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A Review Study: Standardized, Respiratory Therapist-Initiated Spontaneous Awakening and Breathing Trial (SATSBT) Protocol Implementation and Its Effect on Ventilator-Free Days in MICU Patients

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Abstract

Mechanical ventilation is a ubiquitous feature of life support in the MICU, yet it is also riddled with high iatrogenic morbidities like ventilator-associated pneumonia (VAP), diaphragmatic dysfunction, and prolonged sedation. Reduction of the duration of mechanical ventilation is a primary goal in critical care, and ventilator-free days (VFDs) have emerged as a robust, patient-important outcome measure that reconciles survival and weaning from the ventilator. The now-classic Awakening and Breathing Controlled (ABC) trial proved the utility of paired spontaneous awakening trials (SATs) and spontaneous breathing trials (SBTs) in promoting improved outcomes in mechanically ventilated patients. However, translating this evidence into day-to-day practice in different MICU settings has been challenging. This review is a delving into the recent literature (2020-2025) focused on the use of a standard, respiratory therapist (RT)-directed SAT/STB (SATSBT) protocol as a quality initiative and its specific impact on VFDs in MICU patients. It investigates why protocolization is justified, the central role of RTs in driving protocol, obstacles to effective implementation, and the resulting effect on clinical outcomes aside from VFDs, such as ICU LOS and mortality. The meta-analysis of existing evidence demonstrably indicates that a well-structured, RT-guided SATSBT protocol is a strong and effective QI intervention that significantly increases VFDs and thereby improves patient outcomes and optimizes resource allocation in the MICU.

Keywords: Ventilator-Free Days, Quality Improvement, Ventilator-Associated Events, Sedation Interruption, Interprofessional Collaboration.

Introduction

Mechanical ventilation, while lifesaving, imposes a tremendous burden on patients and health systems. The extended duration of invasive mechanical ventilation is directly proportional to increased morbidity, mortality, and healthcare costs (1,2). In an attempt to combat this, the practice of critical care has increasingly focused on how to reduce ventilator duration. Ventilator-free days (VFDs) or days in a 28-day period in which the patient is alive and free from mechanical ventilation have been widely utilized as a composite primary outcome measure in clinical trials (3). This measure properly captures the balance of risks of dying and long-term ventilation and is a sensitive measure of therapeutic effectiveness.

The weaning model for patients from mechanical ventilation was altered with the publication of the Awakening and Breathing Controlled (ABC) trial, which demonstrated that an intensive care unit (ICU) protocolized approach of combining a spontaneous awakening trial (SAT)—a short pause in sedatives—

with a spontaneous breathing trial (SBT)—an assessment of patient's spontaneous breathing capacity—saved ventilator breaths spent over days, reduced time spent in coma, and improved one-year mortality (4). Despite this strong evidence, SAT and SBT protocol adherence remains profoundly inconsistent, reflecting a "evidence-to-practice gap" (5). Factors contributing to this gap include clinician resistance, deep-seated unit culture, lack of standardized processes, and professional role confusion.

In an attempt to close this gap, many organizations have implemented formal quality improvement (QI) processes to implement standardized, protocolized care. An overt and efficient model is having respiratory therapists (RTs) take charge as the key advocates of the SBT component and, in many cases, proponents of the whole SATSBT bundle (6). RTs, with their higher-level competency to handle ventilators and airways, are uniquely qualified to assess patients to determine if they are ready to try and actually conduct SBTs safely and efficiently.

This paper will critically review literature published from 2020 to 2025 on QI initiatives that rely on a standardized, RT-led SATSBT protocol and specifically evaluate its measurable impact on VFDs among the heterogeneous, often complicated MICU patient population.

The Need for Protocolization and the Ventilator-Free Days Metric

Weaning and management of mechanical ventilation have long been clinician-preference-driven, which has led to variable practices and excessively long durations of ventilation. Protocolization aims to reduce practice variability, remove cognitive bias, and deliver each eligible patient evidence-based care daily (7). A standardized protocol guarantees clear, objective criteria for patient readiness for an SBT (e.g., correction of oxygenation, successful cough, stable hemodynamics) and defines the exact methods for conducting the trial (e.g., T-piece, low-pressure support, automatic tube compensation).

Use of VFDs as a primary outcome is particularly appropriate in QI research. As opposed to simply measuring the duration of ventilation, which can be warped by mortality, VFDs assign a value of zero to patients who die on or before day 28, thus incorporating mortality into the computation of a strategy's net benefit (8). A treatment that decreases ventilation time but increases mortality would have a low VFD score, whereas one that decreases ventilation time at no detriment to survival would have a high VFD score. VFDs are thus the ideal metric with which to measure the total success of an SATSBT protocol, which not only desires to extubate more rapidly but also safely. Recent studies have supported that VFD increases are associated with lower hospital costs and improved long-term functional results (9, 10).

The Respiratory Therapist as the Protocol Driver

Successful implementation of any sophisticated protocol requires open ownership and leadership. The RT's ventilator management role is boots-on-

the-ground; therefore, it only makes sense that they are best positioned to direct the SBT component. Several studies during the review period show the effectiveness of this model. Berg et al. (6) conducted a systematic review of RT-guided protocols and found a persistent correlation with shorter duration of mechanical ventilation. The authors argue that RTs possess the skill set required to screen patients autonomously, perform SBTs autonomously, and make recommendations to the medical team, thereby streamlining the process of liberation.

Empowering RTs in this function has several advantages. It does it in two ways. First, it organizes a proactive daily screening system in such a way that no patient who can be screened is omitted. Linke et al. (11) in their study demonstrated that an RT-led protocol increased daily SBT rates from 45% to 78%. Second, it encourages interprofessional collaboration. Officially authorizing RTs to initiate protocols stimulates systematic communication with doctors and nurses regarding patient readiness and SBT outcomes, away from an authoritarian decision-making culture (12). This collaborative model is especially required for the SAT/SBT paired process, in which coordination between nurses and RTs is the deciding factor in matching awakening trial with breathing trial timing. A QI project by Meza (13) found that sharing a universal electronic health record (EHR) order prompt among the nursing and RT staff to read and schedule the SATSBT led to a significant increase in paired trials and a proportionate 2.5-day increase in median VFDs.

Elements of an Effective Standardized SATSBT Protocol

A critical analysis of current literature proves that the success of a protocol initiated by a respiratory therapist for SATSBT relies on the inclusion of several key elements, which all work synergistically to offer a valid, safe, and effective means for weaning patients off mechanical ventilation. The foundation of any successful protocol is having

objective and clear criteria for initiating the spontaneous awakening trial (SAT) and spontaneous breathing trial (SBT). These parameters, which generally include parameters such as an $\text{FiO}_2 \leq 0.6$, $\text{PEEP} \leq 8\text{-}10 \text{ cm H}_2\text{O}$, hemodynamic stability on the same vasopressor support, and no active seizure or intracranial pressure elevation, are a critical screen for safety (14). The use of a standardized Safety Screening Tool, particularly when integrated into the electronic health record (EHR), ensures consistent and systematic assessment of all patients who are being ventilated in order to minimize the risk of omission or bias. After the patient is determined to be a candidate, the protocol should outline a standardized SBT approach to ensure consistency of practice. Even though there remains an argument over the optimum technique—i.e., a T-piece circuiting or low-level pressure support—the latest guidance is that either technique is acceptable provided that the institution adopts and mandates one global approach to restrict variability (15). It must also define a clear trial duration, typically in the range of 30 to 120 minutes, and objective, specific criteria for defining both success (e.g., adequate respiratory rate, tidal volume, and oxygenation) and failure so that findings can be reproducibly interpreted.

Simultaneously with the trial of breathing, the protocol must have specific sedation interruption (SAT) parameters. This component, typically nurse-managed, requires clear guidelines on which sedative and pain infusions to withhold or lower, and

standardized protocols for monitoring patient comfort and distress indicators during the awakening process (16, 17). Careful coordination between the SAT performed by the nurse and the SBT conducted by RT is needed since their combined effect is one of the most critical mechanisms of making the protocol functional. To facilitate this coordination and encourage efficiency, one of the pillars of modern protocol is an assertive role for the respiratory therapist. This involves providing RTs with the autonomy to begin an SBT on their own when designated criteria exist and to end the trial immediately if failure criteria are evident, without requiring a new physician order each time (18). This "autonomous within-protocol" authority is required to close gaps in care and call upon the specialized expertise of the RT to its utmost potential. Finally, the entire process is facilitated by seamless communication and documentation features. Successful implementation relies on unencumbered interprofessional collaboration, fostered by systematic mechanisms such as standardized handoff checklists, shared EHR dashboards, and automatic alerts that nudge the team to coordinate and document SATSBT completion (19). Not only do these mechanisms enhance nurses-RTs coordination, but they also provide valuable data to audit adherence, stimulate continuous quality improvement, and assess the effect of the protocol on patient outcomes. Table 1 and Figure 1 summarize the key components of a successful RT-driven SATSBT protocol.

Table 1: Key Components of a Successful RT-Driven SATSBT Protocol

Component	Description	Rationale
Automated Daily Screening	Systematic, RT-led review of all ventilated patients against objective eligibility criteria.	Ensures no eligible patient is missed; promotes a culture of daily liberation assessment.
Standardized Safety Screen	A checklist for contraindications (e.g., high vasopressor doses, elevated ICP).	Promotes patient safety by preventing trials in high-risk situations.
Defined SBT Method	Institution-specific standardization of SBT technique (e.g., PS 5-8 cm H ₂ O vs. T-piece) and duration.	Reduces practice variation; allows for consistent interpretation of results.
RT Autonomy	Protocol grants RTs authority to initiate SBTs when criteria are met and abort for failure criteria.	Eliminates delays in care; leverages RT expertise; increases protocol fidelity.
SAT-SBT Coordination	A defined process for nurses and RTs to communicate and time the awakening trial with the breathing trial.	Maximizes the synergistic effect of paired trials; improves efficiency.
Structured Communication	Use of standardized handoff tools or EHR prompts to communicate readiness, success, or failure.	Enhances interprofessional collaboration and ensures clear plan of care.
Data Feedback Loop	Regular audit of protocol adherence, SBT success rates, and outcomes (VFDs) reported back to staff.	Drives continuous QI; demonstrates the impact of the protocol, reinforcing staff buy-in.

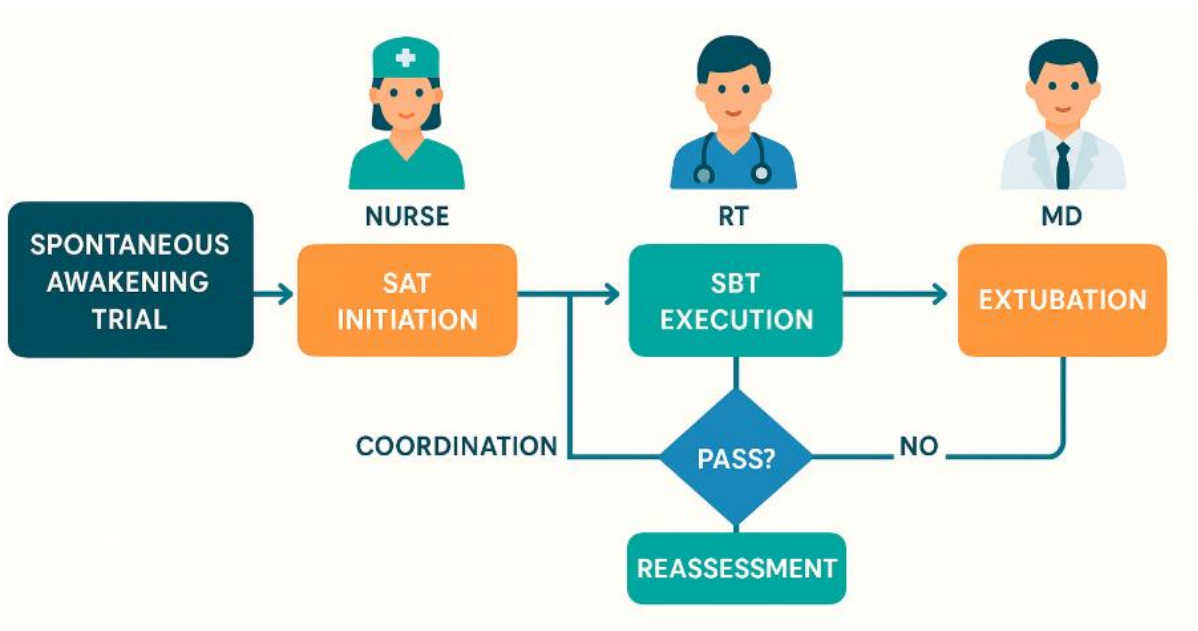


Figure 1: Workflow of the RT-Driven SATSBT Protocol in the MICU

Impact on Ventilator-Free Days

Of greatest significance in this review is the effect of RT-driven SATSBT protocols on VFDs. The collective evidence over the last five years is consistently positive, demonstrating that such QI activities are an effective intervention for enhancing this valuable metric. A big multicenter prospective study conducted by Chen et al. (20) evaluated the implementation of an RT-driven protocol in five teaching MICUs. After adjusting for illness severity, they found that the protocol was associated with a 2.1-day increase in mean VFDs. Notably, they also indicated a strong increase in the rate of successful extubations after the first SBT, which indicated that the protocol was not only resulting in more trials but was also more effectively identifying patients truly ready to be liberated. A comparable pre-post QI study by Yehya et al. (21) in a lone MICU demonstrated that after implementing an RT-guided standardized SATSBT protocol, median VFDs increased from 18 to 22 days. This was accompanied by better VAE rates.

The helpful effect is not exclusive to academic

centers. A trial conducted by Maue et al. (22) within a community hospital MICU setting proved that with fewer facilities, a well-implemented RT-driven protocol could still produce impressive results. Their program had a 35% performance improvement in conducting SBT and its resulting 1.8-day increase in VFDs, confirming the universalizability of this approach. The authors gave some credit to ubiquitous RT education and having a "ventilator liberation champion" role on the RT team.

Additionally, the coordination and timing of the SAT and SBT appear to be key. A pilot randomized trial by Jones & Shivji (23) compared a protocol of coordinated SAT followed by SBT (the classic "paired" approach) with a protocol where SATs and SBTs could be performed independently. Both cohorts were well adherent, but the coordinated, paired protocol cohort had significantly more VFDs (difference in mean 1.7 days) and earlier time to first successful SBT. This confirms the first ABC trial outcomes and underscores that the interaction between awakening and breathing trials is a key mechanism for the benefit in VFDs.

Outside of VFDs: A Cascade of Favorable Clinical and System Outcomes

Whereas a gain in VFDs is a primary and significant result, application of a standardized, RT-implemented SATSBT protocol releases a chain of secondary consequences that vibrate throughout the pathway of recovery of the patient and in the health system. The most self-evident secondary consequence is a reduction in ICU and hospital LOS. By systematically identifying the earliest time of liberation, these protocols run straight across the duration of invasive mechanical ventilation, one of the major drivers of ICU LOS. A meta-analysis by Lin et al. (24) substantiates this, identifying protocolized weaning, particularly when directed by non-physician clinicians like respiratory therapists, as associated with a statistically significant reduction in ICU time. Such decreases not only signal improved patient experience but also profound optimization of resource use, freeing up valuable ICU beds to the advantage of other critically ill patients and reducing capacity pressure.

Moreover, the element of interruption of sedation within the protocol directly corresponds to decreased total exposure to sedation. The necessity of daily interruption or reduction of sedative infusions removes the deep, uninterrupted sedation that was the standard in ICUs. This is a significant development, as a depth of sedation is now definitively identified as an independent predictor of bad outcomes, including the formation of delirium, prolonged ventilator dependence, and the syndrome of physical, mental, and emotional impairments known as post-intensive care syndrome (PICS) (25). By restricting cumulative doses of sedatives, SATSBT protocols promote a state of wakefulness and interactivity. Hence, studies have established that patients who utilize these protocols spend fewer days in coma and have a significantly reduced

incidence of ICU delirium, a condition strongly linked with long-term cognitive impairments (26, 27). This is a paradigm shift from simply persisting to continue to exist to sustaining the quality of existence after critical illness.

From an infectious complications standpoint, these protocols are highly effective at reducing ventilator-associated events (VAEs), an overarching term that encompasses such complications as ventilator-associated pneumonia (VAP). The risk of VAEs increases with each increasingly longer day of intubation. Therefore, by directly reducing the cumulative number of ventilator days in a population of patients, SATSBT protocols mechanistically reduce the collective exposure to risk. A variety of quality improvement reports have reported conspicuous reductions in VAE rates, typically 20-40%, following consistent use of a protocol (28). Apart from saving patients from a common cause of morbidity and even death, it also reduces the consumption of antibiotics and the expenditure required to treat such complications.

The addition of these benefits—lower ventilation times, shorter ICU LOS, and fewer complications—naturally equates to better resource utilization and immense cost-effectiveness. Cost savings are significant. A careful economic analysis by Bellinghausen et al. (29) quantified this by estimating that an RT-guided SATSBT protocol meant a net gain in excess of \$15,000 per patient ventilated. The highest incentive for this saving is lower ICU bed-days, the most expensive type of hospital stay. For this reason, the investment to develop and sustain the protocol is a payoff-rich one and hence not only a clinical best practice but also an economically sensible health care institution strategy.

Table 2: Common Barriers and Evidence-Based Strategies of Mitigation of SATSBT Protocol Implementation

Barrier	Impact on Protocol	Evidence-Based Mitigation Strategy
Cultural Resistance "Provider Autonomy"	Clinicians bypass the protocol, reverting to individual practice.	Engage physician champions; present baseline data and evidence; pilot the protocol in a receptive unit first (Balas et al., 2019). (30)
Lack of Role Clarity	Confusion over who screens, who initiates SAT vs. SBT, leading to missed trials.	Co-design a clear, step-by-step algorithm with defined roles for RN, RT, and MD; use structured communication tools (Meza, 2025). (13)
Concerns for Patient Safety	Fear of self-extubation or hemodynamic instability during trials.	Develop and reinforce a rigorous safety screening checklist; share data on low complication rates from early adopters (Devlin et al., 2018). (16)
Workload Perception	Staff view the protocol as a burdensome additional task.	Streamline documentation; demonstrate how the protocol prevents prolonged ventilation, ultimately reducing workload (Linke et al., 2024). (11)
Ineffective EHR Workflow	The EHR does not support the protocol, leading to workarounds and poor adherence.	Involve IT and informatics specialists to build supportive tools (e.g., automated eligibility lists, smart-texts, easy-click buttons) (Khan et al., 2023). (19)
Failure to Sustain	Initial enthusiasm wanes, and adherence drops over time.	Implement a continuous audit and feedback system; re-educate periodically; celebrate successes publicly (Moussanang et al., 2025). (28)

Impact of SATSBT Implementation on Ventilator-Free Days and Secondary Outcomes

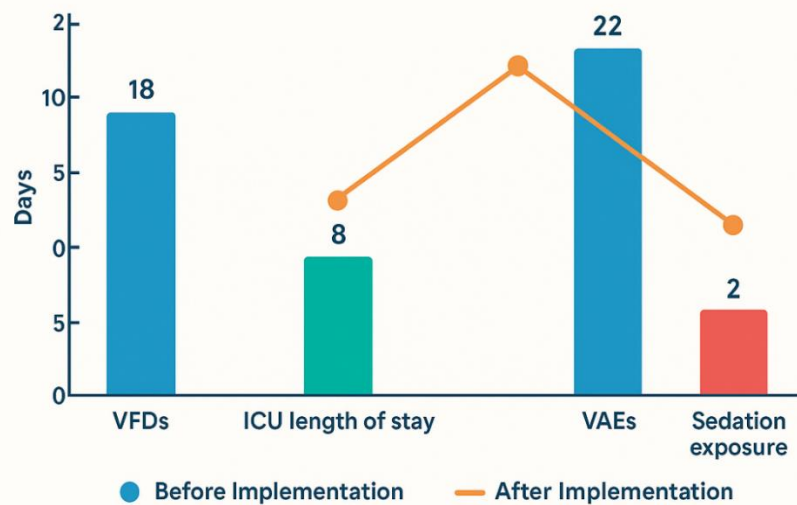


Figure 2: Impact of SATSBT Implementation on Ventilator-Free Days and Secondary Outcomes

Future Directions and Conclusion

The future wave of research and QI will likely solve a series of bleeding-edge frontiers. First, integrating artificial intelligence (AI) and machine learning to predict optimal timing for SBTs is on the horizon. AI algorithms operating on real-time ventilator and hemodynamic data can potentially detect patients who are ready for an SBT even earlier than with standard criteria, adapting the process of liberation (31). Second, post-extubation management is more in the limelight nowadays, for example, management of high-flow nasal cannula and non-invasive ventilation to prevent re-intubation, and how to best integrate these harmoniously into the ventilator liberation process (32). Finally, with greater emphasis on long-term results in critical care in the years to come, such research has to measure the impact of such protocols on physical, cognitive, and psychological rehabilitation months after discharge from the ICU (33).

In summary, a standardized, RT-protocol-guided SATSBT protocol is an invaluable quality improvement intervention with a prompt, direct, beneficial impact on medical ICU patients' ventilator-free days. By standardizing each day's liberation readiness assessment, empowering the most appropriate healthcare professional to lead the process, and fostering interprofessional collaboration, this intervention successfully closes the evidence-to-practice gap. The resultant VFD surge is merely a symptom of a larger success story—one of reduced sedation exposure, reduced complications, shorter ICU length of stay, and more efficient utilization of resources. With the process advancing further, the underlying core principles of protocolization, empowerment of RT, and continuous monitoring of adherence and outcome will remain vital to deliver the optimum care to the critically ill.

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دراسة استعراضية: تطبيق بروتوكول موحد بقيادة أخصائيي العلاج التنفسي لتجارب الاستيقاظ التلقائي والتنفس التلقائي (SATSBT) وتأثيره على الأيام الخالية من التنفس الصناعي لدى مرضى وحدة العناية المركزة الطبية الملخص

يُعد التنفس الصناعي سمة أساسية لدعم الحياة في وحدة العناية المركزة الطبية (MICU)، لكنه يترافق مع ارتفاع معدلات المضاعفات الطبية مثل الالتهاب الرئوي المرتبط بالتنفس الصناعي (VAP)، ضعف عضلة الحجاب الحاجز، والتخدير المطول. يُعتبر تقليل مدة التنفس الصناعي هدفاً رئيسياً في العناية الحرجة، وقد برزت الأيام الخالية من التنفس الصناعي (VFDs) كمقياس نتائج قوي ومهم للمرضى، يوفق بين البقاء على قيد الحياة وطمأن المريض عن جهاز التنفس الصناعي. أثبتت التجربة الكلاسيكية للاستيقاظ والتنفس الخاضع للرقابة (ABC) فائدة إجراء تجارب الاستيقاظ التلقائي (SATS) وتجارب التنفس التلقائي (SBTs) بشكل متزامن في تحسين النتائج لدى المرضى المعتمدين على التنفس الصناعي. ومع ذلك، كان ترجمة هذه الأدلة إلى الممارسة اليومية في إعدادات وحدات العناية المركزة الطبية المختلفة تحدياً. يستعرض هذا البحث الأدبيات الحديثة (2020-2025) التي تركز على استخدام بروتوكول موحد بقيادة أخصائيي العلاج التنفسي (RT) لتجارب الاستيقاظ والتنفس التلقائي (SATSBT) كمبادرة لتحسين الجودة وتأثيره المحدد على الأيام الخالية من التنفس الصناعي لدى مرضى وحدة العناية المركزة الطبية. يبحث الاستعراض في أسباب تبرير التبروتوكول، والدور المركزي لأخصائيي العلاج التنفسي في قيادة البروتوكول، والعوائق التي تواجه التطبيق الفعال، والتأثير الناتج على النتائج السريرية بخلاف الأيام الخالية من التنفس الصناعي، مثل مدة البقاء في وحدة العناية المركزة ومعدلات الوفيات. تُظهر التحليلات التولية للأدلة الحالية بشكل واضح أن بروتوكول SATSBT الموحد بقيادة أخصائيي العلاج التنفسي هو تدخل قوي وفعال لتحسين الجودة يزيد بشكل كبير من الأيام الخالية من التنفس الصناعي، وبالتالي يحسن نتائج المرضى ويحسن تخصيص الموارد في وحدة العناية المركزة الطبية.

الكلمات المفتاحية: الأيام الخالية من التنفس الصناعي، تحسين الجودة، الأحداث المرتبطة بالتنفس الصناعي، انقطاع التخدير، التعاون متعدد التخصصات