INTENS CRIT CARE NUR 76 (2023) 103398

Contents lists available at ScienceDirect

Intensive & Critical Care Nursing

journal homepage: www.sciencedirect.com/journal/intensive-and-critical-care-nursing

Research Article

Sustained adherence to a delirium guideline five years after implementation in an intensive care setting: A retrospective cohort study

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ARTICLE INFO

Keywords:
Adherence
Delirium
Guideline
Implementation
Critical care
Intensive care unit

ABSTRACT

Objective: To explore the level of sustained adherence to a delirium guideline in a university intensive care unit setting five years after cessation of a multifaceted implementation program conducted between April 2012 and February 2015.
Research methodology/design: A quantitative retrospective cohort study was conducted using the medical records of all eligible patients admitted to the intensive care unit from November 2019 to February 2020.
Setting: Four adult intensive care units in a university hospital.
Main outcome measures: Primary outcome is adherence to seven performance indicators indicated in the guideline being: light sedation days, mobilisation, physical therapy, analgesics use, delirium and sedation screening and avoiding benzodiazepines. Clinical patient outcomes such as Intensive care unit stay and prevalence of delirium were also collected. Data were compared with the results of the original implementation study's using descriptive statistics and Kruskal-wallis and Chi-square tests.
Results: Data of 236 patients were included. The most notable decrease in adherence concerned 'number of light sedation days' (−28 %). Adherence to three indicators had increased: 'number of days receiving out-of-bed mobilisation' (+11 %); 'number of days receiving physical therapy' (+9%); and 'use of analgesics' (+12 %). Comparison of clinical outcomes showed an increased intensive care unit length-of-stay from 3 to 5 days ($P < 0.001$). Prevalence of delirium increased over five years from 41 % to 43 % of patients while delirium duration decreased from a median of 3 days to a median of 2 days.
Conclusion: Five years after ceasing of implementation efforts regarding the delirium guideline, partial sustainability has been achieved. The decrease in adherence to 'number of light sedation days' could have contributed to the increased length-of-stay on the intensive care unit.
Implications for clinical practice: After implementation, routine monitoring of performance indicators is required to evaluate the level of sustainment. Further, revisiting reasons for decrease in guideline adherence when contextual changes occur. Reassessment of the perceived barriers and facilitators can guide adaptations to sustain, or even improve, adherence.

Introduction

Delirium is defined as a disturbance in attention with reduced awareness of the environment developing over a short period of time, often fluctuating in severity during the day (American Psychiatric Association, 2022). Additional disturbances in cognition include memory deficit, disorientation, or disturbances in language, perception or visuospatial ability (American Psychiatric Association, 2022). Delirium is the direct physiological consequence of another, non pre-existing physical medical condition, substance intoxication or withdrawal and the symptoms cannot otherwise be explained (American Psychiatric Association, 2022). Three subtypes can be distinguished: hyperactive,

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https://doi.org/10.1016/j.iccn.2023.103398
Received 15 July 2022; Received in revised form 17 January 2023; Accepted 18 January 2023
Available online 31 January 2023

hypoactive, and mixed delirium (Krewulak et al., 2018; American Psychiatric Association, 2022).

A systematic review found an overall pooled prevalence of delirium of 31 % (95 % CI 24–41 %) on intensive care units (ICUs), whereby the prevalence per study depended on type of delirium, type of ICU and patient characteristics (Krewulak et al., 2018). This finding confirmed that patients receiving ICU treatment are at risk of developing delirium (Kotfis et al., 2018; Salluh et al., 2015) due to predisposing factors such as mechanical ventilation (MV), severity of illness, infection, deep sedation and the use of benzodiazepines (Berger et al., 2020; Cavallazzi et al., 2012; Kotfis et al., 2018; Salluh et al., 2015). Delirium is associated with prolonged ICU- and hospital length-of-stay (LOS), prolonged duration of MV, increased chance of premature death, as well as cognitive impairment up to eighteen months after hospital discharge (Cavallazzi et al., 2012; Kotfis et al., 2018; Krewulak et al., 2020; Salluh et al., 2015). Evidence confirming these predisposing factors has furthered the development of evidence-based ICU delirium guidelines such as the Pain, Agitation/sedation, Delirium, Immobility, and Sleep (PADIS) guideline (Devlin et al., 2018). The ABCDEF-bundle, which represents an evidence-based guide for clinicians to approach the organisational changes needed for optimising ICU patient recovery and outcomes, was developed to facilitate implementation of the PADIS-guideline (Ely, 2017), previously known as the Pain Agitation Delirium (PAD)-guideline (Barr et al., 2013). Implementation of the PADIS-guideline or ABCDEF-bundle in practice resulted in lower number of patients who developed delirium, less in-hospital mortality, shorter delirium duration, lesser restraint use, and fewer coma days, while more cases of delirium were detected and the number of MV-free days had increased (Balas et al., 2014; Pun et al., 2019; Trogrlić et al., 2019). Specifically, the ABCDEF-bundle components delirium and mobilisation were found to be associated with decreased ICU-LOS and fewer MV-days (Frade-Mera et al., 2022).

From April 2012 to February 2015, a prospective multicentre, pre-post implementation study was performed, aimed at implementing a delirium guideline in six ICUs in the Netherlands (Trogrlić et al., 2019). This guideline was a combination of the PAD and Dutch ICU delirium guidelines (Barr et al., 2013; Spronk et al., 2010; Trogrlić et al., 2019). An increase in guideline adherence was found, which was significant for 5 out of 7 performance indicators (Trogrlić et al., 2019). Associated improvements were seen in reductions of the delirium duration and the number of coma days (Trogrlić et al., 2019).

Five years after implementation of these guidelines, one of the hospitals in which the study was conducted took into use a new building, which implied changes of contextual factors on the ICU such as room and ward lay-out, composition of nursing teams, new electronic patient record system, removal of video-surveillance, and new technical appliances such as patient hoists, infusion pumps, and beds. In addition, after the implementation study, the PAD-guideline (Barr et al., 2013) was updated to the PADIS-guideline to include immobilisation and sleep disruption as main themes (Devlin et al., 2018). Changes in leadership, staff stability and characteristics of the implementers of a guideline are known to influence its sustainability (Shelton et al., 2018) Five years after implementation of the delirium guideline a study was performed with the aim to ascertain the possible influence of these contextual changes on the level of sustainability. Up until now, scarce data were available about sustained adherence to ICU guidelines (Álvarez-Lerma et al., 2018; Stirman et al., 2012). Sustainment research plays a vital part in understanding what is needed for successful implementation and its sustainment (Shelton et al., 2018; Stirman et al., 2012).This need for sustainment research is emphasised by concerns regarding the sustainment of implementation successes and concerns regarding the linked costs and improved outcomes (Shelton et al., 2018). This study aimed to explore the level of sustained adherence to the delirium guideline recommendations at a university hospital ICU five years after the cessation of a multifaceted implementation program. For this study, the level of sustainability was defined as the adherence to the delirium guideline five years after implementation.

Methods

Study design and population

A retrospective cohort study in a 38-bed ICU of a university hospital in the Netherlands was conducted. Data were analysed of all patients aged 18 years or older admitted to the ICU for ≥24 h in the period from November 2019 until February 2020. The exclusion criteria were a primary neurologic diagnosis, burn injuries or being a patient at the centre for home ventilation in need of chronic respiratory support outside the ICU, which are the criteria applied in the previous studies (Trogrlic et al., 2020; Trogrlić et al., 2019).

Sustained adherence to guidelines

This study used the definition of sustainability from Moore and colleagues: “After a defined period of time, the behaviour change is maintained, the behaviour change may evolve or adapt based on changes in the environment, team structure and policies while continuing to produce benefits for individuals/systems” (Moore et al., 2017).

Changes after initial implementation of intensive care unit delirium guideline

The commissioning of the new hospital with associated new ICU-layout and altered work methods included changes in nursing team-leaders, setting up smaller nursing teams and appointing dedicated doctors per ICU. These changes are known to affect the inner contextual factors, which are highly influential to sustainment (Shelton et al., 2018). Contextual changes that were expected to influence the different aspects of the delirium guideline included longer visiting hours, removal of video-surveillance, and changes to patient surroundings such as bigger room size, layout (including a ceiling patient-hoist in every room) and soundproofing. In addition, a new electronic patient record was put into use including standardised scoring templates for, among other things, pain-, sedation- and delirium assessment. Agreements were made to consult the physical therapist and dietician for patients admitted to the ICU for ≥48 h (Table 1).

Outcome measures

The primary outcome was the level of adherence to the performance indicators defined in the previous studies (Trogrlić et al., 2019): number of days with a delirium screening, number of days with a sedation assessment, number of light sedation days, avoiding benzodiazepines, analgesia first, days with physical therapist treatment, days with out-of-bed mobilisation, with out-of-bed mobilisation not including sitting at the edge of the bed. Complete definitions of the performance indicators can be found in Table 2. Secondary outcomes were clinical outcomes being: Delirium prevalence, delirium duration, coma days, duration of MV, ICU-LOS, ICU mortality and hospital mortality.

Data collection & procedures

For this study, new data were collected from patient records and compared with the data of each of the three periods of the previous studies (Trogrlic et al., 2020; Trogrlić et al., 2019); i.e., before start of implementation (baseline period); after complete guideline implementation (period 1); and process evaluation 6 months after implementation (period 2) (Fig. 1).

Delirium was screened by nurses with the Intensive Care Delirium Score Checklist (ICDSC), with a range of 0–8 and a score of ≥4 indicating delirium (Bergeron et al., 2001). Coma was determined using the

Table 1
Contextual changes between the former hospital and the new hospital.

Former	New	Possible effect on delirium guideline
2 ICUs with 32 beds	4 ICUs with 9–10 beds each.	–
Approximately 70–80 nurses per unit	Approximately 35 – 40 nurses per unit	Overall.
2 nursing team leaders per unit	1 nursing team leader per unit	Overall.
ICU-doctors were not linked to a specific ICU	Every unit has a group of dedicated ICU-doctors	Overall.
Visiting hours 11:00 – 12:30 and 15:00 – 20:00	Visiting hours 11:00 – 21:00	Increased family participation
Video surveillance	No video surveillance	Increase sedation and/ or restraint use.
Nursing station	Individual station per patient room	
	Increased room size	Easier mobilisation
2 mobile patient hoists per ICU	A patient hoist on ceiling of every patient room	Easier mobilisation
	New beds with chair-option	Easier mobilisation
	Rooms are soundproof	Improved sleep
2 different electronic patient records	Electronic patient records merged into one new system.	Easier registration. Standardised scoring templates for, among other things, pain-, sedation- and delirium assessment to be filled out in one single form at the start of each shift.
All scoring instruments needed to be filled out separately in old electronic patient records.	A standardised scoring template for multiple scoring instruments is available, to be filled out at the start of each nursing shift.	Easier registration.
No agreements on when to consult the physical therapist or dietician	Work-agreements to consult the physical therapist and dietician after an ICU-stay ≥48 h	Earlier involvement of physical therapist and therefore more and more intensive mobilisation.

ICU – intensive care unit.

Table 2
Performance indicators.

Performance Indicator	Method of measurement
Percentage of assessments of delirium with ICDSC	Total number of ICDSC assessments divided by the total number of patient days on the ICU.
Percentage of sedation assessments	Total number of days with at least one recorded sedation assessment divided by the total number of patient days on the ICU.
Percentage of mechanically ventilated patients receiving light sedation and/ or opioids.	Number of light sedation days divided by the total number of ICU days on MV AND having received sedation and/or opioids. Definition of light sedation; – Richmond Agitation and Sedation Scale (RASS) ≥ -3
Percentage of mechanically ventilated patients sedated with benzodiazepines.	Number of sedation days with benzodiazepines (continuous IV for more than 2 h) divided by the number of ICU days on MV AND having received sedation and/or opioids. Will be reported as percentage of sedated MV days without the use of benzodiazepines (100 % - outcome)
Percentage of analgesia-first sedation in mechanically ventilated adult ICU patients.The % of days on which sedatives were administered without standard analgesic medication (norm: 0 %)	Number of patient sedation days without the use of analgesia divided by the total number of patient sedation days. Will be reported as percentage of sedated MV days with the use of analgesia (100 % -outcome)
Percentage of patients, with a length of stay (LOS) of more than 48 h, receiving physical therapy.	Number of patient days with physical therapist divided by the total number of patient ICU days; included with LOS greater than 48 h.
Percentage of patients, with a LOS of more than 48 h, receiving out-of-bed mobilisation when feasible.	Number of patient days with out-of-bed mobilisation (not including sitting on the edge of the bed) divided by the total number of patient ICU days; included with LOS greater than 48 h.

Richmond Agitation-Sedation Scale (RASS), with a range of -5 to 5 and a score of -4 or -5 indicating coma (Ely et al., 2003). In addition, the following data were collected, in line with the original study: number of ICU-days, sex, age, admission status, Acute Physiology and Chronic Health Evaluation IV (APACHE-IV), number of MV-days, ICU mortality, in-hospital mortality, ICDSC scores, RASS-scores, daily sedation administration, daily analgesics administration, number of coma days, number of days receiving physical therapy, and number of days receiving out-of-bed mobilisation (Trogrlić et al., 2019).

A description of the patient group, and the corresponding outcome registrations in the electronic patient records were sent to the hospital's data-analytical department, where the data described in the previous paragraph were extracted from the electronic patient records. The raw data were sent in separate files to the principal investigator, who then filtered the raw data using the in- and exclusion criteria and obtained data to supplement the raw data. Data from included patients were merged into two separate files, one for the day-to-day-level data and one for the patient-level data, and processed and analysed.

Individual patients' data were gathered until the patients' discharge from the ICU or until the 15th of March 2020.

Data analysis

A quantitative descriptive analysis was conducted for all study parameters. Continuous data are presented as mean and standard deviation (SD) or as median and interquartile range (IQR). Categorical data and adherence to performance indicators are described using proportions and percentages.

Significance of the achieved sustainment was studied including only the periods from after complete implementation and funding was withdrawn (Stirman et al., 2012), referred to as periods 1, 2 and 3 (see Fig. 1). All categorical outcomes were analysed using the chi-square test for samples of less than a thousand per group or when comparing more than two groups; otherwise, Fisher's 2-sided exact test was used (McDonald, 2014). The continuous data were analysed using the Kruskal Wallis test for multiple groups and the Mann-Whitney *U* test when comparing two groups. Differences were considered significant when $p < 0.05$. All analyses were performed using IBM SPSS statistics version 26.

Only the number of days with delirium and number of patients with delirium could be subject to missing data, in which case listwise deletion was used.

Ethical considerations

This study complied with the 2013 version of the declaration of Helsinki (The Helsinki Declaration of the World Medical Association, 2013). The study protocol was reviewed by the Erasmus MC Medical Ethics Review Board (number MEC 2020-0923) and determined to be

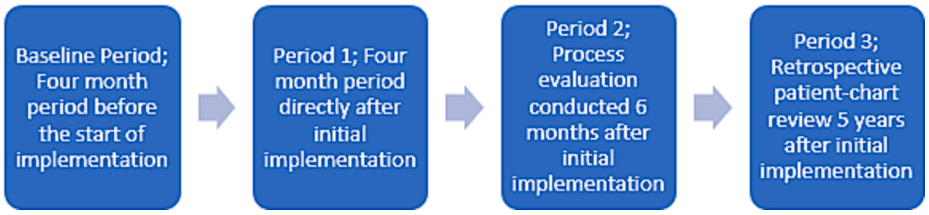

Fig. 1. Periods of measurement.

not subject to the Netherlands Medical Research Involving Human Subjects Act, which implies that no intervention was done impacting on physical or psychological integrity. Considering the retrospective character of the study, the large numbers of patients, and the population's high morbidity and mortality rate, obtaining individual informed consent was considered unfeasible, in line with Dutch legislation (van Bon-Martens and van Veen, 2019). Patient data were pseudonymised and handled according to the European Union General Data Protection Regulation (van Bon-Martens and van Veen, 2019).

Results

During the four-month period of data collection, 486 patients had been admitted to the ICU, of whom 94 were not eligible and 156 were excluded, leading to the inclusion of 236 patients. Of the 156 excluded patients, 126 had a primary neurological diagnosis (Fig. 2). Included patients had a median age of 58 (IQR 48–66) years old, and 62.3 % of patients were male – characteristics that are similar to those in the other periods. The total number of ICU days for the 236 patients was 2053, significantly higher than in the previous periods ($p < 0.001$); i.e., 242 patients with 1571 ICU days directly after implementation (period 1) and 117 patients with 924 ICU days 6 months after implementation (period 2). Most patients (58.9 %) had been admitted to the ICU with a medical admission status. The median APACHE-IV score of 71 (IQR 52–92) was significantly higher than that in post-implementation periods in the earlier studies; i.e., 63 (IQR 41–89) directly after implementation and 61 (IQR 44–78) 6-months after implementation ($p = 0.037$). Medical admission status also was significantly different between periods ($p = 0.033$). Demographics are shown in Table 3.

Primary outcomes – Guideline adherence

Comparing the data of period 1 with those of period 3 made clear that the adherence to four of the performance indicators had decreased: delirium screening, sedation assessments, light sedation and avoiding benzodiazepines. Still, adherence had increased for the three other performance indicators: analgesia first, physical therapy and out-of-bed mobilisation.

Comparing the data of period 2 with those of period 3 revealed that adherence to three performance indicators had remained stable (sedation assessments, out-of-bed mobilisation and physical therapy), adherence to two had decreased (light sedation days and avoiding benzodiazepines), and adherence to two had increased (delirium screening and analgesia first).

The largest decrease in adherence over five years concerned 'number of light sedation days', with a decrease in percentage points of 28 % ($p < 0.001$) (Table 4) since implementation. Adherence to 'avoiding benzodiazepines' had decreased by 7 %. The largest increase in adherence

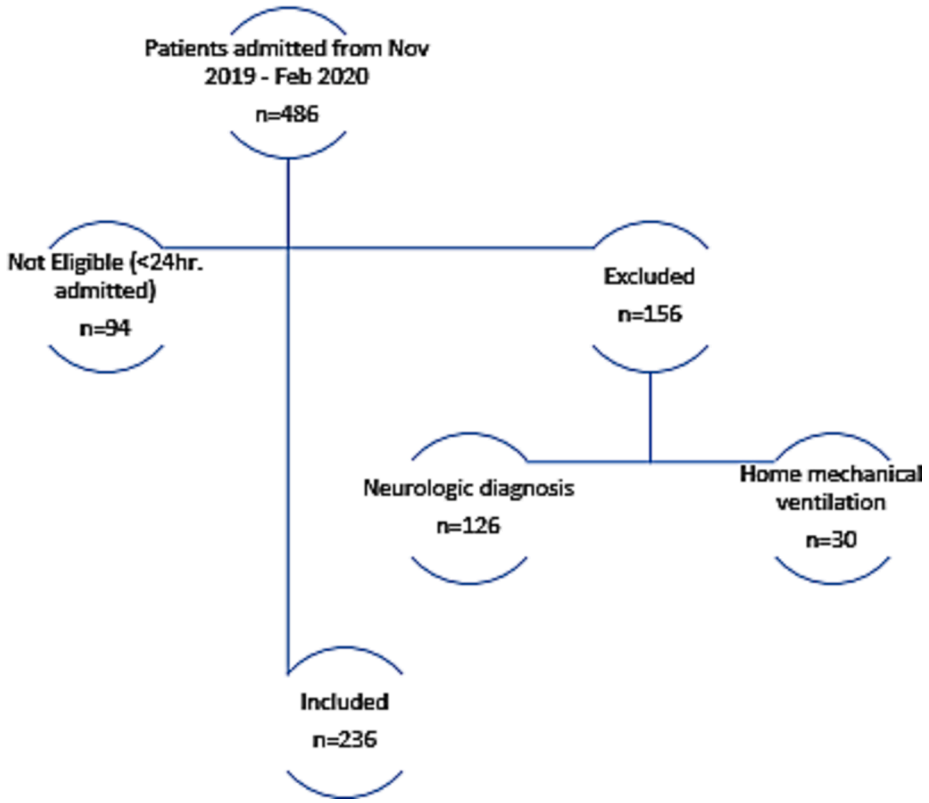

Fig. 2. Flowchart of patient inclusion.

Table 3
Patient demographics and clinical characteristics.

Characteristics	Baseline: Apr 2012– May 2013	Period 1: Directly after ceasing implementation efforts Nov 2014 – Feb 2015	Period 2: 6 Months after ceasing of implementation efforts Sept 2015 – Oct 2015	Period 3: 5 years after ceasing implementation efforts Nov 2019 – Feb 2020	p-value
Patients, n	247	242	117	236	
Total ICU[a] days, n[e]	1634	1571	924	2053	<0.001
Sex, n (%)[f]					0.785
Male	156 (63.2)	156 (64.5)	77 (65.8)	147 (62.3)	
Female	91 (36.8)	86 (35.5)	40 (34.2)	89 (37.7)	
Age (Years)[b,e]	60 (45–70)	60 (48–69)	58 (44–68)	58 (48–66)	0.764
Admission status, n (%)[f]					0.033
Medical	136 (55.1)	144 (59.5)	46 (56.1)	139 (58.9)	
Elective surgery	48 (19.4)	43 (17.8)	16 (19.5)	23 (9.7)	
Emergency surgery	63 (25.5)	55 (22.7)	20 (24.4)	74 (31.4)	
APACHE-IV[b,c,e]	67 (48–89)	63 (41–89)	61 (44–78)	71 (52–92)	0.037
MV[d] patients, n (%)[f]	193 (78.1)	192 (79.3)	96 (82.1)	174 (73.7)	0.150

N.B. Significance does not include the baseline group.
[a] *ICU – Intensive care unit.*
[b] *median (IQR).*
[c] *APACHE-II - Acute Physiology and Chronic Health Evaluation II range 0–71. APACHE-IV - Acute Physiology and Chronic Health Evaluation IV range 0–286.*
[d] *MV - Mechanical Ventilation.*
[e] *p-value was calculated using Kruskal-Wallis test.*
[f] *p-value was calculated using Chi-square.*

Table 4
Primary results, changes in performance indicators.

Indicator	Baseline: Apr 2012 – May 2013	Period 1: Directly after ceasing implementation efforts Nov 2014 – Feb 2015	Period 2: 6 Months after ceasing of implementation efforts Sept 2015 – Oct 2015	Period 3: 5 years after ceasing implementation efforts Nov 2019 – Feb 2020	p-value (period 1 vs Period 3)	p-value (period 2 vs Period 3)
Delirium screening, number of days (%) [a]	1511 (92)	1558 (99)	817 (88)	1875 (91)	<0.001	0.013
Sedation assessments, number of days (%) [a]	1490 (93)	1545 (98)	805 (87)	1764 (86)	<0.001	0.379
Light sedation, number of days (%)[b,c]	812 (83)	685 (91)	432 (77)	613 (63)	<0.001	<0.001
Avoiding benzodiazepines, number of days (%) [b,c]	898 (92)	715 (95)	520 (92)	957 (88)	<0.001	0.009
Analgesia first sedation, number of days (%) [a,c]	951 (97)	683 (90)	502 (89)	1073 (99)	<0.001	<0.001
Physical therapy, number of days (%) [a d]	162 (12)	320 (25)	241 (30)	667 (34)	<0.001	0.123
Out-of-bed Mobilisation, number of days (%) [a,d]	111 (8)	168 (13)	176 (22)	475 (24)	<0.001	0.365

N.B. Significance does not include the baseline group.
[a] *p-value was calculated using Chi-square.*
[b] *p-value was calculated using Fishers exact test.*
[c] *numbers only including MV-days with intravenous opioids and/or sedatives.*
[d] *number only including patients admitted >48 h.*

since the implementation concerned out-of-bed mobilisation with an 11 % increase in percentage points ($P < 0.001$), followed by 'analgesia first', with an increase by 9 % ($P < 0.001$), and physical therapy with a 9 % increase ($P < 0.01$). Supplement 1 displays the changes in adherence to the performance indicators.

Clinical outcomes

The duration of delirium did not differ significantly between data period 1 and period 3 ($p = 0.343$) (Table 5). However, there was a significant difference in delirium duration between period 2 (median 4.5 days (IQR 2–11)) and period 3 (median 2 days (IQR 1–5) ($p = <0.001$). The percentage of patients diagnosed with delirium during

Table 5
Secondary results, clinical outcomes.

Outcome	Baseline: Apr 2012–May 2013 (n = 247)	Period 1: Directly after ceasing implementation efforts Nov 2014 – Feb 2015 (n = 242)	Period 2: 6 Months after ceasing of implementation efforts Sept 2015 – Oct 2015 (n = 117)	Period 3: 5 years after ceasing implementation efforts Nov 2019 – Feb 2020 (n = 236)	p-value (period 1 vs period 3)	p-value (period 2 vs period 3)
Patients with delirium during ICU admission, n(%) [a,e,g]	71 (29)	99 (41)	36 (33)	102 (43)	0.711	0.097
Delirium duration days [d,f]	3 (2–10)	3 (1–6)	4.5 (2–11)	2 (1–5)	0.343	<0.001
Number of coma days, n (%) [f]	214 (15)	74 (5)	57 (7)	392 (22)	<0.001	<0.001
Duration of MV (days) [b,d,f]	1 (1–3)	2 (1–5)	3 (1.5–8)	3 (2–9)	0.164	0.581
ICU-LOS [a,c,d,f]	3 (2–6)	3 (2–7)	3 (2–8)	5 (3–11)	<0.001	0.002
ICU mortality, n (%) [a,e,h]	51 (21)	41 (17)	14 (12)	47 (20)	0.479	0.073
Hospital mortality, n (%) [e]	59 (24)	55 (23)	15 (18)	57 (24)	0.747	0.288

N.B. Significance does not include the baseline group.
[a] ICU - Intensive Care Unit.
[b] MV - Mechanical Ventilation.
[c] LOS - Length of Stay.
[d] Median (IQR).
[e] *p-value was calculated using Fishers exact test.*
[f] *p-value was calculated using Mann-Whitney U test.*
[g] *Period 2; missing data n = 108.*
[h] *Period 2; missing data n = 85.*

ICU-admission varied most between period 2 (33 %) and period 3 (43 %), which difference was not significant (p = 0.097). Coma days increased significantly from 5 % and 7 % in period 1 and period 2, respectively, to 22 % in period 3 (respectively $p < 0.001$ and $p < 0.001$). The median number of MV-days ranged between 2 and 3 days; without a significant difference between periods. The ICU-LOS in period 3 was a median of 5 days compared to a median of 3 days in both period 1 ($p < 0.001$) and period 2 (p = 0.002). The ICU mortality and the hospital mortality were respectively 20 % and 24 % in period 3 compared to 17 % (p = 0.479) and 23 % (p = 0.747) in period 1, and to respectively 12 % (p = 0.073) and 18 % (p = 0.288) in period 2.

Discussion

Five years after implementation of a delirium guide in the ICU, adherence to all seven studied performance indicators had changed significantly compared to directly after implementation. Adherence was lower for four of the indicators, and higher for the other three. The ICU-LOS five years later was significantly longer compared to both directly after implementation and 6 months after implementation. Other secondary outcomes that had changed significantly were a higher number of coma days in period 3 when compared to both period 1 and period 2. Also, a shorter duration of delirium was found in period 3 when compared to period 2.

These results indicate that partial sustainability was achieved, which is congruent with a literature review which concluded that partial sustainability is more common than complete sustainment (Stirman et al., 2012). This finding is supported in three studies regarding in-hospital guideline sustainment, two of which addressed peri-operative care of gastrointestinal surgery (Norman et al., 2020; Williamsson et al., 2019) and one a medication guideline following acute myocardial infarction (Olomu et al., 2014). In all three studies, adherence to some guideline elements was increased, whereas adherence to other elements was decreased (Norman et al., 2020; Olomu et al., 2014; Williamsson et al., 2019). A context-specific comparison of the findings of the present study with findings of comparable previous studies cannot be made, as the latter are non-existent at the time of writing. Also, no studies were found with a similar background of major contextual changes.

The improved adherence to physical therapy and out-of-bed mobilisation found in the present study could be due to increased attention for the benefits of early mobilisation in the ICU (Higgins et al., 2019; Tipping et al., 2017; Zhang et al., 2019) and the newly adopted practice of consulting a physical therapist for patients admitted to the ICU for ≥48 h). It has been recognised that mobilisation without involvement of a physiotherapist is of lower intensity (Jolley et al., 2017). The improvement in adherence to out-of-bed mobilisation might be ascribed to the larger rooms in the new hospital, and greater quantity and quality of equipment such as patient hoists. The availability of adequate equipment has been identified as a facilitator for early mobilisation (Barber et al., 2015). The percentage of patient days with out-of-bed mobilisation (24 %) is equal to that found in a German study (Nydahl et al., 2014). The increase in adherence to out-of-bed mobilisation is most likely due to the named contextual changes and changes in work agreements. However, this increase in period 3 might have been greater had the number of coma days and light sedation days been lower, since deep sedation is a known barrier for mobilisation, due to the inability for patient cooperation (Nydahl et al., 2014).

The decreased adherence to the indicator 'light sedation days' and the corresponding significant increase in number of coma days could be due to the absence of video-surveillance in the new hospital. Patients on MV are prone to anxiety and agitation, risking harming themselves and others (Tate et al., 2012). Agitation can be caused by, among other things, pain, delirium, anxiety or drug withdrawal (Vincent et al., 2016). With the absence of constant video-surveillance, sedation for agitated patients might have been intensified (Tate et al., 2012). In a study on sedation levels, delirium was the main reason for increasing sedation levels (Olsen et al., 2020). The decrease in experienced adequate patient surveillance might have led to more sedation use and, thus, deeper sedation.

The significant increase in the secondary outcome ICU-LOS could be due to a higher severity of illness, as indicated by a significantly higher APACHE-IV score (Zimmerman et al., 2006). Literature also shows that moderate to deep sedation (RASS ≤ -3) is associated with prolonged ICU-LOS (Stephens et al., 2018), which was the case in this study as well, as shown by the significant increase in the proportion of coma days, from respectively 5 % and 7 % of ICU-days in period 1 and period 2–22 % in period 3. An increase in the prevalence of delirium, like in this study between period 2 (33 %) and period 3 (43 %), is known to be associated with an increased ICU-LOS (Salluh et al., 2015). This was, however, not reflected when comparing the small difference in delirium prevalence of period 1 (41 %) with that of period 3 (43 %) while comparison of these two periods also showed an increase in ICU-LOS in period 3. The increased prevalence of delirium could have contributed to the increased ICU mortality between period 2 and period 3 (p =

0.073) (Salluh et al., 2015). Yet, the increased prevalence of delirium could also be the effect of the more intense delirium screening between these two periods and thus a possible increase in delirium detection. However, the multitude of changes in, among other things, medication policy, work environment and patient environment make it impossible to draw direct conclusions on cause and effect from the secondary outcomes. For example, the secondary outcome delirium duration could have been influenced by the longer visiting hours (Deng et al., 2020; Park and Lee, 2019), and noise-cancelling rooms (Park and Lee, 2019).

Strengths and limitations

The main strength of this study was the length of time elapsed between implementation of a guideline and the measurements of guideline adherence; i.e., five years. Often, sustainment studies are conducted within two years after implementation, while periods over two years are advised (Shelton et al., 2018; Stirman et al., 2012). Furthermore, clinical outcomes were compared with those measured five years ago. Clinical outcomes are not frequently repeated in sustainment studies, thus complicating assessment of achieved sustainment on patient outcomes (Stirman et al., 2012). Although the study method did not allow determining causality, the study findings do give insight in how altered adherence to the guideline can result in altered outcomes.

This study had also some limitations. First, the retrospective design, which is common among sustainability studies (Shelton et al., 2018), carries the risk of information bias leading to incomplete, inaccurate or inconsistent measurements (Song and Chung, 2010) However, this aspect could not have influenced the primary outcome, guideline adherence. In the data analysis, therefore, missing data were considered to reflect non-adherence. The retrospective design did lead to the inability to attribute causality to the changes in clinical outcomes. Second, the significant difference in APACHE-IV score between the present study and the previous ones, indicating a greater severity of illness in the present study, might have influenced the number of light sedation days. This is reflected in the literature, indicating that between 18 % and 38 % of ICU-patients need moderate or deep sedation (Olsen et al., 2020; Strøm et al., 2010). Third, medical admission status was registered differently in the electronic patient records. It was unclear how transplantation surgery was categorised in earlier periods, and it was decided to categorise this among emergency surgery. It was, thus, impossible to draw conclusions about this data point. Fourth, during data collection for this study a trial exploring the effect of haloperidol, an anti-psychotic often used to treat delirium, was being conducted. This study used RASS and ICDSC-scores as outcomes (Smit et al., 2020), and could have put the focus back on some performance indicators or the delirium guideline as a whole, causing a temporary or longer-lasting improvement in adherence. However, this is not reflected in the results. Lastly, the level of mobilisation was not assessed with a validated measurement instrument. Mobilisation was differentiated as out-of-bed or other and data on mobilisation were extracted from nursing and physical therapist registration. Due to the incomplete nature of the method of registration, no further distinctions could be made.

Implications

As it is unclear from the present study how the contextual changes in the new hospital have contributed to the partial sustainment of guideline adherence, it is recommended to revisit the barriers and facilitators that guideline executors experience when changes occur. Revisiting barriers and facilitators after implementation efforts have ceased can guide adaptations that are necessary to achieve sustained adherence, or even improve the outcome (Grol & Grimshaw, 2003; Shelton et al., 2018). More research is needed to evaluate the impact of such changes on sustainability, since comparable studies have yet to be published. Such research should be conducted prospectively and preferably over multiple points in time or a longer period of time to capture the possible dynamic and nonlinear nature of sustainment (Shelton et al., 2018). A mixed-methods design would be ideal to identify barriers and facilitators. The clinical outcomes should be evaluated over time to identify possible associations (Shelton et al., 2018).

Conclusion

Five years after the cessation of implementation efforts, the results of our study indicate partially sustained adherence to a delirium guideline. However, as a whole, the change in adherence was greatest during the first six months after implementation and appeared to stabilise thereafter. Without routine monitoring and ongoing education to ensure adherence and effectiveness, the implementation of a guideline alone may not lead to sustained guideline adherence. It would be wise to revisit the fit of implementation activities when a situation changes.

Ethical statement

This study complied with the 2013 version of the declaration of Helsinki (The Helsinki Declaration of the World Medical Association (WMA), 2013). The study protocol was reviewed by the Medical Ethical Committee from Erasmus MC (number MEC-2020-0923) and determined to be not subject to the Medical Research Involving Human Subjects Act.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors thank Z. Trogrlić who helped design this study and conducted the previous studies this study builds on. We also thank J. Hagoort for his excellent editing skills.

Funding source

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Clinical Trial registration number

Not applicable.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2023.103398.

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