BMJ Open

Effectiveness of the ABCDEF bundle on delirium, functional outcomes and quality of life in intensive care patients: a study protocol for a randomised controlled trial with embedded process evaluation

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ABSTRACT

Introduction Hospital mortality for critically ill patients has decreased significantly throughout the developed world over the past two decades, attributable to improvements in the quality of intensive care, advances in critical care medicine and technologies that provide long-term multiorgan support. However, the long-term outcomes of intensive care unit (ICU) survivors is emerging as a real issue. Cognitive and physical impairments suffered by ICU survivors are common including profound weakness, pain and delirium which are inextricably linked. This study aims to determine the effectiveness of the Assess, prevent and manage pain; Both spontaneous awakening and spontaneous breathing trials; Choice of sedation and analgesia; Delirium: assess, prevent and manage; Early mobility and exercise; Family engagement and empowerment (ABCDEF) bundle in reducing ICU-related short-term and long-term consequences of critical illness through a randomised controlled trial (RCT).

Methods and analysis The study will be a single-centre, prospective RCT. A total of 150 participants will be recruited and randomised to either receive the ABCDEF bundle protocol or non-protocolised standard care for the duration of the participant's admission in the ICU. The primary outcome is delirium status measured using the Confusion Assessment Measure for ICU (CAM-ICU). Secondary outcomes include physical function measured by the Functional Independence Measure and quality of life measured by the European Quality of Life five dimensions, five-level questionnaire. A mixed-method process evaluation will contribute to understanding the experience of health teams who implement the ABCDEF bundle into practice.

Ethics and dissemination Ethics approval was provided by the Metro South Health Human Research Ethics Committee (HREC) (EC00167) and the Griffith University's HREC prior to study commencement.
Study results will be disseminated by presentations at conferences and via publications to peer-review journals.

Trial registration number ACTRN12620000736943;
Pre-results.

Strengths and limitations of this study

► A robust randomised controlled trial has been designed to minimise potential bias and maximise generalisability to intensive care unit (ICUs).

► A process evaluation will be undertaken alongside the randomised controlled trial to understand factors that facilitate or hinder the implementation of the Assess, prevent and manage pain; Both spontaneous awakening and spontaneous breathing trials; Choice of sedation and analgesia; Delirium: assess, prevent and manage; Early mobility and exercise; Family engagement and empowerment (ABCDEF) bundle of cares.

► The collection of data up to 12 months following discharge from the ICU will provide an understanding of the association between the ABCDEF bundle and long-term patient-centred outcomes.

► The data will be generated from a single ICU in Australia which limits the generalisability of the findings.

► The model of care in Australian ICUs with 1:1 nurse patient ratio and within-unit intensivists may influence patient outcomes.

INTRODUCTION

A 'bundle of cares' comprises a set of interventions that, when performed collectively, improve the effectiveness and quality of patient care.[1] The Assess, prevent and manage pain; Both Spontaneous awakening and spontaneous breathing trials; Choice of sedation and analgesia; Delirium: assess, prevent and manage; Early mobility and exercise; Family engagement and empowerment (ABCDEF) bundle of cares is proposed as a safe, feasible, evidence-based, interprofessional approach to limit adverse intensive care unit (ICU) patient outcomes.[2] The ABCDEF bundle

differs from other evidence-based, multicomponent ICU interventions as it is applicable to every patient, every day, regardless of mechanical ventilation status or admitting diagnosis.[3]

To date, published research of the ABCDEF bundle has described positive short-term clinical outcomes including mortality, length of stay in ICU and hospital.[3–11] It is a logical progression to investigate if patient-related benefits are realised once they are discharged from hospital.

US researchers have led implementation research of the ABCDEF bundle. However, as there is substantial variability in ICU staffing structure internationally,[12] US results may not be directly transferable to all ICUs. Nurse–patient ratios in the USA are generally 1:2[12]; in contrast to Australia[13] and the UK which support 1:1 nurse to patient ratio for mechanically ventilated patients. ICU allied health support also differs internationally with respiratory therapists managing oxygenation and ventilation in Canada and the USA.[14 15] In contrast, physicians, physiotherapists and registered nurses (RN) perform this role in other countries. Dedicated physiotherapy is reported as available in 34% of US ICUs,[12] while it is a standard service in other parts of the world. These differences may impact patient outcomes. The study of results related to the ABCDEF bundle in ICUs outside of the US will add a global perspective and potentially, the generalisability of the intervention.

The interdisciplinary care model which provides cohesive critical care is an important component of our trial procedures. Little research has systematically evaluated the relationship among interdisciplinary care, the ABCDEF bundle and patient outcomes, and consequently there is minimal data to justify widespread adoption of this bundled approach to ICU patient care.[16]

The current body of evidence that explores the effect of the ABCDEF bundle suggests promising outcomes for the ICU patient community but is primarily based on before-after studies.[3–11] To our knowledge, there are no adequately powered randomised controlled trials (RCTs) focused on patient outcomes related to the ABCDEF bundle compared with standard interdisciplinary healthcare in the ICU. Therefore, a rigorous RCT has been chosen as the methodology to examine the ABCDEF bundle and its effect on ICU survivor's short-term and long-term outcomes.

Our research group conducted a feasibility study in 2015[17] to test important aspects of our research methodology to ensure this appropriately powered RCT would be robust. The selection criteria, recruitment strategy, data collection procedures and outcome measures were measured, tested and reported.

An appropriately powered RCT of the effect of the ABCDEF bundle on ICU patients will provide new, high-level evidence regarding an interdisciplinary approach to reduce the burden of short-term and long-term consequences of critical illness experienced by ICU patients.

OBJECTIVES
Primary objective
To determine whether the ABCDEF bundle provided to adult ICU patients results in reduced incidence of delirium.

Secondary objectives
To examine the effect of the ABCDEF bundle compared with standard care in adult ICU patients on:
► The duration of delirium in the ICU.
► Functional ability in hospital.
► Health-related quality of life up to 12 months following discharge from hospital.

To conduct a process evaluation to investigate the factors that facilitate or hinder the ABCDEF bundle of cares implementation process.

CONCEPTUAL FRAMEWORK
The principles of the UK's Medical Research Council development and evaluation of complex healthcare interventions[18] have been used as a framework to monitor ABCDEF intervention fidelity and to describe how the intervention is implemented. Within this framework, normalisation process theory (NPT)[19] will be used to guide evaluation processes to understand how the ABCDEF bundle is accepted, applied, embedded and sustained in the ICU. This will be achieved by focusing on aspects of individual and collective behaviour and learning about how the work is performed in a real-world healthcare setting.[20] The four constructs of NPT will be considered: coherence or sense making (what is the work?); cognitive participation or engagement (who does the work?); collective action (how does the work get done?); and reflexive monitoring (how is the work understood?).[19]

METHODS
Study design
This trial is designed as a single-centre, prospective, single-blinded, equally randomised (1:1) with varied sized blocks, controlled trial with a concurrent mixed-methods process evaluation. Figure 1 provides a detailed flow chart of participants in the RCT. The Standard Protocol Items: Recommendations for Interventional Trials 2013 checklist[21] was used to guide the design of this study.

Setting
The study will be conducted in an eight-bed, metropolitan mixed medical and surgical adult ICU in Brisbane, Australia.

Recruitment
A consecutive sampling model will be used where all patients admitted to ICU who meet the eligibility criteria will be invited to participate. Patients meeting study criteria will be identified within 24 hours of admission.
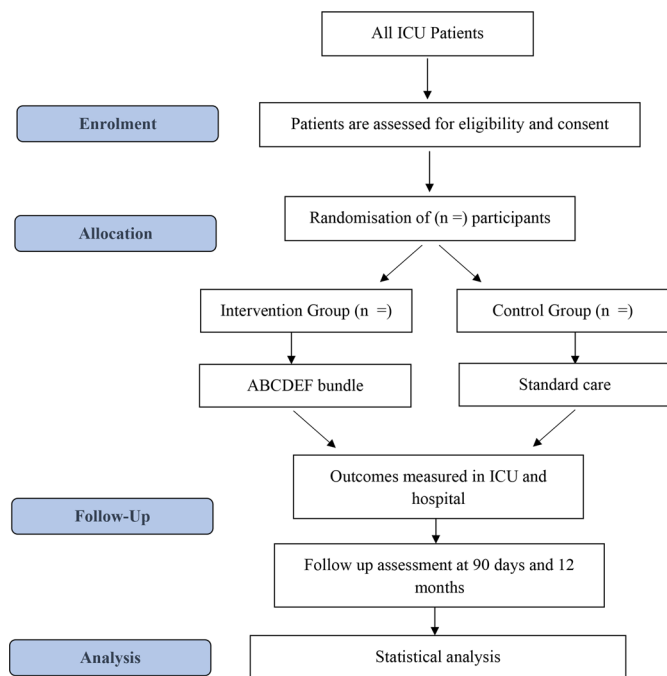
Figure 1 Detailed flow chart of participants. Patients who are eligible for inclusion will be randomised and assigned to one of two groups (ABCDEF bundle or standard care). Outcomes will be evaluated during ICU stay, at discharge and at 3 and 12 months. ABCDEF, Assess, prevent and manage pain; Both spontaneous awakening and spontaneous breathing trials; Choice of sedation and analgesia; Delirium: assess, prevent and manage; Early mobility and exercise; Family engagement and empowerment; ICU, intensive care unit.

Inclusion criteria
Adult patients (18 years and over) who are expected to remain in the ICU for at least 48 hours from admission will be considered for the study.

Exclusion criteria
Patients will be excluded if they are not predicted to survive the current ICU admission; are undergoing end-of-life care, are considered suitable for immediate transfer to a ward; or have been previously enrolled in this trial.

Process evaluation
The process evaluation study population will comprise nursing staff, medical officers and members of the allied health team involved in the delivery of the ABCDEF bundle. Staff who are not permanent employees of the ICU or involved in providing the ABCDEF care bundle will be excluded.

RCT sample size
To ensure the study is powered for the primary outcome measure of the incidence of delirium assessed by the CAM-ICU, a total of 150 patients will be recruited and randomised to receive either the ABCDEF bundle protocol or non-protocolised standard care. It is challenging to accurately predict the incidence of ICU delirium as it has been reported as low as 19%[22] or as high as 87%.[23] Therefore, the pre–post study by Balas *et al*[24] has been used to guide the primary outcome measure to calculate sample size. In order to have 80% power to identify a change in percentage of patients with delirium at any time from 65% to 42.5% or less (ie, a change of 22.5%), 75 patients will be required in each of the treatment group and control group (total of 150 patients).[25] The study site admits approximately 250 patients per year who meet the inclusion criteria, thus it is predicted that recruitment will be completed within 12–18 months.

Randomisation
Participants will be randomised using a secure web-based randomisation system from Griffith University, Australia (http://www151.griffith.edu.au) to either the intervention group who will receive the protocolised bundle of ABCDEF cares or the control group who will receive standard care. The allocation sequence will be computer-generated in a ratio of 1:1, using randomly varied block sizes of four and six to avoid predictability of allocation and to ensure even group sizes. Allocation concealment is guaranteed as the secure web-based randomisation system will only release the randomisation code once screening procedures are completed and the patient or substitute decision-makers have provided consent. Research personnel will be responsible for screening procedures, recording baseline data, obtaining consent and generating the randomisation code from the secure web-based randomisation system.

Intervention
The intervention group will receive the ABCDEF bundle. Collaborative discussions between the principal investigator (PI) and members of the interdisciplinary team regarding specific treatments informed the ABCDEF protocol for the study site. The ABCDEF bundle education programme will commence 2 months prior to study commencement and will be delivered by members of the research team and championed by members of the ICU interdisciplinary team. Multimodal education will be delivered via unit-based presentations and simulation to familiarise staff with study procedures. Ongoing staff support will be provided throughout the trial.

The ABCDEF bundle is a standardised, complex care bundle that will be integrated into patient care and delivered by the appropriate interdisciplinary team member. Protocol components will be embedded into the patient record computerised information system (CIS). Each bundle component will be prescribed by the appropriate member of the interdisciplinary team following completion of safety screening. The CIS will provide an alert when bundle components are due. Bundle components can be completed within a 2-hour window so that clinical staff can plan and fit bundle components into other ICU activities. An electronic signature will validate that each component of the bundle has or has not been completed.

The Template for Intervention Description and Replication[26] has been used to guide the following detailed

description of the intervention. The assess, prevent and manage pain component will emphasise a 'Treat pain first, then sedate' approach. Pain will be assessed using the Numeric Rating Scale (NRS) if the patient is conscious[27] or the Critical Care Observation Tool (CCOT) if unconscious.[27] Significant pain will be assumed and treated if the NRS is greater than four or the CCOT is greater than three.[28] Preprocedural analgesia will be administered. Intravenous opioids will include fentanyl or remifentanil and will be delivered as continuous infusions.

Both spontaneous awakening trial and spontaneous breathing trial (SBT) relates to mechanically ventilated patients only and will focus on setting a time each day to interrupt or reduce sedative medications, orient the patient to time and day, and conduct an SBT in an effort to liberate the patient from the ventilator.[29]

The choice of analgesia and sedation component refers to the safe and effective management of pain and agitation. Level of alertness will be monitored every 4 hours with the Richmond Agitation and Sedation Scale (RASS).[30] Sedation will be optimised by keeping the RASS between light sedation (−2) to restless (+1) unless deemed not appropriate by the treating consultant. Propofol and/or dexmedetomidine will be used primarily for sedation in the intervention group. Benzodiazepines will be considered for patients suffering from refractory epilepsy, alcohol or drug withdrawal, therapeutic hypothermia or neuromuscular blockade use.[31]

The assessment, prevention and management of delirium component ensures that participants receive delirium assessment using the CAM-ICU 12-hourly (8:00 and 20:00 hours).[32 33] Data will be collected if the patient is unable to be assessed for delirium because they are deeply sedated or comatose as evidenced by an RASS of −3 or −4. It is important to include this cohort of patients in the intervention as they are at high risk of developing delirium.[32] Regardless of RASS, reorientation and cognitive stimulation activities will be performed by the occupational therapist, nursing staff and family. Patients will receive a sleep hygiene programme including an afternoon rest period (13:00–15:00 hours) and night sleep period (23:00–5:00 hours) and include the use of earplugs, reduction in light and noise, and organisation of care activities to provide maximum uninterrupted sleep.

An early mobility and exercise programme will be incorporated into patient care. Table 1 provides the detail of the early mobility and exercise programme.

The completion of a screen within the CIS will ensure the patient meets safety criteria prior to mobilisation.[34] Patients who pass the safety screen will progress through a four-level exercise regimen following consultation with the physiotherapist, receiving the highest level of physical activity they can manage. The exercise regimen will be dependent on patient ability and haemodynamic stability.

Families within the intervention group will be offered a daily meeting with a member of the medical team or social worker to provide an opportunity to have questions answered and concerns addressed. Family members will receive information sheets related to delirium on admission to ICU and will be encouraged to be actively involved in delirium prevention and exercise components of the protocol under supervision of the treating team.

Control: usual care

Participants in the control group will receive standard medical, nursing, and allied healthcare. Standard care includes decisions made on a daily basis with no use of protocols: spontaneous breathing and awakening trials as determined by the consultant intensivist on duty; ad hoc management of pain and delirium; once or twice daily passive and active exercise as determined by the physiotherapist of the day with patients generally remaining in bed if they are ventilated.

Potential contamination of the control group has been considered. Patients in the intervention group will receive the protocolised ABCDEF bundle via a care prescription provided to staff within the CIS. Staff caring for patients in the control group will not have access to ABCDEF protocols as they will not be available on their CIS or in any other format. Staff will be reminded throughout the study the importance of providing the bundle only to the intervention group. We will measure and report protocol adherence within both groups. Variation in outcomes for the control group will relate to different clinical practice and effort of individuals. Contamination was not found to be an issue in the feasibility study.[17]

OUTCOME MEASURES
Primary outcome: delirium

The primary outcome is delirium status measured using the reliable and validated CAM-ICU.[23] The incidence of delirium will be defined as a positive CAM-ICU on any ICU day.

Secondary outcomes
Duration of delirium

Duration of delirium will be defined as the number of ICU days in which patients were CAM-ICU positive.

Physical function

The Functional Independence Measure (FIM) provides reliable information regarding patient functional change during rehabilitation across various hospital settings.[35]

Quality of life

The European Quality of Life five dimensions, five-level Questionnaire (EQ-5D-5L) provides a validated, reliable and responsive description of health-related quality of life for a wide range of long-term disability.[36] It describes health in terms of five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression.

Process evaluation

A mixed-method process evaluation will contribute to understanding how the ABCDEF bundle has been

Table 1	Early mobility and exercise programme
Assessment	Patients in the intervention group will be assessed at 7.30 hour by the RN allocated to the patient to ensure they meet minimum safety criteria. the safety screen is a checklist within the early mobility and exercise safety screen within the CIS. The completion of a screen within the CIS will ensure the patient meets safety criteria prior to mobilisation.
Safety screen	**M- Is the myocardium stable?** (No evidence of acute myocardial ischaemia in the previous 24 hours; no dysrhythmias requiring the administration of a new antiarrhythmic.) **O- Is oxygenation adequate?** (FiO_2 ≤0.6 and PEEP ≤10 cm H_2O) **V – Are vasopressors minimal?** (No increase dose of vasopressors for at least 2 hours) **E – Does the patient respond to verbal stimuli?** (RASS ≥ −2) **S – Is the patient safe to mobilise?** (Not receiving treatment that restricts mobility (ie, open abdomen), no injuries which contraindicate mobility (ie, unstable fractures))
Safety screen response	If any questions in the safety screen are answered No—remain with Level one exercise. If all questions in the safety screen are answered Yes, and the Consultant agrees, proceed to early mobility and exercise prescription.
Prescription	Patients who pass the safety screen will progress to the Early Mobility and Exercise tab in the CIS. The RN will prescribe the level of exercise the participant will receive. The ICU physiotherapist will provide guidance as required. Patients will progress through a four-level regime, receiving the highest level of physical activity they can manage.
CIS	Once the appropriate level of exercise is chosen, the RN will create a nursing order which will act as a prescription. The prescribed exercise will appear in the CIS at the appropriate time throughout the day. The RN will be provided a 2-hour window either side of the prescribed time to allow other patient therapies to occur.
Early mobility and exercise prescription	
Level 1—participant does not pass safety screen.	Passive range of motion three times a day (06.00, 13.00, 20.00 hours) Sitting position three times a day (06.00, 13.00, 20.00 hours) in the Hill-Rom Progressa Bed—the standard bed in the site ICU.
Level 2—participant can lift arm on request	Active resistance exercise in bed twice daily (10.00, 18.00 hours). Sitting position in bed three times a day (06.00, 13.00, 20.00 hours). Sitting on edge of bed daily.
Level 3—participant can lift leg on request	Active resistance exercise in bed twice daily (10.00, 18.00 hours). Sitting position in bed three times a day (06.00, 13.00, 20.00 hours). Sitting on edge of bed daily. Active trial of stand once per day.
Level 4—participant can lift leg on request and completed level three the previous day.	Active resistance exercise in bed twice daily (10.00, 18.00 hours). Sitting position in bed three times a day (06.00, 13.00, 20.00 hours). Sitting on edge of bed daily. Active trial of stand once per day. Ambulation once per day (marching, taking steps, walking in corridors).

CIS, computerised information system; FiO2, fractional inspired oxygen; RASS, Richmond Agitation and Sedation Scale; RN, registered nurse.

operationalised and to identify factors that facilitate or impede the implementation process.

First, informed by NPT, a survey has been developed to examine staff knowledge and skills on the bundle, evaluate the effectiveness of the education programme, and describe how staff implement the bundle of cares. All ICU staff who are involved in the study will be invited to respond to the survey at the midpoint and completion of RCT recruitment. The aim is to recruit as many staff as possible from across the interdisciplinary team. Staff will be offered the opportunity to participate via staff email and reminders provided within ICU staff meetings. Staff surveys will be administered using either survey monkey software or hard copy survey form.

Second, face-to-face, semistructured interviews with ICU staff will occur once recruitment to the RCT is complete. All interdisciplinary staff involved in the RCT will be invited to participate. The aim is to recruit participants from all involved disciplines, with a minimum sample of at least two participants in each discipline. Data collection will continue until no new information is forthcoming. Interview questions will be informed by the NPT[19] and developed based on findings from the staff survey and ABCDEF adherence audits. The interviews

will be conducted by independent research personnel who do not have direct working relationships with the participants, and who do not care for ICU patients. Interviews will be audio taped and file notes will be utilised to capture the data collector's reflective thoughts from each interview.

DATA COLLECTION

Patient demographic data will be collected from the patient medical record by trained research personnel and will include age, gender, body mass index, date of ICU admission and discharge, comorbid diseases including cognitive disorders, ICU admission diagnosis, mortality, ICU readmission and discharge destination. Severity of illness will be measured using the APACHE II scoring system. Measures of ICU and hospital length of stay and duration of mechanical ventilation will be extracted from the Australia and New Zealand Intensive Care Society Adult Patient Database.

Sedation levels and delirium status will be measured and recorded by the critical care RN caring for the patient using the validated RASS[37] every 4 hours and the CAM-ICU[23] at least twice per day the critical care RN caring for the patient. Delirium will be monitored throughout the ICU admission and will continue until the patient is considered suitable for transfer to the ward. Pain scores will be measured by the critical care RN caring for the patient using the NRS[38] or the Critical Care Pain Observation Tool[39] every 4 hours.

The FIM will be conducted within 24 hours of the expected ICU discharge or on the Friday before the expected discharge if likely to occur over the weekend. The FIM will be performed by a certified physiotherapist, occupational therapist or RN blinded to participant assignment groups.

The EQ-5D-5L will be performed at baseline while still an inpatient of the ICU, at 90 days and 12 months post discharge from ICU.

Data related to adherence to the ABCDEF protocol will be collected by the direct care critical care RN who will record each component of the ABCDEF bundle as it is or is not delivered within the CIS. To monitor compliance with standard care, research personnel will retrospectively record when participants within the control group received components of the bundle. Research personnel will retrospectively record data on a case report form.

Data collection related to the ABCDEF bundle will continue until the patient is designated non-ICU status, or they die, whichever occurs first. A summary of the schedule of study time points and data collection is presented in table 2.

Blinding

Due to the nature of the intervention, it will not be possible to blind the research personnel or the ICU nursing, medical and allied health staff to group assignment. The outcome assessors who measure the FIM will be blinded to participant assignment.

Table 2 The schedule of enrolment, intervention and data collection

	Enrolment (day −1)	Allocation (day 0)	Daily	Discharge from ICU	Discharge from hospital	Follow-up 90-day	Follow-up 12 months
Eligibility screen	x						
Informed consent	x						
Allocation	x						
ABCDEF protocol		x	x				
Demographic data		x		x		x	x
Delirium scores		x	x				
Sedation scores		x	x				
Pain scores		x	x				
ABCDEF adherence			x				
Duration of ventilation				x			
Mortality				x		x	x
LOS ICU				x			
LOS hospital					x		
FIM				x			
EQ-5D-SL				x		x	x

ABCDEF, Assess, prevent and manage pain; Both spontaneous awakening and spontaneous breathing trials; Choice of sedation and analgesia; Delirium: assess, prevent and manage; Early mobility and exercise; Family engagement and empowerment; EQ-5D-5L, EuroQol Five Dimensions questionnaire Five Levels scale; FIM, Functional Independence Measure; ICU, intensive care unit; LOS, length of stay.

MONITORING
Data monitoring
An interim analysis will be performed on the primary endpoint when 50% of the patients have been randomised. An independent data monitoring committee (DMC) comprising an ICU consultant, ICU RN, and physiotherapist will meet following the interim analysis to ensure participant safety and to validate trial integrity. The DMC will review individual safety reports, data related to the quality, protocol adherence and patient retention rates. Recommendations will be made to continue or terminate the trial.

Harms
No adverse events were reported in the feasibility study.[17] With regard to the RCT, relevant medical personnel will be informed of any adverse event and treatments initiated if required. A serious adverse event (SAE) for this study is defined as any untoward medical occurrence that is believed to be causally related to the study intervention and results in any of the following: life-threatening condition or mortality (ie, immediate risk of death); severe or permanent disability; prolonged hospitalisation or a significant hazard as determined by the DMC. An adverse event that meets the criteria for an SAE between study enrolment and hospital discharge will be reported to both HRECs. With regard to the process evaluation, care will be taken to reduce the risk of harm, discomfort or inconvenience to staff who choose to participate. Participation is voluntary, and staff may withdraw from the study at any time. It will be emphasised that a staff member's participation or withdrawal of participation in the study will not affect their working relationship with the ICU or hospital.

STATISTICAL ANALYSIS
Analyses will be performed on a basis of an intention-to-treat and per-protocol method. Data on participants with at least 48 hours in the ICU will be included in the statistical analysis. Descriptive statistics will be used to determine the frequency and percentage of participants' demographic variables. Values will be compared with ascertain mean outcomes to test whether statistical assumptions for parametric tests are met. Continuous variables that are normally distributed will be compared using the independent t-test. Non-parametric analysis will be conducted for continuous variables that are not normally distributed. Categorical variables will be tested with the χ^2 statistic. Regression models will be used to explain confounders (receipt of certain medications including benzodiazepines and muscle relaxants). Patients who die during the ICU stay will be assigned a score of 0 for ventilator free days, ICU free days, and hospital free days. A $p<0.05$ will be considered statistically significant. Where appropriate, analyses will be reported with mean differences and 95% CIs. Protocol violations will be noted. Imputation will be used to correct for missing data where appropriate.

Statistical analysis will be performed using IBM SPSS software, V.26.0.

QUALITATIVE DATA ANALYSIS
With regard to staff surveys and interviews, descriptive statistics will be used to summarise participants' demographic data. Demographic data will be summarised using means and SD for continuous variables and numbers and percentage for categorial variables. Survey responses will be entered into an Excel database. Staff survey results will be counted, and frequencies of responses will be calculated. The recordings of interviews will be transcribed verbatim by an independent transcription service. Inductive analysis of the interview data will be used to search for patterns and to generate themes. Data will be coded into themes and applied to the four NPT constructs of coherence; cognitive participation; collective action and reflexive monitoring.[19]

PATIENT AND PUBLIC INVOLVEMENT
A past ICU patient who experienced delirium while an in-patient, his wife and adult daughter have reviewed brochures, information sheets and research consent forms. They have considered the intervention and were engaged in discussions regarding the benefit and burden of the intervention for the patient and the family. Their input has been factored into the final version of the protocol.

ETHICS AND DISSEMINATION
Ethics approval
Ethical approval was provided by the Metro South Health Human Research Ethics Committee (EC00167) on 20 August 2020 (HREC/2020/QMS/53574) and the Griffith University's HREC on 3 September 2020 prior to study commencement. The trial is registered with the Australian New Zealand Clinical Trials Registry.

Consent: RCT
Research personnel will seek written consent from any conscious and comprehending patient or substitute decision-makers if the participant lacks the capacity to give consent. Once the participant regains capacity, the study will be explained verbally by research personnel and the participant will be given the opportunity to decide whether to continue to participate. All interactions between research staff, potential or actual participants, and their families will take into consideration the stress associated with their critical illness. Once a patient is enrolled in the study, the research team will make every effort to follow the participant for the entire study period. In the feasibility study, only one patient declined consent, thus recruitment strategies were deemed effective.[17]

Consent: process evaluation

Staff who meet the study criteria will be provided with information regarding the study's purpose and invited to participate by the research personnel. Staff will provide implied consent by completing the staff survey. Written informed consent will be sought for the face-to-face interviews.

Confidentiality

All study documentation and information will be safeguarded maintaining confidentiality through deidentification by coding mechanisms, securely stored under locked conditions and electronic password protected files, and only accessible by the PI and research personnel. To ensure that participants cannot be identified and to protect sensitive patient information, only aggregated group data will be available to other researchers on request.

Dissemination of findings

We intend to clearly articulate the implementation processes and the research results related to this intervention. If there is a positive patient outcome, we will promote the ABCDEF bundle as a standard of care within the Australian critical care environment and other similar ICUs internationally. It is anticipated that study results will be presented at national and international conferences. We expect to publish several papers from this research in high-quality peer-reviewed journals.

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Contributors KS, MM, MC, FL, LM and HW conceived and designed the study. KS, MM, MC, FL, LM and HW drafted the manuscript. KS, MM, MC, FL, LM and HW critically reviewed the manuscript. All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

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REFERENCES

1 Clarkson DM. The role of 'care bundles' in healthcare. *British Journal of Healthcare Management* 2013;19:63–8.
2 Balas MC, Weinhouse GL, Denehy L, *et al*. Interpreting and implementing the 2018 pain, Agitation/Sedation, delirium, immobility, and sleep disruption clinical practice guideline. *Crit Care Med* 2018;46:1464–70.
3 Pun BT, Balas MC, Barnes-Daly MA, *et al*. Caring for critically ill patients with the ABCDEF bundle: results of the ICU liberation collaborative in over 15,000 adults. *Crit Care Med* 2019;47:3–14.
4 Balas M, Olsen K, Gannon D, *et al*. Safety and efficacy of the ABCDE bundle in critically ill patients receiving mechanical ventilation. *Crit Care Med* 2012;40:1–328.
5 Bounds M, Kram S, Speroni KG, *et al*. Effect of ABCDE bundle implementation on prevalence of delirium in intensive care unit patients. *Am J Crit Care* 2016;25:535–44.
6 Burke WJ, Balas MC. O2-01-05: prevention of delirium in the critically ill: effectiveness of the ABCDE bundle. *Alzheimer's & Dementia* 2014;10:P164.
7 Hsieh SJ, Otusanya O, Gershengorn HB, *et al*. Staged implementation of awakening and breathing, coordination, delirium monitoring and management, and early mobilization bundle improves patient outcomes and reduces hospital costs. *Crit Care Med* 2019;47:885–93.
8 Kram SL, DiBartolo MC, Hinderer K, *et al*. Implementation of the ABCDE bundle to improve patient outcomes in the intensive care unit in a rural community hospital. *Dimens Crit Care Nurs* 2015;34:250–8.
9 Loffink A, Barr J, Zimmerman L. 1262: ICU liberation: nurse PRACTITIONER-LED implementation of the ABCDEF bundle in a Va Hospital. *Crit Care Med* 2018;46:614.
10 Zheng M, Tan M, Tang L, *et al*. 1134: implementation of the ABCDEF bundle leads to increased patient mobility and improved disposition. *Crit Care Med* 2016;44:359.
11 Zhorne M, Schuh C, Wright J, *et al*. 1263: improving survival through the implementation of the ABCDEF bundle in a large community hospital. *Crit Care Med* 2018;46:615.
12 Bakhru RN, McWilliams DJ, Wiebe DJ, *et al*. Intensive care unit structure variation and implications for early mobilization practices. An international survey. *Ann Am Thorac Soc* 2016;13:1527–37.
13 ACCCN. *Workforce standards for intensive care nursing*, 2016.
14 Parker AM, Liu X, Harris AD, *et al*. Respiratory therapy organizational changes are associated with increased respiratory care utilization. *Respir Care* 2013;58:438–49.
15 West AJ, Nickerson J, Breau G, *et al*. Staffing patterns of respiratory therapists in critical care units of Canadian teaching hospitals. *Can J Respir Ther* 2016;52:75–80.
16 Kim MM, Barnato AE, Angus DC, *et al*. The effect of multidisciplinary care teams on intensive care unit mortality. *Arch Intern Med* 2010;170:369–76.
17 Sosnowski K, Mitchell ML, White H, *et al*. A feasibility study of a randomised controlled trial to examine the impact of the ABCDE bundle on quality of life in ICU survivors. *Pilot Feasibility Stud* 2018;4:32.
18 Craig P, Dieppe P, Macintyre S, *et al*. Developing and evaluating complex interventions: the new medical Research Council guidance. *BMJ* 2008;337:a1655.
19 Murray E, Treweek S, Pope C, *et al*. Normalisation process theory: a framework for developing, evaluating and implementing complex interventions. *BMC Med* 2010;8:63.
20 McEvoy R, Ballini L, Maltoni S, *et al*. A qualitative systematic review of studies using the normalization process theory to research implementation processes. *Implement Sci* 2014;9:2.
21 Chan A-W, Tetzlaff JM, Altman DG, *et al*. Spirit 2013 statement: defining standard protocol items for clinical trials. *Ann Intern Med* 2013;158:200–7.
22 Mitchell ML, Shum DHK, Mihala G, *et al*. Long-Term cognitive impairment and delirium in intensive care: a prospective cohort study. *Aust Crit Care* 2018;31:204–11.
23 Ely EW, Margolin R, Francis J, *et al*. Evaluation of delirium in critically ill patients: validation of the confusion assessment method for the intensive care unit (CAM-ICU). *Crit Care Med* 2001;29:1370–9.

24 Balas MC, Vasilevskis EE, Olsen KM, *et al*. Effectiveness and safety of the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle. *Crit Care Med* 2014;42:1024–36.

25 Dupont WD, Plummer WD. Power and sample size calculations. A review and computer program. *Control Clin Trials* 1990;11:116–28.

26 Hoffmann TC, Glasziou PP, Boutron I, *et al*. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014;348:g1687.

27 Devlin JW, Skrobik Y, Gélinas C, *et al*. Clinical practice guidelines for the prevention and management of pain, Agitation/Sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. *Crit Care Med* 2018;46:e825–73.

28 Gélinas C, Fillion L, Puntillo KA, *et al*. Validation of the critical-care pain observation tool in adult patients. *Am J Crit Care* 2006;15:420–7.

29 Kress JP, Pohlman AS, O'Connor MF, *et al*. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med* 2000;342:1471–7.

30 Sessler CN, Gosnell MS, Grap MJ, *et al*. The Richmond Agitation-Sedation scale: validity and reliability in adult intensive care unit patients. *Am J Respir Crit Care Med* 2002;166:1338–44.

31 Shehabi Y, Howe BD, Bellomo R, *et al*. Early sedation with dexmedetomidine in critically ill patients. *N Engl J Med Overseas Ed* 2019;380:2506–17.

32 Haenggi M, Blum S, Brechbuehl R, *et al*. Effect of sedation level on the prevalence of delirium when assessed with CAM-ICU and ICDSC. *Intensive Care Med* 2013;39:2171–9.

33 Patel RP, Gambrell M, Speroff T, *et al*. Delirium and sedation in the intensive care unit: survey of behaviors and attitudes of 1384 healthcare professionals. *Crit Care Med* 2009;37:825–32.

34 Sommers J, Engelbert RHH, Dettling-Ihnenfeldt D, *et al*. Physiotherapy in the intensive care unit: an evidence-based, expert driven, practical statement and rehabilitation recommendations. *Clin Rehabil* 2015;29:1051–63.

35 Ottenbacher KJ, Hsu Y, Granger CV, *et al*. The reliability of the functional independence measure: a quantitative review. *Arch Phys Med Rehabil* 1996;77:1226–32.

36 Herdman M, Gudex C, Lloyd A, *et al*. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res* 2011;20:1727–36.

37 Ely EW, Truman B, Shintani A, *et al*. Monitoring sedation status over time in ICU patients: reliability and validity of the Richmond Agitation-Sedation scale (RASS). *JAMA* 2003;289:2983–91.

38 Ahlers SJGM, van Gulik L, van der Veen AM, *et al*. Comparison of different pain scoring systems in critically ill patients in a general ICU. *Crit Care* 2008;12:R15.

39 Severgnini P, Pelosi P, Contino E, *et al*. Accuracy of critical care pain observation tool and behavioral pain scale to assess pain in critically ill conscious and unconscious patients: prospective, observational study. *J Intensive Care* 2016;4:68.