Supportive Care in Cancer (2019) 27:2999–3006
https://doi.org/10.1007/s00520-018-4604-4

ORIGINAL ARTICLE

Trajectory of severity of postoperative delirium symptoms and its prospective association with cognitive function in patients with gastric cancer: results from a prospective observational study

Eun-Jung Shim[1] · Hae Lim Noh[1] · Kwang-Min Lee[2] · Heesung Hwang[3] · Kyung-Lak Son[4] · Dooyoung Jung[5] · Won-Hyoung Kim[6] · Seong-Ho Kong[7] · Yun-Suhk Suh[7] · Hyuk-Joon Lee[7] · Han-Kwang Yang[7] · Bong-Jin Hahm[3,8]

Received: 20 June 2018 / Accepted: 10 December 2018 / Published online: 3 January 2019

Abstract

Purpose Delirium is a common neurocognitive complication in cancer. Despite this, the studies examining the trajectory of the severity of delirium symptoms and its impact on health outcome in gastric cancer is rather limited. This study examined the trajectory of delirium symptom severity (DSS) following resection surgery for gastric cancer and its prospective association with cognitive function.

Methods A three-wave prospective observational study was conducted with 242 gastric cancer patients admitted for resection surgery at a teaching hospital in South Korea from May 2016 to November 2017. DSS was assessed by the clinical staff before and 1, 2, 3, and 7 days after surgery using the Delirium Rating Scale-Revised-98. A survey including the Functional Assessment of Cancer Therapy-Cognitive Scale (FACT-Cog) and Mini-Mental State Examination (MMSE) was administered before surgery (T0), 7 days after (T1), and 3 to 6 months after surgery (T2).

Results Out of 242 participants, 48.8% (118) completed the survey at all three time points, 43.4% (105) did so for two time points, and 7.9% (19) for one time point. No cases of full delirium were observed over four postoperative time points. Latent growth curve modeling analyses indicated that DSS declined over 3 days after surgery. Age and anesthesia time were positively associated with the initial level of DSS. A medication history for memory complaints was related to a slower recovery from delirium symptoms. While the use of propofol as an anesthetic agent was associated with lower initial DSS, it predicted a slower recovery from DSS. A higher initial DSS predicted a lower T1 MMSE score.

Conclusions Severity of postoperative delirium symptoms predicts a short-term and objective cognitive function post-surgery. Monitoring and timely treatment of postoperative delirium symptoms is needed to diminish cognitive consequences in gastric cancer patients.

Keywords Anesthesia · Cognitive function · Delirium · Gastric cancer · Gastrectomy

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00520-018-4604-4) contains supplementary material, which is available to authorized users.

✉ Bong-Jin Hahm
hahm@snu.ac.kr

1 Department of Psychology, Pusan National University, Busan, South Korea

2 Public Health and Medical Service, Seoul National University Hospital, Seoul, South Korea

3 Department of Psychiatry and Behavioral Sciences, Seoul National University College of Medicine, 101 Daehak-ro, Jongno-gu, Seoul 03080, South Korea

4 Department of Psychiatry, Dongguk University Ilsan Hospital, Goyang, South Korea

5 Department of Human Factors Engineering, Ulsan National Institute of Science and Technology, Ulsan, South Korea

6 Department of Psychiatry, Inha University Hospital, Incheon, South Korea

7 Department of Surgery, Seoul National University Hospital, Seoul, South Korea

8 Department of Neuropsychiatry, Seoul National University Hospital, Seoul, South Korea

Introduction

Delirium is a common neurocognitive complication in cancer patients [1], causing considerable distress to them and their family/caregivers [2]. It is associated with increased mortality [3], prolonged hospital stay [3, 4], higher need for convalescence or long-term care, and worse functioning after surgery [4].

Moreover, delirium is related to cognitive function, and a systematic review suggested a link between delirium and a high risk of long-term cognitive impairment [5]. In fact, a longer duration of delirium was an independent predictor of worse cognitive functioning at the 3- and 12-month follow-up in medical intensive care unit patients [6]. Similarly, delirium during the acute phase of hematopoietic cell transplant (HCT) was related to perceived neurocognitive dysfunction as well as low health-related quality of life at 6 months and 1 year [7]. In addition to worse cognitive functioning, a delirium episode during the acute phase of myeloablative HCT was also related to decreased mental health, increased anxiety, fatigue, and cancer- and treatment-related distress symptoms at 80 days after transplantation [8].

Despite the significant impact of delirium symptoms on patient-reported outcomes, prospective studies to examine the longitudinal trajectory of the severity of delirium symptoms and its consequences in patients with cancer, particularly patients with gastric cancer, are rather limited. Gastric cancer is the fifth most frequently diagnosed cancer worldwide with more than 1,000,000 new cases in 2018, and its incidence is particularly elevated in Eastern Asia, with the highest rates observed in South Korea with age-standardized incidence rates of 32.1 for males and 13.2 for females [9].

With improved gastric cancer survival rates observed worldwide, there is increasing concern about the long-term impact of treatment-related symptoms such as delirium on health-related outcomes such as cognitive function. In fact, a decline in cognitive functioning was one of the representative and unrecovered problems after 1 year post-surgery in a longitudinal study with 465 patients who received gastrectomy [10], which warrants clinical attention.

Thus, the purpose of this study was to explore the trajectory of the severity of delirium symptoms over 3 days following surgery as well as its potential association with objective and subjective cognitive function 3 to 6 months after surgery in a prospective observational study with gastric cancer patients.

Methods

Participants and procedures

The participants consisted of gastric cancer patients admitted for curative resection surgery at the surgery department of a teaching hospital in Seoul, South Korea, from May 2016 to November 2017. Research nurses explained the purpose and procedures of the study to eligible patients on the day of admission. Upon obtaining informed consent, trained research nurses or psychiatrists assessed delirium symptoms using the Delirium Rating Scale Revised-98 (before and 1, 2, 3, and 7 days after surgery). A survey that included the FACT-Cognitive Scale, the Min-Mental State Examination, and the Hospital Anxiety and Depression Scale was also administered before (T0), 7 days after surgery (T1), and 3 to 6 months after surgery (T2).

Out of 357 eligible patients, 84 patients declined study participation. Seventeen patients (3 with gastrointestinal stromal tumor, 11 with palliative surgery, 2 with delayed surgery, and 1 with refusal to surgery) were excluded, resulting in a total of 256 participants enrolled at baseline. Data from 14 patients (1 with preoperative delirium; 8 whose MMSE score was ≤ 19, indicative of possible dementia [11]; and 5 whose delirium data were missing) were further excluded, resulting in 242 patients included in analyses.

This study was approved by the Institutional Review Board of the Seoul National University Hospital (IRB No. H-1505-045-671).

Measures

Delirium symptom severity was assessed via the 13-item severity scale from the Delirium Rating Scale-Revised-98 (DRS-R-98) [12]. Severity was assessed by parameters such as sleep-wake cycle disturbances, perceptions and hallucinations, delusions, lability of affect, language, thought processing abnormalities, motor agitation or retardation, orientation, attention, and short- and long-term memory. Clinicians rated symptoms on a 4-point scale (0–3), and the scores ranged from 0 to 39, with higher scores indicating greater severity. Severity scores of 8–14 were considered to be subsyndromal delirium and the scores of over 15 as full delirium [13]. The Cronbach's alpha of the DRS-R-98 severity scale was 0.87 [12].

Subjective cognitive function was assessed by the FACT–Cognitive Scale (FACT-Cog) [14]. The FACT-Cog (Version 3) is a 37-item self-report measure of cognitive complaints in cancer patients and composed of 4 subscales: perceived cognitive impairments (20 items, CogPCI), impact of perceived cognitive impairments on quality of life (4 items, CogQOL), comments from others (4 items, CogOth), and perceived cognitive abilities (9 items, CogPCA). Responders rate each item on a 5-point Likert scale referring to the past 7 days (frequency rating for the subscales of CogPCI and CogOth: 0 = "never" to 4 = "several times a day"; severity rating for the subscales of CogQOL and CogPCA: 0 = "not at all" to 4 = "very much"). The subscale scores are calculated by summing up the items in the respective domain (two items from CogPCI and two from CogPCA are not to be scored), with higher scores corresponding to a higher level of the respective domain. The Cronbach's alpha of the Korean version of the FACT-Cog are 0.92 (CogPCA), 0.95 (CogPCI), 0.84 (CogOth), and 0.87 (CogQOL) [15].

Objective cognitive function was assessed by the Korean version of the Mini-Mental State Examination (MMSE-K) [11]. The MMSE is a brief measure of overall cognitive function with 11 items evaluating orientation, memory registration and recall, attention and calculation, language, and visual construction [16]. A cutoff score of 23 out of 30 is indicative of cognitive function problems [11].

Anxiety and depression were evaluated by the respective 7-item subscales from the Hospital anxiety and depression scale (HADS) [17]. Patients rate each item on a 4-point Likert scale (0–3) referring to the past week. The score of each subscale ranges from 0 to 21. The Cronbach's alpha of the Korean version of the HADS was 0.89 for anxiety and 0.86 for the depression subscale [17].

Clinical characteristics were retrieved from electronic medical charts and operation and anesthesia records. Comorbidities were scored by the ICD-10 version of the Charlson comorbidity index (CCI) [18]. CCI was calculated excluding age as it was examined separately in analyses.

Statistical analyses Chi-square analysis was conducted to examine sociodemographic and clinical characteristics of the study participants. Pearson correlation analyses were performed to identify factors associated with the scores of the FACT-Cog subscales and the MMSE, and significant variables (supplementary Table 1) were entered as covariates in the latent growth curve model analysis (LGM).

LGM was conducted to examine factors associated with the initial level (i.e., postoperative day 1: POD1) and rates of change in DSS (i.e., changes from POD 1 to POD3), and its potential association with cognitive function. LGM allows examination of both intra-individual changes over time and the inter-individual differences in intra-individual changes as well as investigation of antecedents and consequences of change [19]. First, an unconditional LGM examining the intercept (i.e., an initial level of DSS) and the slope (i.e., linear change in DSS) was performed. Second, the conditional LGM was run to examine the relationships of the initial level and rates of change in DSS with the socio-demographic and clinical variables, as well as the impact of the intercept and slope of DSS on T1 and T2 cognitive functions. The goodness of fit of the model was evaluated with the following criteria: Chi-square statistics, a Chi-square to degrees of freedom ratio of less than 2 or 3 [20], Comparative Fit Index (CFI: > .90), Tucker-Lewis Index (TLI: > .90), and root mean squared error of approximation (RMSEA: < .08 with a 90% confidence interval) [21]. The robust maximum likelihood estimator was used to account for the non-normal delirium data. Missing data was handled with full information as maximum likelihood under the missing-at-random assumption. IBM SPSS version 23 for Windows and AMOS 23 were used for the statistical analyses.

Results

Participants' characteristics across time points

Participants' characteristics are shown in Table 1. Out of 242 participants, 48.8% (118) completed the survey at all three time points, 43.4% (105) did so for two time points, and 7.9% (19) for one time point. Participants who completed the test only at one time showed a higher BMI than those who completed all three time points ($F_{(2,\ 237)} = 4.32$, $p < .05$) as well as a higher rate of preoperative midazolam use for anesthesia-assisted gastroscopy (55.6% vs. 29.7%; $X^2_{(2)} = 6.02$, $p < .05$) and CCI stage of over 4 (16.7% vs. 0%; $X^2_{(2)} = 16.68$, $p < .01$).

No cases of full delirium were observed over four time points. Twenty-two patients (9.1%) at postoperative day (POD) 1, 9 patients (3.7%) at POD2, 7 patients at POD3 (2.9%), and 5 patients (2.1%) at POD7 had subsyndromal delirium as determined by the DRS-R-98 severity subscale scores.

Initial level and rates of change of the DSS during the first 3 days after surgery

The unconditional LGM examining the intercept (i.e., at POD1) and slope of DSS (changes from POD1 to POD3) was analyzed. The results indicated good fitness of the model to the data ($X^2 = 5.14$, $df = 3$, $p = .16$, $X^2/df = 1.71$, CFI = .99 TLI = .98, RMSEA = .05 with 90% CI .00–.13). The estimated mean value of the intercept was 4.52 ($SE = .14$, $p < .001$) and that of the slope was − .91 ($SE = .08$, $p < .001$), indicating a significant decrease of DSS over 3 postoperative days. The variances of the intercept and slope were significant (intercept, *variance* = 3.65, $SE = .45$, $p < .001$; slope, *variance* = .71, $SE = .15$, $p < .001$), indicating individual differences in the initial level and rates of change of DSS. The covariance between the intercept and slope was negatively related ($b = -.60$, $p < .01$), indicating that a higher initial level of DSS is associated with its slower decrease over time.

Factors associated with the trajectory of the DSS

Sociodemographic and clinical factors that were associated with the initial level and rate of change of DSS are shown in Table 2. Indices of goodness of fit for all significant and marginally significant variables were in the acceptable range, even though the upper value of 90% CI was over .10 which could

Table 1 Participants' sociodemographic and clinical characteristics across time points ($N = 242$)

Variables	Mean ± SD or N (%)
Sociodemographic variables	
Age	62.05 ± 10.60
Gender (male)	159 (66.0)
Education level (≤ 9 years)	168 (73.7)
Marital status (married)	223 (94.9)
Religion (with religion)	115(49.1)
Monthly income (Korean won)	
~ 2 million KRW	52 (26.8)
2~4 million KRW	57 (29.4)
4~6 million KRW	41 (21.1)
6 million KRW ~	44 (22.7)
Number of family member living together	2.95 ± 1.25
Clinical variables	
Currently smoking	28 (11.9)
Problematic drinking	22 (9.4)
Body mass index (cm/kg^2)	22.92 ± 3.10
> 25	56 (23.3)
< 18.5	17 (7.1)
ECOG status	
0	143 (68.8)
1	60 (28.8)
2	4 (1.9)
3/4	1 (0.5)
Medication history for depression	13 (6.2)
Medication history for memory complaints	3 (1.4)
CCI (except age)	
2–3	19 (7.9)
≥ 4	7 (2.9)
Pre-op midazolam use for anesthesia-assisted gastroscopy	87 (36.0)
T stage	
T1	170 (70.8)
T2 or more	70 (29.2)
Surgical procedure	
Laparoscopic	201 (83.8)
Open	39 (16.3)
Resection type	
Total gastrectomy	48 (20.0)
Subtotal or partial gastrectomy	192 (80.0)
Anesthesia time (min)	274.71 ± 58.84
Main anesthetic agent	
TIVA (propofol)	37 (15.4)
Sevoflurane or desflurane	203 (84.6)
Intraoperative analgesic agent	
Remifentanil	228 (95.0)
Fentanyl	12 (5.0)
Anxiety	5.60 ± 3.68
Depression	5.44 ± 3.54

Note. Monthly income: 2 million KRW equivalent to 1864 USD

ECOG Eastern Cooperative Oncology Group, *CCI* Charlson comorbidity index, *op* operative, *TIVA* total intravenous anesthesia

$^{*}p < .05$; $^{**}p < .01$

be due to the small degrees of freedom [22]. Age and anesthesia time were positively related to an initial level of DSS. A medication history for memory complaints was related to a slower recovery from delirium symptoms. In addition, while use of propofol as the main anesthetic was associated with a lower initial DSS, it predicted a slower recovery from delirium symptoms.

Although a laparoscopic surgery was related to a higher initial DSS with marginal significance ($b = .65$, $SE = .36$, $t = 1.80$, $p = .07$), it was related to a faster recovery ($b = -.38$, $SE = .20$, $t = -1.89$, $p = .06$). Subtotal or partial gastrectomy was related to a lower initial level of DSS ($b = -.62$, $SE = .33$, $t = -1.88$, $p = .06$). In addition, depression was associated with a higher initial DSS ($b = .07$, $SE = .04$, $t = 1.79$, $p = .07$), and the number of family members was related to a faster recovery ($b = -.12$, $SE = .06$, $t = -1.86$, $p = .06$).

A potential association between a trajectory of DSS and cognitive function

A potential association of the trajectory of postoperative DSS with the scores of the MMSE and the FACT-Cog subscales at T1 and T2 were examined.

As for the objective cognitive function, the intercept predicted T1 MMSE ($b = -.30$, $SE = .08$, $p < .001$), indicating higher initial DSS predicting lower MMSE scores at T1 ($X^2 = 45.19$, $df = 28$, $p < .01$, $X^2/df = 1.61$, CFI = .96, TLI = .92, RMSEA = .05 with 90% CI .02–.08), and its predictive ability remained significant even after controlling for preoperative MMSE scores ($b = -.19$, $SE = .07$, $p < .01$) (Fig. 1).

As for subjective cognitive function, the slope ($b = -1.86$, $SE = .86$, $p < .05$) predicted the CogPCI subscale scores at T2, indicating faster recovery from delirium symptoms predicting higher T2 PCI ($X^2 = 52.88$, $df = 25$, $p = .001$, $X^2/df = 2.16$, CFI = .93, TLI = .84, RMSEA = .07 with 90% CI .04–.09). However, on controlling for its preoperative scores, it became non-significant ($b = -1.27$, SE = .80, $p = .11$) (Fig. 2).

Discussion

This study examined the trajectory of DSS over 3 days after surgery, and its association with objective and subjective cognitive function at 7 days (T1) and 3 to 6 months after surgery (T2) in patients with gastric cancer.

DSS declined significantly over the 3 postoperative days. The overall DSS level in patients with gastric cancer was not high. Delirium is more common in the advanced or terminal stage of cancer [1], and the fact that our participants were at a relatively early stage receiving curative surgery might explain the low level of DSS. In fact, a previous finding from a Japanese study with elderly patients with gastric cancer indicated that surgery-related complications such as delirium were not common even in elderly patients at the early stage of gastric cancer, with only four out of 141 patients experiencing delirium [23]. However, previous studies suggest that even features of subsyndromal delirium are significantly related to prolonged hospital stays and worsened functional status [4] or worse cognitive outcomes [24], warranting clinical attention.

The longitudinal trajectory of DSS was associated with a few socio-demographic and clinical factors. Age [25, 26] and anesthesia time were positively associated with the initial DSS. A probable association between time of anesthesia and the DSS has been suggested. In a study with esophageal cancer patients, the occurrence of postoperative delirium was not significantly associated with the duration of anesthesia, but the duration of anesthesia was longer in patients with delirium than in those without, with a marginal significance [25].

Furthermore, a medication history for memory complaints was related to a slower recovery from delirium symptoms, which is understandable with decline in memory being one of the symptoms of delirium [12]. A similar association between preoperative subjective memory complaints and an increased risk of postoperative delirium was previously noted [27].

In addition, while the use of propofol as the main anesthetics was associated with a lower initial DSS, it predicted a slower recovery from delirium symptoms. A previous study with elderly patients receiving laparoscopic surgery indicated that patients on propofol scored higher on the delirium rating scale at postoperative days 2 and 3 than those on sevoflurane anesthesia, whereas the incidence of postoperative delirium during the first 3 days showed no significant intra-group differences [28]. Related to this, early postoperative cognitive dysfunction was higher with propofol as compared with desflurane in patients receiving coronary artery bypass surgery [29] although this association was no longer observed at 3 months after surgery. Yet, previous studies show discrepant results regarding the association between propofol and delirium depending on the studied population or treatment or other clinical characteristics, warranting caution in its interpretation and further investigation into the issue.

Higher initial DSS predicted lower MMSE scores indicative of objective cognitive function at 7 days after surgery even after controlling for its preoperative scores, but not at 3 to 6 months after surgery, consistent with a significant association between postoperative delirium and postoperative cognitive decline assessed by the MMSE, observed in elderly patients with gastric cancer [30]. Similarly, a postoperative delirium was associated with a more pronounced decline in the MMSE scores immediately after cardiac surgery, but the differences of MMSE scores between elderly patients with and without delirium episodes were not seen at 6 and 12 months after surgery [31]. Yet, a delayed recovery of preoperative cognitive functioning was observed in patients with delirium not recovering their previous functions by 1 year after surgery compared to those without delirium recovering their previous level by about 1 month after surgery [31].

As for a subjective cognitive function, the rates of change of DSS predicted a perceived cognitive impairment at 3 to 6 months after surgery, although it became non-significant on controlling for its preoperative level. A prior study comparing perceived cognitive impairments using the same FACT-Cog between survivors of critical illness and their family member controls found no significant differences in FACT-Cog subscale scores 3 and 6 months after discharge [32].

Related to this, a prior study with patients from a cancer rehabilitation unit found a weak association between subjective and objective assessments of cognitive functioning. This was explained by significant associations of emotional status with subjective cognitive functioning versus only weak associations with objective ones [33]. This was also observed in the current study and HADS anxiety and depression scores were correlated to most of the FACT-Cog subscale scores, but only depression was related to the MMSE scores at T1. Significant associations of DSS with objective cognitive function but not with subjective ones found in this study might suggest these varying degrees of influences of various factors on cognitive function.

Table 2 Predictors of the initial level and the rates of change of DSS

Predictors	Estimate (*b*)	SE	*t*	*p*
Regression of initial delirium on				
Age	.05	.01	4.01	< .001
Anesthesia time	.01	.00	3.21	< .001
Use of propofol as main anesthesia	− .97	.37	−2.65	< .01
Regression of rate of change in delirium on				
Memory_Hx	1.48	.66	2.25	< .05
Use of propofol as main anesthesia	.66	.20	3.26	< .001

Note. Education = < 9 vs. ≤ 9; *Memory Hx* medication history for memory complaints

Model fit indices for age, $X^2 = 16.94$, $df = 5$, $p < .01$, $X^2/df = 3.39$, CFI = .95, TLI = .91, RMSEA = .09 with 90% CI .05–.15; model fit indices for anesthesia time, $X^2 = 16.91$, $df = 5$, $p < .01$, $X^2/df = 3.38$, CFI = .95, TLI = .90, RMSEA = .10 with 90% CI .05–.15; model fit indices for memory HX, $X^2 = 15.33$, $df = 5$, $p < .01$ $X^2/df = 3.06$, CFI = .96, TLI = .91, RMSEA = .09 with 90% CI .04–.15; model fit indices for continuous use of propofol, $X^2 = 13.94$, $df = 5$, $p < .05$ $X^2/df = 2.79$, CFI = .96, TLI = .93, RMSEA = .08, 90% CI = 03–.14

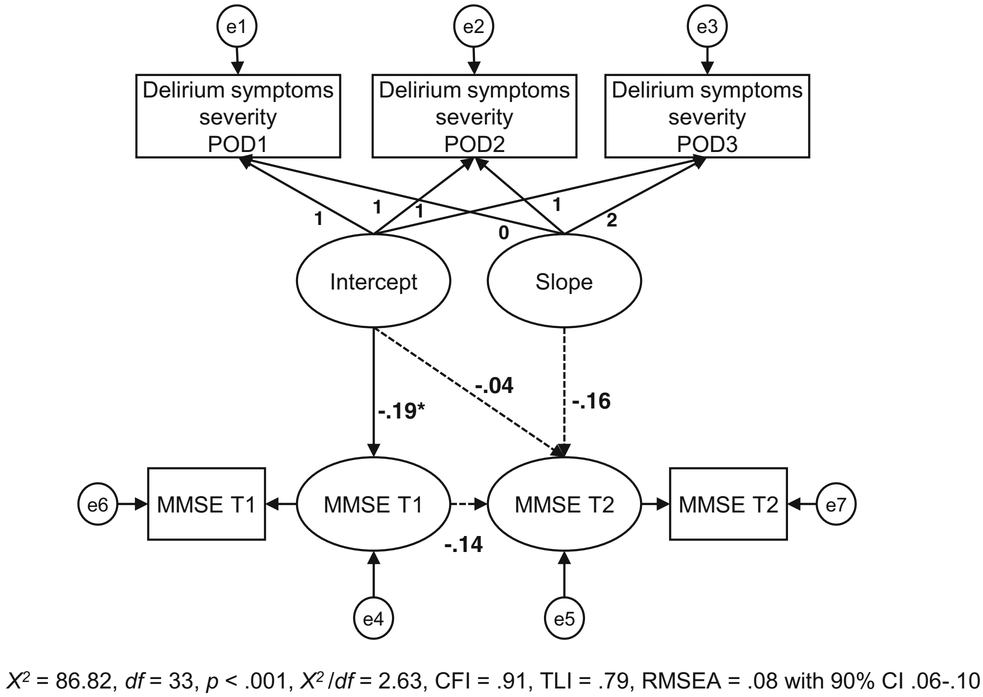

Fig. 1 The trajectory of DSS and objective cognitive function (MMSE). Note: age, education, monthly income, number of family members, ECOG, depression, and preoperative MMSE were entered as covariates

This study has several limitations. Above all, the use of the MMSE as a measure of objective cognitive function might be insufficient to capture subtle cancer treatment-related cognitive deficits, and detailed formal assessment is needed. In addition, the follow-up period was relatively short, and an extended period of follow-up is needed to examine a long-term impact of DSS.

Although postoperative DSS declined after surgery, it predicted worse objective cognitive function 7 days after surgery, warranting the need for monitoring and timely treatment of delirium symptoms following surgery to diminish cognitive consequences. Evidence suggests pharmacological and non-pharmacological interventions for delirium. Evidence for pharmacological interventions for delirium is limited.

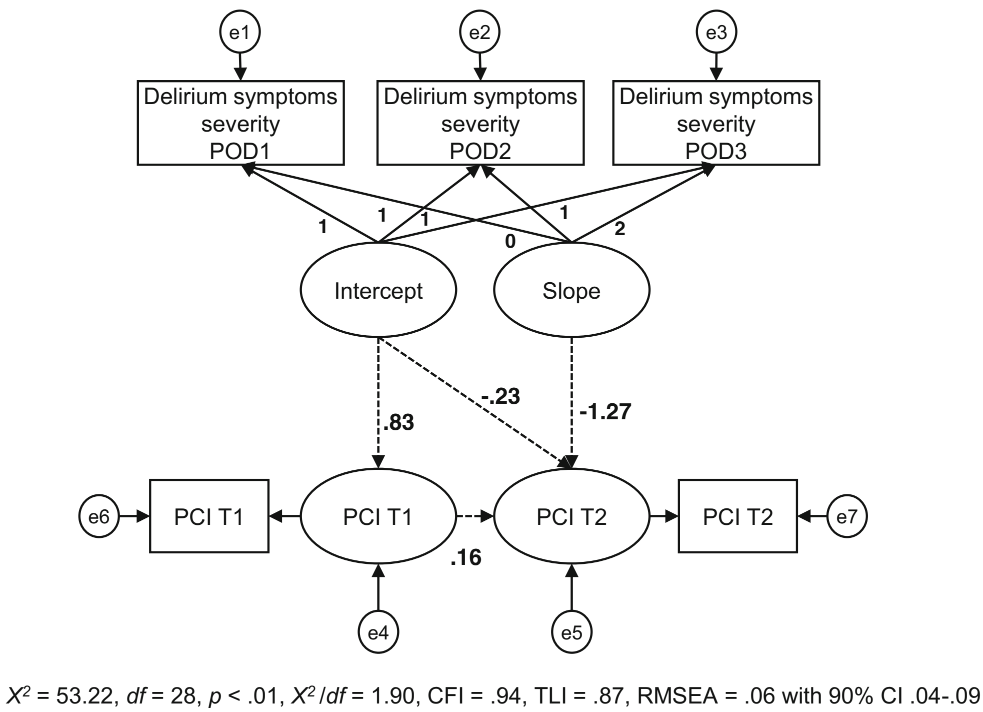

Fig. 2 The trajectory of DSS and subjective cognitive function (FACT-Cog). Note: gender, religion, anxiety, depression, memory_hx, and preoperative PCI were entered as covariates; PCI: perceived cognitive impairment

Although a 2012 review of evidence-based treatment of delirium in patients with cancer recommended the short-term and low-dose use of antipsychotics in treating delirium symptoms with careful monitoring for possible side effects, particularly for older patients with multiple medical comorbidities [34], more recent systematic review and meta-analysis found no significant effect of antipsychotics in the prevention or treatment of delirium [35, 36].

Moreover, despite evidence of the limited effectiveness of non-pharmacological interventions for delirium in patients with cancer [37], another systematic review [38] and a meta-analysis [39] indicate that multi-component non-pharmacological interventions are effective in reducing the incidence of delirium. Related to this, the current study observed a marginally significant association between a number of family members and a faster recovery from DSS. The benefit of family support on delirium prevention was suggested, and the multicomponent intervention delivered by family members which includes re-orientation of the patient or extended visiting time, reduced the incidence of delirium in elderly medical inpatients at intermediate and high risk of delirium [40].

Moreover, although marginally significant, depression was linked to a higher initial DSS, which is consistent with a prior finding with geriatric surgical patients linking occurrence and a longer duration of postoperative delirium to a greater number of preoperative depressive symptoms [41]. Given that delirium and depression can be comorbid, and lability of affect is also a symptoms of delirium [42], screening for depression is warranted.

To conclude, monitoring patients at heightened risk of initial DSS (i.e., older age and longer anesthesia time) and its delayed recovery (i.e., a history of medication for memory complaints and the use of propofol as an anesthetic agent) is warranted in the perioperative care of patients with gastric cancer.

Funding This study was supported by a grant of the Korean Mental Health Technology R & D Project, Ministry of Health & Welfare, Republic of Korea (HM15C1224).

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

We have full control of all primary data and we agree to allow the journal to review their data if requested.

Research involving human participants and/or animals "All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

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

References

1. Lawlor PG, Bush SH (2015) Delirium in patients with cancer: assessment, impact, mechanisms and management. Nat Rev Clin Oncol 12(2):77–92
2. Bruera E, Bush SH, Willey J, Paraskevopoulos T, Li Z, Palmer JL, Cohen MZ, Sivesind D, Elsayem A (2009) Impact of delirium and recall on the level of distress in patients with advanced cancer and their family caregivers. Cancer 115(9):2004–2012
3. Ouimet S, Riker R, Bergeon N, Cossette M, Kavanagh B, Skrobik Y (2007) Subsyndromal delirium in the ICU: evidence for a disease spectrum. Intensive Care Med 33(6):1007–1013
4. Shim J, DePalma G, Sands LP, Leung JM (2015) Prognostic significance of postoperative subsyndromal delirium. Psychosomatics 56(6):644–651
5. MacLullich AM, Beaglehole A, Hall RJ, Meagher DJ (2009) Delirium and long-term cognitive impairment. Int Rev Psychiatry 21(1):30–42
6. Girard TD, Jackson JC, Pandharipande PP, Pun BT, Thompson JL, Shintani AK, Gordon SM, Canonico AE, Dittus RS, Bernard GR (2010) Delirium as a predictor of long-term cognitive impairment in survivors of critical illness. Crit Care Med 38(7):1513–1520
7. Basinski JR, Alfano CM, Katon WJ, Syrjala KL, Fann JR (2010) Impact of delirium on distress, health-related quality of life, and cognition 6 months and 1 year after hematopoietic cell transplant. Biol Blood Marrow Transplant 16(6):824–831
8. Fann JR, Alfano CM, Roth-Roemer S, Katon WJ, Syrjala KL (2007) Impact of delirium on cognition, distress, and health-related quality of life after hematopoietic stem-cell transplantation. J Clin Oncol 25(10):1223–1231
9. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A (2018) Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a Cancer journal for clinicians
10. Kim AR, Cho J, Hsu Y-J, Choi MG, Noh JH, Sohn TS, Bae JM, Yun YH, Kim S (2012) Changes of quality of life in gastric cancer patients after curative resection: a longitudinal cohort study in Korea. Ann Surg 256(6):1008–1013
11. Park J, Kwon Y (1989) Standardization study of the Korean version of the mini-mental state examination (MMSE-K) for older adults - part II: cutoffs and diagnostic validity. J Korean Neurol Assoc 28(3):508–513
12. Trzepacz PT, Mittal D, Torres R, Kanary K, Norton J, Jimerson N (2001) Validation of the delirium rating scale-revised-98: comparison with the delirium rating scale and the cognitive test for delirium. J Neuropsychiatry Clin Neurosci 13(2):229–242
13. Meagher D, Adamis D, Trzepacz P, Leonard M (2012) Features of subsyndromal and persistent delirium. Br J Psychiatry 200(1):37–44
14. Wagner LI, Sweet J, Butt Z, Lai J-S, Cella D (2009) Measuring patient self-reported cognitive function: development of the functional assessment of cancer therapy-cognitive function instrument. J Support Oncol 7(6):W32–W39
15. Park J-H, Bae SH, Jung YS, Jung Y-M (2015) The psychometric properties of the Korean version of the functional assessment of cancer therapy-cognitive (FACT-cog) in Korean patients with breast cancer. Support Care Cancer 23(9):2695–2703
16. Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12(3):189–198

17. Oh SM, Min KJ, Park DB (1999) A study on the standardization of the hospital anxiety and depression scale for Koreans: a comparison of normal, depressed and anxious groups. J Korean Neurol Assoc 38(2):289–296
18. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi J-C, Saunders LD, Beck CA, Feasby TE, Ghali WA (2005) Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care 43:1130–1139
19. Preacher KJ (2010) Latent growth curve models. In: Hancock GR, Mueller RO (eds) The reviewer's guide to quantitative methods in the social sciences. Routledge, New York, pp 185–198
20. Schreiber JB, Nora A, Stage FK, Barlow EA, King J (2006) Reporting structural equation modeling and confirmatory factor analysis results: a review. J Educ Res 99(6):323–338
21. Bentler PM (1990) Comparative fit indexes in structural models. Psychol Bull 107(2):238–246
22. Kenny DA, Kaniskan B, McCoach DB (2015) The performance of RMSEA in models with small degrees of freedom. Sociol Methods Res 44(3):486–507
23. Katai H, Sasako M, Sano T, Fukagawa T (2004) Gastric cancer surgery in the elderly without operative mortality. Surg Oncol 13(4):235–238
24. Cole MG, McCusker J, Voyer P, Monette J, Champoux N, Ciampi A, Vu M, Belzile E (2011) Subsyndromal delirium in older long-term care residents: incidence, risk factors, and outcomes. J Am Geriatr Soc 59(10):1829–1836
25. Takeuchi M, Takeuchi H, Fujisawa D, Miyajima K, Yoshimura K, Hashiguchi S, Ozawa S, Ando N, Shirahase J, Kitagawa Y (2012) Incidence and risk factors of postoperative delirium in patients with esophageal cancer. Ann Surg Oncol 19(12):3963–3970
26. Tei M, Wakasugi M, Kishi K, Tanemura M, Akamatsu H (2016) Incidence and risk factors of postoperative delirium in elderly patients who underwent laparoscopic surgery for colorectal cancer. Int J Color Dis 31(1):67–73
27. Veliz-Reissmüller G, Torres HA, van der Linden J, Lindblom D, Jönhagen ME (2007) Pre-operative mild cognitive dysfunction predicts risk for post-operative delirium after elective cardiac surgery. Aging Clin Exp Res 19(3):172–177
28. Nishikawa K, Nakayama M, Omote K, Namiki A (2004) Recovery characteristics and post-operative delirium after long-duration laparoscope-assisted surgery in elderly patients: propofol-based vs. sevoflurane-based anesthesia. Acta Anaesthesiol Scand 48(2): 162–168
29. Royse C, Andrews D, Newman S, Stygall J, Williams Z, Pang J, Royse A (2011) The influence of propofol or desflurane on postoperative cognitive dysfunction in patients undergoing coronary artery bypass surgery. Anaesthesia 66(6):455–464
30. Shin Y-H, Kim D-K, Jeong H-J (2015) Impact of surgical approach on postoperative delirium in elderly patients undergoing gastrectomy: laparoscopic versus open approaches. Korean J Anesthesiol 68(4):379–385
31. Saczynski JS, Marcantonio ER, Quach L, Fong TG, Gross A, Inouye SK, Jones RN (2012) Cognitive trajectories after postoperative delirium. N Engl J Med 367(1):30–39
32. Baumbach P, Meissner W, Guenther A, Witte O, Götz T (2016) Perceived cognitive impairments after critical illness: a longitudinal study in survivors and family member controls. Acta Anaesthesiol Scand 60(8):1121–1130
33. Poppelreuter M, Weis J, Külz A, Tucha O, Lange K, Bartsch H (2004) Cognitive dysfunction and subjective complaints of cancer patients: a cross-sectional study in a cancer rehabilitation Centre. Eur J Cancer 40(1):43–49
34. Breitbart W, Alici Y (2012) Evidence-based treatment of delirium in patients with cancer. J Clin Oncol 30(11):1206–1214
35. Neufeld KJ, Yue J, Robinson TN, Inouye SK, Needham DM (2016) Antipsychotic medication for prevention and treatment of delirium in hospitalized adults: a systematic review and meta-analysis. J Am Geriatr Soc 64(4):705–714
36. Burry L, Mehta S, Perreault MM, Luxenberg JS, Siddiqi N, Hutton B, Fergusson DA, Bell C, Rose L (2018) Antipsychotics for treatment of delirium in hospitalised non-ICU patients. Cochrane Database Syst Rev (6). https://doi.org/10.1002/14651858.CD005594.pub3
37. Gagnon P, Allard P, Gagnon B, Mérette C, Tardif F (2012) Delirium prevention in terminal cancer: assessment of a multicomponent intervention. Psycho-Oncology 21(2):187–194
38. Siddiqi N, Harrison JK, Clegg A, Teale EA, Young J, Taylor J, Simpkins SA (2016) Interventions for preventing delirium in hospitalised non-ICU patients. The Cochrane Library
39. Hshieh TT, Yue J, Oh E, Puelle M, Dowal S, Travison T, Inouye SK (2015) Effectiveness of multicomponent nonpharmacological delirium interventions: a meta-analysis. JAMA Intern Med 175(4):512–520
40. Martinez FT, Tobar C, Beddings CI, Vallejo G, Fuentes P (2012) Preventing delirium in an acute hospital using a non-pharmacological intervention. Age Ageing 41(5):629–634
41. Leung JM, Sands LP, Mullen EA, Wang Y, Vaurio L (2005) Are preoperative depressive symptoms associated with postoperative delirium in geriatric surgical patients? J Gerontol Ser A Biol Med Sci 60(12):1563–1568
42. Marchington KL, Carrier L, Lawlor PG (2012) Delirium masquerading as depression. Palliat Support Care 10(1):59–62