The Effect of Multiple Assessments on Delirium Detection: a Pilot Study*

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ABSTRACT

Background
Delirium is characterized by fluctuating attention or arousal, with high prevalence in the orthopaedic ward. Our aim was to: 1) establish the prevalence of delirium on an orthopaedic ward, and 2) compare delirium prevalence using a single geriatrician assessment vs. multiple 3D-CAM (3-Minute Diagnostic Interview for Confusion Assessment Method) assessments during the day. We hypothesized that multiple assessments would increase the detection rate due to the fluctuating nature of delirium.

Methods
Comparative study conducted at an academic hospital in Hamilton, Ontario. Participants included patients 65 years and older admitted to the orthopaedic ward (n=55). After a geriatrician made the first assessment of delirium by 3D-CAM on each patient, teams with specialized geriatrics training re-assessed participants up to four times. Delirium rates based on first assessment were compared to cumulative end-of-day rates to determine if detection increased with multiple assessments.

Results
The prevalence of delirium was 30.9% (17 participants) using multiple assessments. Of these cases, 13 (76.4%) were detected in the initial geriatrician assessment. In patients with hip fractures, 70.6% (12 of 17) were identified as delirious by multiple assessments.

Conclusion
As symptoms fluctuate, multiple daily CAM assessments may increase the identification of delirium in orthopaedic inpatients.

Key words: delirium, 3D-CAM, orthopedic, point-prevalence, multiple observations

INTRODUCTION

Delirium is an acute confusional state that commonly occurs in older patients. It is associated with functional decline, worsening cognitive impairment, institutionalization, and increased mortality.1 Orthopaedic inpatients are at particularly high risk of developing delirium, with a reported prevalence of 20–50% in patients with hip fracture.2–4

The Confusion Assessment Method (CAM) was adapted into the 3-Minute Diagnostic Interview for CAM-defined delirium (3D-CAM), a validated tool with 95% sensitivity and 94% specificity.5,6 The 3D-CAM standardizes the evaluation of acuity and fluctuation of confusion, inattention, disorganized thinking, and altered level of consciousness.

Fluctuation in confusion, attention or arousal over the course of the day is a hallmark of delirium.7 Most studies evaluate the prevalence of delirium at a single point during the day.8 Given the fluctuating course of delirium, repeating screening multiple times throughout the day may improve the accuracy of prevalence estimates, although there is little published evidence to support this conjecture.9,10 Additionally, delirium symptoms may worsen in the evening due to dysregulation of circadian rhythm—a phenomenon similar to “sundowning”.11 Prior studies have not specifically captured delirium after 7:00 p.m.12,13

Delirium prevalence on the orthopaedic wards at our local institutions was unknown at the time of this study. We hypothesized that, given the fluctuating course of delirium, repeating CAM assessments in a single day may improve accuracy of detection. Our primary objective was to identify the prevalence of delirium on the orthopaedic ward. Our secondary objective was to compare the prevalence measured by

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one-time CAM assessment, with the prevalence determined by multiple CAM determinations over a 14-hour period.

METHODS

Study Design and Setting
This study was a pilot efficacy study conducted on a 39-bed orthopaedic ward at an academic teaching hospital in Hamilton, Ontario, Canada. We aimed to perform four 3D-CAM assessments per patient during the days of evaluation (March 23 and September 7, 2017), with a sample size of 39 necessitating two study days.

Participants and Enrollment
We included consenting patients age ≥65 admitted to the orthopaedic ward, regardless of diagnosis and operative status. No formal pre-operative delirium screen was completed. Patients with aphasia, a terminal illness or language barrier (not sufficiently proficient in English to carry out a conversation) were excluded from the study. The study was explained to the patient or substitute decision-maker and an information handout was distributed. Verbal consent was obtained prior to each assessment to provide opportunity for patients to refuse assessment.

Individual assessors had access to names of patients for introduction purposes, but other identifiers were anonymized. The principal investigator did not participate in outcome assessments, but had access to the entire list of patients and their corresponding study identification number. The protocol was deemed exempt by the Hamilton Integrated Research and Ethics Board (ID 1840).

Outcome Assessors and Training
A team of geriatricians, geriatric fellows, clinical nurse specialists, and internal medicine residents with at least one month of specialty training in geriatrics underwent a mandatory training session prior to the study day. During this session, a senior geriatrician outlined how to administer the 3D-CAM with reference to the training manual and standardized Mini-Mental Status Examination (sMMSE). Cognitive Assessments
Initial assessment involved an evaluation carried out by a geriatrician at approximately 0800 hours. The evaluation began with a 3D-CAM, followed by relevant history, chart review, collateral history from nurses or visitors, sMMSE, and medication review. Participants transferred to the ward were continuously enrolled throughout the day.

Subsequently, two smaller teams of assessors remained on the ward to repeat 3D-CAM assessments up to three times between 1000 and 2200 hours. Each assessor was assigned specific patients and was blinded to the results of earlier assessments. Assessors did not see the same patient more than once. We planned to complete four 3D-CAM assessments on each patient.

Response to Identified Delirium
Any patient with one or more positive 3D-CAM assessments was considered a prevalent delirium case. After 2200 hours, a member of the study team informed the most responsible physician of detected delirium to ensure initiation of our institution’s delirium management order set. The order set includes investigations for the cause(s) of delirium and recommendations for interventions.

Study Outcomes and Statistical Analysis
The primary outcome was the prevalence of delirium on the orthopaedic ward as measured by one or more positive 3D-CAM assessments. The secondary outcome was the difference in delirium prevalence between single and multiple assessments. Additional secondary outcomes included fluctuations in the four CAM components, and delirium prevalence differences between patients with—and without—fracture. Proportions and means (standard deviations) were presented as descriptive statistics. Comparison of outcomes between single and multiple assessments was calculated using the McNemar’s test for paired nominal data. All data were complete, except for one patient who had an initial assessment but no follow-up assessments.

RESULTS

Of the 84 consecutively screened patients, 67 met inclusion criteria based on age (Figure 1). One patient was excluded due to active palliative management, one excluded due to aphasia, and six excluded due to language barrier. Four patients declined involvement, leaving 55 patients enrolled in the study. Ten patients were discharged during the study period. Of the 44 remaining, 23 (52.3%) completed all four assessments. The mean age of participants was 76.7 yrs. and 51% were female (Table 1). Ten patients had previously diagnosed cognitive impairment and nine patients had prior history of delirium.

The prevalence of delirium by multiple observations was 30.9% (n=17). The prevalence with a single 3D-CAM done by a geriatrician was 23.6% (n=13). Compared with the single assessment, multiple assessments throughout the
day identified five more patients with delirium ($p = .133$). Of the 17 patients identified as delirious, nine had hypoactive delirium, one had mixed subtype, and seven demonstrated no motoric subtype.\(^{17}\) Eight patients remained CAM-positive throughout the day, while nine patients demonstrated changes in their 3D-CAM status (Appendix A). These fluctuations did not display any specific pattern (Table 2). Patients identified as delirious were more likely to have a history of prior dementia (52.9% vs. 2.6%) or delirium (35.3% vs. 7.9%) compared to those without delirium. We were unable to determine the timing of fluctuations because newly admitted patients were continuously enrolled throughout the day.

Over the course of both study days, 17 patients (30.9%) were admitted with a hip fracture. Of these patients, 12 (70.6%) were identified as delirious by at least one 3D-CAM assessment.

### DISCUSSION

The prevalence of delirium in our orthopaedic unit (30.9%) is similar to other studies.\(^{18-20}\) Multiple assessments throughout the day detected more cases of delirium than a single geriatrician assessment. Although the difference in prevalence was not statistically significant, our finding has important clinical relevance as missed delirium is associated with distress among patients, caregivers, and medical staff, as well as worse outcomes and increased mortality.\(^{21-23}\) Each additional case provides an opportunity for early intervention and treatment.

Fluctuations in CAM positivity were noted in both directions (Table 2). This suggests that a proportion of patients not meeting CAM criteria on assessment but who demonstrate some clinical features may have subsyndromal delirium, which has a worse prognosis compared to those without delirium.\(^{24}\) It is possible that some patients described as “not delirious” in previous studies had subsyndromal delirium, and may have met CAM criteria if tested more frequently. Increased delirium detection with multiple assessments may influence future research studies assessing delirium rates. The optimal frequency of delirium screening is yet to be determined.

Despite our attempt at assessing delirium up to four times during the study period, this was seldom achievable. Feasibility of incorporating multiple assessments in a day may be limited by patient fatigue from multiple assessments, frequent tests and procedures off the ward, increased workload imposed on staff, confidence with administration of the CAM, and applying such tools to patients with aphasia or in the setting of language discordance.\(^{25}\) Although multiple observations would logically increase delirium detection, the pragmatic aspect of this task is less straightforward; hence the need for a pilot study. Our intended future study would apply multiple observations to various hospital units with older adults (e.g., medicine, other surgical units). Since it is impractical to do this to all older patients, there needs to be an improved way to identify those at risk of delirium, and only conduct multiple assessments on those patients.

This study had several strengths. Each investigator was trained and performed the 3D-CAM in a standardized manner. Patients were assessed on at least three occasions each day, more than in most studies.\(^{9}\) Each assessor was blinded to the results of prior assessments and to the initial 3D-CAM completed by a geriatrician. The study was conducted over a 14-hour period on each study day.

Limitations of this study include limited sample size. The study was completed over two days to increase the sample size. It was challenging to determine if time of day played a role in delirium fluctuation due to variability in time of patient arrival to the ward. Patient discharges and new patient arrivals later in the day limited the number of 3D-CAM assessments performed on each participant, as did patient refusal after...
multiple assessments. Fifty-eight per cent of patients did not have a fourth assessment.

CONCLUSION

The prevalence of delirium on the orthopaedic ward at our academic centre is 30.9%. Our data suggest that delirium detection increases with more frequent assessments, and that 3D-CAM outcomes fluctuate in parallel with the natural course of delirium. If delirium in acute care is being missed due to fluctuations, increasing frequency of assessments may improve patient outcomes.

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CONFLICT OF INTEREST DISCLOSURES

The authors declare that no conflicts of interest exist.

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| Patient Number | Cognitive Impairment | History of Delirium | Fracture | Fluctuation Patterna | Motor Subtype |
|----------------|----------------------|---------------------|----------|----------------------|---------------|
| 0012           | ü                    | ü                   | ü        | n/a                  | Hypoactive    |
| 0020           | ü                    | ü                   | ü        | n/a                  | Hypoactive    |
| 0023           | X                    | ü                   | X        | + -                  | No-type       |
| 0027           | ü                    | ü                   | ü        | + - +                | Hypoactive    |
| 0028           | ü                    | Unknown             | ü        | + + -                | No-type       |
| 0029           | ü                    | Unknown             | X        | n/a                  | Hypoactive    |
| 0032           | ü                    | ü                   | ü        | n/a                  | Hypoactive    |
| 0034           | X                    | X                   | n/a      | - - +                | Hypoactive    |
| 0039           | X                    | ü                   | ü        | - - - +              | No-type       |
| 0052           | X                    | X                   | ü        | + - -                | Hypoactive    |
| 0053           | X                    | Unknown             | ü        | n/a                  | No-type       |
| 0055           | ü                    | Unknown             | ü        | - + -                | No-type       |
| 0056           | ü                    | Unknown             | ü        | n/a                  | Hypoactive    |
| 0058           | ü                    | X                   | ü        | n/a                  | Mixed         |
| 0064           | X                    | X                   | ü        | + - +                | No-type       |
| 0068           | X                    | X                   | X        | - +                  | No-type       |
| 0071           | X                    | unknown             | X        | + - +                | Hypoactive    |

a Fluctuation Pattern reflects 3D-CAM positivity or negativity at the time of assessment to a maximum of four assessments. ü = presence of risk factor; X = absence of risk factor; + = 3D-CAM positive; - = 3D-CAM negative; n/a = patient with no fluctuations (3D-CAM positive throughout the assessment day).
APPENDICES

APPENDIX A. 3D-CAM assessments by patient outlining positivity of each CAM component

|   | Sex | 3D-CAM 1 | 3D-CAM 2 | 3D-CAM 3 | 3D-CAM 4 |
|---|-----|----------|----------|----------|----------|
| 0011 | 85 F | Negative | Negative | Negative | Negative |
| 0012 | 92 F | Positive | Positive | N/A | N/A |
| 0014 | 73 M | Negative | Negative | Negative | Negative |
| 0016 | 67 M | Negative | Negative | Negative | Negative |
| 0017 | 85 F | Negative | Negative | Negative | Negative |
| 0018 | 86 M | Negative | Negative | Negative | N/A |
| 0020 | 93 F | Positive | Positive | Positive | Positive |
| 0022 | 67 F | Negative | Negative | N/A | N/A |
| 0023 | 82 M | Positive | Negative | N/A | N/A |
| 0024 | 68 M | Negative | Negative | N/A | N/A |
| 0025 | 83 M | Negative | Negative | N/A | N/A |

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### APPENDIX A. Continued

|   | Sex | 3D-CAM 1 | 3D-CAM 2 | 3D-CAM 3 | 3D-CAM 4 |
|---|-----|---------|---------|---------|---------|
| 0027 | 85  | F       | Positive\(^{a,b,c,d}\) | Negative\(^{b}\) | Positive\(^{a,b,c,d}\) | N/A |
| 0028 | 80  | M       | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) | Negative\(^{b,c}\) | Negative\(^{a,b}\) |
| 0029 | 81  | M       | Positive\(^{a,b,c}\) | Positive\(^{b,c,d}\) | Positive\(^{a,b,c}\) | N/A |
| 0030 | 69  | M       | Negative | N/A      | N/A      | N/A |
| 0031 | 72  | F       | Negative | Intra-operative | Negative | N/A |
| 0032 | 77  | F       | Positive\(^{a,b,c,d}\) | Positive\(^{a,b,c,d}\) | N/A      | N/A |
| 0033 | 81  | F       | Negative | N/A      | Negative | N/A |
| 0034 | 72  | M       | Negative\(^{b,c}\) | Negative\(^{b}\) | Positive\(^{b,d}\) | N/A |
| 0035 | 73  | F       | Negative | Negative | Negative | N/A |
| 0037 | 74  | M       | Negative | Negative | Negative | N/A |
| 0038 | 89  | M       | Positive | Positive | Positive | Positive\(^{a,b,c}\) |
| 0039 | 77  | F       | Negative | N/A      | Negative | N/A |
| 0040 | 84  | M       | Negative | N/A      | Negative | Negative |
| 0042 | 75  | M       | Negative\(^{a,b,c}\) | Negative\(^{b}\) | Negative\(^{c}\) | Negative\(^{b}\) |
| 0044 | 73  | M       | Negative | Negative | Negative | N/A |
| 0045 | 68  | M       | Negative\(^{b,c}\) | Negative\(^{b,c}\) | N/A      | N/A |
| 0046 | 74  | F       | N/A      | N/A      | Negative | N/A |
| 0047 | 80  | M       | Negative | Negative | N/A      | N/A |
| 0048 | 70  | M       | Negative | Negative | Negative | Negative |
| 0049 | 73  | F       | Negative | Negative | N/A      | N/A |
| 0051 | 73  | F       | Negative | Negative | Negative | Negative |
| 0052 | 90  | F       | Positive (All) | Negative\(^{a,b}\) | Negative\(^{a,b}\) | Negative\(^{a,b}\) |
| 0053 | 65  | F       | Positive\(^{b,c}\) | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) | N/A |
| 0054 | 77  | M       | Negative\(^{b}\) | N/A      | N/A      | N/A |
| 0055 | 91  | F       | Negative\(^{b,c}\) | Positive\(^{a,b,c,d}\) | Negative\(^{b,c}\) | Negative\(^{b,c}\) |
| 0056 | 83  | M       | Positive\(^{b,c,d}\) | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) | N/A |
| 0058 | 84  | F       | Positive\(^{a,b,c,d}\) | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) |
| 0059 | 66  | F       | Negative | Negative | Negative | Negative |
| 0060 | 81  | F       | Negative\(^{b}\) | Negative | N/A      | N/A |
| 0061 | 72  | M       | Negative\(^{b}\) | Negative\(^{b}\) | Negative\(^{b}\) | Negative\(^{b}\) |
| 0062 | 78  | M       | Negative | N/A      | N/A      | N/A |
| 0064 | 82  | F       | Positive\(^{b,c}\) | Negative | Positive\(^{a,b,c}\) | Negative\(^{b}\) |
| 0065 | 70  | M       | Negative | Negative | Negative | Negative |
| 0066 | 72  | F       | Negative | Negative | Negative\(^{b}\) | Negative\(^{b}\) |
| 0067 | 68  | F       | Negative | Negative | Negative | Negative\(^{b}\) |
| 0068 | 73  | M       | Negative | Negative | Positive\(^{a,b,c}\) | N/A |
| 0070 | 76  | F       | Negative | Negative | Negative\(^{b}\) | Negative |
| 0071 | 81  | F       | Positive\(^{b,c}\) | Negative\(^{a,b}\) | Positive\(^{a,b,c}\) | Positive\(^{a,b,c}\) |
| 0072 | 71  | M       | Negative | Negative | Negative | N/A |
| 0073 | 69  | F       | Negative | Negative | N/A      | N/A |
| 0075 | 71  | F       | Negative | Negative | N/A      | N/A |
| 0076 | 79  | F       | Negative | Negative\(^{b,c}\) | Negative\(^{c}\) | N/A |
| 0077 | 72  | F       | Negative | Negative | N/A      | N/A |
| 0078 | 72  | M       | Negative | Negative | Negative | Negative |

\(^{a}\)Acute onset and/or fluctuations; \(^{b}\)inattention; \(^{c}\)disorganized thinking; \(^{d}\)altered level of consciousness.