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Brown, Keiran Anthony; McCulloch, Alison

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# BMJ Open Quality POSTOPED: improving surveillance of postoperative delirium in a Scottish tertiary hospital

Keiran Anthony Brown , Alison McCulloch

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## ABSTRACT

Delirium is the most common postoperative complication among patients over the age of 65 years. It is associated with increased morbidity and is a significant financial cost to healthcare systems.

We aimed to improve the detection of delirium on the surgical wards of a tertiary surgical centre. This would take the form of completion of 4AT assessments (the 4 AT test for delirium, on admission and 1 day postoperatively). Prior to this project, the 4AT was in use in the surgical admission clerking paperwork for over 65 s, however, 4AT assessments were not routinely performed as part of day 1 postoperative assessment. By introducing routine postoperative assessment and reinforcing the importance of admission assessment, we hoped to allow for objective comparisons to be made about patients cognitive state and thereafter improve delirium identification.

After a baseline snapshot data collection period, we conducted five (Plan, Do, Study, Act) cycles following which repeat snapshot data were collected. Improvement strategies included 'tea-trolley' teaching sessions, adhesive 4AT pro-forma, targeted accompaniment of specialty ward rounds with reminders to complete 4AT assessments and working with nursing staff to promote awareness of delirium among permanent non-rotating healthcare professionals.

For the admission 4ATs, completion improved from a baseline of 74.1%–90.5% in cycle 5. Completion of postoperative 4AT assessments rose from 14.8% at baseline to 47.6% in cycle 5.

We were able to improve the use of a delirium screening tool, (the 4AT) among the postoperative elderly population in this centre via the use of regular teaching sessions, targeted interventions on ward rounds as well working with non-rotating staff. Further improvements could be made by widening access to delirium champion programmes and including delirium as an outcome measure of national surgical audits such as the National Emergency Laparotomy Audit.

## PROBLEM

This project was started after a newly established service within NHS Tayside, the Surgical Acute Frailty Team (SAFT), had noted a considerable number of their referrals were for support with management of delirium in postoperative patients. This was despite the availability of management bundles such as the TIME<sup>1</sup> bundle and guidelines by the

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Delirium is the most common postoperative complication in over 65 s yet it is underdiagnosed in part due to its hypoactive forms. In response to increased referrals for delirium to the surgical frailty service, a 4AT-based assessment system was instituted in postoperative patients to aid delirium detection.

## WHAT THIS STUDY ADDS

⇒ This quality improvement project successfully improved postoperative monitoring in the absence of physical bundle forms in the surgical environment.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Continued use of such low-cost surveillance measures, perhaps within national surgical audits, could provide the data and recognition required to enable targeted interventions and research into perioperative causes of delirium.

National Institute for Health and Care Excellence.<sup>2,3</sup> It was apparent that knowledge of investigation and management of delirium was lacking.

This project was undertaken at Ninewells Hospital, a tertiary care hospital with five inpatient acute surgical wards. NHS Tayside covers a population of approximately 400 000 people,<sup>4</sup> and in 2018–2019, it performed 7019 emergency operations across all surgical specialties.<sup>5</sup> At the inception of this project, the 4AT,<sup>6</sup> a screening tool for delirium, had been embedded into the acute admission clerking documentation for elderly patients (ie, aged ≥65 years of age), but there had been no systematic follow-up of its use, and whether patients had been assessed for delirium postoperatively. This is despite British Geriatrics Society (BGS) guidance that recommends daily 4ATs for surgical inpatients over the age of 65.<sup>7</sup>

Preintervention snapshot data showed that 74.1% of elderly inpatients underwent 4AT assessments on arrival to the acute surgical admission unit; of these 15% were identified as delirious (4AT score ≥4). Only 14.8% of all



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Surgical Acute Frailty Team, NHS Tayside, Dundee, UK

## Correspondence to

Dr Keiran Anthony Brown;  
keiran.brown2@nhs.scot



elderly patients went on to receive postoperative assessments for delirium, of which 50% of these assessments identified delirium. The inference we drew was that assessments were being done when attention was brought to medical staff that a patient was ‘confused,’ which in discussions with ward staff proved to be the case.

This behaviour is reactive in nature, rather than the proactive approach that professional guidelines recommend.<sup>7</sup> This approach risks missing many patients with delirium, and some literature estimates that 60%–66% of delirium diagnoses are missed,<sup>8,9</sup> due partly to hypoactive forms of the syndrome. We wished to change the reactive process that seemed to be happening on the wards, with a proactive one.

From conversations with staff, it was recognised that several barriers existed which prevented this. Namely that, 4AT assessments would take too long on busy surgical ward rounds and that staff were simply not aware that such guidance existed (not surprising given the cited guidance from the BGS was first published in 2021). We aimed to change these views and create an environment where assessment was easier to perform, and in this way improve compliance to perioperative care guidelines. When such monitoring was achieved, further projects could focus on specific management of delirium itself, via bundles such as the TIME bundle<sup>1</sup> and our own POST-OPED bundle (see online supplemental figure 5).

We collected data for this project on the inpatient ‘post-operative’ surgical wards, however, some interventions were implemented on the admission ‘preoperative’ wards (see online supplemental figure 4) both settings during their rotations within the department. This project ran from April 2021 to December 2021.

Our SMART aims were.

1. Increase the proportion of elderly (those aged  $\geq 65$  years) operative patients who had an admission 4AT assessment from 74.1% to 95% by December 2021.
2. Increase the proportion of elderly operative patients who had a day 1 postoperative 4AT assessment from 14.8% to 50% by December 2021.

These two aims were formed to produce a situation where an individual patient would have a ‘baseline’ cognitive assessment on admission and a ‘repeat’ cognitive assessment in the postoperative period. Enabling objective comparison for an individual patient across their hospital stay, in an environment where multiple ward changes are common early in the patient journey.

## BACKGROUND

Delirium is an acute fluctuant confusional state composed of a disturbance in attention and awareness that is a change from the baseline cognition.<sup>9–12</sup> The criteria for delirium make clear that for such a diagnosis, there must be evidence that the presentation is of a ‘direct physiological consequence’ of another medical condition or state. As a syndromic classification, delirium has a broad definition, and many precipitating factors of ‘physiological

consequence’ have been identified, yet it is usually multifactorial.<sup>13</sup> Several of these physiological antecedents are frequently encountered in the surgical environment.

Delirium is the most common surgical complication among those aged above 65 years of age.<sup>14 15</sup> In 2018, 25% of all hip fracture repair patients in England met the diagnostic criteria for delirium.<sup>16</sup> Such a diagnosis adversely affects patients; a study of Canadian postoperative elderly patients found that those that met the diagnostic criteria for delirium spent on average 7.4 days more in hospital than those without, at a cost of \$C1 million.<sup>17</sup> Delirium contributes significantly to mortality.<sup>18</sup> A US Medicare claimants study<sup>19</sup> found that it was associated with increased mortality risk relative to controls up to 12 months post index presentation. Though commonly associated with an acute cognitive deficit, delirium appears to be influential in subsequent long-term cognitive decline, with a pathological mechanism distinct from dementia and age related cognitive impairment.<sup>20 21</sup>

The TIME<sup>1</sup> bundle was developed for use within the AMU (Acute Medical Unit) department at North Middlesex Hospital as both a surveillance and management strategy for delirium. Using an improvement strategy of staff education and practical aids for the ward environment, they had notable success in increasing the use of the 4AT from 40% to 61% within one Plan, Do, Study, Act (PDSA) cycle. Since then, the TIME bundle has seen support among care of the elderly departments across the UK and has been taught at medical schools. Seeing the proliferation of this project, we sought to adapt their methods to the surgical environment and attempting some of their further recommendations, in particular the use of frailty link nurses. Adaptation of delirium education materials to environments other than medical wards has precedent, with a quality improvement project involving the Greater Manchester Critical Care Network showing improvement in the use of screening tools.<sup>22</sup>

## MEASUREMENT

Data for this quality improvement project were collected in a series of six ‘snapshots,’ totalling 149 patients, between March 2021 and November 2021. The first snapshot, ‘baseline,’ was taken on 26 March 2021. In each intervention cycle, a planning meeting would occur, actions would thereafter be taken, and then approximately a month following said action a data snapshot of current progress to our aims would be taken.

Data collection snapshots were collected on 22 June (cycle 1), 30 July (cycle 2), 4 September (cycle 3), 18 October (cycle 4) and 25 November 2021 (cycle 5).

## Inclusions

All patients on the acute surgical wards aged 65 years or above at the time of admission that had undergone surgical management while in hospital and were at least 1 day postoperative. Those with prior cognitive impairment were included, as this is a significant risk factor for

delirium.<sup>23</sup> Surgical management was defined as having undergone an operative or endoscopic procedure while in hospital. This included interventional radiology procedures and endoscopic retrograde cholangiopancreatography.

### Exclusion

All patients under the age of 65 years were excluded. Elective surgical patients were excluded. Orthopaedics patients were not included. The elective surgical ward in the study hospital had a different management pathway, with a different route of admission, and therefore, the decision was made to exclude elective patients. Orthopaedic patients often did not share a common admission pathway and were therefore excluded for similar reasons. We excluded all patients where 4AT was not completed due to inability to engage due to reasons of language or consciousness (n=0).

### Data collection

Patient sex, age, parent surgical specialty and procedure data were collected. Data were collected on whether patients had had a 4AT score completed on admission and whether this had been repeated at least 24 hours postoperatively. The raw 4AT scores were collected, and these were then evaluated to determine the percentage of positive (ie, greater than or equal to 4) scores in each snapshot sample. From the third snapshot onwards, data were also collected on uptake of the use of 4AT test stickers, the use of which is expanded below.

### DESIGN

The main intervention was the use of 'tea-trolley' teaching sessions (teaching slides are found in online supplemental figure 6). Recognising the time pressures of medical and nursing staff to attend formalised teaching sessions, the SAFT conducted short 5–10 min teaching sessions within doctors' rooms on the surgical floor wards in which we were trying to promote change along with providing snacks and drinks as an incentive. At the launch of the project, we conducted a similar session to senior surgical colleagues at a grand rounds 'clinical effectiveness meeting' in April 2021.

With presentations in smaller groups for shorter periods, we hoped to strengthen audience engagement over more didactic lecture theatre-based methods. Such sessions would also act as reminders for the resources made available to staff, such as the THINK delirium toolkit,<sup>24 25</sup> patient information leaflets, delirium management guidelines and in later cycles, the use of 4AT assessment stickers. By improving the interactive nature of our education, we reasoned that this would promote increased compliance to our audit standard and lead to improved delirium surveillance.

From the third snapshot cycle onwards, we introduced adhesive 4AT tools. Evaluating previous interventions seen for peripheral venous catheter bundles<sup>26</sup> and surgical handovers, we felt that the use of detailed

documentation paperwork could prove obstructive to our aims of promoting a quick, easy and effective screening tool. We, therefore, supplied all intervention wards with 4AT assessment 'checkbox like' stickers (online supplemental figures 2 and 3), enabling clear and speedy documentation of delirium screening. These were placed on medical notes trolleys on the wards to enable ease of access on ward rounds.

Additional interventions included accompanying specialty ward rounds, engagement with frailty link nurses and highlighting in departmental meetings to surgical colleagues the prevalence and importance of postoperative delirium. We noted a few issues with our planned interventions at the outset of this study. First was the issue of engagement with all ward staff. We noted that despite our best efforts, it would not always be possible to reach all ward staff on our teaching days. Therefore, we aimed to complete sessions in the period after lunch, at the time of the 'back' shift starting. Consequently, our tea-trolley sessions would be to wards at the highest staffing levels during the day in a period where much of the ward work had been completed and staff had had their lunch breaks. This we reasoned would optimise engagement with, and reach of, our sessions. We also widened our education activities in later intervention cycles to non-rotating staff such as nurses.

Second, the issue of whether to use a 'bundle form', à la checklist manifesto culture.<sup>27</sup> A trend in the production of quality improvement project checklists and forms was noted at the commencement of this project. Considering the NHS (National Health Service) paper-lite strategy, and being keen to streamline our approach to assessment, we deliberately did not produce a bundle-like A4 sheet form for staff to fill. While this may initially make improvement harder to implement without objective, clear and deliberate forms to take note of, we deemed this a more sustainable design, as by implementing a culture of assessment independent of material resources, surveillance would occur when said forms were not available, and thus survive the duration of the quality improvement project.

The SAFT consists of a consultant geriatrician, a specialty doctor, one advanced nurse practitioner and one clinical fellow. Our intervention sessions involved the use of resources that were easily replicable, consistent in their messaging and could be delivered by all levels of the multidisciplinary team. SAFT consists of permanent, non-rotating staff, who have regular contact with the intervention wards via regular ward rounds and reviews. We, thus, deemed our interventions to be sustainable.

### STRATEGY

At the outset of this project, we spoke informally to ward staff, and SAFT discussed their experiences with referrals to their team for delirium advice in design meetings. We took a baseline snapshot set in March 2021. Following this, we conducted five PDSA cycles.

### PDSA cycle 1

We delivered the first of our interactive tea-trolley sessions across all five surgical wards and put-up copies of our POSTOPED mnemonic poster (see online supplemental figures 5 and 6) within doctor's rooms. This achieved an increase in admission 4ATs of 8.5% and an increase of postoperative 4ATs of 2.6%. We reasoned that not all staff had been reached by our interventions so sought to repeat teaching to staff in the following cycle and further signpost resources. In meetings with doctors and in discussions among SAFT, we sought to make documentation of the 4AT easier in the time-pressured environs of a surgical ward round. To this end, we decided to implement the 4AT assessment adhesive tool.

### PDSA cycle 2

We repeated our tea-trolley sessions, this time making sure to hit the key time of approximately 15:00 hours, when backshift staff started, and all other staff had had their breaks. This led to a decrease of admission 4AT completion percentage by—5.3% compared with PDSA 1 but still an increase of 3.2% on baseline. 4AT postoperative completion increased by 14.4% from PDSA 1, 17.0% from baseline. Such findings gave confidence to the notion our initial PDSA teaching had not circulated widely enough. However, uptake of the 4AT adhesive tool was poor, with none being used on postoperative patients.

### PDSA cycle 3

For the third cycle, we noted that the rotation of junior medical staff was due to occur in the first week of August 2021. Therefore, we ensured that our teaching session was included in the induction programme for junior doctors. We noted that the adhesive 4AT tools were not being used and so we moved them from the doctor's room to the ward round notes trolleys, envisaging that they would be better used if on hand during twice daily ward rounds. 4AT admission completion increased by 2.7% from the previous cycle, an increase of 5.9% from baseline. Postoperative 4AT completion percentage was—18.5% on the previous cycle, -1.5% on baseline.

### PDSA cycle 4

It was apparent that relying on rotating foundation trainees would not produce the sustainable improvements required, as those regularly prompted to complete assessments left the wards to new clinical rotations. In our next cycle, therefore, in addition to promoting the adhesive stickers and running tea-trolley sessions for medical staff, we expanded the scope of our interventions. Noting that most of our snapshot patients were vascular patients, the SAFT team accompanied the vascular ward round weekly, prompting 4AT assessments in postoperative patients. Postoperative delirium was also raised as a prevalent complication at formal and informal meetings with the surgical senior team. 4AT admission completion percentage rose by 4.6% from the previous cycle, 10.6% on the baseline. 4AT postoperative completion

percentage rose by 9.7% on the previous cycle, 8.3% on the baseline percentage.

### PDSA cycle 5

Rationalising that several members of staff we were aiming to educate were brand new to the NHS we felt that our efforts would be best directed on fostering stronger relationships with the frailty link nurses, ward charge nurses and emphasising good practice on select ward rounds. We also performed another teaching cycle. 4AT admission completion percentage rose by 5.9% on previous, giving a final percentage improvement of 16.4% from baseline (74.1%–90.5%). Postoperative 4AT completion rose by 24.5% on the previous cycle, 32.8% from baseline (14.8%–47.6%). 4AT stickers were not used at all during this cycle.

## RESULTS

The results are summarised above in [table 1](#). Line charts for the SMART aims of this project are shown in [figure 1](#). [Figure 2](#) is a run chart showing changes from the baseline completion percentages.

Snapshot patients were majority male in five out of six snapshot cohorts, the mean age was 76.5 between across all six snapshot cohorts, with each cohort being within 1 SD of this average and each other cohort. Vascular contributed the most patients of the three specialties in four out of six of the cohorts with general surgery contributing the most in two snapshots.

From the baseline snapshot cohort to the final cycle (cycle 5) in December 2021, the percentage of patients who had a complete admission 4AT assessment rose from 74.1% to 90.5%, a rise of 16.4%, this was below our stated SMART goal of 95% (see [figure 1](#)).

From the baseline snapshot cohort to the final cycle (cycle 5) in December 2021, the percentage of patients who had a 4AT assessment at least 1 day postoperatively rose from 14.8% to 47.6%. This was below our stated SMART goal of 50% (see [figure 1](#)).

Improvements were seen across a 6-month period both for 'on-the-door' admission assessments and postoperative assessments.

The percentage of those who were positive for delirium (a score of 4 or greater) was never greater than 15% on admission, and always above 30% postoperatively. Noting that much larger data sets in hip fracture patients have found prevalence of delirium at 25%,<sup>16</sup> this may suggest a remnant of selective testing in some patients. Of note is that the lowest prevalence of delirium postoperatively was found in cycle 5, where screening was at its highest.

The use of the adhesive 4AT assessment tools saw poor uptake, the use of them in cycle 5, where postoperative 4AT assessments were at their highest, was completely absent. Suggesting the improvements observed were independent of the implementation of this intervention.

The postoperative 4AT completion percentage sharply fell in cycle 3. This cycle occurred at the point of the

**Table 1** Cycle by Cycle Project Data

	Baseline	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
No of patients in snapshot	27	23	22	30	26	21
Mean age (years)	75.7	77.4	78.1	75.7	74.8	77.0
Age standard deviation (years)	5.6	8.0	7.7	6.1	6.9	9.3
Male (%)	40.7	52.2	63.6	60.0	61.5	71.4
Largest specialty	Vascular	Vascular	Vascular	Gen Surg	Gen Surg	Vascular
General surgery (%)	33.3	39.1	45.5	46.7	50.0	38.1
Vascular (%)	63.0	56.5	50.0	40.0	46.2	42.9
Urology (%)	3.7	4.3	4.5	13.3	3.8	19.0
Admission 4AT complete (%)	74.1	82.6	77.3	80.0	84.6	90.5
Admission positive 4AT score (%)	15.0	10.5	0.0	8.3	0.0	5.3
Postoperative 4AT complete (%)	14.8	17.4	31.8	13.3	23.1	47.6
Postoperative positive 4AT score (%)	50.0	50.0	42.9	50.0	33.3	30.0
4AT adhesive sticker use postoperative (%)			0.0	50.0	16.7	0.0

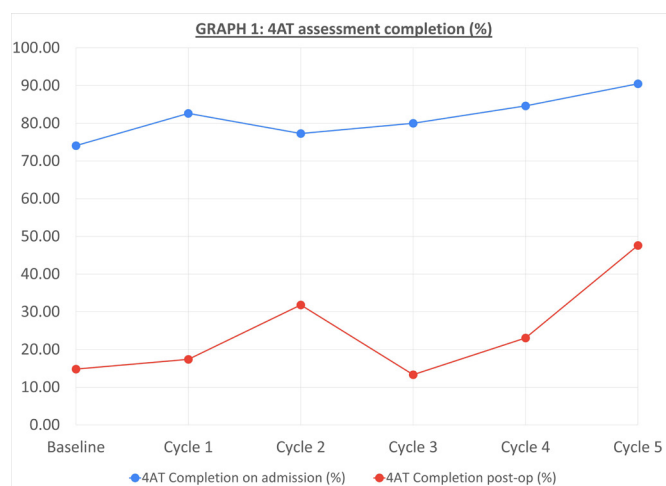
Cycle data was collected on the dates specified in 'measurements'. Postoperative positive 4AT score percentage refers to the percentage of postoperatively assessed patients who had a 4AT score of 4 or greater, it does not include those patients not tested. As adhesive 4AT tools were introduced in cycle 2, data for them appears only from cycle 2 onwards.

4AT, 4 A's Test for Delirium.

foundation trainee changeover in August, where the new foundation year 1 trainees were inducted to the wards.

## LESSONS AND LIMITATIONS

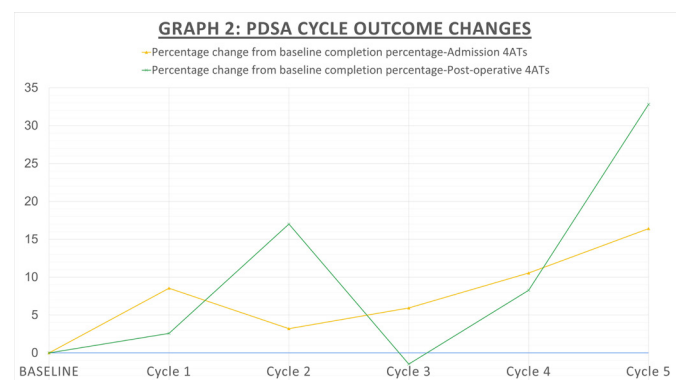
Our findings suggest that a combination of regular education and training, involvement of the multidisciplinary team as well as targeted intervention in areas of high prevalence of our problem of interest was effective in producing progress towards the project aims.



**Figure 1** Percentage of patients that underwent 4AT assessment on admission and at least day 1 postoperatively within each of the snapshot cycles. The SMART aims of the project were for 95% of patients to be assessed on admission (blue) and 50% of patients to be assessed at least day 1 postoperative (red) by the projects end.

As stated in our design, we wished to promote a delirium surveillance culture. Our changes, and their effects, would not be rooted in material resources but rather in the altered awareness of professionals to a common postoperative complication. Improvements were seen despite, rather than due to, the introduction of 4AT assessment stickers on the wards, where uptake was virtually absent. In crowded ward environments full of paper forms and limited space to place them, we could not account for instances where on-ward staff overrode our strategic placing of resources.

We did not survey medical or nursing staff on their use of the 4AT adhesive tools, this could have been something



**Figure 2** This graph illustrates the improvement in 4AT completion percentage from the baseline percentage prior to interventions. Positive percentages indicate improvement, negative percentages indicate fall in 4AT completion compared to baseline. PDSA, Plan, Do, Study, Act.

we completed after the first cycle of their introduction to further understand their reception and better use them. We also did not survey those who received teaching via our tea-trolley sessions to see the reach of our teaching sessions, which would have enabled objective assessment of efficacy of the sessions and the number of staff reached.

Later in the project, we focused our efforts on vascular patients, as they were a plurality within the snapshot cohorts. The vascular surgery department has smaller number of medical staff but a significantly comorbid and frail patient population. SAFT did not have the resources to accompany every surgical ward round, but focusing on the particularly morbid population, dialoguing directly with the small number of medical staff responsible for their care we reasoned we could have a significant impact. This appears to have been the case noting significant incremental increases in compliance to our standard following these interventions. Targeted interventions were, therefore, a particularly effective strategy.

We found a significant reduction in compliance following one of our cycles due in part to the influx of medical staff new to both the NHS and the surgical department. We tried to counter this by including nursing staff in our interventions, with surgical advance nurse practitioners and frailty link nurses who delivered teaching sessions and disseminated reminders to nursing staff. This could be improved on, however. Previously, the Royal College of Nursing ran a CPD (continuing professional development) scheme called 'delirium champions'<sup>28</sup> which educated nurses on recognising delirium in their patients and beginning initial assessment via the 4AT. Future interventions could include reinstatement of such a scheme locally, with accompanying remuneration/portfolio recognition for revalidation purposes. This could help to incentivise uptake as it would avoid such a scheme as being seen as an 'extracurricular' process, and instead be one which would be part of one's normal workload, making it easier to staff to learn and engage with the material within.

Our focus in this project was on surveillance with acute inpatients. We did not assess the efficacy of interventions for our 4AT positive patients. Although we had produced a surgically orientated management strategy in the POSTOPED bundle poster, given that surveillance was so poor postoperatively at the outset of this project, we felt that this would be a step for the future. Once regular monitoring for delirium was in place, we would be better placed to introduce surgically targeted delirium management schemes, and thus be able to follow in separate projects, whether, for example, pain and analgesia had been appropriately reviewed.

Of note is that delirium is an outcome measure in the National Hip Fracture database as a postsurgical complication.<sup>16</sup> This project was conducted in a single centre, however, a top-down approach could also be of benefit, as it is noted that the National Emergency Laparotomy Audit does not include delirium or 4AT surveillance as an outcome measure,<sup>29</sup> despite the procedure encumbering

similar delirium antecedent factors. Such a change could highlight the awareness that delirium needs in the surgical environment. Locally, SAFT collects data on delirium in the frail postoperative patients to review outcomes and to improve care of patients with delirium.

Our approach was labour-intensive and reliant on regular teaching sessions. This could not continue indefinitely. Going forward, such sessions would be conducted 4 monthly for junior medical staff during induction periods with frailty nurses providing sessions for nursing staff at similar intervals. Towards the end of this project, several specialties in this centre were migrating to electronic note platforms (in this case eKORA), where specific types of entry form exist for different clinical encounters (such as uploading of operation notes, admission forms and certification of death). A specific postoperative review form which would require the 4AT to be filled in before submission, was discussed as a possible further intervention once the surgical departments had migrated to this system, as it was felt an electronic system would make completion easier. This migration has not yet occurred.

## CONCLUSIONS

In summary, delirium is the most common postoperative complication in the elderly and is significantly under-diagnosed and recognised. Medical staff should assess patients with a specific and sensitive validated scoring tool, the 4AT, on admission and 1 day postoperatively (to allow for the wearing off of anaesthetic). Doing so will enable earlier recognition of potential triggering causes as well as earlier treatment, and thus reduce mortality and morbidity due to both delirium and its associated effects. The 4AT is ideal for this as it is a short tool, which is easy to train staff to use appropriately and is sensitive and specific for delirium.

During this project, we educated staff in the use of the 4AT and promoted awareness via reminders both on ward rounds and via poster media. We had begun to form a network of staff to continue our work, but further action is required with top-down interventions via inclusion of delirium surveillance in national audit schemes and consideration of funding for accredited CPD schemes. This project was incredibly valuable as a learning experience and should provide the launchpad for several further improvement projects to build on the progress made.

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**Contributors** KAB collected data, performed interventions such as tea-trolley teaching sessions, designed the POSTOPED poster, collected data, analysed data and produced the manuscript drafts. KAB drafted the response to peer-review comments and edited the returned manuscript. AM collected data, performed interventions, including tea-trolley teaching, contributed edits to the manuscript and contributed feedback edits to the POSTOPED poster used in interventions. AM

reviewed the response to peer-review comments and the edited manuscript. KAB is the guarantor of this study.

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#### ORCID iD

Keiran Anthony Brown <http://orcid.org/0000-0002-9997-8206>

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**Supplemental figure captions**

**Figure 1-** This is the long-form 4AT assessment tool form that is found on the 4AT website, <https://www.the4at.com/4at-images/4at> This acts as the basis for the 4AT adhesive sticker.

**Figure 2-** This is the A7 size 4AT adhesive sticker used in the project and described as one of the interventions.

**Figure 3-** The A7 adhesive sticker in figure 2 is presented in a mock-up of a ward round in the same continuation notes sheet that was used on the wards where interventions took place. This figure serves to illustrate the way in which the stickers were designed to be used.

**Figure 4-** This figure illustrates the typical patient journey of a surgical inpatient in this centre and the locations where 4AT assessments were being promoted as a means to detect delirium. This is included to illustrate that a typical patient moves wards several times and therefore objective cognitive measures are needed, and thus serial measurements of the 4AT are indicated.

**Figure 5-** This figure is the poster that was poster on wards and doctors offices to remind them to complete the 4AT and what steps should be taken next to identify causes and potential avenues for referral and treatment.

**Figure 6-** These are the slides used in the tea-trolley sessions. There are only 7 slides as brevity was hoped to engender engagement.



## Assessment test for delirium & cognitive impairment

Patient name: \_\_\_\_\_

(label)

Date of birth: \_\_\_\_\_

Patient number: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

Tester: \_\_\_\_\_

### CIRCLE

#### [1] ALERTNESS

This includes patients who may be markedly drowsy (eg. difficult to rouse and/or obviously sleepy during assessment) or agitated/hyperactive. Observe the patient. If asleep, attempt to wake with speech or gentle touch on shoulder. Ask the patient to state their name and address to assist rating.

Normal (fully alert, but not agitated, throughout assessment)	0
Mild sleepiness for <10 seconds after waking, then normal	0
Clearly abnormal	4

#### [2] AMT4

Age, date of birth, place (name of the hospital or building), current year.

No mistakes	0
1 mistake	1
2 or more mistakes/untestable	2

#### [3] ATTENTION

Ask the patient: "Please tell me the months of the year in backwards order, starting at December."  
To assist initial understanding one prompt of "what is the month before December?" is permitted.

Months of the year backwards	Achieves 7 months or more correctly	0
	Starts but scores <7 months / refuses to start	1
	Untestable (cannot start because unwell, drowsy, inattentive)	2

#### [4] ACUTE CHANGE OR FLUCTUATING COURSE

Evidence of significant change or fluctuation in: alertness, cognition, other mental function (eg. paranoia, hallucinations) arising over the last 2 weeks and still evident in last 24hrs

No	0
Yes	4

**4 or above:** possible delirium +/- cognitive impairment  
**1-3:** possible cognitive impairment  
**0:** delirium or severe cognitive impairment unlikely (but delirium still possible if [4] information incomplete)

## 4AT SCORE

#### GUIDANCE NOTES

The 4AT is a screening instrument designed for rapid initial assessment of delirium and cognitive impairment. A score of 4 or more suggests delirium but is not diagnostic: more detailed assessment of mental status may be required to reach a diagnosis. A score of 1-3 suggests cognitive impairment and more detailed cognitive testing and informant history-taking are required. A score of 0 does not definitively exclude delirium or cognitive impairment: more detailed testing may be required depending on the clinical context. Items 1-3 are rated solely on observation of the patient at the time of assessment. Item 4 requires information from one or more source(s), eg. your own knowledge of the patient, other staff who know the patient (eg. ward nurses), GP letter, case notes, carers. The tester should take account of communication difficulties (hearing impairment, dysphasia, lack of common language) when carrying out the test and interpreting the score.

Version 1.2. Information and download: [www.the4AT.com](http://www.the4AT.com)

**Alertness:** Altered level of alertness is very likely to be delirium in general hospital settings. If the patient shows significant altered alertness during the bedside assessment, score 4 for this item. **AMT4 (Abbreviated Mental Test - 4):** This score can be extracted from items in the AMT10 if the latter is done immediately before. **Acute Change or Fluctuating Course:** Fluctuation can occur without delirium in some cases of dementia, but marked fluctuation usually indicates delirium. To help elicit any hallucinations and/or paranoid thoughts ask the patient questions such as, "Are you concerned about anything going on here?"; "Do you feel frightened by anything or anyone?"; "Have you been seeing or hearing anything unusual?"

© 2011-2014 MacLulich, Ryan, Cash

4AT tool (circle score in each section on right and total score)		Circle
Alertness: this includes patients who are markedly drowsy (e.g. difficulty to rouse and/or obviously sleepy during assessment) or agitated/hyperactive. Observe the patient, if asleep, attempt to wake. Ask patient to state name and address to assist rating	Normal (fully alert, but not agitated, throughout assessment)	0
	Mild sleepiness for <10 secs after waking then normal	0
	Clearly abnormal	4
AMT4 (age, D.O.B., place (hospital), current year)	No mistakes	0
	1 mistake	1
	≥ 2 mistakes/untestable	2
Attention: Ask the patient: "please tell me the months of the year in backwards order, starting at December"	Achieves 7 months or more correctly	0
	Starts but scores <7 months/refuses to start	1
	Untestable (cannot start because unwell, drowsy, inattentive)	2
Acute change or fluctuating course: Evidence of significant change or fluctuation in alertness, cognition, other mental function (e.g. paranoia, hallucinations) arising over the last 2 weeks and still evident in the last 24 hours.	No	0
	Yes	4
SCORE 4 OR MORE THIS IS POSSIBLE DELIRIUM +/- CONGNITIVE IMPAIRMENT		Total

**HISTORY/CONTINUATION SHEET**

Ward/Clinic/ Hosp. **NINEWELLS** Cons. \_\_\_\_\_

Burname **SMITH** C.H.I. No. **0000000000**

First Name **JOHN** (age 68) M. State \_\_\_\_\_ Sex \_\_\_\_\_

Address \_\_\_\_\_

UNIT/WARD/DEPT. **Surgery** G.P. & Address (G.P. Requests only) \_\_\_\_\_

USE BLOCK LETTERS OR PATIENT LABEL

DATE **01/01/01** Page \_\_\_\_\_

**Ward round - consultant surgeon**

**Day 1 post-op review - laparoscopic cholecystectomy**


**NEWS 1 - HR100, 4AT = 0 (see below)**

**Slightly in discomfort, well controlled with break through medications**

**wound clean**

**otherwise well, keen for home**

**HS 1+1+0**



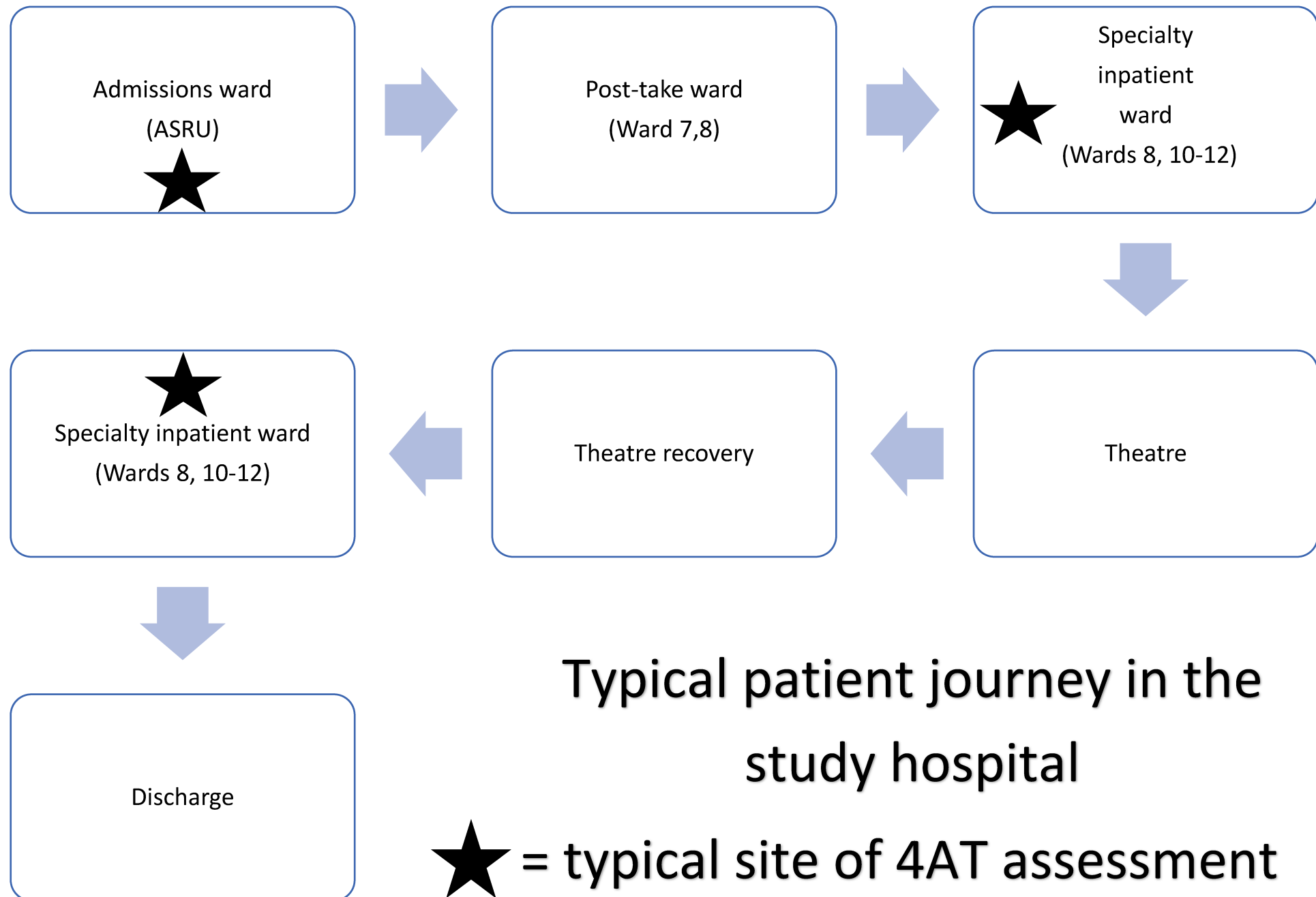
**plan - regular charting of bowels**

**keep eye on pain aim home tomorrow.**

*[Signature]*

**F42**

4AT tool (circle score in each section on right and total score)		Circle
Alertness: this includes patients who are markedly drowsy (e.g. difficulty to rouse and/or obviously sleepy during assessment) or agitated/hyperactive. Observe the patient, if asleep, attempt to wake. Ask patient to state name and address to assess rating	Normal (fully alert, but not agitated, throughout assessment)	<b>0</b>
	Mild sleepiness for <10 secs after waking then normal	0
	Clearly abnormal	4
AMT4 (age, D.O.B., place (hospital), current year)	No mistakes	<b>0</b>
	1 mistake	1
	≥ 2 mistakes/untestable	2
Attention: Ask the patient "please tell me the months of the year in backwards order, starting at December"	Achieves 7 months or more correctly	<b>0</b>
	Starts but scores <7 months/refuses to start	1
	Untestable (cannot start because unwell, drowsy, inattentive)	2
Acute change or fluctuating course: Evidence of significant change or fluctuation in alertness, cognition, other mental function (e.g. paranoia, hallucinations) arising over the last 2 weeks and still evident in the last 24 hours.	No	<b>0</b>
	Yes	4
<b>SCORE 4 OR MORE THIS IS POSSIBLE DELIRIUM +/- COGNITIVE IMPAIRMENT</b>		<b>0</b>
Total		<b>0</b>



## POST-OPED?

Delirium Assessment in the Older Surgical Patient.

**Perform a Post-Op 4AT in all patients  $\geq 65$  Years****PAIN**- Are they on appropriate analgesia? Regular/PRNs? What is the source of the pain?

- How much PRN are they using? Would they benefit from a PCA or a Pain Team Review?

**ORAL INTAKE/Nutrition**- Is there a food chart? Do they have **IV fluids prescribed?**

- **NG/PEG/TPN?**

**SUGARS**- Are they diabetic? Any hypoglycaemic or hyperglycaemic episodes?

- Review blood sugar chart and check for insulin and diabetic medications.

**TESTS**- What post-op investigations have been done?

- **Review the blood and micro results**
  - AKI? Any Electrolyte abnormalities?
  - Post-op Anaemia?
  - Any cultures/swabs awaited or back?
  - Any post op imaging to request or review?
  - Anything to support post-op infection or underlying collection?

**ORAL HYGIENE**- Dentures in? Able to brush teeth? Dry lips? Check tongue and palate.**POST-OP NAUSEA**- **Anti-emetics prescribed?** Regular? PRN? Are they needed orally or IV?**ELIMINATION**-

- Catheter in place? Check urine output and fluid balance.
- ? Retention -Do a bladder scan.
- Review all drain sites. Output? Check for erythema,pus,pain.
- Bowels moving? Stool Chart and consider regular laxatives.

**Drugs**- Any new medications? Check for Anti-cholinergics ,neuropathics and other centrally acting drugs? Are they opiate toxic?

Refer to Surgical Acute Frailty Team if any concerns regarding Delirium.




# Why does Delirium matter in post op patients?

# Increased stay.....

## SCIENTIFIC ARTICLES

### Health Economic Implications of Perioperative Delirium in Older Patients After Surgery for a Fragility Hip Fracture

Zywiell, Michael G. MD<sup>1</sup>; Hurley, Richard T. MD<sup>1</sup>; Perruccio, Anthony V. PhD<sup>1</sup>; Hancock-Howard, Rebecca L. PhD<sup>2</sup>; Coyte, Peter C. PhD<sup>2</sup>; Rampersaud, Y. Raja MD<sup>1</sup> [Author Information](#) 

The Journal of Bone and Joint Surgery: May 20, 2015 - Volume 97 - Issue 10 - p 829-836  
doi: 10.2106/JBJS.N.00724

**One hundred and sixteen (48%) of the 242 patients developed perioperative delirium during their stay in the hospital.**

**Compared with patients with no delirium, delirium was associated with a mean incremental total length of hospital stay of 7.4 days**



# Increased mortality....

Open Access

Research

## **BMJ Open** Delirium as a predictor of mortality in US Medicare beneficiaries discharged from the emergency department: a national claims-level analysis up to 12 months

---

Juhi Israni, Adriane Lesser, Tyler Kent, Kelly Ko

**Over time, delirium was consistently associated with increased mortality risk compared with controls up to 12 months (HR 2.07; 95% CI 2.01 to 2.13).**

**Covariates that affected mortality included older age, comorbidity and presence of dementia.**

Eur J Vasc Endovasc Surg (2020) 59, 598–605

## Incidence and Risk Factors for Delirium in Elderly Patients with Critical Limb Ischaemia

Joost P. Roijers<sup>a,\*</sup>, Yannick S. Rakké<sup>a</sup>, Cornelis J. Hopmans<sup>a</sup>, Mathijs G. Buimer<sup>a</sup>, Hans G.W. de Groot<sup>a</sup>, Gwan H. Ho<sup>a</sup>, Eelco J. Veer<sup>a</sup>, Paul G.H. Mulder<sup>a</sup>, Lijckle van der Laan<sup>a,b</sup>

<sup>a</sup>Department of Surgery, Amphia Hospital Breda, The Netherlands

<sup>b</sup>Department of Cardiovascular Sciences, KU Leuven, Belgium

Common to all specialities...

### Risk factors;

- Age
- Operation time
- WCC >10.0
- Urea > 7.5
- Immobility
- Prior cognitive dysfunction
- Blood transfusions
- Presence of urinary catheter
- Opioid analgesia



The image shows the cover of an issue of The American Journal of Surgery (AJS). The cover features the journal's logo and a graphic of four stylized human heads in different colors (orange, blue, green, purple) overlapping each other. Below the logo, the text reads: 'CLINICAL SCIENCE | VOLUME 208, ISSUE 1, P26-32, JULY 01, 2014'. The main title of the article is 'Incidence and risk factors of delirium in the elderly general surgical patient'. Below the title, the authors are listed: 'Steve M.M. de Castro, Ph.D., M.D. • Çağdaş Ünlü, M.D. • Jurriaan B. Tuijnman, Ph.D., M.D. • ... Bart A. van Wagenveld, Ph.D., M.D. • E. Philip Steller, Ph.D., M.D. • Bart C. Vroenenraets, Ph.D., M.D. • ...'. There is a 'Show all authors' link. At the bottom, it says 'Published: March 28, 2014 • DOI:'. The journal's name 'AJS The American Journal of Surgery' is at the top left.

### Incidence & Risk Factors of Postoperative Delirium After Spinal Surgery in Older Patients

Taewook Kang, SiYoung Park<sup>✉</sup>, Jin Hyeok Lee, Soon Hyuck Lee, Jong Hoon Park, Seul Ki Kim & Seung Woo Suh

"Doctor. Ms X seems a bit agitated!"

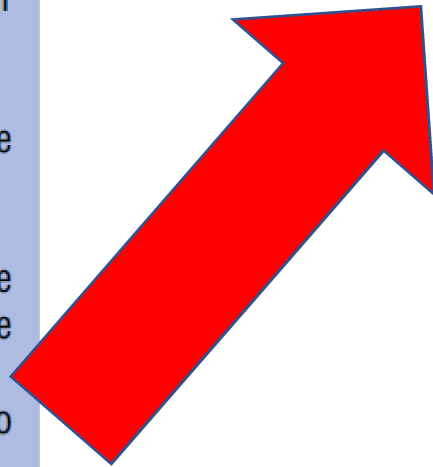
**Box 1** Standard interview questions for researchers with nursing staff to elicit delirium

I have just interviewed\_\_ and I wonder if you could help me form an opinion as to whether he/she has been experiencing delirium or confusion.

1. How many days approximately have you been looking after \_\_?
2. Do you think he/she is delirious or acutely confused?
3. Has there been a sudden change in \_\_'s mental state since coming into hospital?
  - a. If so, when did you notice this change?
4. Do you think he/she is able to focus well when you are talking to him/her or does he/she tend to ramble off the point?
5. Does he/she seem better at any period in the day compared to other times?
6. Has\_\_ 's level of consciousness been altered at all—has he/she been drowsy or not interacting, or perhaps hyperaware at times?

**4AT**

**RAPID CLINICAL TEST FOR  
DELIRIUM**



# The 4AT is a validated screening tool for delirium- which relates to the DSM-V criteria for delirium

## ALERTNESS AMT4 ATTENTION ACUTE CHANGE

4AT tool (circle score in each section on right and total score)	Circle	
Alertness: this includes patients who are markedly drowsy (e.g. difficult to rouse and/or obviously sleepy during assessment) or agitated/hyperactive. Observe the patient if asleep, attempt to wake. Ask patient to state name and address to assist rating.	Normal (fully alert, but not agitated, throughout assessment)	0
	Mild sleepiness for <10 secs after waking then normal	4
	Clearly abnormal	
AMT4 (age, D.O.B, place (hospital), current year)	No mistakes	0
	1 mistake	1
	≥2 mistakes/untestable	2
Attention: Ask the patient: "please tell me the months of the year in backwards order, starting at December."	Achieves 7 months or more correctly	0
	Starts but scores <7 months/refuses to start	1
	Untestable (cannot start because unwell, drowsy, inattentive)	2
Acute change or fluctuating course: Evidence of significant change or fluctuation in alertness, cognition, other mental function (e.g. paranoia, hallucinations) arising over the last 2 weeks and still evident in last 24 hours.	No	0
	Yes	4
<b>Total</b>		

### DSM-5\*

The presence of delirium requires all the criteria to be met:

- Disturbance in attention and awareness
- Disturbance develops acutely and tends to fluctuate in severity
- At least one additional disturbance in cognition
- Disturbances are not better explained by a preexisting dementia
- Disturbances do not occur in the context of a severely reduced level of arousal or coma
- Evidence of an underlying organic cause or causes

# POST-OPED

PAIN

ORAL INTAKE/NUTRITION

SUGARS

TESTS

ORAL HYGIENE

POST-OP NAUSEA

ELIMINATION (INC DRAINS)

DELIRIUM

## ELDERLY PATIENT RETURNED FROM SURGERY?

Have they been POST-OPED?

**PAIN**- Are they on appropriate analgesia? Regular/PRNs? What is the source of the pain?

- How much PRN are they using? Would they benefit from a PCA?
- Do they need a pain team review?

**ORAL INTAKE/Nutrition**- Is there a food chart? Do they have IV fluids prescribed? Are they known to dietetics?

- Do they need **Ensures/NG/PEG/TPN**?
- Significant **anaemia**? B12/Folate, Iron studies

**SUGARS**- Are they diabetic? Any Hyper/hypo BMs?

- Review regular insulins and Diabetic drugs.

**TESTS**- What post op investigations have been done?

- **Review the bloods**
  - Any AKI? Any Electrolyte abnormalities?
  - Anaemia?
  - Any cultures/swabs/PCRs awaited?
- Any post op imaging to request/review?
  - Suspect infection? Collections? Drains dislodged?

**ORAL HYGIENE**- Dentures clean? Brushing? Dry/Ulcered lips? Mouth sponges needed?

**POST-OP NAUSEA**- **Anti-emetics prescribed?** Regular? PRN? IV + PO?

- What is the source of the nausea?

**ELIMINATION**-

- Catheter in place? Check their Input/output.
- Retention? Do a bladder scan.
- Review all drain sites. Output? Erythema/pus/pain?
- Bowels moving? Stool Chart, regular laxatives, IV fluids.

**DELIRIUM**- DO A POST-OP 4AT

Compare to their admission 4AT, get a collateral history.