**Supplemental Digital Content**

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**ABCDEF Bundle – Brief History and Development**

The ABCDEF bundle was developed from hundreds of peer-reviewed publications, and the details of its history are previously published.(1) The bundle was sequentially tested through numerous collaboratives sponsored by the Institute for Healthcare Improvement,(2) at a single center in Nebraska,(3) and in a healthcare system in California.(4) While supported by guideline recommendations (5,6), bundle adoption varies widely, primarily because it requires significant transformation of ICU culture.(7,8) The Gordon and Betty Moore Foundation worked with the Society of Critical Care Medicine (SCCM) to establish the ICU Liberation collaborative, at which time a the large interprofessional group of academicians, clinicians, and ICU teams was assembled by the SCCM ([www.iculiberation.org](http://www.iculiberation.org)). The collaborative sought to equip participating sites with tools and skills to foster the culture change needed to implement the ABCDEF bundle into their systems and adopt it as standard practice. More about the particular elements used including team building training, implementation steps, and pitfalls to avoid during the process are outlined by Barnes-Daly.(9)

**SDC Methods 1: ICU Collaborative Description**

While a more in depth description of the history of the Collaborative, the evidence-based implementation strategies used to foster change and teamwork, and the performance and outcome metrics used to monitor progress is recorded by Barnes-Daly,(9) a brief description of the important components of the QI project is outlined here.

**Application for Participation in the ICU Liberation Collaborative and Choice of Sites:**

When the Gordon and Betty Moore Foundation decided to fund a program for improving overall ICU Care, they emphasized that the chosen strategy should go beyond a specific disease state and towards a more holistic and patient-centered approach. We had been developing the ABCDE Bundle from the emerging literature for over a decade at the time. The Moore Foundation emphasized that this program should also include critically ill patients family members, and given that there were robust data on the importance of family in the ICU,(10-15) we added an “F” to the bundle. After an iterative process and voting, the title of the Quality Improvement (QI) initiative was determined to be “ICU Liberation”, indicating that this program would be “liberating” to patients, families, and the entire ICU team.

The ICU Liberation Collaborative was started in August 2015 and initially included 69 adult academic, community, and Veterans Health Administration (VA) hospitals from 29 states and Puerto Rico. Two of the original hospitals ceased participation and an additional ICU was added prior to the first in-person meeting and data collection. Sixty-eight discrete adult ICUs therefore contributed to the database until the collaborative officially completed in April 2017. ***To qualify for participation***, each site was required to have a core interprofessional implementation team comprised of the following: at least one physician and one registered nurse who practiced in their ICU, plus one or two additional team members (physical therapist, occupational therapist, respiratory therapist, or pharmacist), plus formal buy-in from their administration officials that the team would be provided time and personnel needed to collect performance and outcome data. Core team members participated in in-person regional meetings, monthly co-learning calls, database training sessions, and the e-Community listserv. They also assumed responsibility for overseeing their institutions’ educational, implementation, and data collection efforts.

**Collaborative Timeline and Key Activities:**

Given the interprofessional nature of the ABCDEF Bundle, the Collaborative’s Steering Committee believed participating teams would need to utilize a variety of multifaceted and multilevel implementation strategies.(16, 17) Collaborative leaders decided early on that equipping teams with the knowledge and skills necessary to deploy evidence-based implementation strategies and improve provider communication skills was as important as providing ABCDEF Bundle specific education. For these reasons, all of the Collaborative’s data collection tools, regional in-person meetings, monthly co-learning calls, and e-Community discussions were designed to capture and share both ABCDEF Bundle implementation and clinical effectiveness information.

At the first regional in-person meeting (Fall 2015), teams were introduced to the purpose and specific goals of the Improvement Collaborative, the science and history behind the latest ABCDEF bundle, importance, prevalence, and etiology of Post Intensive Care Syndrome, and the operational definitions and tools used for the individual ABCDEF Bundle elements. Teams were also presented with a description of the *ICU Care Survey* that was designed to assess: 1) institutional readiness for change, 2) perceived barriers and facilitators to ABCDEF bundle adoption, 3) degree of interprofessional team collaboration,(18) and 4) the six *American Association of Critical Care Nurses* standards for establishing and sustaining a healthy work environment.(19) We instructed participants that these on-line surveys were to be administered to all of their ICU team members twice (i.e., prior to beginning their unit level implementation work and at the end of the Collaborative). We discussed a number of specific implementation strategies during the initial in-person meeting including the importance of providing audit and feedback, conducting cyclical small tests of change, and providing ongoing multimodal educational offerings. Sites were further encouraged to engage staff in local consensus discussion, develop a formal implementation and quality-monitoring plan, and identify and involve ABCDEF Bundle champions, early adopters, local opinion leaders, and former ICU patients/families in the implementation process. Breakout sessions at this initial meeting helped to reinforce and provide beneficial strategies for facilitating effective ICU communication, collaboration, and cooperation. We provided each team with copies of all of the power point slides used during the meeting so they could use them for their own implementation efforts and provider training.

Between the first and second in-person meeting, teams submitted their baseline ABCDEF Bundle performance and outcome data and their initial *ICU Care Surveys.* Prospective performance and outcome data collection formally began on January 1, 2016. Monthly co-learning calls in this early implementation period focused mainly on ABCDEF Bundle specific topics (e.g., how best to assess, prevent, and manage pain, agitation, delirium; the importance of safety-screen guided SATs and SBTs, evidence-based analgesic/sedative medication selection, how to perform early exercise/mobility with a variety of high-risk ICU patients, and strategies to engage and empower ICU patients and families). We asked each team to have their key implementation leaders and any other staff interested in the topics attend the monthly meetings. The on-line e-Community was particularly active during this early time period with various questions related to IRB and data collection challenges, the sharing of ABCDEF Bundle related policies and protocols, and how to use the Bundle with more challenging ICU populations (e.g., cardiac, neurosurgery).

The second and third in-person regional meetings (April and November 2016) focused heavily on interactive interprofessional problem solving, shared learning, and support. This was also the time sites had the opportunity to review aggregate and site-specific ICU Care Surveys and performance, compliance, and outcome data. Each team received their site-specific data to share with others at their home institution. A review and discussion of the aggregate level data was also provided during the meetings so teams had the ability to compare their results to similar institutions (i.e., for benchmarking purposes). During the meetings, each team displayed a poster highlighting their implementation efforts to date and had 10 minutes to present and answer questions on any successes or challenges they were having with their ABCDEF Bundle implementation efforts. We then divided teams into discipline specific working groups for regional faculty facilitated discussions. Common themes that emerged from these roundtable discussions were then presented to the larger group to capture how various clinicians made something work in their setting and then share it with others. We also dedicated allotted time for individual teams to develop their own site-specific short- and long-term goals.

Following these meetings, monthly co-learning calls focused heavily on developing and organizing systems and procedures that monitor and improve clinical processes and outcomes. Topics included how to use the Collaborative data for auditing and feedback purposes, strategies for effective interprofessional rounds and early mobilization efforts, interprofessional team coaching in the ICU, and designing ABCDEF Bundle documentation for use in electronic medical records. A variety of eCommunity discussion occurred, covering topics such as how to order pain medications when using a behavioral pain assessment tool, improving patient and family-centered care using open visitation and pet therapy, mobilizing patients with various catheters and tubes, sleep enhancing strategies, and the continued uncertainty regarding how to administer the suggested pain, agitation, and delirium assessment tools. Teams continued to share and receive feedback on their ABCDEF Bundle related protocols, policies, and educational toolkits/reminders.

Prior to the final in-person meeting (April 2017), an advisor from the *Institute for Healthcare Improvement* was hired to specifically address ways to move participating ICU teams forward in their implementation efforts and address ways to build reliability and promote sustainability. Teams also consistently identified a need for better buy-in and support from their local hospital administrators. For these reasons, we made the decision to have each team invite one of their administrators to attend the final in-person meeting. During this meeting, we presented teams and their administrative partner with the results of the final *ICU Care Survey* and performance, compliance, and outcome data. Discipline specific affinity learning exercises occurred and the administrators participated in a separate discussion on ways to support improvement and sustainability efforts. Similar to the second and third meeting, storyboard rounding occurred and teams had dedicated focus time with their administrators to strategize the next steps for process improvement. Finally, all teams were encouraged to bring and share laminated copies of tools they found particularly effective in their efforts.

**Data Collection**

The Collaborative used Research Electronic Data Capture (REDCap), a secure, web-based application for validated data entry, transmission and storage (grant support UL1 TR000445 from NCATS/NIH). Local staff, who attended a one-hour training webinar, entered de-identified data into the collaborative’s database at their individual hospitals. Sites collected data retrospectively during a 6-month **baseline** period (January 2015-June 2015) and prospectively during a 14-month **implementation** period (January 2016-Feburary 2017). During the baseline period (pre-collaborative involvement), each site entered data on the first five consecutively admitted patients each month (30 baseline patients per site). Throughout the implementation period, each site collected data on the first 15 consecutively admitted patients per month. In both periods, data were collected for a maximum of seven ICU days or until the patient transferred out of the ICU, was placed off ICU status or died, whichever occurred first.

**SDC Table 1. Operational Definitions of ABCDEF Bundle Performance\***

|  |  |  |
| --- | --- | --- |
| **Bundle**  **Element** | **Days eligible** | **Performance**  **In the last 24 hours it was documented that the patient received**: |
| **A** | All days | > 6 pain assessments using a valid and reliable instrument (i.e., numeric rating scale, Behavioral Pain Scale,(20) or Critical Care Pain Observation Tool(21)) |
| **B1** | Only days when patient received continuous or intermittent sedation | A spontaneous awakening trial (SAT) if receiving continuous or intermittent sedative infusions |
| **B2** | Only days when patient was on ventilatory support | A spontaneous breathing trial (SBT) if receiving mechanical ventilation |
| **C** | All days | > 6 agitation-sedation assessments using a valid and reliable instrument (i.e., Richmond Agitation-Sedation Scale(22) or Sedation-Agitation Scale(23)) |
| **D** | All days | > 2 delirium assessments using a valid and reliable instrument (i.e., Confusion Assessment Method for the ICU(24) or Intensive Care Delirium Screening Checklist(25)) |
| **E** | All days | Mobility activities that were higher than active range of motion (i.e., dangling at edge of bed, standing at side of bed, walking to bedside chair, marching in place, walking in room or hall) |
| **F** | Only days when family was present | And a family member/significant other was educated on the ABCDEF bundle and/or participated in at least one of the following: rounds; conference; plan of care; or ABCDEF bundle related care. |

\*This table includes the operational definitions of performance used by the ICU Liberation Collaborative. Using these rules/definitions, we calculated the data that are presented in this paper. Note: The pain, agitation-sedation, and delirium assessment scales and frequencies were chosen based on the recommendations in the 2013 Clinical Practice Guidelines for the Management of Pain, Agitation, and Delirium in Adult Patients in the Intensive Care Unit and faculty consensus.(5) The Family piece was built to conform to elements of the Family Guidelines that we knew were forthcoming and which have subsequently been published.(6)

The primary independent variable used in our multivariable models was ABCDEF bundle performance. There are six main ABCDEF bundle elements, and we tracked element B as having two components (so a total of 7 components were possible). All ICU patients were eligible to receive four of the elements (ACDE) on a daily basis; patients with family or other support available were also eligible to receive element F. Element B was comprised of two parts, **B**oth SATs and SBTs: B1 was spontaneous awakening trials [SATs], which meant turning off sedation every day to allow qualifying patients to awaken spontaneously; B2: spontaneous breathing trials [SBTs], which meant turning off the ventilator every day for qualifying patients to allow them to breath spontaneously. All patients receiving continuously infused or intermittent sedatives were eligible for a daily SAT (B1), and all mechanically ventilated patients were eligible for a daily SBT (B2).

We defined ***“complete performance”*** as a patient-day in which every eligible element of the bundle was performed (i.e., 100% of the bundle versus anything less). We defined ***“proportional performance”*** as the percentage of eligible elements a patient received on a given day (i.e., “bundle dose”). We measured complete and proportional bundle performance only if the patient was in the ICU for a full 24 hours.

**SDC Methods 2. Tipping Point Sensitivity Analysis**

Due to the diversity of typical data collection across our 68 sites nationwide, we were unable to adjust for measures of severity of illness (SOI). Though every observational study has the potential limitation of unmeasured confounding, in this case the inability to adjust for SOI poses an important and particularly interesting limitation. A traditional sensitivity analysis, where we adjust for SOI for the few sites that collected a measure, could actually produce a biased or misleading result: The most common SOI score among our participating sites (APACHE III) was only collected at six institutions, and there is a strong chance that those six sites had additional unmeasured differences from the other sites (for example, nearly all these scores were from teaching hospitals, but over 1/3 of our cohort was from community hospitals).

For this reason, we believe that a “tipping point” analysis is better able to account for this limitation.(26, 27) This type of analysis allows us to quantify the amount of total unmeasured confounding from SOI needed to render our analysis inconclusive (i.e., such that the confidence interval for an odds or hazard ratio would include 1). To do this, we explore the hypothetical relationships between the exposure (e.g., bundle performance), the outcome (e.g., delirium, mechanical ventilation, or ICU discharge), and the unmeasured confounder (e.g., SOI). The tipping point analysis incorporates the relationship between the exposure and outcome observed in our original results (see Table 2 of the main manuscript); fixes the relationship between the unmeasured confounder and either the exposure or the outcome, using available data or prior knowledge; and uses those quantities to estimate the size of the remaining relationship needed to render the original results inconclusive. This is in some ways a conservative analysis, because it assumes that the unmeasured confounder is not associated with any of the covariates we included in our models, which was almost certainly not the case (we would expect SOI to be related to mechanical ventilation and ICU discharge, for example).

In this case, we fixed the relationship between SOI (unmeasured confounder) and ABCDEF bundle performance (exposure), estimating that relationship using the available 950 patients with APACHE III (our most common measure of SOI). The Table shows this relationship as the “Difference in Means” (standardized, so that the scale of the variable has no effect on the results).

We then determined the odds or hazard ratio that would have to be observed between the unmeasured confounder, e.g. SOI, and each outcome in order to render our results inconclusive. We present these results in the “Observed” column in the Table, as they are based on the relationships between SOI and the exposure that we observed in our data. We also used a more conservative estimate, in which we assumed the difference in SOI between exposed and unexposed groups was 25% larger than what we observed (ie, more confounding was present); we present this in the “Conservative” column.

For the convenience of the reader, we also present the original odds or hazard ratio for ABCDEF Bundle performance (yes/no) and each outcome (which is adjusted for 18 potential confounders determined *a priori* as listed in Methods, but is unadjusted for SOI).

**SDC Table 2. Tipping Point Sensitivity Analysis Results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcome** | **Complete Bundle Performance**  (Odds and Hazard Ratios, adjusted but not for SOI) a | **Difference in APACHE Means (Standardized)b** | **Tipping Point Analyses c** | |
| **Observed Odds/Hazard Ratios for APACHE III Needed to Tip** | **Conservative Odds/Hazard Ratios for APACHE III Needed to Tip** |
| **Odds Ratios < 1 = Beneficial** | | | | |
| Mechanical  Ventilation | 0.28 (0.22, 0.36) | 0.41 | 0.08 | 0.13 |
| Coma | 0.35 (0.22, 0.56) | 0.40 | 0.23 | 0.31 |
| Delirium | 0.60 (0.49, 0.72) | 0.43 | 0.47 | 0.55 |
| Physical  Restraints | 0.37 (0.30, 0.46) | 0.41 | 0.15 | 0.22 |
| Death | 0.32 (0.17, 0.62) | 0.28 | 0.17 | 0.25 |
| **Hazard Ratio > 1 = Beneficial** | | | | |
| ICU  Discharge | 1.17 (1.05, 1.30) | 0.28 | 1.19 | 1.15 |
| Hospital  Discharge | 1.19 (1.01, 1.40) | 0.28 | 1.05 | 1.04 |

**Abbreviations:** APACHE, Acute Physiologic Assessment and Chronic Health Evaluation; ICU, intensive care unit; SOI, severity of illness.

**Table Footnotes:**

a. This column shows the odds and hazard ratios presented in Table 2 in the main manuscript, which are being used to explore the potential confounder of severity of illness (SOI). Note that these are adjusted odds and hazard ratios (adjusted for the covariates listed in Methods, which did not include SOI).

b. “Difference in Means” describes the fixed relationship between SOI (the unmeasured confounder represented in this tipping point analysis) and ABCDEF bundle performance (the exposure). It uses the mean APACHE III scores between the performed & not performed groups, and is estimated by the available APACHE III scores from 950 patients in our cohort. It is standardized, so that the scale of the variable has no effect on the results.

c. These tipping point analyses calculations use the actual results from our main analysis (the first column here **a** and Table 2 in main manuscript) and the estimates from our available APACHE III data (second column) to calculate the odds/hazard ratios that would be needed in order to “tip” the actual findings to an inconclusive (null) result. The closer these ratios are to 1, the more likely the unobserved relationship of SOI with the bundle could be to tip our original results to inconclusivity (crossing the bounds of 1). Two sets of odds/hazard ratios are presented. The “Observed” ratios are calculated based on our observed data. Because the 950 patients with APACHE III available may or may not be an accurate representation of our population, we also did a more conservative version, in which we assumed more unmeasured confounding than is suggested by our available data.

**Examples:**

For mechanical ventilation (MV) the tipping point analysis indicate that an odds ratio of 0.08 between a one-unit change in SOI and MV would be needed to tip our observed results to inconclusivity (a null result) – an extremely large and unrealistic effect size. Using a more conservative approach, we would still need an unlikely strong odds ratio of 0.13 to move our original results to inconclusivity (closer to 1). Because these are both extreme and unlikely values, we are more confident that, while the true effect of the ABCDEF bundle may not be as large as we observed, there is still likely to be a clinically relevant association.

**Interpretation:**

Based on these results for the outcomes of mechanical ventilation, coma, delirium, physical restraints, and death, we have more confidence that even if the true adjusted associations between Bundle performance and all 5 in-ICU outcomes were smaller than observed after adjusting for SOI, they would still be meaningful.

In contrast, it would take a much smaller (and therefore more plausible) relationship between SOI and both ICU and hospital discharge to change our conclusions (i.e., the tipping point ratios are closer to 1). For example, using our observed data, a relationship of only 1.05 between SOI and ABCDEF bundle performance would be necessary to move the observed association with hospital discharge to inconclusivity (i.e., the lower bound of the CI to 1). For this reason, the findings of our tipping point analysis led us to de-emphasize our significant findings for these two outcomes (ICU and hospital outcome) in this manuscript.

**SDC Methods 3. Severity of Illness Sensitivity Analysis**

One acknowledged limitation of this project is the inability to adjust for potential confounding of severity of illness (SOI) in the relationship between ABCDEF Bundle performance and ICU outcomes, as study sites collected several different SOI scores if collected at all. We therefore performed a sensitivity analysis on the 6% patients with the APACHE III score, the most commonly available measure of SOI, available, adjusting for this score in addition to other covariates as specified in the Methods section.

Patients with APACHE III available were nearly all from teaching hospitals (vs community) and in medical/surgical or cardiac/surgical/trauma units. APACHE III patients were more likely to experience mechanical ventilation during their ICU admission (although they spent less time on mechanical ventilation than ventilated patients without APACHE III) and have slightly longer hospitalizations. APACHE III patients were also more often admitted for sepsis and respiratory problems, more likely to be white and non-Hispanic, and tended to be a bit younger than patients with no APACHE III available.

Despite some differences between patients with and without APACHE III scores available, we considered these two groups clinically similar enough to perform a set of sensitivity analyses adjusting for this score valuable. We ran the same models for ABCDEF performance (yes/no) which incorporated the same methodology (with minor exceptions explained below) and covariates as our original analyses, and additionally adjusted for APACHE III. Exceptions to the original methodology include:

* In the original analyses, we used Huber-White sandwich estimation to account for differences between sites. Here, we have too few sites (n=6) and too much overlap between individual site and our covariate of ICU type, so we only adjusted for ICU type and did not cluster by site. In addition, the few cardiac/surgical patients with an APACHE III score were combined with mixed medical/surgical patients.
* In the original analyses, we adjusted for hospital type (community vs teaching). Because so few patients with APACHE III available were hospitalized at community hospitals, we were unable to adjust for this in our sensitivity analysis.
* Some categorical covariates were collapsed from their original level of detail due to low counts in some categories. These included age, race, primary admission reason, and ICU type.

These analyses should be interpreted with caution, as they represent a very small subgroup of our entire cohort (<6% for time-to-event outcomes, with even fewer included in daily outcome models, which required two consecutive ICU days). However, they may be helpful (alongside the tipping point analysis also included in this supplement) in determining how robust our original estimates are in the presence of confounding by severity of illness.

**SDC Table 3. Outcomes for Subset of Patients with APACHE III scores with Complete (Versus Incomplete) ABCDEF Bundle Performance: [data are adjusted hazard ratios (AHRs) and adjusted odds ratios (AORs)]** a

|  |  |  |  |
| --- | --- | --- | --- |
| **Outcomes** | **Complete Bundle Performance** | | ***P* Value** |
| **Patient-Related Outcomes** | **Adjusted HR (95% CI)** |  | |
| ICU discharge | 1.16 (0.90–1.49) | 0.248 | |
| Hospital discharge | 0.79 (0.50–1.27) | 0.336 | |
| Deathb | \*\*\*\*\*\*\*\*\* |  | |
| **Symptom-Related Outcomes** | **Adjusted OR (95%CI)** |  | |
| Mechanical ventilation | 0.30 (0.11–0.86) | 0.025 | |
| Comab | \*\*\*\*\*\*\*\*\* |  | |
| Delirium | 0.38 (0.15–0.92) | 0.033 | |
| Significant pain | 1.71 (0.98–2.97) | 0.058 | |
| Physical restraints | 0.11 (0.03–0.46) | 0.003 | |
| **System-Related Outcomes** | **Adjusted OR (95%CI)** |  | |
| ICU readmissionb | \*\*\*\*\*\*\*\*\* |  | |
| Discharge destination | 0.83 (0.40–1.75) | 0.627 | |

**Abbreviations:** APACHE, APACHE, Acute Physiologic Assessment and Chronic Health Evaluation; HR, hazard ratio; ICU, intensive care unit; OR, odds ratio.

**Table Footnotes:**

a. Detailed descriptions of the methods used in the original analyses can be found both in the Methods Section and the footnote of Table 2 in the main manuscript.

b. Due to the distributions and/or event rates of three of the original outcomes (i.e., death, coma, and ICU readmission), we were unable to perform these models incorporating all covariates specified in the original analysis. Specifically, we saw low event rates in this subset of patients for mortality and ICU readmission; in addition, no patient with APACHE III available and full Bundle performance had coma the following day, leading to a cell count of 0.

**Interpretation:**

In this subgroup analysis, we see that after adjusting for available confounders including APACHE III, performance of the ABCDEF Bundle on a given day is associated with a lower likelihood of being on mechanical ventilation the following day, a lower likelihood of being delirious the following day, higher odds of significant pain the following day, and lower odds of restraint use the following day among the patients we were able to include in this model. Though the effect size for ICU discharge in this sensitivity analysis was nearly identical to the original analysis using the full cohort, it is no longer statistically significant. Though effect sizes and variability are different in this subset, these conclusions are qualitatively similar to our original analyses. In contrast, the point estimates for hospital discharge were in qualitatively different directions and insignificant in this subgroup analysis. Likewise, we did not see a significant relationship between ABCDEF Bundle performance and discharge to a location other than home among patients who survived hospitalization. This lack of significance in these three outcomes could be due to lack of power from our restricted sample size or a true confounding effect from severity of illness.

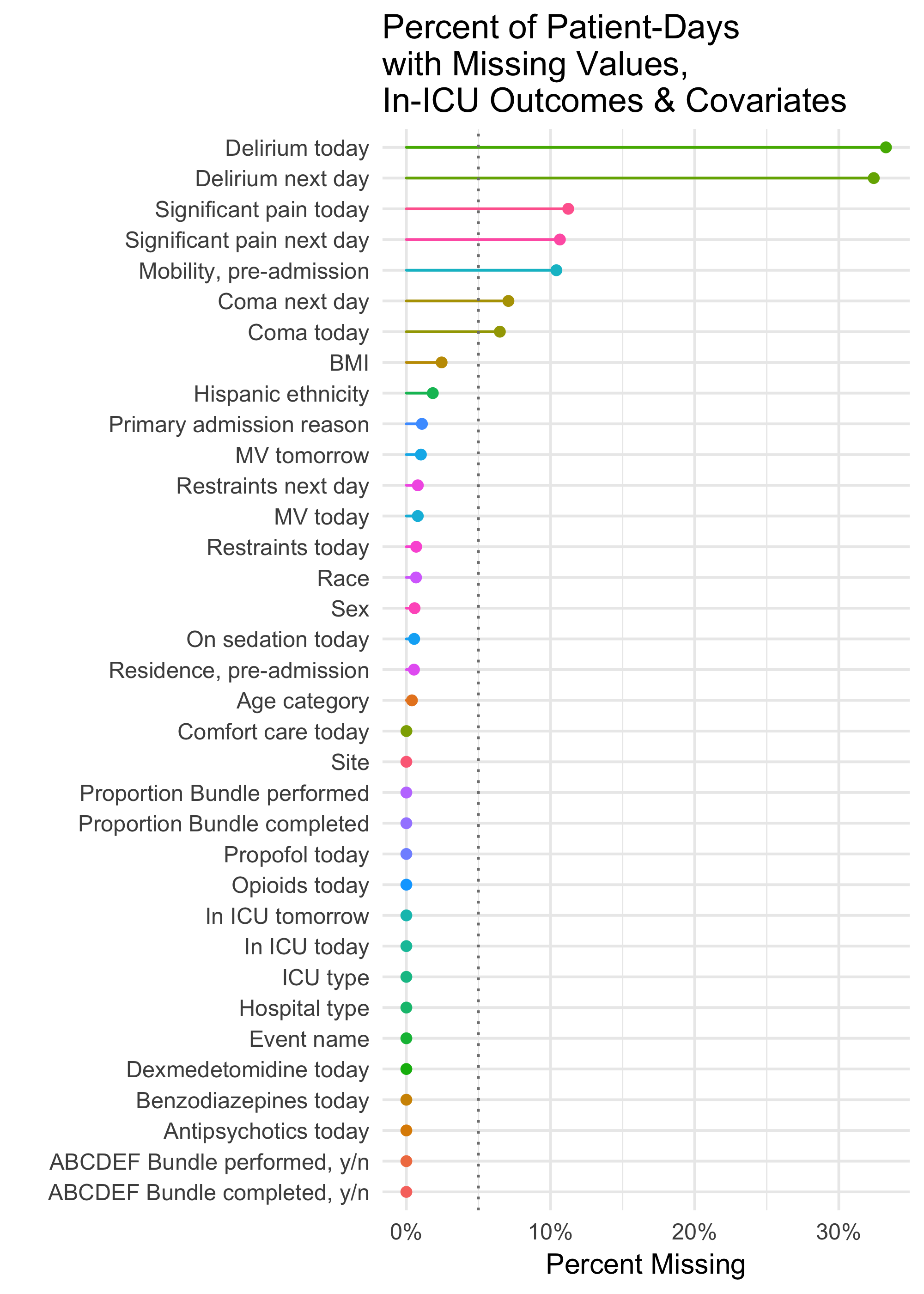
**SDC Table 4. Data on ICU Days and ABCDEF Bundle Performance\***

|  |  |  |
| --- | --- | --- |
| **Characteristic** | **N** | **N=49018** |
| **Element A**  Element A: performed | 49018 | 77% 37767⁄49018 |
| Number of pain assessments via self-report or with validated tool (BPS, CPOT), median (IQR) | 48701 | 10 (6-16) |
| Had ≥1 pain assessment via self-report or with validated tool | 49018 | 91% 44605⁄49018 |
| Had ≥1 assessment of significant pain self-reported | 31105 | 49% 15317⁄31105 |
| Had ≥ 1 assessment of significant pain using validated tool (BPS/CPOT) | 21403 | 36% 7691⁄21403 |
| Had ≥ 1 assessment of significant pain, either self-reported or by BPS/CPOT | 44086 | 49% 21512⁄44086 |
| **Element B** |  |  |
| On continuous/intermittent sedation | 48735 | 45% 21744⁄48735 |
| Element B1 (SAT): performed | 21744 | 34% 7369⁄21744 |
| On mechanical ventilation | 48602 | 50% 24312⁄48602 |
| Element B2 (SBT): performed | 24312 | 36% 8757⁄24312 |
| SAT performed before SBT (Paired SAT/SBT) | 4186 | 76% 3175⁄4186 |
| **Element C** |  |  |
| Element C: performed | 49018 | 59% 28791⁄49018 |
| Number of sedation assessments with validated tool (RASS/SAS), median (IQR) | 48504 | 6 (3-11) |
| Had >1 sedation assessment with validated tool | 49018 | 85% 41818⁄49018 |
| Comatose- | 45530 | 15% 6931⁄45530 |
| Received benzodiazepines- | 49018 | 21% 10202⁄49018 |
| Received opioids- | 49018 | 63% 30780⁄49018 |
| Received propofol- | 49018 | 23% 11379⁄49018 |
| Received dexmedetomidine- | 49018 | 9% 4598⁄49018 |
| Received antipsychotics (typical/atypical)- | 49018 | 7% 3286⁄49018 |
| **Element D** |  |  |
| Element D: performed | 49018 | 56% 27533⁄49018 |
| Number of delirium assessments with validated tool (CAM-ICU/ICDSC), median (IQR) | 48725 | 2 (0-3) |
| Had > 1 delirium assessment with validated tool | 49018 | 74% 36034⁄49018 |
| Delirious, per validated tool | 33474 | 29% 9592⁄33474 |
| **Element E** |  |  |
| Element E: performed | 49018 | 29% 14091⁄49018 |
| Mobility > active range of motion documented | 49018 | 29% 14091⁄49018 |
| Highest level of mobility | 49018 |  |
| Active range of motion in bed |  | 17% 8401⁄49018 |
| Dangle, side of bed |  | 3% 1579⁄49018 |
| Stand at side of bed |  | 2% 850⁄49018 |
| Active transfer, bed to chair |  | 12% 5768⁄49018 |
| March in place |  | 0% 209⁄49018 |
| Walk in room |  | 5% 2367⁄49018 |
| Walk in hall |  | 7% 3318⁄49018 |
| No level documented |  | 54% 26526⁄49018 |
| On physical restraints- Yes | 48667 | 33% 16094⁄48667 | |
| **Characteristic** | **N** | **N=49018** |
| **Element F** |  |  |
| Family present- Yes | 49018 | 58% 28391⁄49018 |
| Element F: performed | 28391 | 63% 18021⁄28391 |
| Family invited to participate in rounds/conference | 28391 | 37% 10458⁄28391 |
| Family participated in rounds | 28391 | 34% 9648⁄28391 |
| Family participated in plan of care/ABCDEF care | 28391 | 44% 12630⁄28391 |
| Family educated on ABCDEF bundle/related topics | 28391 | 36% 10233⁄28391 |
| On comfort care | 49015 | 1% 692⁄49015 |
| **Total Bundle \*\*** |  |  |
| Overall ABCDEF performance | 49018 | 8% 3831⁄49018 |
| Number of ABCDEF elements eligible to be performed | 49018 |  |
| 4 |  | 21% 10136⁄49018 |
| 5 |  | 31% 15206⁄49018 |
| 6 |  | 24% 11787⁄49018 |
| 7 |  | 24% 11889⁄49018 |
| Proportion of elements performed, median (IQR) | 49018 | 0.33 0.50 0.75 |

\* Abbreviations: BPS, Behavioral Pain Scale; CAM-ICU, Confusion Assessment Method for the Intensive Care Unit; CPOT, Critical Care Pain Observation Tool; ICDSC, Intensive Care Delirium Screening Checklist; ICU, Intensive Care Unit; IQR, interquartile range; RASS, Richmond Agitation-Sedation Scale; SAT, Spontaneous Awakening Trial; SBT, Spontaneous Breathing Trial; SAS, Sedation-Agitation Scale

\*\* Note related to “Total Bundle Performance”: The 8% (3,831/49,018) number derives from an analysis of all ICU days in the cohort. However, to be included in the logistic regression models related to clinical outcomes, the patient had to have two consecutive ICU days (because without two days you cannot analyze directionality of outcomes). In this study, 8% “total” bundle performance means that all 7 components of the bundle only happen about 1 in 10 patient days. That is not to take away from the many days that substantial partial bundle compliance occurs, Analysis of such partial compliance found a consistent dose-response relationship between higher proportional bundle performance and improvements in each of the above-mentioned clinical outcomes (all P<0.002).

**SDC Figure 1. Missingness: Proportion of Patient Days with Missing Values in ICU Outcomes and Covariates**

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**Legend for SDC Figure 1**: This figure reports the proportion of patient days when each represented data point was missing for both the ICU outcomes and covariates used in the multivariable models. Among patient-days eligible for inclusion in the models, several of the outcomes that require assessments to evaluate (i.e., delirium, significant pain and coma) had high rates of missingness. However, most covariates had low rates of missingness, with the exception of mobility level prior to Collaborative admission (10% of patient-days missing). A reference line at 5% missingness is included because that is an arbitrary cut-off below which it is customary not to factor in missingness.

**SDC References:**

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