

# Delirium Index Six-Monthly in Patients with Dementia, Mild Cognitive Impairment and Subjective Cognitive Impairment: Keys to Interpreting Delirium Index in Cognitive Impairment

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## Abstract

**Background:** The delirium index (DI) is a simple non-copyrighted test which captures most delirium symptoms and signs. Despite its attractiveness it has been used in only 21/589 (3.6%) delirium articles published after DI appeared.

**Methods:** Prospective observational cohort study in a geriatric memory clinic. We followed 259 community-dwelling elderly with dementia, mild cognitive impairment (MCI) and subjective cognitive impairment (SCI). Measurements: six-monthly DI, Mini-Mental State (MMSE), Montreal Cognitive Assessment (MoCA), Addenbrooke Cognitive Assessment (ACE-R), Frontal Assessment Battery (FAB) to predict the declines in instrumental activities of daily living (IADL). Mean follow-up was 622 days.

**Results:** Mean DI increased from baseline  $3.20 \pm 1.90$ , to six-month  $3.41 \pm 2.00$ , twelve-month  $3.61 \pm 2.13$ , and peaked at eighteen-month  $4.10 \pm 2.2$ . It then declined to  $3.71 \pm 2.43$  at twenty-four months,  $3.98 \pm 2.24$  at thirty months. Spearman rank correlations were significant at a  $P < 0.0001$  level between baseline DI and baseline and six-month IADL, MMSE, MoCA, ACE-R, FAB and with later DI at six, twelve, eighteen, twenty-four, thirty and thirty-six months. Comparing 227/259 patients with baseline DI 0 - 5 to 32/259 with baseline DI  $\geq 6$ , the two groups differed significantly in baseline IADL (22% difference between means of the two groups,  $P = 0.004$ ), baseline MMSE (35%,  $P < 0.001$ ), baseline MoCA (48%,  $P < 0.001$ ), baseline FAB (41%,  $P < 0.001$ ), and baseline ACE-R (36%,  $P < 0.0001$ ).

**Conclusions:** Mean delirium index increased progressively every six months to eighteen months in a memory clinic. DI is a good tool

to monitor elderly at risk for delirium.

**Keywords:** Delirium; Delirium index; Instrumental activities of daily living; Dementia

## Introduction

The two main instruments for diagnosis of delirium are the Diagnostic and Statistical Manual (DSM-IV) criteria [1], used primarily by psychiatrists, and the Confusion Assessment Method (CAM) used by physicians [2]. While these instruments can be used to monitor the resolution of features of delirium, they were not designed for this purpose. More than eight scales have been used to quantitate delirium symptoms and signs. Unfortunately there are virtually no studies comparing the utility of these eight scales. We suggest that there are four reasons to use a formal instrument to monitor the course of delirium: 1) Certain features such as aggression and agitation are easily observed and may be overemphasized; 2) Other features such as apathy are easily written off as "normal for a sick older person"; 3) In patients with dementia there is an overlap of features such as disorientation and disorganized thinking; 4) Formal instruments allow comparisons between studies of the rate and extent of resolution. There are many diagnostic tests for delirium and all of them have problems when used in patients with pre-existing dementia.

The Neecham Confusion Scale [3] has nine behavioral observations. The test for inattention in the Neecham scale is crude - gross inattention. Other scales such as delirium index use a psychometric attention test. Several items in the Neecham scale rate general medical condition (e.g. vital signs, oxygen saturation, and urinary incontinence) rather than delirium. People with dementia will also have high scores on the Neecham scale. Severe dementia could produce a score of 40% that for maximal delirium on the Neecham Confusion Scale.

The Delirium Observation Screening Scale [4] has 25 items. It is primarily used by hospital nurses. The Delirium Observation Scale was subsequently reduced from 25 to 13

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**Table 1.** Baseline Features of 259 Memory Clinic Patients

| Feature                   | Mean $\pm$ SD / Proportion (%)  |
|---------------------------|---------------------------------|
| Age                       | 79.5 $\pm$ 6.3                  |
| Female                    | 130/259 (50.2)                  |
| Years education           | 10.0 $\pm$ 2.0                  |
| Weight (kg)               | 69.0 $\pm$ 15.9                 |
| BMI                       | 26.3 $\pm$ 5.1                  |
| No cognitive impairment   | 29/259 (11.2%)                  |
| Mild cognitive impairment | 99/259 (38.2%)                  |
| Dementia                  | 131/259 (50.6%)                 |
| Median follow-up          | 20 months (range 3 - 43 months) |

items [5]. This tool can falsely label patients with dementia as delirious.

The Delirium Symptom Interview [6] combines medical history with observations of attention, alertness, lethargy, grasping, picking, tremors, and distractibility. Thirty-one of the 691 key delirium articles we analyzed from 1988 to 2012 used the Delirium Symptom Interview (4.5%). This tool was invariably used on admission and not repeated serially.

The Delirium Rating Scale Revised (DRS-R98) [7] has 13 items each rated 0 (normal) to 3. This tool has the same problems as the other tools.

The Memorial Delirium Assessment Scale (MDAS) [8] has 10 items each scored 0 - 3. Total score is from 0 (no features of delirium) to 30 (maximal features). MDAS < 10 is mild delirium. MDAS 10 - 15 is moderate, MDAS  $\geq$  15 is severe. The MDAS includes digit span forwards and digit span backwards.

The Richmond Agitation Sedation Scale (RASS) [9] is particularly suited for selected aspects of ICU delirium. It assesses consciousness and gross behaviors such as pulling out indwelling catheters and punching staff members.

Assessment of delirium is much easier in patients with no cognitive impairment (NCI) compared to those with dementia. Any abnormality such as 5-word recall in MoCA of 3/5 at 5 minutes would constitute a new deficit. However, at least 50% of delirium in the elderly occurs in people with dementia. It is not possible to determine if impaired clock drawing in a patient with informant history supporting dementia over 18 months but no prior medical or neuropsychological assessment is old or new.

The delirium index was devised by McCusker in Montreal in 1998 [10]. We reviewed 689 key articles about de-

lirium in geriatric, psychogeriatric, neurology and other medical journals from 1980 to 2012. Twenty-one of the 589 articles published after DI appeared in 1998 (3.56%) used the delirium index [10 - 28]. Seventeen of the 21 DI papers (81%) were from Canadian studies. Despite its attractive ease of use and lack of copyright, DI has been used rarely since 1998. The delirium index (DI) is a simple non-copyrighted test which is cost-free other than labor time. If the Mini-Mental State Examination is completed first, the DI takes two extra minutes. DI captures most delirium symptoms and signs. Only eight of 21 DI studies (38%) measured DI at least twice. DI can be completed by any health professional. When used serially the word recall elements and the five-letter word to spell backwards can be changed daily.

Some episodes of delirium resolve within 48 hours and the role of severity instruments is small compared to episodes that last more than seven days. Patients may be falsely assumed to be stable and sent from home to nursing homes prematurely without delirium instruments.

## Methods

The Wyong Memory Clinic at Wyong Hospital 100 km north of Sydney is for elderly with dementia, mild cognitive impairment (MCI) and subjective cognitive impairment (SCI). The inclusion criteria for this study were: 1) Age 60+ with dementia, MCI or SCI; 2) Delirium index (DI) measured at least once between 15 January 2009 and 12 April 2012; 3) Survival follow-up at least ninety days; 4) Community-dwelling; 5) English speaking. Dementia was diagnosed using the DSM-IV criteria following a consensus conference

**Table 2.** Six-monthly Cognitive and IADL Scores in 259 Elderly Memory Clinic Patients

| Months | DI          | MMSE       | MoCA       | FAB        | ACE-R       | IADL       |
|--------|-------------|------------|------------|------------|-------------|------------|
| 0      | 3.20 ± 1.90 | 23.3 ± 4.6 | 17.8 ± 5.9 | 10.4 ± 4.0 | 66.1 ± 16.3 | 14.5 ± 5.4 |
| 6      | 3.41 ± 2.00 | 23.0 ± 5.0 | 17.6 ± 6.2 | 10.5 ± 4.2 | 68.1 ± 14.4 | 14.2 ± 5.6 |
| 12     | 3.61 ± 2.13 | 22.5 ± 5.7 | 17.5 ± 6.7 | 10.7 ± 4.2 | 68.8 ± 15.6 | 13.5 ± 3.5 |
| 18     | 4.10 ± 2.21 | 21.5 ± 5.8 | 16.7 ± 6.5 | 10.0 ± 4.0 | 65.4 ± 16.4 | 12.2 ± 5.9 |
| 24     | 3.71 ± 2.43 | 22.1 ± 6.6 | 17.2 ± 7.2 | 10.4 ± 4.5 | 66.6 ± 18.1 | 11.6 ± 6.2 |
| 30     | 3.98 ± 2.29 | 21.8 ± 6.1 | 17.0 ± 6.6 | 10.2 ± 4.0 | 66.9 ± 16.1 | 11.3 ± 5.9 |

0 denotes baseline. DI (Delirium index, 0 = best, 21 = worst). MMSE (Mini-Mental State Examination, 30: best, 0: worst). MoCA (Montreal Cognitive Assessment, 30: best, 0: worst). FAB (Frontal Assessment Battery, 18: best, 0: worst). ACE-R (Addenbrooke Cognitive Examination Revised, 100: best, 0: worst). IADL (Nottingham Instrumental Activities of Daily Living, 22: best, 0: worst).

between EH, clinical nurse consultant, and PR, geriatrician. MCI was diagnosed in a similar consensus conference which used lack of dementia by DSM-IV. Given the lack of a full neuropsychological assessment to establish 1.5 SD below age and sex specific norms, some readers may prefer the term CIND (cognitive impairment not dementia). EH, clinical nurse consultant, interviewed patients on arrival at the Memory Clinic, completing the MMSE and ACE-R. PR, geriatrician, then interviewed patients completing MoCA, FAB, DI and Center for Epidemiologic Studies Depression Score (CES-D). CES-D scores are not reported in this paper but patients with CES-D above 16/60 were further assessed for depression. The caregiver or informant completed the Nottingham Instrumental Activities of Daily Living Score (IADL) [29] which has 22 items and is scored from 0 (totally dependent IADL) to 22 (totally independent). More than 80% had CT or MRI brain scans within 12 months of the initial clinic visit. All patients had full blood count, electrolytes, serum urea and creatinine, serum calcium, TSH, serum vitamin B12 and red cell folate.

### Ethics

The Research Ethics Committee was approached to obtain ethics clearance. The advice was that since study subjects were clinic patients receiving routine Memory Clinic Care with no additional patient measurements for research, we did not need patient consent. All patients were de-identified.

### Analysis

We used Stats Direct Version 2.7.8b 9 November 2011 to calculate chi square, Fisher exact tests, Spearman rank cor-

relations and Mann-Whitney non-parametric comparisons.

## Results

Table 1 shows the baseline features of the 259 community dwelling memory clinic patients. Table 2 shows baseline and six-monthly DI, MMSE, MoCA, FAB, ACE-R and IADL.

### Spearman rank correlations with baseline DI

Ranked by correlation coefficients with initial DI, baseline MMSE ( $r = -0.869$ ,  $P < 0.0001$ ); six-month DI ( $r = 0.823$ ,  $P < 0.0001$ ); baseline ACE-R ( $r = -0.812$ ,  $P < 0.0001$ ); 24-month DI ( $r = 0.791$ ,  $P < 0.0001$ ); 12-month DI ( $r = 0.783$ ,  $P < 0.0001$ ); baseline MoCA ( $r = -0.767$ ,  $P < 0.0001$ ); 30-month DI ( $r = 0.754$ ,  $P < 0.0001$ ); six-month MMSE ( $r = 0.703$ ,  $P < 0.0001$ ).

### Comparison of low and high baseline DI

We divided the 259 subjects by baseline DI into low DI (0-5) and high DI (6-8). The 227 subjects in the low DI group differed from the 32 subjects in the high DI group in age ( $79.1 \pm 6.3$  versus  $82.3 \pm 5.6$ ,  $P = 0.015$ ); baseline IADL ( $14.9 \pm 5.1$  versus  $11.6 \pm 6.6$ ,  $P = 0.004$ ); baseline MMSE ( $24.4 \pm 3.7$  versus  $15.8 \pm 3.7$ ,  $P < 0.0001$ ); baseline MoCA ( $18.9 \pm 5.3$  versus  $9.9 \pm 3.7$ ,  $P < 0.0001$ ); baseline FAB ( $10.9 \pm 3.7$  versus  $6.4 \pm 3.2$ ,  $P < 0.0001$ ); baseline ACE-R ( $69.5 \pm 14.1$  versus  $44.5 \pm 12.6$ ,  $P < 0.0001$ ); IADL at six months ( $14.6 \pm 5.3$  versus  $10.4 \pm 6.3$ ,  $P = 0.0035$ ); MMSE at six months ( $24.0 \pm 4.0$  versus  $16.3 \pm 6.0$ ,  $P < 0.0001$ ); MoCA at six months ( $18.7 \pm 5.5$  versus  $9.9 \pm 5.0$ ,  $P < 0.0001$ ); FAB at

six months ( $11.1 \pm 3.9$  versus  $6.4 \pm 3.4$ ,  $P < 0.0001$ ); ACE-R at six months ( $69.9 \pm 13.7$  versus  $53.1 \pm 11.2$ ,  $P < 0.0001$ ); DI at six months ( $3.1 \pm 1.8$  versus  $5.8 \pm 1.6$ ,  $P < 0.0001$ ).

### Composite outcome

Residential Care or Death 20 subjects entered residential care (12 nursing home (high level care) and eight hostels (low level care)) during a median 20-month follow-up. 11 subjects died yielding composite poor outcome in 31/259 (12.0%). The 31 with poor outcome were on average 4.1 years older than the 228 who remained in the community ( $83.1 \pm 5.2$  versus  $79.0 \pm 6.3$ ,  $P = 0.0004$ ); their baseline DI was 19% greater than the good outcome group ( $3.7 \pm 1.8$  versus  $3.1 \pm 1.9$ ,  $P = 0.106$ ); their baseline IADL was 19% worse ( $12.0 \pm 5.6$  versus  $14.8 \pm 5.2$ ,  $P = 0.0066$ ); their baseline MMSE was similar to the good outcome group ( $22.7 \pm 4.1$  versus  $23.4 \pm 4.7$ ,  $P = 0.267$ ); baseline MoCA was 13% worse than the good outcome group ( $15.7 \pm 5.0$  versus  $18.1 \pm 6.0$ ,  $P = 0.0369$ ); their baseline FAB was 19% worse than the good outcome group ( $8.6 \pm 3.3$  versus  $10.6 \pm 4.0$ ,  $P = 0.0082$ ); their baseline ACE-R was 10% worse than the good outcome group ( $59.8 \pm 15.8$  versus  $66.8 \pm 16.2$ ,  $P = 0.091$ ).

### Readmissions

Ninety-three of 259 subjects (35.9%) were readmitted at least once during a median 20-month follow-up. Delirium was listed as one of the readmission diagnoses in nine of 93 readmissions (9.7%). This low number of delirium readmissions precludes further analysis by DI or IADL.

### Discussion

The DI was invented in Canada and 81% of DI case series were in Canadian studies. In general the 21 DI articles we surveyed ignore the likelihood that prior dementia alters the DI. The average patients in our study had 3.8 DI measurements. Our 1,006 individual patient DI measurements are significant compared to the entire medical literature of 21 articles reporting 5,435 individual patient measurements.

Our article compares 13 predictors of IADL at months 6, 12, 18, 24, 30 and 36. Five variables were cognitive: 1) Delirium index; 2) MMSE; 3) Montreal Cognitive Assessment (MoCA); 4) Addenbrooke's Cognitive Assessment (ACE-R); 5) Frontal Assessment Battery (FAB). Five variables were demographic: 1) Sex; 2) Marital status; 3) Living alone; 4) Education; 5) Home support services. Three other variables: 1) Cumulative Illness Rating Scale to measure comorbidity; 2) Weight; 3) BMI. A typical study from the former 21 DI articles used five predictors. Baseline DI was strongly correlated with baseline and subsequent MMSE, MoCA, FAB, ACE-R, IADL and DI.

There were too few readmissions of study subjects for delirium to comment on changes in DI from the most recent clinic visits.

We recommend measuring DI every six months at the time of cognitive and IADL assessment in dementia and MCI because the most recent DI measurement can be used as the baseline for assessing resolution of delirium.

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### Conflicts of Interest

None. The work was presented in part at the American Geriatrics Society Annual Scientific Meeting in Washington DC on 1 May 2011 and at the International Psychogeriatrics Association Scientific Meeting in Cairns on 10 September 2012.

### Authors' Contributions

Paul Regal was involved in all aspects of the study. Eileen Hetherington assessed patients in the memory clinic. Balakrishnan Nair assisted in analysis of results and writing the manuscript.

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