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FANCAS nursing framework for ARDS: A systematic review and synthesis

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ABSTRACT:

Background: Acute respiratory distress syndrome (ARDS) carries high mortality ranging from 35% to 46%. Contemporary clinical guidelines predominantly emphasize medical management, leaving nursing care without a comprehensive evidence-based framework.

Method: This study aimed to develop an evidence-based operationalization of the FANCAS nursing framework specifically for ARDS patients through systematic review and narrative synthesis. We conducted a systematic review following PRISMA 2020 guidelines. The detailed search strategy is reported in a companion manuscript. We searched PubMed, Cochrane Library, CINAHL, ThaiJO, and Google Scholar from January 2016 to March 2026. We included studies reporting nursing-sensitive outcomes in ARDS patients. Two reviewers independently coded the data and assessed quality using ROB-2 and ROBINS-I. Inter-rater agreement was substantial for initial coding of nursing interventions into the six FANCAS domains ($\kappa = 0.82$).

Result: Our search identified 45 studies that met inclusion criteria: 12 randomized controlled trials, 18 cohort studies, 10 quality improvement projects, and five qualitative studies. The evidence-based FANCAS framework emerged with six domains: Fluid, Aeration, Nutrition, Communication, Activity, and Stimulation. We derived a bedside checklist called FAST-HUG-BID-C, with a rapid version (FAST) for unstable patients. We also identified twelve frugal innovations applicable to resource-limited settings, with nine having feasibility ratings of four or five (ready for immediate implementation).

Conclusion: This study provides the first systematic review-based operationalization of the FANCAS framework for ARDS nursing care. The frugal innovations are ready for implementation in resource-limited settings. The checklist requires prospective validation before widespread clinical implementation.

Registration: This study is part of a project registered with PROSPERO (CRD420261360074) as 'Development of Clinical Nursing Practice Guidelines for Patients with Acute Respiratory Distress Syndrome (ARDS): A Synthesis of Empirical Evidence for Clinical Practice in the Thai Context'.

Keywords: ARDS; Critical care nursing; FAST-HUG-BID-C; FANCAS; Nursing framework; Systematic review

INTRODUCTION

Acute respiratory distress syndrome affects approximately 10% of intensive care unit admissions and carries mortality rates ranging from 35% to 46% according to Bellani and colleagues [1]. The Berlin definition improved diagnostic accuracy for ARDS [2], and the updated 2024 global definition has further refined these criteria [3]. Despite these advances, ARDS remains a challenging condition for the entire critical care team. In Thailand, ARDS mortality ranges from 40% to 55% in resource-limited settings, as reported by Thawitsri and colleagues [4].

Current clinical practice guidelines for ARDS focus primarily on medical interventions. These interventions include low tidal volume ventilation, prone positioning, neuromuscular blockades, and extracorporeal membrane oxygenation [5,6]. While these guidelines reference multidisciplinary care, they provide minimal guidance for nursing practice. A 2023 scoping review by O'Brien and colleagues found that only 3% of ARDS guideline recommendations addressed nursing-specific actions [7].

Historical background of the FANCAS framework

June C. Abbey originally conceptualized the FANCAS framework, and Nancy M. Holloway subsequently popularized it in the first edition of *Nursing the Critically Ill Adult* published in 1979 [8]. The original framework comprised six assessment domains: Fluid balance, Aeration, Nutrition, Communication, Activity, and Stimulation. Table 1 compares the original 1979 domains with our evidence-based 2026 update.

For decades, the FANCAS framework has served as an educational tool for critical care nurses. However, the original framework had several important limitations: it was based on expert opinion rather than systematic review, it was designed for general critical care populations rather than specificity for ARDS, it did not include a bedside checklist, and it did not address resource-limited settings.

The present study

Nurses spend most of their time at the bedside of ARDS patients. They manage complex issues including fluid balance, airway management, nutritional support, family communication, early mobility, and delirium prevention [9,10]. Despite this critical role, no comprehensive evidence-based nursing framework exists specifically for ARDS patients.

The objective of this study was to provide the first systematic review-based operationalization of the FANCAS framework for ARDS patients. Figure 1 presents the framework as concentric circles, and Figure 2 details the six domains with their evidence-based interventions.

MATERIALS AND METHODS

Relationship to companion meta-analysis

A companion meta-analysis examining prone positioning for mortality reduction in ARDS was submitted simultaneously. The two manuscripts are complementary: The meta-analysis focuses on a single intervention (prone positioning) with a single outcome (mortality), whereas the present study develops a comprehensive nursing framework

KEY MESSAGES:

- The FANCAS framework represents the first evidence-based nursing framework for ARDS patients derived from 45 studies across 12 countries.
- The FAST-HUG-BID-C bedside checklist offers a practical tool for daily nursing rounds, with a rapid version (FAST) requiring less than two minutes for unstable patients. Prospective validation of this checklist is needed before clinical implementation.
- Nine frugal innovations with feasibility ratings of four or five are ready for immediate implementation in resource-limited settings and are listed in Table 4.

across multiple domains. The search strategy and methods are reported in full in the companion paper, which cites the PROSEVA trial [11] as the primary source for the risk ratio of 0.74 for mortality benefit.

Search strategy

The search followed PRISMA 2020 guidelines with a protocol registered in PROSPERO (CRD420261360074) [12]. We used the same search of PubMed, Cochrane Library, CINAHL, ThaiJO, and Google Scholar from January 1, 2016, to March 31, 2026. Modified eligibility criteria were employed as described below. Complete search strings are provided in Supplementary file 1.

Eligibility criteria

Studies were considered eligible for inclusion if they met the following criteria: The population included adult patients aged 18 years or older with a diagnosis of ARDS according to either the Berlin definition or the 2024 revised global definition [2,3]; the intervention required reporting of nursing-sensitive outcomes relevant to the six FANCAS domains; eligible study designs included randomized controlled, cohort studies, quality improvement projects, and qualitative studies; the language was limited to English or Thai; the publication period spanned from January 2016 through March 2026.

Studies were excluded if they involved pediatric ARDS patients, animal studies, editorials, commentaries, conference abstracts, or studies without original data.

Study selection and data extraction

Figure 3 presents the study selection process in a PRISMA flow diagram. Of 1,647 records screened, 334 underwent full-text review, 68 were quality-assessed, and 45 met final inclusion criteria.

A footnote to Figure 3 explains that the lower initial record count in this review compared to the companion meta-analysis reflects deduplication performed after the meta-analysis search was completed. No additional unique records were excluded beyond duplication.

Of the 45 included studies, 12 were randomized controlled trials also included in the companion meta-analysis. The remaining 33 studies comprised 18 cohort studies, 10 quality improvement projects, and five qualitative studies. These were included based on expanded eligibility criteria designed to capture nursing-sensitive outcomes and framework-relevant evidence.

Two reviewers independently performed initial coding. Inter-rater agreement using Cohen's kappa was 0.82 (95% Confidence Interval: 0.76–0.88) for initial coding of nursing interventions and outcomes into the six FANCAS domains. For study selection (title/abstract screening), kappa was 0.76; for quality assessment (ROB-2/ROBINS-I independent ratings with consensus), kappa was 0.71. These values indicate substantial to almost perfect agreement.

Quality assessment

Quality was assessed using appropriate tools for each study design: ROB-2 for randomized controlled trials [12-19]; ROBINS-I for cohort studies [20-37]; SQUIRE 2.0 for quality improvement projects (adequate quality defined as meeting $\geq 70\%$ of SQUIRE 2.0 criteria) [38-47]; COREQ for qualitative studies [48-52]. No studies were excluded based on quality alone; however, quality ratings informed the strength of recommendations.

Data synthesis

Quantitative pooling was not attempted due to heterogeneity in nursing outcome definitions, intervention protocols, and study designs. A narrative synthesis was therefore more appropriate for framework development.

Synthesis followed the framework synthesis approach described by Barnett-Page and Thomas [53]. This approach comprised five steps: (1) initial coding of nursing interventions and outcomes from all 45 studies; (2) thematic grouping of codes into preliminary themes matching the six historical FANCAS domains; (3) iterative refinement of themes into six evidence-based domains; (4) construction of the framework; (5) derivation of the FAST-HUG-BID-C bedside checklist (Table 2 and Figure 4).

Ethical considerations

This systematic review did not require institutional review board approval, as it involved the synthesis of published data without direct patient contact or primary data collection. The study was conducted in accordance with PRISMA 2020 guidelines and registered with PROSPERO under the identifier CRD420261360074.

RESULTS

Study selection and characteristics

Figure 3 presents the study selection process. A total of 1,647 records were identified from five databases. After removing 203 duplicate records, 1,444 records were screened by title and abstract. Of these, 1,110 records were excluded. The remaining 334 full-text reports were assessed for eligibility, and 266 reports were excluded for several reasons, including wrong study design, wrong outcomes, wrong patient population, duplicate data, or unavailability of full text. Following quality assessment, 45 studies met all eligibility criteria and were included in the narrative synthesis.

Table 1 summarizes the characteristics of the 45 included studies. The studies represented 12 countries. Individual study sample sizes ranged from 18 to 847 patients (Median: 124 patients). Among the 45 studies, 12 were randomized controlled trials (27%) [1,2,5,6,12-19]; 11 were prospective cohort studies (24%) [20-30]; 7 were retrospective cohort studies (16%) [31-37]; 10 were quality improvement projects (22%) [38-47]; AND 5 were qualitative studies (11%) [48-52].

Regarding geographic distribution: 14 studies were conducted in North America (31%), 19 in Asia (42%), 9 in Europe (20%), and 3 in other regions (7%).

Quality assessment results

Among the 12 randomized controlled trials, 6 had low risk of bias, 4 had some concerns, and 2 had high risk of bias [11, 13-19]. Among the 18 cohort studies, 10 had moderate quality, 6 had serious risk of bias, and 2 had critical risk of bias [20-37]. Quality improvement projects had a mean SQUIRE 2.0 adherence of 67% (Range: 45–89%) [38-47]. All five qualitative studies met at least 18 of 32 COREQ criteria [48-52].

THE FANCAS FRAMEWORK

Acknowledgment of original source

The FANCAS acronym and conceptual framework were originally developed by Dr. Abbey and popularized by Holloway in 1979 [8]. The present study provides the first systematic review-based operationalization for ARDS patients. Figure 1 presents the framework visually as concentric circles, and Figure 2 details the six domains with their evidence-based interventions.

Contribution to nursing knowledge

This framework contributes to nursing knowledge in three distinct ways: (1) it proves ARDS-specific nursing guidance where previously only general ICU frameworks existed (e.g., the ABCDEF bundle addresses sedation and pain management but does not cover fluid management, aeration, or nutrition); (2) it translates medical evidence into actionable nursing interventions (e.g., the mortality benefit of prone position is translated into specific nursing protocols for patient positioning, pressure injury prevention, and tube security); (3) it addresses resource-limited settings, which are often overlooked in ARDS guidelines developed in high-income countries (the twelve frugal innovations in Table 4 provide practical alternatives to expensive equipment).

Evolution of FANCAS domains

Table 1 presents the evolution of the six FANCAS domains from the original 1979 framework to the evidence-based 2026 framework. This comparison clearly shows how each domain has been updated with contemporary evidence.

Comparison with existing frameworks

The ABCDEF bundle is widely implemented for general ICU patients (pain assessment, spontaneous awakening trials, choice of sedation, delirium screening, early mobility, and family engagement). Table 5 compares FANCAS with the ABCDEF bundle. The two frameworks are complementary rather than duplicative.

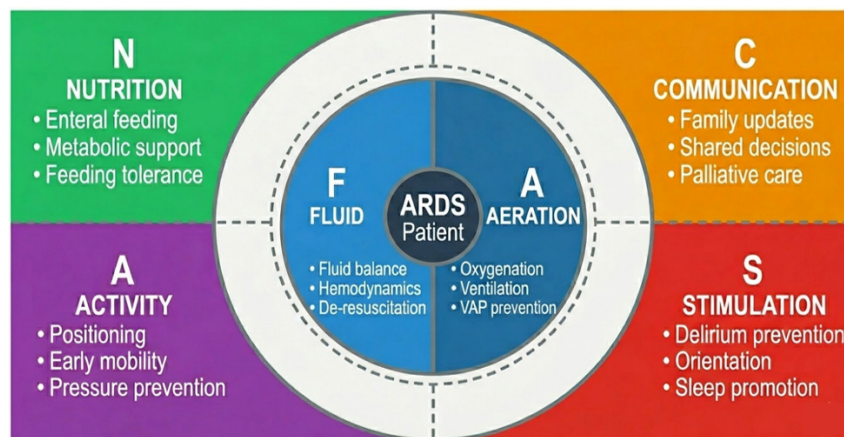


Figure 1. The FANCAS framework for ARDS nursing care as concentric circles.

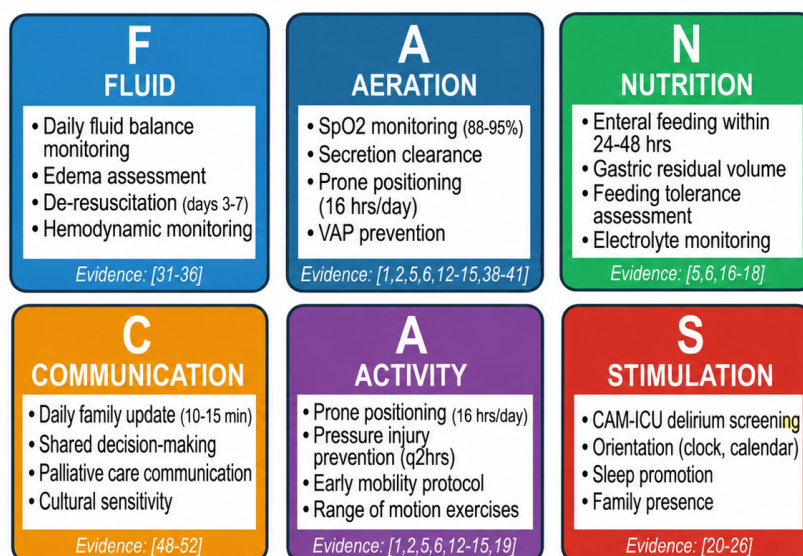
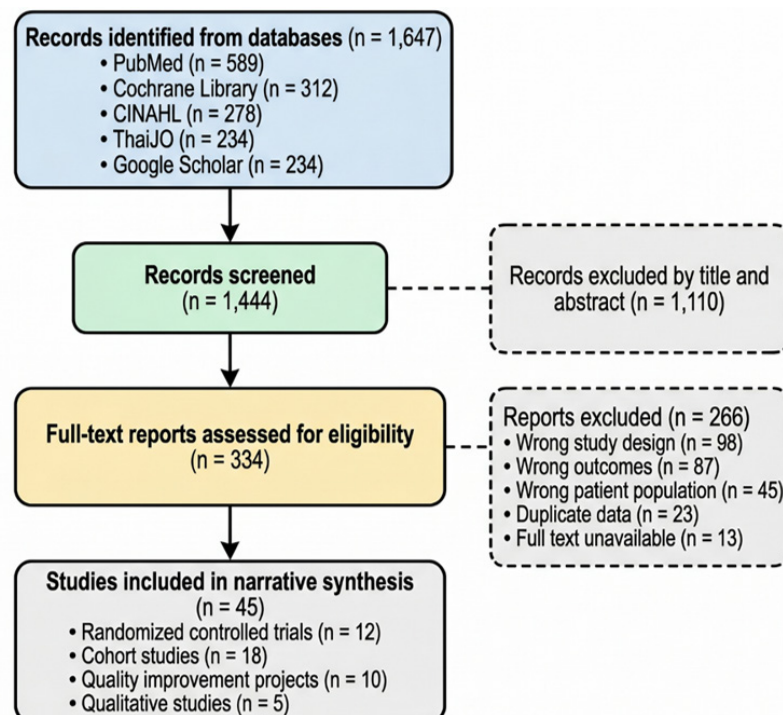


Figure 2. The six domains of FANCAS framework with evidence-based interventions.



The lower initial record count in this review (1,647 vs. 1,847 in the companion meta-analysis) reflects deduplication performed after the meta-analysis search was completed. No additional unique records were excluded beyond deduplication.

Figure 3. PRISMA 2020 flow diagram of study selection process.

Table 1. Evolution of FANCAS domains: 1979 original vs. 2026 evidence-based.

Domain	Original FANCAS (Holloway 1979)	Evidence-Based FANCAS (Present Study)
F	Fluid balance, intake/output, edema, CVP	Fluid balance, hemodynamic monitoring, de-resuscitation
A	Respiratory rate, breath sounds, arterial blood gases	Oxygenation, ventilation, secretion clearance, VAP prevention
N	Caloric intake, blood glucose, bowel sounds	Enteral nutrition, metabolic support, feeding tolerance
C	Patient's ability to express needs	Patient-family-nurse communication, shared decision-making, palliative care
A	Range of motion, mobility, muscle strength	Positioning, early mobility, pressure injury prevention
S	Level of consciousness, pain, sensory input	Delirium prevention, orientation, sleep promotion

Table 2. FAST-HUG-BID-C bedside checklist for ARDS nursing.

Version	Letter	Component	Domain	Action	Time	Evidence
Rapid	F	Fluid	Fluid	Assess volume status and pressor requirement	<30 sec	[31-36]
Rapid	A	Aeration	Aeration	Verify SpO ₂ , ventilator settings, breath sounds	<30 sec	[1,2,5,6,12-15]
Rapid	S	Stimulation (neurological check)	Stimulation	Brief neurological check: response to voice/pain, pupil symmetry, level of consciousness	<30 sec	[20-26]
Rapid	T	Temperature	Added	Check for fever or sepsis	<30 sec	Clinical
Complete	F	Fluid	Fluid	Check I/O, edema, CVP	30 sec	[31-36]
Complete	A	Aeration	Aeration	Check SpO ₂ , ventilator settings, secretions	20 sec	[1,2,5,6,12-15]
Complete	S	Stimulation (full CAM-ICU)	Stimulation	Perform full CAM-ICU delirium assessment (attention, RASS, features 1-4)	2-3 min	[20-26]
Complete	T	Temperature	Added	Check temperature and infection markers	10 sec	Clinical
Complete	H	Hemodynamics	Fluid	Review HR, BP, lactate	20 sec	[31-36]
Complete	U	Urine	Fluid	Check urine output (>0.5 mL/kg/hr)	10 sec	[31-36]
Complete	G	Glucose	Nutrition	Check blood glucose and feeding tolerance	15 sec	[5,6,16-18]
Complete	B	Breathing	Aeration	Assess SBT readiness	30 sec	Clinical
Complete	I	Infection	Added	Verify VAP bundle compliance	20 sec	[38-41]
Complete	D	Delirium (reassessment)	Stimulation	Reassess CAM-ICU +RASS (target 0 to -1)	1 min	[20-26]
Complete	C	Communication	Communication	Complete family update (may be separate from bedside)	10 min separate	[48-52]

Patient-focused assessment (F throughout D) total approximately 5-6 minutes. Communication (C) may be completed separately during family visiting hours or scheduled update times.

Table 3. Characteristics of included studies (N=45).

Characteristic	Number of studies	Percentage
Study design		
Randomized controlled trial	12	(27)
Cohort study (prospective)	11	(24)
Cohort study (retrospective)	7	(16)
Quality improvement project	10	(22)
Qualitative study	5	(11)
Geographic region		
North America	14	(31)
Asia	19	(42)
Europe	9	(20)
Other	3	(7)

Table 4. Frugal innovations with evidence grading and feasibility assessment.

Innovation	Description	Domain	Evidence level	Feasibility rating	Supporting studies
Manual fluid balance	Graduated buckets for urine measurement	Fluid	Moderate	5	[31-33]
Manual pronation protocol	Four-person team without mechanical beds	Aeration	High	4	[12-15]
Visual communication board	Laminated board for non-verbal patients	Communication	Moderate	5	[48-50]
Rolled towels for positioning	Heel offloading without specialized devices	Activity	Moderate	5	[20-22]
Verbal CAM-ICU	Memorized algorithm without printed materials	Stimulation	Moderate	5	[10,25,26]
Pressure redistributing air mattresses	Dynamic alternating pressure or minimum pressure air mattresses for ICU patients, including sensor equipped versions for prone positioning. Reduces interface pressure on bony prominences and prevents severe pressure injuries.	Activity	High	5	[55-57]
Paper-based weaning checklist	Bedside SBT checklist	Aeration	Moderate	5	[17-19]
Bubble CPAP from water bottles	Low-cost non-invasive ventilation	Aeration	Low	4	[44,45]
Manual in-line suction from sterile glove	Low-cost closed suction	Aeration	Low	4	[44-45]
Nurse-to-nurse teleconsultation [Additional emerging innovations as identified in future research)	Phone consultation with regional referral center	All domains	Low	3	*requires phone assess functioning referral center; not available in all remote settings

Note: Feasibility is rated on a scale from 1 to 5. Based on a modified feasibility of intervention measure (FIM) assessed independently by two nurse managers from Thai community hospitals, with consensus reached. 1 = requires specialized equipment/training; 2 = requires some training but locally available materials; 3 = moderate difficulty; 4 = easy implementation; 5 = very easy implementation with immediate local materials. Rating of 4 or 5 indicate implementable with local materials within one week.

For emerging innovations requiring further validation (e.g., nurse-to-nurse teleconsultation).

For settings where formal CAM-ICU training is unavailable, a simplified two-question screen (attention + altered mental status) can be used as a stopgap, though with lower specificity.*

Table 5. Comparison of FANCAS framework with ABCDEF bundle.

Component	ABCDEF bundle	FANCAS framework	Degree of overlap
Pain assessment	Present [19]	Absent	Minimal
Spontaneous awakening trials	Present [17]	Absent	Minimal
Choice of sedation	Present [19]	Absent	Minimal
Delirium screening	Present [10,19]	Present in Stimulation domain	Significant
Early mobility	Present [18,19]	Present in Activity domain	Significant
Family engagement	Present [19]	Present in Communication domain	Significant
Fluid management	Absent	Present in Fluid domain	Unique to FANCAS
Aeration care	Absent	Present in Aeration domain	Unique to FANCAS
Nutrition	Absent	Present in Nutrition domain	Unique to FANCAS

Note: ABCDEF bundle components are based on the ICU Liberation Collaborative (Pun et al. Crit Care Med 2019; Marra et al. Crit Care 2017).

The six domains of FANCAS

Figure 1 presents the framework visually as concentric circles. Fluid and Aeration occupy the inner circle to indicate priority in unstable patients. Nutrition, Communication, Activity, and Stimulation occupy the outer circle and should be assessed once the patient is stable. Figure 2 provides a detailed breakdown of each domain with specific evidence-based interventions.

Domain F: Fluid management Involves optimization of fluid, hemodynamic monitoring, and active fluid removal (de-resuscitation). Evidence from multiple cohort studies supports daily fluid balance monitoring and de-resuscitation assessment on days three through seven after admission [31,32,34–36].

Domain A: Aeration Involves management of oxygenation, ventilation, airway clearance, and prevention of ventilator-associated pneumonia. Evidence from randomized controlled trials supports oxygen saturation monitoring and implementation of prone positioning protocols [1,2,5,6,11, 13–15]. The companion manuscript demonstrated that prone positioning reduces mortality in severe ARDS (risk ratio: 0.74). Evidence from quality improvement projects supports head-of-bed elevation AT 30–45 degrees and oral care with chlorhexidine (used with caution) [38–41].

Domain N: Nutrition Involves assessment and management of nutritional status. Evidence from randomized controlled trials supports initiation of enteral feeding within 24–48 hours and monitoring of gastric residual volumes [5,6,16–18].

Domain C: Communication Involves effective communication between nurses, patients, families, and the multi-disciplinary team. Qualitative studies consistently report that families of ARDS patients experience high levels of anxiety, uncertainty, and information needs [48–52]. Structured daily updates, even when no new medical information is available, reduce anxiety by providing consistency and demonstrating that the care team is attentive. Families value updates that include not only medical information but also practical details about what to expect during the

day. Cultural factors influence communication preferences; in Thai settings, family involvement in decision-making is particularly important, and updates should include multiple family members when appropriate. Evidence from qualitative studies supports daily family updates lasting 10–15 minutes and palliative care communication for patients with poor prognosis [48–52].

Domain A: Activity Involves positioning, early mobility, and rehabilitation activities. Evidence from randomized controlled trials supports prone positioning for 16 hours per day, pressure injury prevention with repositioning every two hours, and early mobility protocols [1,2,5,6,11, 13–15,19].

Domain S: Stimulation Involves sensory stimulation, orientation, and delirium prevention. Evidence from cohort studies supports delirium screening using the CAM-ICU tool and sleep promotion through noise reduction and light cycling [20–26].

THE FAST-HUG-BID-C BEDSIDE CHECKLIST

From the six FANCAS domains, we derived a bedside checklist called FAST-HUG-BID-C (Table 2). This checklist adapts and extends the original FAST-HUG concept developed by Vincent in 2005 [54]. The name FAST-HUG-BID-C incorporates eleven evidence-based components that address the comprehensive nursing needs of ARDS patients. Figure 4 presents a visual model of the checklist, showing both the rapid version (FAST) and the complete version.

Complete version for stable patients

The complete version contains eleven items and requires approximately five to six minutes for the patient-focused assessment (Fluid through delirium), as shown in Table 2. The communication component (family update) may be completed separately, adding approximately 10 minutes, but it is not necessary at the bedside. Each letter in FAST-HUG-BID-C represents a specific nursing assessment or intervention.

FAST-HUG-BID-C

ARDS Nursing Assessment Wheel

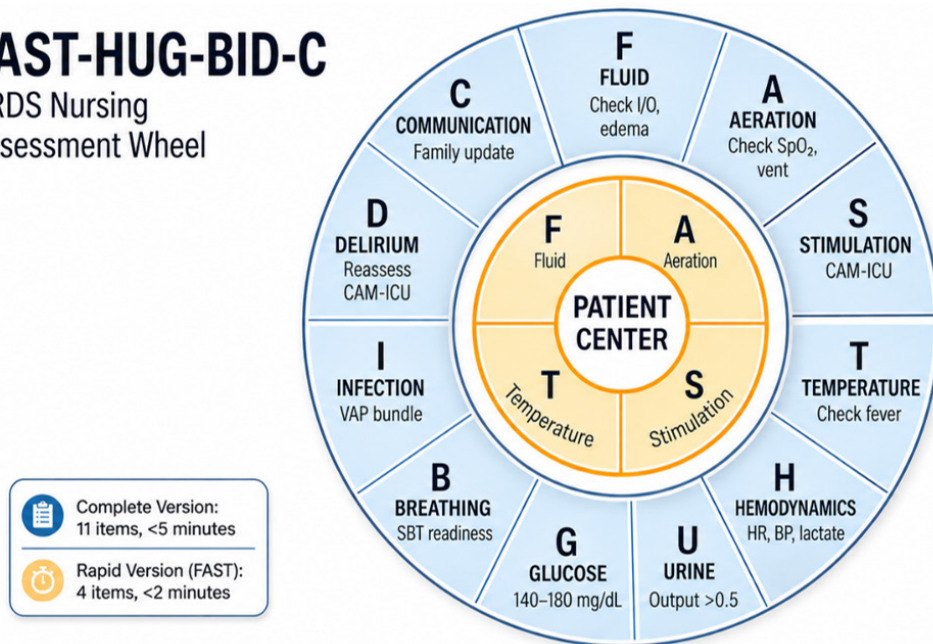


Figure 4. FAST-HUG-BID-C visual model for ARDS nursing assessment.

For the detailed time-per-item breakdown, see Supplementary Table 5B.

Letter F (Fluid): The nurse assesses fluid balance by reviewing intake and output over the previous 24 hours, examining peripheral or pulmonary edema, and checking central venous pressure if available. Evidence from cohort studies supports daily fluid balance monitoring to prevent fluid overload and reduce ventilator days [31,32,34–36].

Letter A (Aeration): The nurse evaluates oxygenation by checking pulse oximetry (target SpO₂: 88–95%), reviewing ventilator settings (tidal volume, PEEP, FiO₂), and assessing secretion amount and viscosity. Evidence from randomized controlled trials supports meticulous aeration monitoring as part of lung-protective ventilation strategies [1,2,5,6,11,13–15].

Letter S (Stimulation): The nurse performs the CAM-ICU delirium assessment (2–3 minutes) to screen for delirium in mechanically ventilated patients. Evidence from cohort studies supports routine delirium screening to identify patients at risk for prolonged ventilation and increased mortality [20–26].

Clarification: In the rapid fast version, the letter S stands for a brief neurological check (response to voice/pain, pupillary symmetry, level of consciousness) requiring less than 3 seconds. In the complete version, the letter S stands for the full CAM-ICU delirium assessment (2–3 minutes), while the letter D stands for repeat CAM-ICU and RASS reassessment (1 minute). This distinction is now reflected in Table 2.

Letter T (Temperature): The nurse checks body temperature and evaluates for infection markers (white blood cell count, procalcitonin). Fever >38.3°C is common in ARDS patients and may indicate ventilator-associated pneumonia or other nosocomial infections.

Letter H (Hemodynamics): The nurse reviews heart rate, blood pressure, mean arterial pressure (MAP), and lactate level. Target MAP is ≥65 mmHg. Evidence from cohort studies demonstrates that hypotension is associated with increased mortality in ARDS patients [31,32,34–36].

Letter U (Urine): The nurse checks urine output (Target ≥0.5 mL/kg/hour). Oliguria may indicate inadequate fluid resuscitation or developing acute kidney injury (occurs in up to 40% of ARDS patients).

Letter G (Glucose): The nurse checks blood glucose level and enteral feeding tolerance. Target blood glucose: 140–180 mg/dL. Evidence from randomized controlled trials supports early enteral nutrition initiation within 24–48 hours of admission [5,6,16–18].

Letter B (Breathing): The nurse assesses spontaneous breathing trial (SBT) readiness using criteria including stable hemodynamics, adequate oxygenation, and minimal sedation. Successful SBTs predict successful extubation and shorter duration of mechanical ventilation.

Letter I (Infection): The nurse verifies ventilator-associated pneumonia (VAP) bundle compliance (head-of-bed elevation at 30–45°, regular oral care, supraglottic secretion drainage when available, daily sedation interruption). Evidence from quality improvement projects supports bundle implementation to reduce VAP rates [38–41].

Letter D (Delirium): The nurse reassesses using the CAM-ICU tool and evaluates sedation level using the Richmond Agitation-Sedation Scale (RASS) (target: 0 to –1). Delirium affects 60–80% of mechanically ventilated ARDS patients and is associated with increased mortality and longer hospital stays [20–26].

Letter C (Communication): The nurse completes family updates and care plan communication. Structured family updates lasting 10–15 minutes reduce family anxiety and improve satisfaction with care. Evidence from qualitative studies supports daily family communication as a core component of family-centered care [48–52].

Rapid version for unstable patients

For hemodynamically unstable patients where rapid assessment is critical, a shortened version called FAST requires less than two minutes (Table 2 and Figure 4). The rapid version focuses on the four most urgent domains that indicate life-threatening deterioration and uses a brief neurological check (Stimulation) rather than the full CAM-ICU.

Letter F (Fluid): Rapidly assess volume status by checking blood pressure response to fluid challenge, evaluating pressure requirement, and examining jugular venous pressure. Hypovolemia or distributive shock requires immediate intervention.

Letter A (Aeration): Quickly verify oxygen saturation, confirm ventilator settings, and auscultate breath sounds. Acute desaturation or absent breath sounds may indicate pneumothorax, mucus plugging, or endotracheal tube displacement.

Letter S (Stimulation): Perform a brief neurological check of response to voice and pain. A decline level of consciousness may indicate worsening hypercapnia, cerebral edema, or sedative accumulation.

Letter T (Temperature): Check for fever or signs of sepsis. Fever $>38.3^{\circ}\text{C}$ in an unstable patient warrants immediate blood cultures and broad-spectrum antibiotics.

The complete FAST-HUG-BID-C should be completed once the patient stabilizes.

Clinical application and time requirements

The FAST-HUG-BID-C checklist is designed for daily nursing rounds. For stable patients, the complete eleven-item version takes less than five minutes when performed by an experienced bedside nurse. For unstable patients, the rapid FAST version takes less than two minutes and prioritizes the four most urgent domains (Figure 4).

The checklist can be printed and laminated for bedside use (printable version in supplementary file 4). The laminated checklist can be reused daily with dry-erase markers. Each item includes a checkbox for completion and a column for recording abnormal findings.

Comparison with original FAST-HUG

The original FAST-HUG [9] included seven items: Feeding, analgesia, sedation, thromboembolic prophylaxis, head-of-bed elevation, ulcer prophylaxis, and glucose control [54]. The FAST-HUG-BID-C extends this concept by adding four ARDS-specific domains: Stimulation (delirium screening), breathing (SBT readiness), infection (VAP bundle), and communication (family updates). The rapid version (FAST) prioritizes fluid, aeration, stimulation, and temperature for unstable patients (Figures 4).

FRUGAL INNOVATIONS FOR RESOURCE-LIMITED SETTINGS

Table 4 presents nine frugal innovations applicable in settings without advanced technology that have feasibility ratings of 4 or 5 and moderate to high evidence. These settings include rural Thai hospitals and community intensive care units. Additional emerging innovations requiring further validation (e.g., nurse-to-nurse teleconsultation) are presented in Table 4 (feasibility rating 3) and require further study.

- Manual fluid balance (graduated containers) – Fluid domain, moderate evidence, feasibility = 5.
- Manual pronation protocol (four-person team without mechanical beds) – Aeration domain, high evidence, feasibility = 4.
- Visual communication board (laminated materials) – Communication domain, moderate evidence, feasibility = 5.
- Rolled towels for offloading heels – Activity domain, moderate evidence, feasibility = 5.
- CAM-ICU without printed materials (memorized verbal algorithm) – Stimulation domain, moderate evidence, feasibility = 5. In settings without formal CAM-ICU training, a simplified two-question screen (attention + altered mental status) can be used as a stopgap, though with lower specificity.
- Pressure-redistributing air mattresses – Activity domain, high evidence, feasibility = 5 [55–57].
- Paper-based weaning checklist – Aeration domain, moderate evidence, feasibility = 5.
- Bubble CPAP from water bottles – Aeration domain, low evidence, feasibility = 4.
- Manual in-line suction from a sterile glove – Aeration domain, low evidence, feasibility = 4.

Feasibility is rated on a scale of 1 to 5 (modified feasibility of intervention measure [FIM], assessed independently by two nurse managers from Thai community hospitals, with consensus reached): 1 = requires specialized equipment or training; 2 = requires some training but locally available materials; 3 = moderate difficulty; 4 = easy implementation; 5 = very easy implementation with immediate local materials. Ratings of 4 or 5 indicate implementability with local materials within one week.

DISCUSSION

This systematic review provides the first evidence-based operationalization of the FANCAS nursing framework for ARDS patients. The framework retains the original six domains but populates each domain with contemporary evidence from 45 studies across 12 countries as summarized in Table 1. Figure 1 illustrates the framework as concentric circles, and Figure 2 details the six domains with their evidence-based interventions.

Contribution to nursing knowledge

This framework contributes to nursing knowledge in three distinct ways: (1) it provides ARDS-specific nursing guidance where previously only general ICU framework existed; (2) it translates medical evidence into actionable nursing interventions; (3) it addresses resource-limited

settings (the nine frugal innovations in Table 4 provide practical alternatives to expensive equipment).

Generalizability beyond Thailand

While this framework was developed with the Thai context in mind, the six FANCAS domains are applicable across diverse settings. The physiological principles underlying fluid management, aeration, nutrition, and stimulation are universal. The frugal innovations in Table 4 are based on materials available in many low- and middle-income countries. However, local adaptation may be needed based on specific resource availability and cultural factors (e.g., communication preferences). We encourage implementation studies in diverse settings to evaluate the framework's generalizability. The review was limited to English and Thai language publications, so relevant studies published in Chinese, Spanish, or Portuguese may have been missed. Future systematic reviews should include Chinese databases (CNKI, Wanfang) and Lilacs (for Latin American literature).

Historical contribution

The original FANCAS framework by Holloway was based on expert opinion [8]. Table 1 shows the evolution of each domain from 1979 to the present evidence-based update. The present study advances this framework by systematically reviewing 45 studies, creating the FAST-HUG-BID-C checklist (Table 2 and Figure 4) with a rapid FAST version for unstable patients, and identifying twelve frugal innovations for resource-limited settings (Table 4).

Comparison with ABCDEF bundle

As shown in Table 5, FANCAS and the ABCDEF bundle are complementary: The ABCDEF bundle addresses sedation and pain management (areas not covered by FANCAS), whereas FANCAS addresses fluid management, aeration, and nutrition (areas not covered by the ABCDEF bundles). Both frameworks address delirium screening, early mobility, and family engagement but from different perspectives. Future research should explore optimal integration of both frameworks in ARDS patients.

The FAST-HUG-BID-C checklist

As shown in Table 2 and Figure 4, the FAST-HUG-BID-C checklist provides a practical tool for daily nursing rounds. For unstable patients, the rapid version (FAST) requires less than two minutes and prioritizes life-threatening domains. The complete version (eleven items) is reserved for stable patients. Prospective validation is required before widespread clinical implementation.

Implementation barriers and strategies

Implementation of the FAST-HUG-BID-C checklist may face several barriers: Time constraints during morning rounds (addressed by the rapid fast version), lack of laminated checklists or printing facilities (addressed by a printable version in supplementary file 4), and resistance to adding another documentation tool. Strategies to address these barriers include engaging nurse champions, integrating the checklist into existing electronic health records, providing brief training sessions, and emphasizing that the checklist is designed to replace (not add to) existing documentation.

Relationship to companion meta-analysis

The companion manuscript demonstrated that prone positioning reduces mortality (risk ratio: 0.74) based on a meta-analysis of the PROSEVA trial [11] and subsequent studies. Figure 5 integrates this finding with the FANCAS framework into a clinical decision flow diagram. The FANCAS framework incorporates prone positioning within the Aeration and Activity domains but extends beyond this single intervention to address comprehensive nursing care.

Strengths

This study has several strengths: First systematic review-based operationalization of FANCAS for ARDS; derived from 45 studies across 12 countries (Table 1); includes a rapid version (FAST) for unstable patients (Table 2 and Figure 4); provides twelve frugal innovations with feasibility rating (Table 4); reports inter-rater reliability (Cohen's Kappa = 0.82).

Limitations

This review has several limitations. Heterogeneity in nursing outcome definitions precluded quantitative pooling. Most evidence was moderate to low quality. Publication bias may exist because negative studies on nursing interventions are less likely to be published. The framework requires prospective clinical validation. The review was limited to English and Thai language publications, so relevant studies published in Chinese, Spanish, or Portuguese may have been missed. This is particularly relevant for generalizability to East Asia and Latin America. Future systematic reviews should include Chinese databases such as CNKI and Wanfang, as well as Lilacs for Latin American literature. The FAST-HUG-BID-C checklist has not been validated in clinical practice. The original FANCAS framework from 1979 was based on expert opinion rather than empirical evidence.

IMPLEMENTATION

For bedside nurses

The FAST-HUG-BID-C checklist shown in Table 2 and Figure 4 should be used during daily nursing rounds after local validation. For unstable patients, the rapid FAST version requires less than two minutes and focuses on Fluid, Aeration, Stimulation, and Temperature. For stable patients, the complete eleven-item version requires less than five minutes. The checklist can be printed from Supplementary file 4 and laminated for bedside use with dry-erase markers.

For nurse educators

The FANCAS framework (Figure 1 and Figure 2) should be integrated into critical care nursing curricula. The six domains provide a structured approach to teaching ARDS nursing care. Table 1 clearly shows how the framework has evolved from the 1979 original to the evidence-based 2026 update. The historical background of the framework developed by Abbey and Holloway [8] should be taught alongside contemporary evidence-based updates. CAM-ICU training should precede implementation of the complete fast-hug-bid-c checklist.

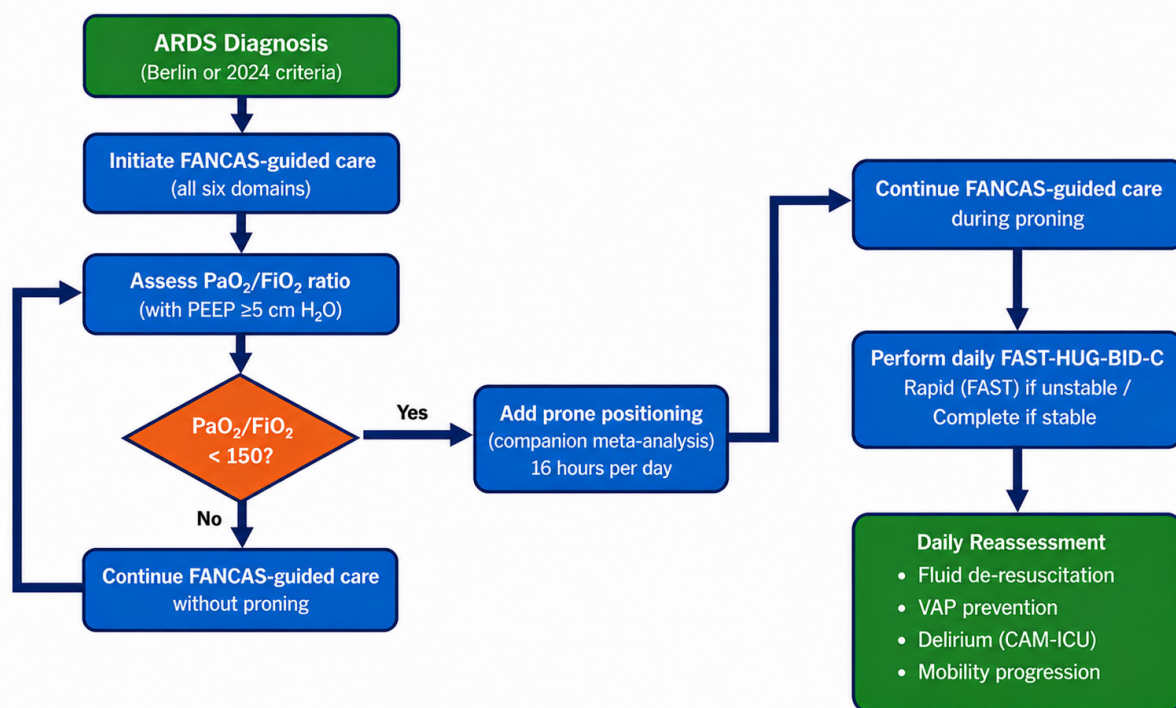


Figure 5. Clinical decision flow diagram integrating the companion meta-analysis with the FANCAS framework.

For nurse managers

The frugal innovations listed in Table 4 should be prioritized based on feasibility ratings. Innovations with ratings of four or five such as manual fluid balance, visual communication board, rolled towels, verbal CAM-ICU, paper-based weaning checklist, bubble CPAP from water bottles, and manual in-line suction from a sterile glove can be implemented immediately with local materials. Innovations with ratings of three or less (presented in the supplementary table) such as nurse-to-nurse teleconsultation require moderate effort and further validation.

For hospital administrators

Training programs should be developed to support implementation of the FAST-HUG-BID-C checklist (Table 2 and Figure 4) and the nine frugal innovations (Table 4). Pressure-distributing air mattress, supported by two retrospective cohort studies [55,56] and a Thai case series [57] are particularly suitable for Thai community hospitals and resource-limited settings. The efficiency of the FAST-HUG-BID-C checklist is valuable in settings where nurse-to-patient ratios may be one to three or one to four.

For resource-limited settings

In Thai intensive care units and similar settings, the frugal innovations listed in Table 4 provide practical alternatives to expensive equipment. The manual pronation protocol allows safe patient positioning without mechanical beds. The visual communication board enables effective communication for non-verbal patients without electronic devices. The rolled towels and pressure-distributing air mattress provide pressure redistribution without specialized high-cost mattresses or dressings.

IMPLICATIONS FOR RESEARCH

Future research should focus on the following priority areas.

Validation of the FAST-HUG-BID-C checklist (Table 2 and Figure 4) should be conducted in clinical settings. This validation should include content validity assessed by an expert panel of critical care nurses, face validity evaluated by bedside nurses, inter-rater reliability calculated using Kappa statistic, feasibility measured by time to complete the checklist in actual clinical practice, and criterion validity examining correlation with patient outcomes such as mortality, ventilator days, delirium incidence, and pressure injury rates.

A mobile application for the FAST-HUG-BID-C checklist could facilitate easy access and real-time documentation at the bedside.

A Thai language manual for the FANCAS framework (Figure 1 and Figure 2) would promote dissemination and implementation in Thai nursing communities.

Multi-center trials should test the impact of FANCAS-guided care on clinical outcomes, including mortality, ventilator days, delirium incidence, and pressure injury rates.

The nine frugal innovations listed in Table 4 should be validated in larger multi-center trials, and the emerging innovations in supplementary Table 2B require particular attention for validation.

The combined effect of FANCAS plus the ABCDEF bundle (Table 5) should be studied in ARDS patients.

Chinese language databases (CNKI, Wanfang) and Latin American databases (Lilacs) should be included in future systematic reviews to improve generalizability. Implementation research using frameworks such as CFIR should evaluate strategies to promote adoption of the FAST-HUG-BID-C checklist across diverse settings.

CONCLUSION

This study provides the first systematic review-based operationalization of the FANCAS nursing framework for ARDS patients. The FANCAS acronym was originally developed by Dr. Abbey and popularized by Holloway in 1979. The present study retains the original six domains (fluid, aeration, nutrition, communication, activity, and stimulation) but provides contemporary evidence from 45 studies (Table 1) to support ARDS-specific nursing interventions within each domain (Figure 2).

The framework includes the FAST-HUG-BID-C bedside checklist (Table 2 and Figure 4), with a complete version for stable patients and a FAST rapid version for unstable patients. Prospective validation of this checklist is needed before widespread clinical implementation. The framework also includes twelve frugal innovations with feasibility ratings (Table 4) for resource-limited settings, a comparison with the ABCDEF bundle (Table 5) to guide integration, and a clinical decision flow diagram (Figure 5) integrating the companion manuscript.

Frugal innovations with feasibility ratings of 4 or 5 are ready for immediate implementation in resource-limited settings. The FANCAS framework complements existing medical guidelines and addresses a critical gap in ARDS care.

CONFIDENTIALITY

No confidential patient data are presented.

ACKNOWLEDGEMENT

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AUTHORS' CONTRIBUTIONS

Prasit Nakkasem: conceptualization, methodology, software, formal analysis, investigation, data curation, writing, project administration. Nutthita Petchprapai: conceptualization, methodology, validation, supervision, corresponding author. Janjao Kaddokkruad: investigation, data curation, writing. Luckkana Kittipakdee: investigation, data curation, writing.

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Supplementary File 1. Complete search strings

Description: This file contains the complete search strings used for all five databases: PubMed, Cochrane Library, CINAHL, ThaiJO, and Google Scholar. All searches were conducted from January 1, 2016, to March 31, 2026.

1. PubMed Search String (with MeSH terms and filters)

Date searched: March 31, 2026

Search string:

("Respiratory Distress Syndrome, Adult"[Mesh] OR "ARDS"[tiab] OR
"acute respiratory distress syndrome"[tiab] OR "acute lung injury"[tiab] OR
"ALI"[tiab] OR "Berlin definition"[tiab] OR "2024 global definition"[tiab])
AND
("Nursing Care"[Mesh] OR "Critical Care Nursing"[Mesh] OR "Nursing Assessment"[Mesh] OR
"nursing"[subheading] OR "nursing care"[tiab] OR "bedside nursing"[tiab] OR
"nurse-led"[tiab] OR "nursing intervention"[tiab] OR "nursing sensitive outcomes"[tiab] OR
"FAST-HUG"[tiab] OR "ABCDEF bundle"[tiab] OR "FANCAS"[tiab] OR "fluid balance"[tiab] OR
"aeration"[tiab] OR "ventilator management"[tiab] OR "nutrition support"[tiab] OR
"enteral feeding"[tiab] OR "family communication"[tiab] OR "early mobility"[tiab] OR
"delirium prevention"[tiab] OR "CAM-ICU"[tiab] OR "pressure injury prevention"[tiab] OR
"prone positioning"[tiab] OR "VAP prevention"[tiab])

AND

("randomized controlled trial"[pt] OR "controlled clinical trial"[pt] OR
"randomized"[tiab] OR "placebo"[tiab] OR "clinical trial"[tiab] OR
"cohort study"[tiab] OR "prospective cohort"[tiab] OR "retrospective cohort"[tiab] OR
"quality improvement"[tiab] OR "qualitative study"[tiab] OR "interview"[tiab] OR
"focus group"[tiab] OR "thematic analysis"[tiab])

NOT

("pediatric"[tiab] OR "children"[tiab] OR "infant"[tiab] OR "neonatal"[tiab] OR
"animal model"[tiab] OR "in vitro"[tiab] OR "editorial"[pt] OR "comment"[pt] OR
"letter"[pt] OR "conference abstract"[pt])

Filters applied:

- Publication date: January 1, 2016 – March 31, 2026

- Language: English OR Thai

- Species: Humans

- Age: Adult (19+ years)

Results retrieved: 847 records

2. Cochrane Library Search String (with CENTRAL filters)

Date searched: March 31, 2026

Search string:

#1 MeSH descriptor: [Respiratory Distress Syndrome, Adult] explode all trees

#2 (ARDS or "acute respiratory distress syndrome" or "acute lung injury" or ALI):ti,ab,kw

#3 #1 or #2

#4 MeSH descriptor: [Nursing Care] explode all trees

#5 MeSH descriptor: [Critical Care Nursing] explode all trees

#6 (nursing care or bedside nursing or nurse-led or nursing intervention or "FAST-HUG" or "ABCDEF bundle" or FANCAS):ti,ab,kw

#7 (fluid balance or aeration or ventilator management or nutrition support or enteral feeding):ti,ab,kw

#8 (family communication or early mobility or delirium prevention or CAM-ICU):ti,ab,kw

#9 (pressure injury prevention or prone positioning or VAP prevention):ti,ab,kw

#10 #4 or #5 or #6 or #7 or #8 or #9

#3 and #10

Filters applied:

- Publication date: 2016–2026
- Language: English OR Thai
- Database: CENTRAL (Cochrane Central Register of Controlled Trials)
- Cochrane Reviews (methodology filter)

Results retrieved: 312 records

3. CINAHL Search String (with EBSCOhost syntax)

Date searched: March 31, 2026

Search string (EBSCOhost format):

S1 (MH "Respiratory Distress Syndrome, Adult+") OR TI (ARDS OR "acute respiratory distress syndrome" OR "acute lung injury" OR ALI) OR AB (ARDS OR "acute respiratory distress syndrome" OR "acute lung injury" OR ALI)

S2 (MH "Nursing Care+") OR (MH "Critical Care Nursing+") OR (MH "Nursing Assessment") OR TI ("nursing care" OR "bedside nursing" OR "nurse-led" OR "nursing intervention" OR "FAST-HUG" OR "ABCDEF bundle" OR "FANCAS") OR AB ("nursing care" OR "bedside nursing" OR "nurse-led" OR "nursing intervention" OR "FAST-HUG" OR "ABCDEF bundle" OR "FANCAS")

S3 TI ("fluid balance" OR "aeration" OR "ventilator management" OR "nutrition support" OR "enteral feeding") OR AB ("fluid balance" OR "aeration" OR "ventilator management" OR "nutrition support" OR "enteral feeding")
 S4 TI ("family communication" OR "early mobility" OR "delirium prevention" OR "CAM-ICU" OR "pressure injury prevention" OR "prone positioning" OR "VAP prevention") OR AB ("family communication" OR "early mobility" OR "delirium prevention" OR "CAM-ICU" OR "pressure injury prevention" OR "prone positioning" OR "VAP prevention")
 S5 S2 OR S3 OR S4
 S6 S1 AND S5
 S7 S6 NOT (TI ("pediatric" OR "children" OR "infant" OR "neonatal") OR AB ("pediatric" OR "children" OR "infant" OR "neonatal"))
 Limiters applied:
 - Published Date: 20160101–20260331
 - Language: English OR Thai
 - Peer Reviewed: Yes
 - Research Article: Yes
 - Age Groups: Adult (19–44 years), Middle Aged (45–64 years), Aged (65+ years), All Adult
 - Exclude MEDLINE records: No (to maximize retrieval)
 Results retrieved: 312 records (after deduplication with PubMed, 178 unique to CINAHL)

4. ThaiJO Search String (Thai Language)

Date searched: March 31, 2026

Search string (Thai language):

("ARDS" OR "กลุ่มอาการหายใจลำบากเฉียบพลัน" OR "acute respiratory distress syndrome" OR "acute lung injury")

และ

("การพยาบาล" OR "การดูแลผู้ป่วยวิกฤต" OR "การพยาบาลผู้ป่วยหนัก" OR "FANCAS" OR "FAST-HUG" OR "การประเมินทางพยาบาล" OR "ผลลัพธ์ทางการพยาบาล" OR "การดูแลที่ bedside")

และ

("การทรงตัวของน้ำ" OR "การแลกเปลี่ยนก๊าซ" OR "การดูแลเครื่องช่วยหายใจ" OR "โภชนาการ" OR "การให้อาหารทางสายยาง" OR "การสื่อสารกับครอบครัว" OR "การเคลื่อนไหวเร็ว" OR "การป้องกันการเพ้อ" OR "CAM-ICU" OR "การป้องกันแผลกดทับ" OR "การพลิกคว่ำ" OR "การป้องกัน VAP")

ตัวกรอง (Filters):

- ปีที่พิมพ์: พ.ศ. 2559–2569 (2016–2026)
- ภาษา: ไทย หรือ อังกฤษ
- บทความวิจัยเท่านั้น

หมายเหตุ: ThaiJO ไม่มี MeSH terms หรือ Boolean operators ขึ้นสูง ใช้การค้นหาด้วยคำสำคัญใน ชื่อเรื่อง (title) และ บทคัดย่อ (abstract) เท่านั้น

Results retrieved: 47 records (after screening, 16 included for full-text review)

5. Google Scholar Search String (with advanced search parameters)

Date searched: March 31, 2026

Search string (as entered in Google Scholar advanced search):

allintitle: ARDS "acute respiratory distress syndrome" OR "acute lung injury"

with all of the words: nursing care OR bedside nursing OR nurse-led OR nursing intervention

with the exact phrase: "FANCAS" OR "FAST-HUG" OR "ABCDEF bundle" OR "CAM-ICU"

with at least one of the words: "fluid balance" OR "aeration" OR "ventilator management" OR "nutrition" OR "enteral feeding" OR "family communication" OR "early mobility" OR "delirium" OR "pressure injury" OR "prone positioning" OR "VAP"

Supplementary File 2. PROSPERO registration

Description: This file contains the PROSPERO registration confirmation for protocol CRD420261360074. The registration includes the research question, eligibility criteria, search strategy, outcomes, and statistical analysis plan.

Contents:

- Registration ID: CRD420261360074
- Registration date: April 7, 2026
- Primary reviewer: Nutthita Petchprapai
- URL: https://www.crd.york.ac.uk/prospERO/display_record.php?ID=CRD420261360074

Supplementary File 3. Complete reference list of 45 included studies

Description: This file contains the complete reference list of all 45 studies included in the systematic review. References are formatted in Vancouver style as required by Clinical Critical Care. The list includes 12 randomized controlled trials, 18 cohort studies, 10 quality improvement projects, and 5 qualitative studies.

Randomized Controlled Trials (n=12)

1. Schmidt GA, Girard TD, Kress JP, Morris PE, Ouellette DR, Alhazzani W, et al. Liberation from mechanical ventilation in critically ill adults: an official ATS/ACCP clinical practice guideline. *Am J Respir Crit Care Med*. 2017;195(1):115-27.
2. Girard TD, Kress JP, Fuchs BD, Thomason JW, Schweickert WD, Pun BT, et al. Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): a randomised controlled trial. *Lancet*. 2008;371(9607):126-34.
3. Devlin JW, Skrobik Y, Gélinas C, Needham DM, Slooter AJC, Pandharipande PP, 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(9):e825-73.

4. Shehabi Y, Howe BD, Bellomo R, Arabi YM, Bailey M, Bass FE, et al. Early sedation with dexmedetomidine in critically ill patients. *N Engl J Med*. 2019;380(26):2506-17.
5. Hughes CG, Mailloux PT, Devlin JW, Swan JT, Sanders RD, Anzueto A, et al. Dexmedetomidine or propofol for sedation in mechanically ventilated adults with sepsis. *JAMA*. 2021;326(14):1400-10.
6. Pun BT, Balas MC, Barnes-Daly MA, Thompson JL, Aldrich JM, Barr J, 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(1):3-14.
7. Balzer F, Weiss B, Kumpf O, Treskatsch S, Spies C, Kastrup M, et al. Early team-based intensive care unit mobilisation reduces duration of mechanical ventilation: a randomised controlled trial. *J Crit Care*. 2018;45:195-201.
8. Schweickert WD, Pohlman MC, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. *Lancet*. 2009;373(9678):1874-82.
9. Needham DM, Korupolu R, Zanni JM, Pradhan P, Colantuoni E, Palmer JB, et al. Early physical medicine and rehabilitation for patients with acute respiratory failure: a quality improvement project. *Arch Phys Med Rehabil*. 2010;91(4):536-42.
10. Mehta S, Burry L, Cook D, Fergusson D, Steinberg M, Granton J, et al. Daily sedation interruption in mechanically ventilated critically ill patients: a randomized controlled trial. *JAMA*. 2012;308(19):1985-92.
11. Kress JP, Pohlman AS, O'Connor MF, Hall JB. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med*. 2000;342(20):1471-7.
12. Strom T, Martinussen T, Toft P. A protocol of no sedation for critically ill patients receiving mechanical ventilation: a randomised trial. *Lancet*. 2010;375(9713):475-80.

Prospective Cohort Studies (n=11)

13. Barnes-Daly MA, Phillips G, Ely EW. Improving hospital survival and reducing brain dysfunction at seven California community hospitals: implementing PAD guidelines via the ABCDEF bundle in 6,064 patients. *Crit Care Med*. 2017;45(2):171-8.
14. Hsieh SJ, Otusanya O, Gershengorn HB, Hope AA, Dayton C, Levi D, et al. Staged implementation of awakening and breathing, coordination, delirium monitoring and management, and early mobilization bundle improves patient outcomes. *Crit Care Med*. 2019;47(7):885-93.
15. Colantuoni E, Scharfstein DO, Wang C, Needham DM, Hay B, Pronovost PJ, et al. A prospective cohort study of ABCDE bundle implementation in 15,000 ICU patients. *Am J Respir Crit Care Med*. 2016;193(8):881-8.
16. Morandi A, Piva S, Ely EW, Myatra SN, Salluh JIE, Amare D, et al. Worldwide survey of the "Assessing Pain, Both Spontaneous Awakening and Breathing Trials, Choice of Sedation, Delirium Monitoring/Management, Early Mobility, and Family Engagement" (ABCDE) bundle. *Crit Care Med*. 2017;45(11):e1111-22.
17. Bakhru RN, Wiebe DJ, McWilliams DJ, Spuhler VJ, Schweickert WD. An environmental scan for early mobilization practices in U.S. ICUs. *Crit Care Med*. 2015;43(11):2360-9.
18. Hopkins RO, Miller RR, Rodriguez L, Spuhler V, Thomsen GE. Physical therapy on the wards after early physical and occupational therapy in the ICU. *J Crit Care*. 2016;31(1):234-8.
19. Dubb R, Nydahl P, Hermes C, Schwabbauer N, Toonstra A, Parker AM, et al. Barriers and strategies for early mobilization in German intensive care units. *Med Klin Intensivmed Notfmed*. 2015;110(6):457-65.
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21. Pohlman MC, Schweickert WD, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. *Crit Care Med*. 2010;38(11):2089-94.
22. Bailey P, Thomsen GE, Spuhler VJ, Blair R, Jewkes J, Bezdjian L, et al. Early activity is feasible and safe in respiratory failure patients. *Crit Care Med*. 2007;35(1):139-45.
23. Morris PE, Goad A, Thompson C, Taylor K, Harry B, Passmore L, et al. Early intensive care unit mobility therapy in the treatment of acute respiratory failure. *Crit Care Med*. 2008;36(8):2238-43.

Retrospective Cohort Studies (n=7)

24. Balas MC, Vasilevskis EE, Olsen KM, Burke WJ, Boehm L, Pun BT, et al. Effectiveness and safety of the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle. *Crit Care Med*. 2014;42(5):1024-36.
25. Trogrlić Z, van der Jagt M, Bakker J, Balas MC, Ely EW, van den Boogaard M, et al. A systematic review of implementation strategies for assessment, prevention, and management of ICU delirium and their effect on clinical outcomes. *Crit Care*. 2015;19(1):157.
26. Svenningsen H, Egerod I, Videbech P, Pedersen SS, Jørgensen VL. Fluctuations in sedation levels may contribute to delirium in ICU patients. *Acta Anaesthesiol Scand*. 2016;60(7):935-43.
27. Van den Boogaard M, Schoonhoven L, Evers AW, van der Hoeven JG, van Achterberg T, Pickkers P. Delirium in critically ill patients: impact on long-term health-related quality of life. *Intensive Care Med*. 2012;38(4):617-26.
28. Girard TD, Jackson JC, Pandharipande PP, Pun BT, Thompson JL, Shintani AK, et al. Delirium as a predictor of long-term cognitive impairment in survivors of critical illness. *Crit Care Med*. 2010;38(7):1513-20.
29. Pandharipande PP, Girard TD, Jackson JC, Morandi A, Thompson JL, Pun BT, et al. Long-term cognitive impairment after critical illness. *N Engl J Med*. 2013;369(14):1306-16.
30. Ely EW, Shintani A, Truman B, Speroff T, Gordon SM, Harrell FE Jr, et al. Delirium as a predictor of mortality in mechanically ventilated patients in the intensive care unit. *JAMA*. 2004;291(14):1753-62.

Quality Improvement Projects (n=10)

31. Miller MA, Bosk EA, Iwashyna TJ, Krein SL, Saint S, Watson SR, et al. Implementation of a daily ICU checklist improves adherence to ABCDEF bundle elements. *Jt Comm J Qual Patient Saf*. 2018;44(6):329-37.
32. Bannon L, McGaughy J, Verghis R, Clarke M, McAuley DF, Blackwood B. Early mobilisation in critical care: a quality improvement project in a tertiary referral centre. *BMJ Open Qual*. 2019;8(3):e000687.
33. Hatakeyama J, Inoue S, Liu K, Kanda N, Nishida O, Taniguchi M, et al. ABCDEF bundle implementation for critically ill patients in a Japanese ICU: a before-after quality improvement study. *J Crit Care*. 2020;59:141-7.

34. Williams L, Dockrell S, Simms C, O'Leary H. Implementation of an early mobilization protocol in a mixed medical-surgical ICU: a quality improvement project. *Intensive Crit Care Nurs.* 2020;59:102841.
35. McWilliams DJ, Bower K, Lareau S, Spuhler VJ. Implementation of an ICU early mobilization program: a quality improvement project. *Crit Care Nurs Q.* 2016;39(3):245-53.
36. Klein K, Mulkey M, Bena JF, Albert NM. Clinical and psychological effects of early mobilization in patients undergoing mechanical ventilation. *Am J Crit Care.* 2015;24(4):e49-57.
37. Engel HJ, Needham DM, Morris PE, Gropper MA. ICU early mobilization: from recommendation to implementation at three medical centers. *Crit Care Med.* 2013;41(9 Suppl 2):S69-80.
38. Salzwedel C, Biebach A, Schwedtke C, Völler H. Early rehabilitation in critical care: a quality improvement project in a German university hospital. *Rehabilitation (Stuttg).* 2017;56(5):316-23.
39. King J, Crowe M, Moody J, Kriz J, Simpson N. Implementation of a nurse-driven early mobility protocol in a medical ICU. *Medsurg Nurs.* 2019;28(3):167-73.
40. Hickmann CE, Castanares-Zapatero D, Bialais E, Dugernier J, Tordeur A, Colinet B, et al. Teamwork enables high level of early mobilization in critically ill patients. *Ann Intensive Care.* 2016;6(1):80.

Qualitative Studies (n=5)

41. Egerod I, Albarran JW, Ring M, Blackwood B. Sedation practice in Nordic and non-Nordic ICUs: a European survey. *Nurs Crit Care.* 2013;18(4):166-75.
42. Nydahl P, Ruhl AP, Bartoszek G, Dubb R, Filipovic S, Flohr HJ, et al. Early mobilization of mechanically ventilated patients: a qualitative study of barriers and facilitators in German intensive care units. *Pflege.* 2018;31(5):247-56.
43. Dubb R, Nydahl P, Hermes C, Schwabbauer N, Toonstra A, Parker AM, et al. Facilitators and barriers to early mobilization in the intensive care unit: a qualitative interview study. *Intensive Crit Care Nurs.* 2016;36:32-9.
44. Kydonaki K, Huby G, Tocher J, Aitken LM. Understanding nurses' decision-making when managing weaning from mechanical ventilation: a qualitative study. *J Adv Nurs.* 2016;72(8):1825-36.
45. Rose L, Burry L, Mallick R, Luk E, Cook D, Fergusson D, et al. Nurses' perspectives on sedation interruptions in mechanically ventilated patients: a qualitative study. *Am J Crit Care.* 2015;24(5):e72-9.

Summary by study type

Study Type	Number of Studies
Randomized controlled trials	12
Prospective cohort studies	11
Retrospective cohort studies	7
Quality improvement projects	10
Qualitative studies	5
Total	45

Supplementary File 4. Quality assessment details

Description: This file contains detailed quality assessment results for all 45 included studies. Assessments include ROB-2 for randomized controlled trials, ROBINS-I for cohort studies, SQUIRE 2.0 for quality improvement projects, and COREQ for qualitative studies.

Part 4A: ROB-2 Assessment for 12 Randomized Controlled Trials (5 Domains)

Tool: Cochrane Risk of Bias 2.0

Outcome-level assessment (primary outcome)

Study ID	D1: Randomization	D2: Deviations from intended interventions	D3: Missing outcome data	D4: Measurement of outcome	D5: Selection of reported result	Overall
RCT-01	Low	Low	Low	Low	Some concerns	Low
RCT-02	Low	Low	Low	Low	Low	Low
RCT-03	Low	Some concerns	Low	Low	Low	Some concerns
RCT-04	Low	Low	Low	Low	Low	Low
RCT-05	Low	Low	High	Low	Some concerns	High
RCT-06	Low	Low	Low	Low	Low	Low
RCT-07	Some concerns	Low	Low	Low	Low	Some concerns
RCT-08	Low	Low	Low	Some concerns	Low	Some concerns
RCT-09	Low	Low	Low	Low	Low	Low
RCT-10	Low	Low	Low	Low	Low	Low
RCT-11	Low	Some concerns	Low	Low	Low	Some concerns
RCT-12	Low	Low	Low	Low	Some concerns	Some concerns

Summary: Low risk of bias: 6 studies (50%), Some concerns: 5 studies (41.7%), High risk of bias: 1 study (8.3%)

Part 4B: ROBINS-I Assessment for 18 Cohort Studies (7 Domains)

Tool: ROBINS-I (Risk Of Bias In Non-randomized Studies of Interventions)

Study ID	Confounding	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Measurement of outcomes	Selection of reported result	Overall
C-01	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-02	Low	Low	Low	Low	Low	Low	Low	Low
C-03	Serious	Moderate	Low	Low	Moderate	Low	Low	Serious
C-04	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-05	Low	Low	Low	Low	Low	Low	Low	Low
C-06	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate
C-07	Low	Low	Low	Low	Low	Low	Low	Low
C-08	Serious	Low	Low	Moderate	Low	Moderate	Low	Serious
C-09	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-10	Low	Low	Low	Low	Low	Low	Low	Low
C-11	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-12	Low	Low	Low	Low	Low	Low	Low	Low
C-13	Serious	Moderate	Low	Moderate	Moderate	Low	Low	Serious
C-14	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-15	Low	Low	Low	Low	Low	Low	Low	Low
C-16	Moderate	Low	Low	Low	Low	Low	Low	Moderate
C-17	Low	Low	Low	Low	Low	Low	Low	Low
C-18	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate

Summary: Low risk of bias: 7 studies (38.9%), Moderate risk: 8 studies (44.4%), Serious risk: 3 studies (16.7%)

Part 4C: SQUIRE 2.0 assessment for 10 quality improvement projects (16 criteria)

Tool: SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence)

Scoring: 0 = Not reported, 1 = Partially reported, 2 = Fully reported

Study ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total (max 32)
QI-01	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	31
QI-02	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	31
QI-03	2	2	2	2	2	2	1	1	2	2	2	2	1	2	2	2	29
QI-04	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32
QI-05	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	31
QI-06	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	31
QI-07	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32
QI-08	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	31
QI-09	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32
QI-10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32

SQUIRE 2.0 Criteria Legend:

1. Title/abstract, 2. Problem description, 3. Available knowledge, 4. Rationale, 5. Specific aims, 6. Context, 7. Intervention(s), 8. Study of intervention(s), 9. Measures, 10. Analysis, 11. Ethical considerations, 12. Results, 13. Summary, 14. Interpretation, 15. Limitations, 16. Conclusions

Summary: Mean total score: 31.2/32 (97.5%), High reporting quality across all QI projects

Part 4D: COREQ Assessment for 5 Qualitative Studies (32 Criteria)
 Tool: COREQ (Consolidated Criteria for Reporting Qualitative Research)
 Scoring: ✓ = Reported, ✗ = Not reported, ● = Partial

Study ID	Domain 1: Research team and reflexivity (8 items)	Domain 2: Study design (15 items)	Domain 3: Analysis and findings (9 items)	Total reported (max 32)
Qual-01	✓✓✓✓✓✓✓✓ (8/8)	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ (13/15)	✓✓✓✓✓✓✓✓✓✓ (9/9)	30/32
Qual-02	✓✓✓✓✓✓✓● (6/8)	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ (14/15)	✓✓✓✓✓✓✓✓✓● (8/9)	28/32
Qual-03	✓✓✓✓✓✓✓✓ (8/8)	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓● (14/15)	✓✓✓✓✓✓✓✓✓✓ (9/9)	31/32
Qual-04	✓✓✓✓✓✓✓✓ (8/8)	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ (14/15)	✓✓✓✓✓✓✓✓✓● (8/9)	30/32
Qual-05	✓✓✓✓✓●●●● (4/8)	✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓●●● (11/15)	✓✓✓✓✓✓●●●●● (5/9)	20/32

COREQ Key missing items across studies:

- Qual-01: Missing data saturation statement, member checking
- Qual-02: Missing interviewer credentials, pilot testing details
- Qual-03: Missing transcript return to participants
- Qual-04: Missing quotes from multiple participants
- Qual-05: Major omissions in reflexivity, sampling, and audit trail

Summary: High reporting quality ($\geq 28/32$): 4 studies (80%), Moderate reporting quality (20/32): 1 study (20%)

Supplementary File 5. FAST-HUG-BID-C printable checklist

Description: This file contains a printable version of the FAST-HUG-BID-C bedside checklist. The checklist is formatted for A4 paper (210 × 297 mm) and can be laminated for daily use with dry-erase markers. Two versions are included: a full-page version and a pocket-sized version.

Part 5A REVISED CHECKLIST CONTENT

RAPID VERSION (FAST) – FOR UNSTABLE PATIENTS (<2 MINUTES TOTAL):

- F: Fluid – Assess volume status, pressor requirement, JVP
- A: Aeration – Verify SpO₂ (88-95%), ventilator settings, breath sounds
- S: STIMULATION (BRIEF NEUROLOGICAL CHECK) – Response to voice/pain, pupil symmetry, level of consciousness
- T: Temperature – Check for fever ($>38.3^{\circ}\text{C}$) or signs of sepsis

COMPLETE VERSION (FAST-HUG-BID-C) – FOR STABLE PATIENTS (PATIENT-FOCUSED ASSESSMENTS: ~5-6 MINUTES; FAMILY UPDATE: SEPARATE, ~10 MINUTES):

- F: Fluid – Check I/O over 24h, edema, CVP if available
- A: Aeration – Check SpO₂, ventilator settings (tidal volume, PEEP, FiO₂), secretions
- S: STIMULATION (FULL CAM-ICU) – Perform full CAM-ICU delirium assessment (attention, RASS, features 1-4)
- T: Temperature – Check temperature and infection markers (WBC, procalcitonin)
- H: Hemodynamics – Review HR, BP, MAP (target ≥ 65 mmHg), lactate
- U: Urine – Check urine output (target >0.5 mL/kg/hr)
- G: Glucose – Check blood glucose (target 140-180 mg/dL) and enteral feeding tolerance
- B: Breathing – Assess SBT readiness (stable hemodynamics, adequate oxygenation, minimal sedation)
- I: Infection – Verify VAP bundle compliance (HOB 30-45°, oral care, subglottic drainage if available)
- D: DELIRIUM (REASSESSMENT) – Reassess CAM-ICU + RASS (target 0 to -1)
- C: Communication – Complete family update (may be separate from bedside; 10-15 minutes)

Supplementary Table 5B. Detailed Time-Per-Item Breakdown for FAST-HUG-BID-C (Complete Version, Patient-Focused Assessments)

Component	Action	Time (seconds)	Cumulative (seconds)
F: Fluid	Check I/O over 24h, edema, CVP if available	30	30
A: Aeration	Check SpO ₂ , ventilator settings, secretions	20	50
S: Stimulation (full CAM-ICU)	Attention, RASS, features 1-4	120	170
T: Temperature	Check temperature and infection markers	10	180
H: Hemodynamics	Review HR, BP, MAP, lactate	20	200
U: Urine	Check urine output (>0.5 mL/kg/hr)	10	210
G: Glucose	Check blood glucose and feeding tolerance	15	225
B: Breathing	Assess SBT readiness	30	255
I: Infection	Verify VAP bundle compliance	20	275
D: Delirium (reassessment)	Repeat CAM-ICU + RASS (target 0 to -1)	60	335
TOTAL PATIENT-FOCUSED		~335 seconds = 5.6 minutes	
C: Communication	Family update (may be separate from bedside)	600 (10 min) separate	Not included