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Validation of a medical record-based delirium risk assessment

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Abstract

Objectives—To improve identification of patients at high risk for delirium, this study developed a chart abstraction tool for delirium risk and validated the tool against clinical expert diagnosis of delirium

Design—Prospective Cohort Study

Setting—Tertiary VA Hospital in New England

Participants—100 Veterans admitted to the medical service

Measurements—While admitted, each participant underwent serial assessments for delirium by a clinical expert. Using the four criteria of a validated delirium prediction rule (e.g. cognitive impairment, sensory deficit, severe illness, and dehydration), chart review terms were selected for each criteria and delirium risk was the sum of criteria present (range 0–4; 4-worst). After discharge, the chart tool was completed by a nurse blinded to the expert's diagnosis.

Results—The participants (n=100) were largely older (mean age 81 ±7years) men (94% male) and 23% developed overall delirium (14% incident). The rate of overall delirium in participants with 0, 1–2, and 3–4 risk factors was 11%, 18%, and 50% (p=.01) respectively with a c-statistic of 0.65 (95% Confidence Interval 0.54, 0.76). For incident delirium, the rate was 11%, 13%, and 25% (p=.53) and the c-statistic of 0.56 (95%CI 0.42, 0.74). Discharge to a rehabilitation center or nursing home increased with increasing delirium risk (0%, 18%, 60%, p=.02).

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Study Concept and Design: Rudolph, Harrington, Chester, Lucatorto, and VA Delirium Working Group;
Acquisition of Data: Chester, Harrington, and Rudolph;
Analysis and interpretation of data: Rudolph, Chester, Harrington, Shay, and Lucatorto;
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Critical Revision of the Manuscript: Rudolph, Chester, Harrington, Shay, Francis, VA Delirium Working Group
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Conclusions—A chart abstraction tool was effective at identifying overall delirium risk, but not incident delirium risk. While the tool cannot replace clinical assessment and diagnosis of delirium, the use of this tool as an educational, clinical, or quality measurement aid warrants additional study.

Keywords

Delirium; risk; hospitalization; quality measurement

Introduction

Despite the morbidity, mortality, and cost of delirium[1], many cases are frequently unrecognized with published reports of 33–66% of cases missed by physicians[2, 3] and 69% of cases missed by nurses[4]. While there has been substantial progress on the understanding and prevention of delirium, translating progress into clinical practice has been slow.

In most published work on delirium, the groups targeted for study or intervention have been in populations at intermediate and high-risk for delirium. The method used to identify intermediate and high delirium risk groups in studies has included event (hip fracture)[5, 6], procedure (surgery)[7], location (ICU)[8], or a validated prediction rule for delirium risk.[9] Prediction rules can improve our understanding of who is at greater likelihood for developing delirium, but the perception that their use is complex or time consuming, especially if cognitive screening is required, may discourage their application. As a result, the validated prediction rules for delirium in medical patients[10], non-cardiac surgery[11], and cardiac surgery[12] are infrequently used clinically.

To improve the clinical utility of delirium prediction rules, we developed a chart abstraction tool to define delirium risk based on information commonly available in the medical record within the first 24 hours of admission. The Inouye prediction rule for medical patients is based on four independent components of delirium risk: cognitive impairment, severe illness, sensory loss, and dehydration.[10] Using this framework, the tool was designed with specific terms and chart locations for abstraction. The advantages of such a tool are threefold: a) it will reduce the amount of time required to complete the prediction rule or if an electronic medical record is present, it could possibly be completed automatically; b) it will focus a clinician's attention on the information previously identified to be independent risk factors for delirium; and c) it could be used as a systemic performance measure of delirium identification.

The purpose of this study was to determine if a chart review tool for delirium risk predicted delirium, as diagnosed clinically. We hypothesized that participants with increasing delirium risk based on the chart review tool would be more likely to develop delirium. As a secondary aim, we sought to compare the discharge location and length of stay of the patients with increasing number of delirium risk factors.

Methods

Assembly of the Sample

One hundred patients, over age 65 years, admitted to the medical service of the VA Boston Healthcare System were recruited for the sample. On the day after admission, patients were approached about participation and provided written informed consent. Patients were excluded if they came to the medical ward from a nursing home, rehabilitation center, intensive care unit, or other hospital, if they were expected to leave the hospital within one day, or if they had an impairment that would prevent their ability to complete the informed consent and cognitive screening tests. Of the 225 patients approached, 64 patients refused participation, 42 were leaving that day, 19 had impairments that prevented participation. One hundred patients provided written informed consent. After informed consent, demographic information was obtained from the patients and the Mini-Mental State Examination was performed. The Mini-Mental State Examination is a screening measure of cognitive function (scored 0–30; lower scores indicate worse performance).[13] From the patient and medical record, information necessary to complete the Charlson Comorbidity Index, a ranked list of comorbidities associated with hospital mortality, was completed.[14]

Delirium Assessment

Upon enrollment and daily thereafter, a geriatrician performed a comprehensive mental status interview (approximately 30–45 minutes) including assessments of attention, executive function, memory, and mood, as well as a review of medical records. Delirium was diagnosed according to DSM-IV criteria[15] by a geriatrician with clinical experience in delirium diagnosis. Overall delirium was defined as the presence of delirium on any hospital day. Incident delirium was determined by excluding those who had delirium upon initial assessment (prevalent delirium). Prior work has identified standardized clinical assessment as having high inter-rater reliability for delirium.[16–18]

Chart Abstraction Tool

The Inouye prediction rule has 4 components (1 point each): cognitive impairment, sensory deficits, severe illness, and blood urea nitrogen to creatinine ratio (BUN/Cr) and delirium risk is determined by the sum of points.[10] In the Inouye study, delirium was reported in 3–9% of subjects with 0 risk factors;, 16–23% of those with 1–2 risk factors, and 32–83% of those with ≥3 risk factors.[10] With the subject expertise of the VA Delirium Working Group (VADWG), an interdisciplinary group of healthcare professionals interested in delirium, terms to satisfy the components of the Inouye prediction rule were proposed. The group then specified the location in the medical record from which this could be abstracted. The group focused on the chart information collected within the first 24 hours of admission, because this period is critical to identify and manage delirium risk. After the VADWG developed the instrument, the VA Office of Quality and Performance translated the instrument into a chart review and scoring algorithm suitable for use by trained chart abstractors. The instrument is included in the appendix.

Cognitive impairment—For the cognitive impairment component, appropriate terms were related to cognitive impairment and existing delirium. Cognitive impairment terms

included: memory loss, dementia, Alzheimer's Disease, poor historian, disoriented, and uncooperative. Terms related to acute mental status change included: change in mental status, altered mental status, confused, encephalopathic, lethargic, obtunded, stuporous, combative, and unarousable. This information was taken from the history and physical. If one or more of the terms was present, then the cognitive impairment component was scored as present.

Sensory impairment—The presence of vision or hearing deficit was abstracted from the admission history and physical, the problem list, and the nursing admission assessment, which are separate sections of the medical record. The included hearing terms were hearing impairment, hard of hearing, wears hearing aids, and presbycussis. The vision terms were blindness, visual loss, and wears glasses. In the presence of either a hearing or vision deficit, the sensory impairment criterion was scored as present.

Severe illness—The Inouye prediction rule utilized the Acute Physiology, Age, and Chronic Health Evaluation (APACHE) tool as a measure of illness severity.[19, 20] The VADWG determined that the abstraction of the full APACHE tool was too time consuming for an effective chart review tool. However, the use of the APACHE threshold in the Inouye prediction rule allowed the creation of a crude measure of illness severity by identifying high value components within the APACHE algorithm.[19, 20] Particularly beneficial was the fact that nearly half of the necessary APACHE points are given for patient age of 60 years and older.[20] Thus, in addition to age, only one of the subsequent terms was necessary to score the severe illness criterion as present.

Dehydration—The blood urea nitrogen (BUN) and creatinine (Cr) levels were obtained from the inpatient laboratory values that were reported in the chart closest to date and time of admission. In general, these labs were done in the emergency room or upon floor admission for most patients. The BUN/Cr ratio, a marker of dehydration, was calculated and the BUN/Cr criterion scored as present if the BUN/Cr ratio was ≥18.[10]

Chart Abstraction—After the participant was discharged, a nurse reviewed the charts of the enrolled patients using the chart abstraction tool The nurse was blinded to delirium status.. The nurse looked for the information only in the predetermined locations of the electronic medical record and only counted criteria if included in the first 24 hours after admission. If the term(s) could not be found in the predetermined chart location, it was presumed to be negative (zero imputation). Only admission values were used; values that changed over the course of a hospital stay were not included in the delirium risk assessment. The nurse also recorded the length of stay and location of discharge for each participant. To measure the average time of a chart review, we recorded the abstraction time on a sample (n=15) of chart reviews.

Statistics

For the primary outcome, the number of criteria were summed and compared to the prevalence of delirium. Consistent with the Inouye prediction rule[10], zero criteria was regarded as low risk; intermediate risk was defined as having one or two criteria; and high

risk was defined as the presence of three or four criteria. Using a chi-square test, we compared the overall and incident delirium rates to the low, intermediate, and high delirium risk. A c-statistic was calculated for the risk groups relative to incident and overall delirium.

For the analysis of discharge location, we created a categorical variable of discharge to the pre-hospitalization residence (home), discharge to a rehabilitation center, and discharge to a nursing home. Participants who were discharged home with hospice were considered discharged home. A chi-square test was used to compare delirium risk factors and discharge location. ANOVA was utilized to compare length of stay with delirium risk level. Post hoc analysis used a Bonferroni correction to compare length of stay between individual risk factor levels. All analyses were conducted with STATA v11.0 (Stata, Inc. College Station, TX)

Results

The cohort consisted of older patients (mean age 81 ±7 years) who were largely white (90%) and male (94%). Table 1 describes the characteristics of the population. On admission, the mean Mini Mental State Examination score was (24.6 ±4) and there was high comorbidity (3.9 ±2.4), as measured by the Charlson Comorbidity Index. The chart abstraction took on average 2 minutes 19 seconds (±41 seconds). Overall delirium developed in 23% (n=23) of the cohort and incident delirium occurred in 14% (n=13) after excluding those with prevalent delirium (n=10). Table 2 describes the prediction rule components, the corresponding terms, location of the search, and terms used. The prediction rule criteria were scored as present for sensory deficits (59%) and dehydration (62%) at a higher rate than for cognitive impairment (23%) and severe illness (29%). Patients identified as cognitively impaired through chart abstraction had lower MMSE (21.6 ±4.8 vs. 25.4 ±3.3, p<.001) relative to those without and those with chart identified severe illness had higher Charlson comorbidity index scores (4.6 ±2.1 vs. 3.6 ±2.4, p=.05) relative to those without.

Table 3 presents the overall delirium rate with increasing delirium risk factors. Consistent with the Inouye prediction rule, the delirium rate at 1 and 2 risk factors was similar (18% and 17%, respectively), justifying the collapse of these into a single “intermediate risk” group. The increasing overall delirium rate with increasing risk factors was found to be statistically significant (χ^2=9.2, df=2, p=.01). The C-statistic for the prediction rule was 0.65 (95% Confidence Interval 0.54, 0.76). Excluding the 10 participants with delirium upon initial assessment, the incident delirium rate increased with increasing risk factors, but not significantly (χ^2=1.3, df=2, p=.53; c-statistic 0.56, 95% CI 0.42, 0.74)

The discharge location associated with increasing delirium risk factors is described in Table 4. Participants with increasing delirium risk factors were significantly less likely to return home and consequently more likely to be discharged to a rehabilitation center or nursing home (χ^2=19.2, df=4, p=.001). Additionally, participant length of stay increased with increasing delirium risk (F=7.7, df=2, p<.001), particularly in those patients with high delirium risk. Lengths of stay in the high and intermediate delirium risk groups were significantly different even after correction for multiple comparisons using the Bonferroni adjustment (p=.001). There was no difference in length of stay between low and

intermediate risk groups (p=0.99). There was a trend toward a length of stay difference between high and low risk groups (p=.09).

Discussion

This study evaluated a chart abstraction tool designed to assess delirium risk and validated the tool in older medical inpatients. We found that an increase in the number of delirium risk factors, measured with the abstraction tool, was associated with increasing rate of overall delirium, but not incident delirium. Additionally, increased delirium risk factors were associated with increased discharge to rehabilitation centers and nursing homes, as well as increased length of stay. The implications of a chart abstraction tool for delirium risk opens up several avenues for expansion into educational, research, intervention, and quality measurement domains.

The abstraction tool is a measure of delirium risk, but not actual delirium, which remains a clinical diagnosis. Consistent with this, a chart abstraction tool will never be as good as the in-person assessment of delirium risk factors such as cognition, vision, and hearing. In this study, this is highlighted by the reduced performance of the chart review tool for incident delirium, which occurred outside of the chart abstraction window. Risk prediction should not replace clinical surveillance and assessment for delirium, but can alert healthcare providers to the need for additional clinical assessments and potential interventions for high-risk patients.

Hospital-associated complications are a major contributor to high costs and poor outcomes, and delirium is among the most common complications among hospitalized elders.[1] Recognition of elevated delirium risk is important, since there is compelling evidence from prior studies that multi-faceted interventions specifically targeted at high-risk older patients in the hospital can reduce the incidence of delirium and prevent other forms of functional decline. [5, 9] Programs such as the Hospital Elder Life Program and Geriatric Fracture Centers have improved patient outcomes, retained function, and lowered costs.[21–24] A chart abstraction tool used at the time of admission could assist in the identification of high-risk patients for inclusion in these programs. Additionally, these systems could be used to alert clinicians, as well as, to automatically trigger more intensive evidence-based case management strategies. Ultimately, with risk factors assessed as structured data elements within an electronic health record, this delirium risk assessment could be automated, setting the stage for real-time electronic decision support system for providers and nurses. Once such a system was developed and validated, the heightened delirium surveillance could be used to monitor the targeting of delirium prevention measures to intermediate and high-risk patients.

Systemic interventions to recognize delirium risk and initiate prevention strategies have proven cost-effective[21–24], yet their implementation requires local clinical champions and motivated and educated senior leadership.[25] Quality indicators can be a highly effective tool for educating and motivating clinical leadership.[26] Consistent with this, the Assessing Care of Vulnerable Elders project has identified delirium risk assessment and subsequent clinical assessment as the quality indicator for delirium.[27] By validating the chart abstraction tool

against the accepted reference standard (clinical diagnosis), this study has laid the groundwork for the operationalization of a delirium quality measure based on chart review.

This study has strengths that deserve mention. First, the diagnosis of delirium by a delirium expert according to the DSM-IV diagnostic criteria is the reference standard. Second, developing a tool based on an existing delirium prediction rule provided face validity in that the prediction rule terms have been validated elsewhere. This study benefited from the electronic medical record of the VA system which has been in place for over 10 years and includes standardized admission assessments of many areas identified. Further validation of the chart abstraction method of delirium risk in other medical records and systems is required prior to widespread use. Finally, the chart abstractor was blinded to the clinical expert's diagnosis of delirium, affirming the internal validity of the abstraction tool.

The major limitation of this study is the small sample size. While similar to the validation arms of other prediction rule studies[10, 12], increasing the sample size would provide a more statistically stable measure of delirium risk. Because of this limitation, there is need for additional validation in studies with more diverse patients (i.e. age, gender, ethnicity), different medical record systems, and different hospital systems. Additionally, validation against clinically administered delirium prediction rules would provide a better measure of the accuracy of the chart derived prediction rule, including estimates of the risk factor prevalence and with larger sample sizes, the differentiation of a low delirium risk group. These validation studies need completion prior to widespread use of the chart-abstraction method of calculating delirium risk.

This study is also limited by the generalizability of the population. We recruited participants, mostly older, white men, at a single site. Validation in more diverse patient populations and in other hospitals and health systems is warranted. Additionally, this study required informed consent and thus, the participants had to possess a baseline level of cognitive functioning. Thus, the overall delirium rate of the study population may have been lower than expected in a general age- and gender-matched cohort. However, the group analyzed for incident delirium was older with low MMSE scores[28], so our incident delirium may be higher than expected. Further measurement in low and high delirium risk populations would improve understanding. Importantly, this abstraction tool provides an estimate of delirium risk and cannot replace in person delirium evaluation and diagnosis by a qualified provider.

Because delirium is common in older patients and is associated with increased morbidity and mortality, past work has advocated for delirium assessment on all hospitalized older patients. Yet, efforts to encourage broader assessment have not been successful. In this study, we developed a chart abstraction tool using the framework of a validated delirium prediction rule and then, validated the abstraction tool against clinically diagnosed delirium as assessed by an expert clinician. The validation of this abstraction tool enables retrospective demonstration of the prevalence of unrecognized delirium risk and ultimately, support for educational and clinical interventions to improve identification, prevention, and assessment of delirium. Additionally, methods to assess the quality of care for patients with intermediate and high delirium risk can be developed, tested, and compared to improve the outcomes of older hospitalized patients.

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Table 1

Characteristics of the Population

Characteristic	Value n=100
Age, years (SD)	80.8 (7.4)
Male Sex, n (%)	94 (94%)
White race, n (%)	90 (90%)
Charlson Comorbidity Index, mean (SD)	3.9 (2.4)
Mini Mental State Examination, mean (SD)	24.6 (4.0)
Delirium Risk Factors, n (%)	
Cognitive impairment	23 (23%)
Sensory impairment	59 (59%)
Severe Illness	29 (29%)
BUN/Cr ratio ≥ 18	62 (62%)

BUN/Cr – Blood Urea Nitrogen/Creatinine; SD – standard deviation

Table 2

Performance of the Delirium Chart Abstraction Prediction Rule

Delirium Risk	Risk Factors	Any Delirium ** n/N (%)	Incident Delirium† n/N (%)
Low	0	1/9 (11%)	1/9 (11%)
Intermediate	1–2 *	13/73 (18%)	9/69 (13%)
High	3–4	9/18 (50%)	3/12 (25%)

* One and two risk factors were combined because the delirium rate was similar in overall delirium (17–18%) and incident delirium (12–13%)

** Chi-square = 9.2 (df=2), p=.01

† Chi-square = 1.3 (df=2), p=.53

Table 3

Delirium Risk Factors, Discharge Location, and Length of Stay*

		Discharge Location n (%)†			Length of Stay Days (SD) ‡
Delirium Risk	**Risk Factors (#)**	**Prehospital Residence**	**Rehabilitation**	**Nursing Home**	
Low	0	9 (100%)	0 (0%)	0 (0%)	6.1 (8.1)
Intermed	1–2	57 (81%)	12 (17%)	1 (1%)	5.2 (4.0)
High	3–4	6 (40%)	6 (40%)	3 (20%)	10.6 (6.0)

*Six patients are not included in the total because of transfer to another hospital (n=4) and death (n=2).

†A Chi-square test found a significant association with risk factors and discharge location (χ^2=19.2, df=4, p=.001).

‡Using ANOVA, there was a significant differences between delirium risk groups (F=7.7, df=2, p<.001)

Appendix

Delirium Prediction Rule: chart abstraction tool terms and location

Risk Factor	*Abstraction Terms*	Abstraction Location(s)
Cognitive Impairment		
Scoring: Positive if one of these terms is present	Dementia	H&P-HPI; H&P-PMH; PL
	Alzheimer's Disease	H&P-HPI; H&P-PMH; PL
	Poor Historian	H&P-HPI; H&P-PMH; H&P-PE; NIA
	Memory loss	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Unarousable	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Uncooperative	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Demented	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Delirium	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Change in Mental Status	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Confused	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Encephalopathic	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Disoriented	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Lethargic	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Obtunded	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Stuporous	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Combative	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
	Altered Mental Status	H&P-CC; H&P-HPI; H&P-PMH; H&P-PE; NIA
Sensory Impairment		
Scoring: Positive if one of these terms is present	Visual Loss	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Blindness	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Wears glasses	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Hearing impairment	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Hard of hearing	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Wears hearing aids	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
	Presbycussis	H&P-HPI; H&P-PMH; H&P-PE; NIA; PL
Dehydration		
Scoring: Positive if BUN/Cr ≥ 18	Blood Urea Nitrogen	Adm-LV; H&P-LV
	Creatinine	Adm-LV; H&P-LV
Severe illness		
Scoring: Positive if 2 of these terms	Age >60	Adm – cover sheet; H&P-HPI; NIA
	Metastatic Cancer	H&P-HPI; H&P-PMH; PL
	Lymphoma	H&P-HPI; H&P-PMH; PL
	Leukemia	H&P-HPI; H&P-PMH; PL
	AIDS	H&P-HPI; H&P-PMH; PL
	RR >25/min	H&P-PE; Adm - VS
	Systolic blood pressure <100 mmHg	H&P-PE; Adm - VS
	Pulse >120/min	H&P-PE; Adm - VS
	Creatinine >2.0 mg/dL	Adm-LV; H&P-LV

Risk Factor	*Abstraction Terms*	Abstraction Location(s)
	Albumin <2.5 g/dL	Adm-LV; H&P-LV
	Total Bilirubin >2.9 mg/dL	Adm-LV; H&P-LV

Adm – admission; BUN – blood urea nitrogen; CC – chief complaint; Cr – creatinine; H&P – history and physical; HPI – history of present illness; LV – laboratory values; NIA – nursing intake assessment; PMH – Past Medical History; PE – physical exam; PL – Problem List; VS – vital signs