Development of a Simple and Practical Delirium Screening Tool for Use in Surgical Wards

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ABSTRACT

Background: Delirium is an important and common medical condition, particularly in hospitalized patients, that is associated with adverse outcomes. The identification, prevention, and treatment of delirium are increasingly regarded as major public health priorities.

Purpose: The aim of this study was to create a simple-to-use screening tool for delirium in hospitalized patients using clinical manifestations of delirium regularly observed by nurses.

Methods: This study was conducted using data on 2,168 patients who had been admitted to the surgical ward between January 2011 and December 2014. Data were collected retrospectively from medical records. Univariate and multivariate analyses were performed, and a logistic regression model was constructed for the development of a predictive screening tool. After constructing a new screening tool for delirium, a receiver operating characteristic curve was drawn, the most appropriate cutoff value was decided, and the area under the curve was obtained. Bootstrapping was used for the internal model validation.

Results: A screening tool for delirium (Subjective Delirium Screening Scale by Nurse) with a total score of 5 points was constructed as follows: 2 points for disorientation and 1 point each for restless-ness, somnolence, and hallucination. The area under the curve for the Subjective Delirium Screening Scale by Nurse was 81.9% (95% CI [77.9%, 85.8%]), and the most appropriate cutoff value was determined to be 2 (sensitivity of 61.0% and specificity of 96.7%). Bootstrapped validation beta coefficients of the predictive factors were similar to the original cohort beta coefficients.

Conclusions: We created a screening tool for delirium using factors that were regularly observed and recorded by nurses. This tool is simple and practical and has adequate diagnostic accuracy.

KEY WORDS: delirium, screening tool, surgical ward.

Introduction

Delirium, characterized by an acute change in the level of consciousness, inattention, and disturbed cognitive function, is an important and common medical condition, particularly in hospitalized patients. Delirium is associated with adverse outcomes such as increased mortality, accidental falls, cognitive decline, functional dependence, and healthcare costs. The identification, prevention, and treatment of delirium are increasingly regarded as major public health priorities (Chaput & Bryson, 2012; Greer et al., 2011; Inouye, Westendorp, & Saczynski, 2014; O’Regan, Fitzgerald, Timmons, O’Connell, & Meagher, 2013).

In our hospital, we began addressing issues related to delirium beginning in 2011. These actions were as follows: early assessment of the risk of delirium after admission and repeated assessments thereafter, acquiring information on drugs with a risk for delirium (benzodiazepine, etc.), physical therapy (cognitive stimulation, promotion of good sleep, early mobilization, etc.), nutritional support (including avoidance of dehydration), family education, and early introduction of therapy using medications (quetiapine, risperidone, haloperidol, etc.; Inouye et al., 1999; Martinez, Tobar, & Hill, 2015; National Institute for Health and Care Excellence, 2010; Siddiqi et al., 2016; Zhang et al., 2013). Delirium was screened and diagnosed using the Delirium Screening Tool (DST) and the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU). We have recently reported risk factors for delirium in patients hospitalized for more than 5 days in surgical wards (Kubota et al., 2018).

We then wanted to assess the incidence of delirium in our hospital before the implementation of the abovementioned actions (i.e., before 2011). However, DST and CAM-ICU were unavailable because we did not screen for delirium using these tools before 2011.

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Therefore, the aim of this study was to devise a convenient screening tool for delirium in patients hospitalized for more than 5 days in surgical wards, using clinical observations that are typically recorded by nurses subjectively in clinical records. This new screening tool would allow us to obtain information on whether or not a patient had delirium by checking past records retrospectively.

Methods

This study was approved by the local ethical committee of St. Luke’s International Hospital (#16-09). Written informed consent had been provided by all of the patients at admission for use of their data for publication.

The study was conducted using data collected retrospectively from hospital medical records on 2,168 patients who had been admitted to the surgical ward of St. Luke’s International Hospital for 5 days or more between January 2011 and December 2014 (Kubota et al., 2018). The most frequent surgeries in our hospital are appendectomy, cholecystectomy, and herniorrhaphy. Their clinical paths for hospitalization range between 3 and 4 days. We rarely encounter delirium in short-term hospitalization patients. In one study of postoperative delirium, entry criteria included the expectation of a hospital stay of more than 48 hours after surgery (DeCrane et al., 2011). General hospitals in Japan typically hospitalize patients for 1–2 days before surgery (Kubota et al., 2018). Therefore, we considered 5 days or more as a sufficiently long period of hospitalization for the purposes of this study.

Clinical variables obtained from the medical records included age, gender, underlying disease, results of DST and CAM-ICU, observational factors recorded by nurses, length of hospital stay, and mortality. Factors observed and recorded by nurses subjectively included hypomotivation, somnolence, hallucinations, visual hallucinations, auditory hallucinations, disorientation, disturbance, insomnia, depression, and restlessness. A list of over 50 signs and symptoms were observed and recorded by nurses in an electronic medical chart. The nurses routinely observed the patients and recorded “yes or no” for each sign or symptom in the usual clinical settings. In this study, we selected 10 psychological problems among the list of items and analyzed the data electronically.

In this study, the definition of delirium onset was made when the score for either the DST or CAM-ICU was positive for delirium. Univariate analysis was performed to investigate the relationship between each factor observed and recorded by nurses subjectively and delirium as determined by either the DST or CAM-ICU. To select the final predictive factors and develop a scoring formula, a multivariate analysis was performed using all of the candidate observed factors in the univariate analysis. Scores for each corresponding factor were obtained based on the beta value from the final prediction model.

On the basis of these results, a screening tool for delirium (Subjective Delirium Screening Scale by Nurse: SDS-N) was constructed. We calculated the total SDS-N score for each patient and the sensitivities and specificities for each cutoff value of the SDS-N score. A receiver operating characteristic curve was then drawn, and the area under the curve (AUC) was obtained.

For internal validation, a bootstrapping technique with 1,000 iterations was used to simulate unbiased expected future performance. The internal validity of a predictive logistic regression model may best be estimated using bootstrapping analysis, which provides stable estimates with low bias (Ohde et al., 2010; Steyerberg et al., 2001). All analyses were performed using SPSS Version 22.0 (IBM, Inc., Armonk, NY, USA).

Results

Table 1 shows the background characteristics of the patients included in this study. Delirium was identified in 205 of the 2,168 patients (9.5%).

Table 2 shows the results of the univariate analysis of the relationship between delirium and factors observed subjectively and recorded by nurses. According to the results of the univariate analysis, logistic regression analysis was constructed, with all of the identified factors determined to be candidate predictors by the univariate analysis (Table 3). Disorientation, restlessness, somnolence, and hallucination were identified as statistically independent factors of delirium in the multivariate analysis. Disorientation was identified as the factor with the greatest effect, with an odds ratio of 9.632.

On the basis of these results, a simple and practical screening tool for delirium (SDS-N) with a total score of 5 points

| TABLE 1. Characteristics of Study Patients (N = 2,168) |
|--------------------------------------------------|
| Characteristic | n | % |
| Age (years; M and SD) | 65 | 15.4 |
| Range | 16–100 |
| Gender | |
| Male | 1,255 | 57.9 |
| Female | 913 | 42.1 |
| Underlying disease | |
| Gastrointestinal cancer | 860 | 39.7 |
| Other malignancy | 33 | 1.5 |
| Gastrointestinal disorder | 1,018 | 47.0 |
| Hernia | 154 | 7.1 |
| Others | 103 | 4.7 |
| Surgery | |
| Yes | 1,531 | 70.6 |
| No | 637 | 29.4 |
| Length of stay (M and SD) | 15.7 | 19.2 |
| Range | 5–412 |
| Outcome | |
| Improved | 2,076 | 95.8 |
| Died | 92 | 4.2 |
was constructed as follows: 2 points for disorientation and 1 point each for restlessness, somnolence, and hallucination, as shown below:

\[
[\text{SDS-N}] = [\text{Disorientation}]^2 + [\text{Restlessness}] + [\text{Somnolence}] + [\text{Hallucination}].
\]

We calculated the total SDS-N score for each patient and drew a receiver operating characteristic curve. Table 4 shows the sensitivities and specificities for each cutoff value of the SDS-N score when the cutoff values were changed from 1 to 5. The AUC of this novel screening tool was 81.9% (95% CI [77.9%, 85.8%]; Figure 1). On the basis of these results, the

![Receiver operating characteristic (ROC) curve for the Subjective Delirium Screening Scale by Nurse. AUC = area under the curve.](image)

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**TABLE 2.**

**Results of Univariate Analysis of the Relationship Between Delirium and Nurse-Observed Factors (N = 2,168)**

| Factor               | Delirium No (n = 1,963) | Delirium Yes (n = 205) |
|----------------------|------------------------|------------------------|
|                      | n          | %         | n           | %         | p      |
| Hypomotivation No    | 1,958      | 99.7      | 202         | 98.5      |        |
| Yes                  | 5          | 0.3       | 3           | 1.5       | .007   |
| Somnolence No        | 1,949      | 99.3      | 193         | 94.1      |        |
| Yes                  | 14         | 0.7       | 12          | 5.9       | <.001  |
| Hallucination No     | 1,941      | 98.9      | 131         | 63.9      |        |
| Yes                  | 22         | 1.1       | 74          | 36.1      | <.001  |
| Visual hallucination No | 1,962    | 99.9      | 199         | 97.1      |        |
| Yes                  | 1          | 0.1       | 6           | 2.9       | <.001  |
| Auditory hallucination No | 1,963   | 100.0     | 194         | 94.6      |        |
| Yes                  | 0          | 0        | 11          | 5.4       | <.001  |
| Disorientation No    | 1,900      | 96.8      | 83          | 40.5      |        |
| Yes                  | 63         | 3.2       | 122         | 59.5      | <.001  |
| Disturbance No       | 1,958      | 99.7      | 204         | 99.5      |        |
| Yes                  | 5          | 0.3       | 1           | 0.5       | .546   |
| Insomnia No          | 1,936      | 98.6      | 189         | 92.2      |        |
| Yes                  | 27         | 1.4       | 16          | 7.8       | <.001  |
| Depression No        | 1,959      | 98.8      | 204         | 99.5      |        |
| Yes                  | 4          | 0.2       | 1           | 0.5       | .420   |
| Restlessness No      | 1,897      | 96.6      | 91          | 44.4      |        |
| Yes                  | 66         | 3.4       | 114         | 55.6      | <.001  |

**TABLE 3.**

**Results of Logistic Regression Analysis of the Predictors of Delirium**

| Factor       | Adjusted Odds Ratio | 95% CI     | Score Point | p   |
|--------------|---------------------|------------|-------------|-----|
| Disorientation | 9.632         | [5.403, 17.171] | 2           | <.001 |
| Restlessness  | 4.336          | [2.386, 7.878]  | 1           | <.001 |
| Somnolence    | 3.605           | [1.130, 11.498] | 1           | .030  |
| Hallucination | 2.916           | [1.498, 5.678]  | 1           | .002  |

**TABLE 4.**

**Sensitivities and Specificities for Each SDS-N Score**

| SDS-N Score | Sensitivity (%) | Specificity (%) |
|-------------|-----------------|-----------------|
| 1           | 67.3            | 94.9            |
| 2           | 61.0            | 96.7            |
| 3           | 52.2            | 97.8            |
| 4           | 35.1            | 99.1            |
| 5           | 1.0             | 99.9            |

Note. SDS-N = Subjective Delirium Screening Scale by Nurse.
most appropriate cutoff value was determined as 2 (sensitivity: 61.0%; specificity: 96.7%).

We then conducted bootstrap cross-validation with 1,000 iterations for the SDS-N. Table 5 shows the originally observed beta coefficient and the bootstrapped validation beta coefficient. Scores assigned to each predictive factor were identical in both the original and bootstrapped results, which supports that this model is relatively robust.

### Discussion

We conducted this study to construct a chart-based DST to be administered to patients hospitalized for more than 5 days in surgical wards using clinical observations that are typically recorded by nurses subjectively. In the study group, delirium was screened and diagnosed using the CAM-ICU and DST. We then searched for key factors associated with delirium to create a chart-based tool: SDS-N. The SDS-N included four predictive factors for delirium screening: disorientation, restlessness, somnolence, and hallucination. The AUC showed good accuracy (AUC = 0.819, 95% CI [0.779, 0.858]). Delirium was diagnosed with a sensitivity of 61.0% and a specificity of 96.7% in comparisons with the DST and CAM-ICU. However, caution is still advised in applying the AUC, as subjective observational diagnoses often miss or fail to recognize the onset of delirium (Inouye, Foreman, Mion, Katz, & Cooney, 2001).

Some reviews have reported currently available assessment tools for delirium (Grover & Kate, 2012; van Meenen, van Meenen, de Rooij, & ter Riet, 2014). Our colleagues, Kobayashi et al., introduced the Chi-Square Automatic Interaction Detector Decision Tree Analysis Model, which is an easy-to-implement model for detecting the development of delirium in patients in medical wards (Kobayashi, Takahashi, Arioka, Koga, & Fukui, 2013). In addition, the NEECHAM Confusion Scale (Neelon, Champagne, Carlson, & Funk, 1996) and the Nursing Delirium Screening Scale (Gaudreau, Gagnon, Harel, Tremblay, & Roy, 2005) are based on nursing assessments similar to the SDS-N, with 80%–90% sensitivity and specificity. As these scales include specifically determined items and the recording of each item uses a scale, they are not suitable for use in research such as that conducted in this study. The Chart-based Delirium Identification Instrument was developed to identify delirium retrospectively from information that is typically included on medical charts (Inouye et al., 2005). However, this scale is overly complicated and difficult to apply in daily clinical settings and, although potentially helpful for determining delirium in individual patients, it may not be suited for screening large numbers of patients. The SDS-N developed in this study has an advantage over existing screening tools in that it is simple and practical because it includes only factors that are regularly observed subjectively and recorded by nurses. Furthermore, the SDS-N has shown adequate diagnostic accuracy.

Various interventions, including Multicomponent Interventions and Hospital Elder Life Program, have been proposed as strategies to prevent delirium in hospitalized patients (Inouye et al., 1999; Martinez et al., 2015). Several practice guidelines, for example, the National Institute for Health and Care Excellence guidelines, have encouraged the establishment of multicomponent interventions programs to prevent the incidence of delirium (National Institutes for Health and Care Excellence, 2010), which have subsequently been shown to be effective in reducing the incidence, duration, and severity of delirium and in decreasing healthcare costs.

A major limitation of this study is our exclusive focus on cognitive disturbances such as disorientation, restlessness, somnolence, and hallucination and exclusion of important symptoms such as acute onset and fluctuation in the new SDS-N tool. We are now conducting a prospective cohort study of delirium focused on dementia and cerebrovascular disease. In addition, diagnostic accuracy in this study was evaluated in comparison with the DST and CAM-ICU, which are also screening tools. Our newly developed tool should be evaluated in comparison with a standard diagnostic tool such as the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Another limitation of this study was its retrospective design. Replication of the results is needed using a study with a prospective design and external validation.

In conclusion, the SDS-N, a novel screening tool for delirium in patients hospitalized for more than 5 days in surgical wards, was created in this study using factors that are typically recorded by nurses subjectively in clinical settings. The developed tool is simple and practical and has adequate diagnostic accuracy.

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### Author Contributions

Study conception and design: KK, AS
Data collection: IF, AK
Data analysis and interpretation: SO

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**TABLE 5.** Bootstrap Validation of the Model and Comparison With the Original Model

| Factor       | Logistic Regression Beta Coefficient | Bootstrapped Beta Coefficient | 95% CI          |
|--------------|--------------------------------------|------------------------------|-----------------|
| Disorientation | 2.265                               | 2.278                        | [1.575, 2.997]  |
| Restlessness  | 1.467                               | 1.468                        | [0.687, 2.130]  |
| Somnolence    | 1.282                               | 1.280                        | [0.687, 2.130]  |
| Hallucination | 1.070                               | 1.093                        | [0.322, 1.875]  |
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Critical revision of the article: UY

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References

Chaput, A. J., & Bryson, G. L. (2012). Postoperative delirium: Risk factors and management: Continuing professional development. Canadian Journal of Anesthesia, 59(3), 304–320. https://doi.org/10.1007/s12630-011-9658-4

DeCrane, S. K., Sands, L., Ashland, M., Lim, E., Tsai, T. L., Paul, S., … Leung, J. M. (2011). Factors associated with recovery from early postoperative delirium. Journal of PeriAnesthesia, 26(4), 231–241. https://doi.org/10.1016/j.jopain.2011.03.001

Gaudreau, J. D., Gagnon, P., Harel, F., Tremblay, A., & Roy, M. A. (2005). Fast, systematic, and continuous delirium assessment in hospitalized patients: The nursing delirium screening scale. Journal of Pain and Symptom Management, 29(4), 368–375. https://doi.org/10.1016/j.jpainsymman.2004.07.009

Greer, N., Rossom, R., Anderson, P., MacDonald, R., Tacklind, J., Rutks, I., … Wilt, T. J. (2011). Delirium: Screening, prevention, and diagnosis—A systematic review of the evidence [Internet]. Washington, DC: U.S. Department of Veterans Affairs.

Grover, S., & Kate, N. (2012). Assessment scales for delirium: A review. World Journal of Psychiatry, 2(4), 58–70. https://doi.org/10.5498/wjp.v2.i4.58

Inouye, S. K., Bogardus, S. T. Jr., Charpentier, P. A., Leo-Summers, L., Acampora, D., Holford, T. R., … Cooney, L. M. Jr. (1999). A multicomponent intervention to prevent delirium in hospitalized older patients. New England Journal of Medicine, 340(9), 669–676. https://doi.org/10.1056/NEJM199903043400901

Inouye, S. K., Foreman, M. D., Mion, L. C., Katz, K. H., & Cooney, L. M. Jr. (2001). Nurses’ recognition of delirium and its symptoms: Comparison of nurse and researcher ratings. Archives of Internal Medicine, 161(20), 2467–2473. https://doi.org/10.1001/archinte.161.20.2467

Inouye, S. K., Leo-Summers, L., Zhang, Y., Bogardus, S. T. Jr., Leslie, D. L., & Agostini, J. V. (2005). A chart-based method for identification of delirium: Validation compared with interviewer ratings using the confusion assessment method. Journal of the American Geriatrics Society, 53(2), 312–318. https://doi.org/10.1111/j.1532-5415.2005.53120.x

Inouye, S. K., Westendorp, R. G., & Saczynski, J. S. (2014). Delirium in elderly people. Lancet, 383(9920), 911–922. https://doi.org/10.1016/S0140-6736(13)60688-1

Kobayashi, D., Takahashi, O., Ariohta, H., Koga, S., & Fukui, T. (2013). A prediction rule for the development of delirium among patients in medical wards: Chi-Square Automatic Interaction Detector (CHAID) decision tree analysis model. American Journal of Geriatric Psychiatry, 21(10), 957–962. https://doi.org/10.1016/j.jgp.2012.08.009

Kubota, K., Suzuki, A., Ohde, S., Yamada, U., Hosaka, T., Okuno, F., … Kishida, A. (2018). Age is the most significantly associated risk factor with the development of delirium in patients hospitalized for more than five days in surgical wards: Retrospective cohort study. Annals of Surgery, 267(5), 847–877. https://doi.org/10.1097/SLA.0000000000002347

Martinez, F., Tobar, C., & Hill, N. (2015). Preventing delirium: Should non-pharmacological, multicomponent interventions be used? A systematic review and meta-analysis of the literature. Age and Ageing, 44(2), 196–204. https://doi.org/10.1093/ageing/afu173

National Institute for Health and Care Excellence. (2010). Delirium: Diagnosis, prevention and management—Clinical guideline [CG103]. London, England: Author.

Neelon, V. J., Champagne, M. T., Carlson, J. R., & Funk, S. G. (1996). The NEECHAM Confusion Scale: Construction, validation, and clinical testing. Nursing Research, 45(6), 324–330.

Ohde, S., Hayashi, A., Takahasi, O., Yamakawa, S., Nakamura, M., Osawa, A., … Fukui, T. (2010). A 2-week prognostic prediction model for terminal cancer patients in a palliative care unit at a Japanese general hospital. Palliative Medicine, 25(2), 170–176. https://doi.org/10.1177/0269216310383741

O’Regan, N. A., Fitzgerald, J., Timmons, S., O’Connell, H., & Meagher, D. (2013). Delirium: A key challenge for perioperative care. International Journal of Surgery, 11(2), 136–144. https://doi.org/10.1016/j.ijsu.2012.12.015

Siddiqi, N., Harrison, J. K., Clegg, A., Teale, E. A., Young, J., Taylor, J., … Simpkins, S. A. (2016). Interventions for preventing delirium in hospitalised non-ICU patients. Cochrane Database of Systematic Reviews, 3, CD005563. https://doi.org/10.1002/14651858.CD005563.pub3

Steyerberg, E. W., Harrell, F. E. Jr., Borsboom, G. J., Eijkemans, M. J., Vergouwe, Y., & Habbema, J. D. (2001). Internal validation of predictive models: Efficiency of some procedures for logistic regression analysis. Journal of Clinical Epidemiology, 54(8), 774–781. https://doi.org/10.1016/S0895-4356(01)00341-9

van Meenen, L. C., van Meenen, D. M., de Rooij, S. E., & ter Riet, G. (2014). Risk prediction models for postoperative delirium: A systematic review and meta-analysis. Journal of the American Geriatrics Society, 62(12), 2383–2390. https://doi.org/10.1111/jgs.13138

Zhang, H., Lu, Y., Liu, M., Zou, Z., Wang, L., Xu, F. Y., … Shi, X. Y. (2013). Strategies for prevention of postoperative delirium: A systematic review and meta-analysis of randomized trials. Critical Care, 17(2), R47. https://doi.org/10.1186/cc12566