher frailty ($p < 0.001$) and CCI scores ($p = 0.029$) (Table 1).

Frailty

When the patients were grouped as frail and prefrail-robust, it was seen that the frail group was significantly older ($p = 0.017$), had longer hospital stay ($p < 0.001$), and had worse scores of MMSE ($p < 0.001$), IADL ($p < 0.001$), MNA ($p < 0.001$), and CDT ($p < 0.001$). It was also observed that the PSS ($p < 0.001$) and CCI ($p < 0.001$) scores were significantly higher in the frail group than not-frail group (Table 1).

Multivariate analysis revealed that frailty (OR:23.695 95%CI:6.912–81.231 $p < 0.001$), POSSUM operative score (OR:1.118 95%CI:1.021–1.224 $p = 0.016$) and preoperative systolic blood pressure (OR:0.937%95CI:0.879–0.999 $p = 0.048$) were independently related factors for POCs (Table 2).

Postoperative delirium

Delirium frequency was 3.7%. Patients developed delirium were more likely to have longer hospital stay and half of them had dementia. Patients with delirium were older ($p = 0.039$), more dependent in IADL ($p = 0.049$), had worse MMSE scores ($p = 0.004$), and were more likely to be frail ($p = 0.008$). Within surgical scores, only the PSS score was found to be significantly higher in the delirium group ($p = 0.01$). The CCI score did not show any significant difference (Table 3).

Mortality

During the 30-day follow-up, only one patient who was robust died after myocardial infarction in postoperative first day.

Discussion

This study aimed to specify the importance of CGA in predicting 30-day POCs, delirium and mortality in older patients undergoing elective surgery. The results revealed that preoperative frailty assessment predicted POCs and delirium. As an advantage to previous studies, CGA and frailty assessment were evaluated in addition to surgical risk scoring and demonstrated superiority at predicting postoperative morbidity to surgical risk scoring systems. The strength of this study is its comprehensive assessment including various surgical risk tools, CGA, and frailty assessment at the same setting.

In previous studies involving geriatric patients, postoperative complication rate ranged from 16.4 to 48.7. This was found to be 28.7 in our study [2, 31]. This difference was thought to be related to the heterogeneous group and the type of operations. CGA domains were applied preoperatively and MMSE, IADL, MNA, and CDT scores predicted 30-day postoperative major complications. In several retrospective studies, a correlation was found between CGA components and 30-day POCs. While ADL and IADL were significant in some of these studies, depression and cognitive dysfunction were significant in some other [2, 32]. In a prospective study evaluating older patients deterioration in IADL predicted 30-day POCs [33].Similarly, Fagard et al. reported that ADL was the strongest predictor of 30-day POCs [34]. Previous studies showed that MMSE was inadequate to demonstrate 30-day POCs; however, in our study, MMSE score predicted 30-day POCs [32, 35, 36]. As the education level affects MMSE, different results can be obtained in different studies. In contrast to the current studies, this study has shown that possible malnutrition based on MNA-sf could predict 30-day POCs [32, 36]. Another prospective study evaluating malnutrition with Subjective Global Assessment (SGA) prior to elective colorectal surgery showed SGA was a risk factor for postoperative morbidity. Preoperative CGA is useful in identifying health problems, detecting

Table 1 General characteristics, comprehensive geriatric assessment and surgical scoring systems according to frailty and complication groups

	Total (n:108)	Complication			Frailty		
		No complication (n:77)	Any complication (n:31)	*p*	Robust-Prefrail (n:81)	Frail (n:27)	*p*
Female gender,%	68 (63)	50 (64.9)	18 (58.1)	0.504	51 (63)	17 (63)	1.000
Age, year, median	71 (65–84)	71 (65–84)	71 (65–84)	0.485	70 (65–84)	74 (65–84)	**0.017**
BMI, kg/m^2, median	27.22 (18.77–43.11)	27.64 (18.8–38.2)	26.77 (20.1–43.1)	0.630	27.3 (18.8–43.1)	26.2 (20.1–43)	0.528
Diabetes mellitus, n (%)	27 (25)	17 (22.1)	10 (32.3)	0.269	15 (18.5)	12 (44.4)	**0.007**
Hypertension, n (%)	64 (59.3)	50 (64.9)	14 (45.2)	0.058	51 (63)	13 (48.1)	0.175
Congestive heart failure, n (%)	7 (6.5)	3 (3.9)	4 (12.9)	0.103	2 (2.5)	5 (18.5)	**0.003**
Dementia, n (%)	4 (3.7)	3 (3.9)	1 (3.2)	0.867	1 (1.2)	3 (11.1)	**0.019**
Number of drugs, number, median	3 (0–12)	3 (0–12)	3 (0–8)	0.591	3 (0–12)	4 (0–9)	0.312
Length of stay, day, median	8 (2–63)	7 (2–63)	15 (4–63)	**<0.001**	8 (2–39)	15 (4–63)	**<0.001**
Systolic BP, mmHg, mean	119.86 ± 10.35	120.9 ± 10.4	117.3 ± 10	0.098	120 ± 10.6	119.4 ± 9.8	0.811
Diastolic BP, mmHg, mean	72.92 ± 7.24	73.3 ± 7.5	71.9 ± 6.5	0.374	73 ± 7.7	72.6 ± 5.9	0.763
Fried score, median	1 (0–4)	1 (0–4)	3 (0–4)	**<0.001**	1 (0–2)	3 (3–4)	**<0.001**
Mini mental test score, median	28 (2–30)	28 (2–30)	27 (10–30)	**0.026**	29 (2–30)	26 (10–29)	**<0.001**
Katz ADL score, median	6 (2–6)	6 (2–6)	6 (2–6)	0.764	6 (3–6)	6 (2–6)	0.285
Lawton-Brody IADL score, median	8 (0–8)	8 (1–8)	7 (0–8)	**0.032**	8 (1–8)	6 (0–8)	**<0.001**
MNA-SF score, median	12 (4–14)	12 (5–14)	10 (4–14)	**0.001**	12 (5–14)	8 (4–14)	**<0.001**
Clock drawing test scores, median	6 (0–6)	6 (0–6)	4 (0–6)	**0.046**	6 (0–6)	1 (0–6)	**<0.001**
Yesavage GDS score, median	2 (0–11)	2 (0–11)	2 (0–8)	0.760	2 (0–11)	3 (0–8)	0.099
Physiologic Severity Score (PSS), median	18 (13–31)	18 (13–30)	21 (16–31)	**0.005**	18 (13–30)	22 (16–31)	**<0.001**
Operative Severity Score (OSS), median	13.5 (6–31)	11 (6–25)	15 (6–31)	**0.015**	13 (6–31)	15 (6–31)	0.194
ASA score, median	1 (1–3)	1 (1–2)	2 (1–3)	0.056	1 (1–2)	2 (1–3)	0.143
BUPA score, median	3.5 (2–5)	3 (2–5)	4 (2–5)	0.262	3 (2–5)	4 (2–5)	0.143
Charlson comorbidity index score, median	5 (2–11)	4 (2–11)	5 (2–8)	**0.029**	4 (2–11)	5 (4–9)	**0.001**

BMI body mass index, *Systolic BP* Systolic Blood Pressure, *Diastolic BP* Diastolic Blood Pressure, *ADL* Activities of Daily Living, *IADL* Instrumental Activities of Daily Living, *MNA-SF*: Mini-Nutritional Assessment short form, *GDS* Geriatric Depression Scale, *PSS* Physiologic Severity Score, *OSS* Operative Severity Score, *ASA* American Society of Anesthesiologists, *BUPA* British United Provident Association

Table 2 Independently related factors in developing postoperative complications

	p	Exp(B)	95% C.I
Frailty	<0.001	23.695	6.912–81.231
Operative Severity Score	0.016	1.118	1.021–1.224
Systolic Blood Pressure	0.048	0.937	0.879–0.999

The parameters those included in multivariate analysis were weight loss, presence of malignancy, frailty status, IADL, MNA, Physiological severity score, Operative severity score, Charlson comorbidity index score, hypertension, congestive heart failure, falls, ASA score, Systolic blood pressure

risk groups, finding solutions and thus guiding perioperative care. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) and the AGS published the need to focus on CGA, including cognitive status, nutritional, functional status, and depression for the preoperative optimal evaluation of geriatric patients [7]. For this reason, CGA application should be expanded before surgery.

In our study, frailty status independently predicted POCs. In previous studies frail group had higher mortality and morbidity [37, 38]. Some other studies including both cancer patients and surgical patients, obtained similar results [39, 40]. Frailty allows detecting patients with high

Table 3 General characteristics, comprehensive geriatric assessment and surgical scoring systems according to postoperative delirium status

Characteristic	Total (*n*:108)	Postoperative Delirium		*p*
		No (*n*:104)	Yes (n:4)	
Age, year, median	71 (65–84)	71 (65–84)	79 (71–82)	**0.039**
Female gender,%	68 (63)	65 (62.5)	3 (75)	0.611
Diabetes mellitus, n (%)	27 (25)	26 (25)	1 (25)	1.000
Hypertension, n (%)	64 (59.3)	63 (60.6)	1 (25)	0.302
Dementia, n (%)	4 (3.7)	2 (1.9)	2 (50)	**0.006**
Number of drugs, number, median	3 (0–12)	3 (0–12)	1.5 (1–3)	0.216
Length of stay, day, median	8 (2–63)	8 (2–63)	19 (8–24)	**0.043**
Katz ADL score, median	6 (2–6)	6 (2–6)	5.5 (3–6)	0.317
Lawton-Brody IADL score, median	8 (0–8)	8 (1–8)	4.5 (0–8)	**0.049**
MNA-SF score, median	12 (4–14)	12 (4–14)	8 (6–14)	0.104
Mini mental test score, median	28 (2–30)	28 (2–30)	20 (20–25)	**0.004**
Clock drawing test scores, median	6 (0–6)	6 (0–6)	0.5 (0–1)	**0.025**
Yesavage GDS score, median	2 (0–11)	2 (0–11)	3.5 (0–6)	0.460
Fried score, median	1 (0–4)	1 (0–4)	3 (3–4)	**0.008**
Physiologic Severity Score (PSS), median	18 (13–31)	18 (13–31)	25 (21–31)	**0.010**
Operative Severity Score (OSS), median	13.5 (6–31)	13 (6–31)	15 (7–17)	0.609
ASA score, median	1 (1–3)	1 (1–2)	1.5 (1–3)	0.510
BUPA score, median	3.5 (2–5)	3 (2–5)	4.5 (2–5)	0.487
Charlson comorbidity index score, median	5 (2–11)	5 (2–11)	4.5 (4–7)	0.811

ADL Activities of Daily Living, *IADL* Instrumental Activities of Daily Living, *MNA-SF* Mini-Nutritional Assessment short form, *GDS* Geriatric Depression Scale, *PSS* Physiologic Severity Score, *OSS* Operative Severity Score, *ASA* American Society of Anesthesiologists, *BUPA* British United Provident Association

risk of decompensation. Currently, there is no consensus regarding routine frailty assessment in preoperative evaluation of the older patient. Frailty assessment is useful for evaluation of perioperative risk and may be useful to make beneficial modifications prior to surgery [39, 41]. The majority of studies focused on post-surgical outcomes of frailty, and lack of evidence of correct management of preoperative frailty to improve surgical outcomes. Future studies that will be conducted in this direction are needed.

Another striking result of this study is that there is no relationship between advanced age and POCs**.** Previous studies have indicated that biological age was better prognostic factor than chronological age in older patient. Therefore, these findings support that performing CGA preoperatively is more appropriate than depending on the chronological age [42, 43]. It is an unnecessary concern that geriatric patients should be withdrawn from major surgeries because of advanced age.

The ASA physical classification is the simplest and most widely used risk scoring system to evaluate patients' operability, which is based on the presence of comorbidities. However, it was demonstrated in many studies like our study that ASA was inadequate to predict postoperative outcomes in older patients. In addition, the PSS and OSS are complex and cannot be used in some cases and do not allow preoperative risk management because of the risks experienced during the operation as well as preoperatively [31, 44, 45]. These methods do not take into account the important factors that are detected by assessing frailty. Few studies compared CGA with other preoperative risk assessment systems [2, 46]. We compared ASA, POSSUM, PUBA and CCI with CGA, and found that frailty was better at predicting post-operative morbidity and delirium than these scores. This is one of the rare studies where CGA and frailty are evaluated together with these wide scoring systems.

In previous studies, the rate of postoperative delirium ranged 4–42%, whereas in our study it was 3.7%. This can be explained by using benzodiazepine was low, alcohol withdrawal was not observed, and the staff is trained to prevent delirium. Consistent with our results, postoperative delirium was significantly associated with old age in many studies [47, 48]. In our study, CGA and frailty assessment were shown to predict postoperative delirium [49]. Another strength of this study compared to other studies is that, CGA and frailty evaluation were compared with surgical

scoring systems, ASA, POSSUM, PUBA, and these systems were found to be insufficient in predicting postoperative delirium. The CCI was found to be useless in the detection of postoperative delirium [50].

This study has several limitations. First, we used only one frailty evaluation index. Second, delirium rate was low; therefore multivariate analyses for delirium could not be performed. This can be attributed to the strict implementation of measures to prevent delirium development in surgical wards of our hospital. Finally, while many other studies were designed to include specific disease groups, our study included a heterogeneous group. On the other hand, this may not be attributed as a limitation, as we aimed to determine the impact of CGA on any kind of surgery in old patients.

This study is the first to perform CGA and frailty together, compare surgical risk scores, and share data on postoperative morbidity, mortality and delirium. Despite the shortcomings, this study is valuable because of prospective follow-up and multidimentional evaluations. Prospective design and close follow-up of patients allowed accurate evaluation.

Conclusions

CGA and frailty assessment are valuable for predicting POCs and delirium in surgical geriatric patients. CGA enables to take necessary precautions on time in the preoperative period and provides more careful postoperative management. CGA and frailty assessment should be a routine part of preoperative assessment.

Funding None.

Compliance with ethical standards

Conflict of interest The Authors' declares that they have no conflict of interest.

Informed consent Informed consent was obtained from all participants included in the study.

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