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Validation of a Consensus Method for Identifying Delirium from Hospital Records

Elvira Kuhn¹, Xinyi Du², Keith McGrath¹, Sarah Coveney¹, Niamh O'Regan¹, Sarah Richardson³, Andrew Teodorczuk³, Louise Allan³, Dan Wilson⁴, Sharon K. Inouye⁵, Alasdair M. J. MacLullich⁶,⁷, David Meagher⁸, Carol Brayne⁹, Suzanne Timmons¹, Daniel Davis⁶,⁹,¹⁰,

¹ Centre for Gerontology and Rehabilitation, School of Medicine, St. Finbarr’s Hospital, Cork, Ireland, ² School of Medicine, University of Cambridge, Cambridge, United Kingdom, ³ Institute of Neuroscience, Newcastle University, Newcastle, United Kingdom, ⁴ Department of Clinical Gerontology, Kings College Hospital NHS Foundation Trust, London, United Kingdom, ⁵ Aging Brain Center, Institute for Aging Research, Hebrew SeniorLife, and Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, United States of America, ⁶ Centre for Cognitive Ageing and Cognitive Epidemiology, University of Edinburgh, Edinburgh, United Kingdom, ⁷ Edinburgh Delirium Research Group, University of Edinburgh, Edinburgh, United Kingdom, ⁸ Department of Psychiatry, University of Limerick, Limerick, Ireland, ⁹ Department of Public Health and Primary Care, University of Cambridge, Cambridge, United Kingdom, ¹⁰ MRC Unit for Lifelong Health and Ageing, University College London, London, United Kingdom

Abstract

Background: Delirium is increasingly considered to be an important determinant of trajectories of cognitive decline. Therefore, analyses of existing cohort studies measuring cognitive outcomes could benefit from methods to ascertain a retrospective delirium diagnosis. This study aimed to develop and validate such a method for delirium detection using routine medical records in UK and Ireland.

Methods: A point prevalence study of delirium provided the reference-standard ratings for delirium diagnosis. Blinded to study results, clinical vignettes were compiled from participants’ medical records in a standardised manner, describing any relevant delirium symptoms recorded in the whole case record for the period leading up to case-ascertainment. An expert panel rated each vignette as unlikely, possible, or probable delirium and disagreements were resolved by consensus.

Results: From 95 case records, 424 vignettes were abstracted by 5 trained clinicians. There were 29 delirium cases according to the reference standard. Median age of subjects was 76.6 years (interquartile range 54.6 to 82.5). Against the original study DSM-IV diagnosis, the chart abstraction method gave a positive likelihood ratio (LR) of 7.8 (95% CI 5.7–12.0) and the negative LR of 0.45 (95% CI 0.40–0.47) for probable delirium (sensitivity 0.58 (95% CI 0.53–0.62); specificity 0.93 (95% CI 0.90–0.95); AUC 0.86 (95% CI 0.82–0.89)). The method diagnosed possible delirium with positive LR 3.5 (95% CI 2.9–4.3) and negative LR 0.15 (95% CI 0.11–0.21) (sensitivity 0.89 (95% CI 0.85–0.91); specificity 0.75 (95% CI 0.71–0.79); AUC 0.86 (95% CI 0.80–0.89)).

Conclusions: This chart abstraction method can retrospectively diagnose delirium in hospitalised patients with good accuracy. This has potential for retrospectively identifying delirium in cohort studies where routine medical records are available. This example of record linkage between hospitalisations and epidemiological data may lead to further insights into the inter-relationship between acute illness, as an exposure, for a range of chronic health outcomes.

Introduction

Delirium is a severe, acute neuropsychiatric syndrome which affects at least 1 in 8 hospital inpatients [1]. It is associated with multiple adverse outcomes, including increased risk of complications, longer length of stay, mortality, and high levels of personal and family distress [2–4]. Delirium is also associated with enormous healthcare costs, with UK analyses estimating an extra £13,200 per hospital admission [5]. It is characterised by an acute and fluctuating impairment of cognition and attention precipitated by medical illness. It mainly affects older adults, especially those with pre-existing cognitive impairment and other comorbidities.

It is well recognised that delirium during hospitalisation is associated with poor cognitive outcomes [2]. Indeed, because delirium is partly preventable [6,7], delirium interventions might even prevent dementia [8,9]. However, around half of dementia...
Methods

between delirium and any subsequent cognitive impairment. The prospectiv
uncertainty about an individual's premorbid cognitive function. DSM-IV
diagnosis of delirium (reference standard) applied as part of a 
vignette; (ii) an expert panel assigning diagnoses by consensus (DSM-IV) 
criteria for delirium [19] to produce a short clinical vignette; (iii) 
Statistical Manual of Mental Disorders (Fourth Edition) employed: (i) 
abstracting symptoms relevant to the Diagnostic and Statistical Manual of 
Mental Disorders (Fourth Edition) of delirium [13]. Despite this, a chart-based 
method for retrospectively identifying delirium has been validated against 
trained interviewers using the Confusion Assessment Method (CAM) as a 
reference standard [14,15]. This instrument has been innovative in 
identifying incident delirium in community-based persons with dementia 
being followed up with regular cognitive assessments, showing an 
association with more rapid trajectories of decline [16,17]. This tool was 
developed in the US healthcare system and there are differences in how 
medical records are kept in the UK and Ireland. Hence there may be a need 
for a complementary approach for use outside the USA.

The aim of the present study is to develop and validate a 
retrospective measure of delirium based on routine medical records 
used in the general hospital setting in the UK and Ireland. From the 
medical records of participants in an independent study of delirium 
prevalence [18], two separate processes were employed: (i) 
abstraction of symptoms relevant to the Diagnostic and 
Statistical Manual of Mental Disorders (Fourth Edition) 
(DSM-IV) criteria for delirium [19] to produce a short clinical 
vignette; (ii) an expert panel assigning diagnoses by consensus 
(index test). These diagnoses could then be validated against the 
DSM-IV diagnosis of delirium (reference standard) applied as part of 
the delirium prevalence study.

Methods

The protocol followed the STAndards for the Reporting of 
Diagnostic accuracy studies (STARD) guidelines [20].

Delirium reference standard

The reference standard for delirium was based on direct clinical 
assessment in the Cork Delirium Point Prevalence Study [18]. In 
this study, the entire adult inpatient population of a general 
hospital (excluding ICU and moribund patients) was examined for 
delirium over a single day. Assessments were performed in two 
stages. Firstly, participants were screened for inattention using the 
spatial span forwards (where participants are asked to remember 
the sequence of coloured dots presented on a card) and months 
backwards. Participants were additionally screened for subjective 
confusion by asking: “Have you felt muddled in your thinking, or 
fuddled, since you came into hospital?” Further information was 
derived from nurse informants and hospital records. Those 
screening positive on any of these components, and a random 
sample of screen negative participants, were assessed in more 
detail. The second stage consisted of two independent delirium 
asessments: the CAM [15] and the Delirium Rating Scale – 
Revised-98 (DRS-R98) [21]. These were conducted by trained 
registrars or consultants in geriatric medicine and experienced 
psychiatrists. The final diagnosis of delirium was based on DSM-
IV criteria, applied by consensus using all available psychometric, 
clinical and informant data. Accordingly, all persons in the 
prevalence study were thus assigned a diagnosis of ‘delirium’ or ‘no 
delirium’ for a specific day.

Dementia status

Evidence for pre-existing cognitive impairment or dementia 
ed (e.g. diagnosis made at a memory clinic) was sought through 
examination of the medical notes. If this was not apparent, 
premorbid cognition was assessed using the short form of the 
Informant Questionnaire on Cognitive Decline in the Elderly 
(IQCODE) [22]. This was done for all participants with delirium 
(n = 55) as well as a random subsample of those aged ≥65 years 
without delirium (n = 40).

Chart abstraction technique

A random selection of case notes was identified using the 
RAND() function in Excel. The sample was designed to maintain the 
underlying prevalence of delirium (that is, 20% of the 
identified hospital records were delirium cases). The case notes 
were then requested from the medical records department on a 
convenience basis, in batches.

All relevant clinical documentation was scanned for keywords 
(Table 1) and used for abstraction. This included all entries by 
medical, nursing, therapy and social work staff from the date of 
admission, up until the date of the point-prevalence study (15/05/ 
2010). If the inpatient stay had been longer than two weeks, only 
clinical information from the two weeks leading up to the index 
date was used. This included verbatim reports from the entirety of 
the medical, nursing and allied health professional records.

Evidence for each criterion of the DSM-IV classification was 
sought, along with specific synonyms or clinically recorded 
parameters (Table 1). For example, evidence for Criterion A 
(disturbance of consciousness) might include references to agitation, 
drowsiness, or any formal rating of arousal (e.g. Alert-Voice-
Pain-Unresponsive). All verbatim comments, e.g. “drowsy”, “agitated”, were recorded for each Criterion A-D, resulting in 
a clinical vignette (see Supporting Information: File S1 for typical 
examples, fictionalised for confidentiality). The Charlson co-
morbidities index [23], metabolic and physiological parameters 
were recorded closest to the date the reference standard was 
assessed.

Abstractors were specialist trainees in geriatric medicine, that is, 
qualified physicians undergoing postgraduate training in geriatric 
medicine. Each received a half-day training session and the first 
five abstractions were performed together. Time taken to produce a 
vignette was not formally recorded, but could take between 5 
and 30 minutes, depending on the complexity of the inpatient 
episode. Case notes were abstracted multiple times to assess the 
influence of abstracting author on the consensus process. The 
inter-rater reliability was therefore tested by separately submitting 
each vignette to the consensus panel and then assessing if vignette 
abstractor was associated with changes in final diagnostic outcome.

Consensus diagnosis

The consensus diagnosis process was the basis of the index 
test. The consensus panel comprised three geriatricians and an old age 
psychiatrist, all of whom provide specialist clinical services for 
delirium patients (LA, AT, DW, AMacL). Assessors only had 
access to the abstracted vignettes, and rated each independently as 
unlikely, possible or probable delirium. Assessors were asked to use 
each criterion from the DSM-IV classification to support their 
assigned diagnoses. Cases where the initial diagnoses were not
Results

Ethical procedures

All analyses were conducted in Stata, version 12.1 (Stata Corps, Texas, USA). Sensitivities, specificities, positive and negative likelihood ratios were calculated from 2 x 2 tables, with confidence intervals testing significance at 95%. ROC curves were derived from estimates of sensitivity and specificity. For each individual with multiple vignettes (one vignette per abstractor), Fisher’s exact test was used to assess if differences in the initially-assigned diagnostic categories varied according to abstractor.

Statistical methods

Table 3 gives the diagnostic test accuracy of the individual expert raters. Using a cut-point for ‘possible delirium’, ratings performed by experts individually (prior to consensus panel meeting) demonstrated sensitivity of 0.84 and specificity of 0.77. At a higher threshold for ‘probable delirium’, sensitivity was 0.63 and specificity 0.92 (AUC 0.84, 95% confidence interval (CI) 0.80 to 0.89). Furthermore, the individual DSM-IV criteria performed less well than the panel’s overall impression (Table 3). Insofar as these could be evidenced in the clinical record, the order of test accuracy for each criterion (highest to lowest) was: change in cognition (B), demonstration of an acute change (C), documentation of inattention (A), physiological precipitant (D).

A consensus diagnosis was applied, there was a small improvement in diagnostic test accuracy. Vignette abstractor was not significantly associated with the eventual consensus diagnosis. For ‘possible delirium’, sensitivity was 0.88 and specificity 0.75; ‘probable delirium’ showed sensitivity 0.58 and specificity 0.93 (AUC 0.86, 95% CI 0.77 to 0.87). In the 31 persons with delirium prevalence of 31%, the post-test probability of having ‘probable delirium’ given a positive chart identification is 82% (95% CI 73% to 89%).

In this sample, delirium was present in 50% of the participants aged ≥70 years. With LR+= 5.3 and LR− = 0.5, the post-test probability for ‘probable delirium’ increased to 84% (95% CI 74% to 92%). Therefore, depending on the setting, the chart based abstraction method had a moderate impact on decision making.

Table 3 also shows that sensitivity for ‘possible delirium’ remains high (0.88) in the subgroup of persons aged ≥70 years (n = 57) (AUC 0.82, 95% CI 0.77 to 0.87). In the 31 persons with prior cognitive impairment identified by previously documented dementia or by IQCODE score (≥3.5), sensitivity for ‘possible delirium’ and ‘probable delirium’ was 0.88 and 0.71 respectively. Specificity in this group was 0.57 for both ‘possible delirium’ and ‘probable delirium’ (AUC 0.69, 95% CI 0.44 to 0.94).

Ten cases (11%) were retrieved for which no usable vignette could be abstracted, due to insufficient clinical records in the period leading up to the day of the point prevalence study. Whether a vignette could yield sufficient information was decided by consensus.
Discussion

Here we present a new method for retrospectively ascertaining delirium from health care records, extending the original work in the US setting (see below) [14]. We found that diagnoses assigned by consensus panel based on abstracted clinical vignettes (index test) was sensitive to ‘possible delirium’ and more specific to ‘probable delirium’ when compared to DSM-IV diagnoses applied.

Figure 1. STARD flow diagram showing the numbers receiving the index test and reference standard. TP true positive; TN true negative; FP false positive; FN false negative.

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Table 2. Characteristics of participants, by delirium status.

<table>
<thead>
<tr>
<th></th>
<th>DSM delirium (n = 29)</th>
<th>No DSM delirium (n = 66)</th>
<th>P value*</th>
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<tr>
<td>Age</td>
<td>80.6 (74.9–88.6)</td>
<td>68.2 (53.5–80.2)</td>
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<tr>
<td>Sex</td>
<td>14 (50%)</td>
<td>33 (50%)</td>
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<td>Dementia</td>
<td>6/9</td>
<td>3/22</td>
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<tr>
<td>Co-morbidity score</td>
<td>4 (2–6)</td>
<td>2 (0–4)</td>
<td>0.44</td>
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<tr>
<td>Median CRP</td>
<td>57.3 (13–121.2)</td>
<td>37.0 (0—120.0)</td>
<td>0.49</td>
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<tr>
<td>Median Urea: creatinine</td>
<td>0.11 (0.09–0.14)</td>
<td>0.08 (0.06–0.10)</td>
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<td>Median VIEWS</td>
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<td>AVPU A = 26/29 V/P/U = 3/29</td>
<td>A = 66/66</td>
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<td>HR</td>
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<td>82.3</td>
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<td>RR</td>
<td>19.5</td>
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<tr>
<td>BP</td>
<td>125</td>
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<td>Temp</td>
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<tr>
<td>SaO₂</td>
<td>96</td>
<td>96</td>
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<tr>
<td>FiO₂</td>
<td>Y = 6 N = 23</td>
<td>Y = 9 N = 57</td>
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</table>

DSM delirium = reference standard delirium.
Dementia ascertained through IQCODE.
Co-morbidity score = Charlson co-morbidity index.
CRP C-reactive protein.
AVPU = assessment of arousal where categories are Alert, Verbally-responsive, Pain-responsive, Unresponsive.
FiO₂ is scored as Y = supplemental oxygen; N = room air.

*Aggregate information derived from multiple vignettes, therefore the standard errors (not shown) are not robust to the clustered nature of the data. The p values are derived from estimates with robust standard errors.

doi:10.1371/journal.pone.0111823.t002
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<th>LR−</th>
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<td>UCI</td>
<td>LCI</td>
<td>UCI</td>
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<td>Inattention</td>
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<td>Change in cognition</td>
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LR: Likelihood ratio; AUROC: area under the curve; LCI: lower 95% confidence interval; UCI: upper 95% confidence interval.

doi:10.1371/journal.pone.0111823.t003
during assessment by a psychiatrist or geriatrician (reference standard). The diagnostic test accuracy remained similar in the subgroup of persons aged ≥70 years, though performed less well in the group with dementia. Overall, the likelihood ratios suggest that positive identification of probable delirium had a moderate effect on decision making.

One other approach has pioneered the use of medical records to derive a retrospective measure [14]. Developed in the US healthcare system, it has been effective in leveraging information from dementia cohorts. That study was larger, and used different methods. Firstly, a one-stage approach was used for abstraction and diagnosis (with variation in agreement assessed by kappa). Secondly, the CAM administered by expert assessors after cognitive testing was used as a reference standard, though this has very high sensitivity and specificity for DSM diagnoses in the centre developing the abstraction tool. As with our findings, diagnostic test accuracy was lower in the group with dementia, also ascertained through an informant test (modified Short Blessed Test [24]). The overall accuracy of the US chart technique reported sensitivity 0.74 and specificity 0.83. Our findings are comparable, though the outcome from the consensus panel in the present paper offered ‘possible’ (when sensitivity is more important), and ‘probable’ (when specificity is more important) diagnostic categories.

The strengths of our study lie in the use of routine clinical records of participants which were compared to expert delirium assessments. The consensus panel builds on a standard approach to case-ascertainment in psychiatric epidemiology. Use of multiple vignettes showed that the two-stage (diagnostic) process was robust, as variations between abstractors recorded in the vignette did not ultimately influence the diagnosis reached at consensus. That is, slight variations in abstracted information due to individual abstractors did not affect the overall judgements. It should be noted that abstractors in this study had more general clinical training than the method using nurse abstractors [14]. This may account for the greater inter-abstractor agreement shown here, rather than use of the consensus panel itself.

References


Supporting Information

File S1 Four examples of abstracted case vignettes.

These are fictionalised given their clinical origins, but are typical cases.

(XLSX)

Author Contributions

Conceived and designed the experiments: NO SR AT LA DW AM SI DM CB ST DD. Performed the experiments: EK XD KM SC NO SR AT LA DW AM SI DD. Analyzed the data: DD. Contributed reagents/materials/analysis tools: DM ST. Wrote the paper: EK XD KM SC NO SR AT LA DW SI AM DM CB ST DD.

