**Supplementary Materials for**

**Data Omission By Physician Trainees on Intensive Care Unit Rounds**

Kathryn A. Artis, MD, MPH; James Bordley, MD; Vishnu Mohan, MD; Jeffrey A. Gold, MD

Correspondence to: artisk@ohsu.edu

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**MATERIALS AND METHODOLOGY**

**1) Definitions and Explanation of Predictor Variables (Human and Sociotechnical factors):**

*A) Patient characteristics:*

i) **Follow-up** or **Newly admitted**

Patients were categorized as “newly admitted” if the presenter utilized the “H&P” (history and physical) rather than “SOAP” (Subjective/Objective/Assessment and Plan) format during their rounds presentation. Using this designation, a patient who had been hospitalized on the wards for many days but had just transferred to the ICU overnight and presented as a new patient during morning rounds would be considered “newly admitted.”

ii) **Remaining in the ICU** or **Ready to leave ICU**

Patients were categorized as “ready to leave ICU” if they were described as “ward status,” “awaiting a floor bed,” or if a plan was made to request a ward bed during the rounds presentation. Patients did not have to receive a ward bed to receive this designation as the intent was to categorize patients who no longer required ICU level care and had a lower severity of illness than those remaining in the ICU. Patients for whom there was no mention of the disposition plan were assumed to be “remaining in the ICU.”

iii) **On vasopressors/inotropes within the last 24 hours** or **None**

Supplementary Table 6 lists the specific vasopressor and inotropic medications patients in our audit received though we assessed for the presence of any of these types of medications. For example, dopamine and milrinone would have also been recorded but none of the patients were on these medications. We retrospectively chart reviewed for the presence of these medications from 8AM the day prior to the time of the beginning of the patient’s rounding presentation on the day of the rounds audit. Patients were included even if they had weaned off their vasopressor or inotrope medications by the time of the presentation.

iv) **Invasive mechanical ventilation within the last 24 hours** or **None**

Any type of positive pressure mechanical ventilation that was provided via endotracheal or tracheal interface. Thus, bi-level and continuous positive airway pressure ventilation were excluded from this definition. We retrospectively chart reviewed for the presence of invasive mechanical ventilation from 8AM the day prior to the time of the beginning of the patient’s presentation on the day of the rounds audit. Patients were included even if they had been liberated from mechanical ventilation by the time of the presentation.

v) **Receipt of renal replacement therapy within the last 48 hours** or **None**

Any type of renal replacement therapy administered via fistula or dialysis catheter (including intravascular and peritoneal catheters). We retrospectively chart reviewed for the receipt of renal replacement therapy from 8AM two days prior to the time of the beginning of the patient’s rounding presentation on the day of the rounds audit since many patients are maintained on an every 48-hour renal replacement schedule.

vi) **≥1 Life-support modality** or **None**

Patients receiving one or more of the following therapies: vasopressor/inotropes (within previous 24 hours), invasive mechanical ventilation (within previous 24 hours) or renal replacement therapy (within previous 48 hours) were included in this definition with the hypothesis that data communication of patients with at least one of those three organ failures might be more medically complex than patients with none.

NOTES:

* *Capturing patient severity of illness*

Patient characteristics ii) through vi) listed above are all means of capturing patient severity of illness. In designing the study, we also considered using well-established severity of illness instruments such as APACHE-2 or SOFA scores. However we abandoned the use of these scores for two reasons: 1) many patients had incomplete data (i.e. no available arterial blood gases, inconsistently documented Glascow Coma Scores) making the accuracy of such scores suspect and 2) these scores are by design intended to be used upon admission to the ICU or upon onset of critical illness or organ failure. By contrast, we sought to understand whether there was a correlation between a patient’s severity of illness on the same day of ICU rounds rather than the date of ICU admission, hypothesizing that the presently sicker, more medically complex patients might pose greater cognitive burden on trainees preparing for rounds. We selected cardiac, respiratory and renal forms of organ failure as our surrogates for severity of illness because all of three of these have forms of life-support that the receipt of which can be unambiguously identified through chart review.

*B) Rounds presentation & Team characteristics:*

i) **Low census (<14 patients)** or **High census (≥14 patients)**

Team census was defined as the number of patients under the ICU team’s care as

of 8AM on the day of the rounding audit. We chose 14 patients as a threshold to define

‘high census’ given previous research that suggests 14 patients is a critical ICU team census threshold above which patient outcomes may worsen (Neuraz A et al, “Patient mortality is associated with staff resources and workload in the ICU: A multicenter observational study,” *Crit Care Med*, 2015;43:1587-1594).

ii) **Early (1st to 7th patient presentation)** or **Late order (8th to 14th patient presentation)**

We recorded the order in which patients were presented as previous work has shown that ICU patients presented after many preceding patients may receive less cognitive engagement by the team (McKenzie et al, “An observational study of decision making by medical intensivists,” *Crit Care Med*,2015), perhaps as a result of decision fatigue, cognitive overload or a desire to conclude rounds. We chose these specific intervals because they are similar to those used in our previous study (Artis et al, “Accuracy of Laboratory Data Communication on ICU Daily Rounds Using an Electronic Health Record,” *Crit Care Med*, 2017). However, unlike our previous study which included subgroups “1st to 7th,” “8th to 14th” and “>14th patient presented,” in the current study, we had only 1 patient in the >14th patient group thus this patient was excluded from analysis and we report only “1st to 7th” and “8th to 14th” groups.

iii) **Rounds Presentation duration: ≤10 minutes, >10 to 20 minutes, >20 minutes**

We chose these intervals because they are similar to those used in our previous study (Artis et al, “Accuracy of Laboratory Data Communication on ICU Daily Rounds Using an Electronic Health Record, *Crit Care Med* 2017) in which there was a significant difference between data communication accuracy at these different time increments.

iv) **Attending is viewing the EHR** or **Not viewing**

This was defined as the attending having the EHR open on their personal mobile computer at the time of the rounds presentation. Researchers did not ascertain whether the attending was consistently viewing the chart of the patient being presented, rather simply whether the attending did any form of real-time EHR viewing during the presentation. In general, individual attendings at our institution are consistent in their use or non-use of mobile computers during rounds. In other words, attendings use the EHR on all rounds presentations or do not use it at all. We included this as a predictor as we hypothesized that presenters might be less likely to omit patient data if they knew the attending habitually viewed the patient’s EHR during rounds.

NOTES:

* *Use of EHR-equipped computers by other team members*

The MICU team rounds with 2 to 3 mobile computers. One computer is always allotted to a resident to enter orders on the patient being presented. If the attending’s preference is to view the EHR in real-time while listening to the rounds presentation, a second mobile computer is designated as theirs. If available, a third mobile computer is available to another resident without any specific role assigned to this computer during rounds. In many cases though, the third mobile computer will be used by the senior resident paired with the junior trainee presenter for EHR viewing of the patient being discussed. Nurses and pharmacists do not have their own mobile computers to access during rounds presentations. Some pharmacists bring their laptop computers to ICU rounds to view patient charts. However, similar to nurses and respiratory therapists, they are not allotted a mobile computer. We did not collect data on the frequency of laptop computer use by pharmacists during ICU rounds.

v) **Presentation Interrupted** or **Not Interrupted**

An interruption was defined as any event that halted the rounds presentation. For example, a code blue that caused the ICU team to disperse would be considered an interruption whereas a side conversation between a nurse and a resident that did not result in the presenter stopping talking would not. This was a binary variable, thus even if a rounds presentation was interrupted multiple times it was counted as simply “interrupted,” the same as a presentation with only one interruption.

*C) Presenter training level*

i) **MS-4 (4th year medical student)** or **Residents/PGY 1-3 (post-graduate year 1-3)**

Medical students in our study complete a single 4-week ICU rotation during medical school thus those audited in our study were on their first ICU rotation experience of medical school. Residents in our program rotate through the medical ICU on 3-week rotations once or twice every year of their training.

ii) **Intern/PGY-1** or **Senior Resident/PGY-2, 3**

In our medical ICU, interns are paired with a senior resident (PGY-2 or 3). There are three of these intern/dyads assigned to the day shift (6AM to 6PM) and one intern/resident dyad on the night shift (6PM-6AM). However, to allow trainees days off, there are only 4 or 5 day shift trainees present on any given day. Thus, some interns and residents will be “solo” without their paired trainee. On “intern solo” days, other senior residents provide informal supervision and guidance of the intern. Interns do not provide any assistance to residents on “resident solo” days. The roles of PGY-2 and PGY-3 residents rotating in our ICU are identical thus for the purposes of our study, we combined these as a group in our analysis.

NOTES:

* *EHR training provided to trainees*:

Prior to starting their clinical rotations or upon starting employment, all trainees receive our institution’s EHR onboarding training. However, within the first three months of their intern year (and prior to data collection for this study), all internal medicine PGY-1 residents also undergo an EHR navigation exercise in which they are tasked with retrieving clinical data to write a daily progress note on a simulated ward patient with built-in patient safety “traps” (such as the need to recognize that a patient has no deep vein thrombosis prophylaxis ordered). As part of this exercise, they receive feedback on their performance as well as EHR navigation guidance about high-yield EHR screens for use on the wards. A more detailed description of this EHR training activity can be found in our group’s previous publication: March et al, “Use of Electronic Health Record Simulation to Understand the Accuracy of Intern Progress Notes,” *J Grad Med Educ*, 2016. While not specific to the ICU environment, this educational exercise provides EHR navigation training that is likely more applicable to the ICU setting than the general all-employee onboarding EHR course and was not provided to the medical students in our study.

* *ICU rounds orientation provided to trainees:*

Prior to starting their MICU rotation, every trainee is emailed orientation documents, including a “Basic Rounding/Presentation Guide.” This document provides a suggested pre-rounding workflow but does not endorse a specific artifact type, nor even suggest that trainees use an artifact at all. The presentation guide describes the standardized order in which data domains should be verbalized but does not detail to the level of individual tests or data points and does not explicitly state that presenters should verbalize 100% of available data. However, the culture of our MICU is, “If a test is ordered, you should talk about it, or not order it,” and the guide document does include language against ordering daily labs unnecessarily, further promoting a culture of valuing patient data that is actually collected. This document is described in greater detail in the section below on “Rationale for selection of Data Domains and Data elements.” Individual attendings and MICU fellows will also informally orient trainees. Our study methodology does not capture specific attending rounding preferences that may differ from what is contained in the MICU orientation documents.

*D) Artifact characteristics*

i) **Artifact manually-generated** or **EHR-generated**

Manually generated artifacts are those for which the presenter either hand-wrote or free-typed the entirety of data they extracted from the EHR in preparation for rounds. EHR-generated artifacts could take a number of forms (Supplementary Table 9) but by definition were at least in part electronically generated through the EHR. Thus, artifacts with a mixture of macros and handwritten data were classified as “EHR-generated.”

ii) **Data element present on artifact** or **Absent**

In our previous study (Artis et al, “Accuracy of Laboratory Data Communication on ICU Daily Rounds Using an Electronic Health Record, *Crit Care Med* 2017), presence of laboratory data on the presenter artifact was the strongest predictor of verbalization during rounds, hence the inclusion of this variable in this study as well. The data element could be either manually or electronically imported (or both) to count as present on the artifact.

iii) **Data element extracted manually only, via macros only** or **via both means**

For data elements that were found on the artifact, we assessed whether they appeared to have been extracted from the EHR manually (via handwriting or free-typing) or whether the presenter had utilized a macros to electronically extract the data element. After some initial audits, it became clear that some data were frequently both electronically and manually extracted on the same artifact, thus we included a third category of “both.”

**2. Definitions and Explanations of Outcome Variables:**

**Artifact Omission** (*also referred to as* ***“extraction failure”***): Audited data element types that can retrospectively be found in the EHR, but are not found on the photocopy of the trainee’s artifact.

**Verbal omissions**: Instances in which audited data element types that can be retrospectively found in the EHR are not specifically named or described at any point in the rounds audio-recordings or transcripts such that a listener could be certain that the data existed without prior knowledge of the patient’s case. Instances in which listeners had to make assumptions (such as assuming additional labs existed as part of a panel even they were not named, or assuming data must be normal or unimportant rather than unviewed by the presenter if not mentioned) were considered omissions.

1. **Presenter verbal omissions:** Data elements not verbalized by the trainee presenter

that may or may not be verbalized by another team member.

1. **ICU Team verbal omissions:** Data elements not verbalized by either the trainee presenter or any other member of the MICU inter-professional team.

NOTES:

* *Data availability caveat:*

These definitions are based on the assumption that the data viewed in the EHR at the time of a retrospective chart review was similar to the data available to presenters immediately prior the beginning of the rounds presentation. However, this assumption is problematic in regards to test results in which there is a delay between the time tests are performed and when they actually result and populate in the EHR. At our institution, tests results are listed under the time the same was collected, not when it was interpreted. Thus, it would be unfair to audit a laboratory test as “omitted” if it were collected but not actually resulted at the time of rounds. To address this issue, we utilized an EHR query that pulled the timestamps for when laboratory, microbiology and imaging test results were listed in the EHR as “ordered,” “collected,” and “resulted” and only audited those tests for which there was at least a preliminary result with a time-stamp that occurred prior to the start of the rounds presentation.

* *Data accuracy caveat:*

These definitions address only data “completeness.” In other words, we did not penalize presenters for extracting or verbalizing outdated, inaccurate (wrong value) or incorrectly interpreted data. Similarly, presenters were not penalized for efficiently summarizing data without individually naming each data element. See Supplementary Table 1 for illustrative examples that demonstrate these points.

* *EHR viewing caveat:*

Our study used audio-recording and not video-recording. Thus, it is possible that there were instances of non-verbal data communication or individual viewing of omitted data during rounds not captured by our methodology. However, given one purpose of daily ICU rounds is to ensure that all team members have a shared understanding of the patient’s current condition, we considered “verbalization omissions” a reasonable surrogate for identifying data that were not reviewed or acknowledged by the entire rounding team.

* *Clinical relevance of omissions caveat:*

Our study design does not include any attempt to link specific data omissions to patient outcomes or harms and we did not weight the clinical relevance of specific data omissions. This was a deliberate decision after multiple failed attempts by the researchers to create a reproducible methodology for assigning clinical relevance. Ultimately all of our attempts to create such a methodology were limited by the subjective and complex nature of making these judgments as well as no pre-existing standard or scale to reference. Finally, in considering the potential sample size of our study (>100 patients with 20 to 30 unique data elements per patient), the possibility of needing to individually resolve clinical disagreement between all the researchers on several thousand different data elements was deemed an unfeasible task. Thus, for the purpose of our study and analysis, every data element omission is weighted equally.

**3. Rationale for selection of Data Domains and Data elements**

*A) Data Domains*

Study authors KA and JAG (board-certified pulmonary critical care attendings) and JB (board-eligible pulmonary critical care fellow at the time of the study design) selected the following nine broad categories of data types (termed “**data domains”**) for auditing:

1) Vitals

2) Fluid Balance

3) Respiratory device and settings

4) Laboratory values (excluding cultures)

5) Microbiologic laboratory cultures

6) Continuous infusion medications

7) Imaging studies

8) Physician consultant notes/recommendations

9) Non-physician consultant notes/recommendations

The decision to include these data domains was based on two criteria:

**i) Inclusion on the MICU rounding script document provided to rotating trainees**

Prior to beginning their rotation in the MICU, all trainees are emailed orientation documents including a “Basic Rounding/Presentation Guide.” An excerpt is shown below (Supplementary Figure 1), in which trainees are instructed about the data domains to include in their rounding presentations.

**Supplementary Figure 1: Excerpt from Basic Rounding/Presentation Guide**

* Present data in the basic format below:
  + New patients should have an ID/CC or reason for admit
  + Start with a brief summary of the case
  + Interval Events since previous rounds
  + Subjective
  + **Vitals** – provide *context* and *trends*
  + **Ventilator settings** (see ventilated patients section)
  + **Fluid Balance**
  + Physical Exam, include level of sedation (RASS Score and goal) and CAM-ICU delirium screen
  + **Labs** (provide context: ie “Cr is 2.9 up from 1.3 yesterday”)
  + Update **Culture data**
  + New **imaging**/test results

This list identified 6 (bolded in the figure above) of the 9 data domains included in the study design.

**ii) Clinical judgment by the researchers**

Based on their own clinical experience as intensivists, the researchers KA, JAG and JB also decided to include “physician consultant recommendations” and “non-physician consultant recommendations” data domains to the audit as they considered the patient being seen by a consultant as both an “interval event since the previous rounds” and as a clinically important piece of data to consider in formulating the patient’s overall care plan. The researchers also unanimously agreed that knowing the patient’s current respiratory device (even if the patient were not mechanically ventilated) was important in terms of putting the patient’s respiratory vital signs and overall clinical state in context. Thus, the category of “ventilator settings” was expanded to “respiratory device and settings” to include all oxygenation and ventilator support devices. Finally, whereas it is not an expectation in our MICU that trainees present a patient’s entire medication list, in the researchers’ judgment, trainees are expected to know and demonstrate awareness of what continuous infusion medications (such as vasopressors, sedatives) their patients are receiving. Thus, the 9th data domain, “Continuous infusion medications” was also added.

*B) Data Elements*

The “Basic Rounding/Presentation Guide” orientation document does not specify for trainees what specific data points **(“data elements”**) within each data domain should be presented during rounds. Thus, the researchers KA, JAG and JB collectively discussed and individually resolved (by 2 out of 3 majority vote) which data elements to include in the audit. A full list of data elements included in the study design is listed in Supplementary Tables 2-8.

Some data domains were audited *exhaustively* – ie an attempt was made to include all listed data elements within the category. In our study, these data domains included:

* Laboratory values (excluding cultures)
* Microbiologic laboratory cultures
* Continuous infusion medications
* Imaging studies
* Physician consultant notes/recommendations
* Non-physician consultant notes/recommendations

Other data domains were audited *selectively* – ie only specific data elements were chosen for audit within the data domain. In our study, these data domains included:

* Vital signs
* Fluid balance
* Respiratory Device and settings

The decision to exhaustively audit the laboratory value domain was based on a desire to expand upon our previous work (Artis et al, “Accuracy of Laboratory Data Communication on ICU Daily Rounds Using an Electronic Health Record, *Crit Care Med* 2017 which audited only a sample of 20 laboratory tests. Additionally, the lab, microbiology culture and imaging domains were data types for which we could utilize an EHR query that automatically listed all available data elements within the EHR for the audit time frame. Audit of continuous infusion medication and consultant note elements could only be ascertained by manual chart review. However, given the low number of unique elements per patient (and some patients would not have any of these elements), this was deemed a feasible task to complete.

For the selectively audited domains, the researchers tried to pick a combination of data elements that in their judgment would be universally recognized as part of the data domain (for example, temperature, blood pressure, heart rate, respiratory rate and SpO2 of vital signs) or less universally recognized (for example bowel movement of fluid balance) but that might yield interesting insights about types of data for whom it is not clear which ICU team member should be the designated reporter.

**Supplementary Table 1: Illustrative Examples of Artifact and Verbal Omission Coding:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Hypothetical patient scenario*  Actual EHR laboratory data: WBC 16, Hb 7.4 (stable), Platelets 540 | | | | | |
| **Example** | **Artifact data** | **Verbalized data** | **Extraction Failures?** | **Presenter Verbalization Failures?** | |
| **Rationale** | | |
| #1 | WBC 16, Hb 7.4, Plt 540 | “WBC 16, Hb 7.4, Plt 540” | No | No | |
| All elements of the CBC are listed and presented. | | |
| #2 | WBC 16, Hb 7.4, Plt 540 | “CBC is stable” | No | | No |
| All elements of the CBC are listed and described. | | |
| #3 | CBC - stable | “CBC is stable” | No | No | |
| All elements of the CBC are described. | | |
| #4 | WBC 12, Hb 8, Plt 510 (yesterday’s values) | “WBC 12, Hb 8, Plt 510” | No | No | |
| Data is complete, even though outdated. | | |
| #5 | Hb 7 | “Hb is 7 and stable” | No: Hb  Yes: WBC, Plt | No: Hb  Yes: WBC, Plt | |
| WBC and platelet elements omitted; listener unsure whether:  1) CBC *or* just Hb lab drawn  2) WBC and Plt unremarkable *or*  presenter did not look at them | | |
| #6 | WBC 16, Hb 7.4, Plt 540 | “Hb is 7 and stable” | No | No: Hb  Yes: WBC, Plt | |
| WBC and platelet elements omitted; listener unsure whether:  1) CBC *or* just Hb lab drawn  2) WBC and Plt unremarkable *or* presenter did not look at them | | |
| #7 | WBC 16, Hb 7.4, Plt 540 | “CBC is notable for falling Hb” | No | No | |
| All elements of the CBC are listed and described even though description is inaccurate. | | |

EHR = electronic health record, WBC = white blood cell count, Hb = hemoglobin, Plt = platelet count

**Supplementary Table 2: Data Elements within Vital Signs & Fluid Balance Domains**

|  |  |
| --- | --- |
| **Data Domain** | **Audited Data Elements** |
| Vital Signs | Temperature |
| Heart Rate |
| Blood Pressure or Mean Arterial Pressure |
| Respiratory Rate |
| SpO2 |
| Fluid Balance | 24 hour input (total) |
| 24 hour output (total) |
| 24 hour net balance |
| Hospital length-of-stay net balance |
| Most recent bowel movement |

SpO2 = peripheral capillary oxygen saturation

NOTE: This list does not represent an exhaustive list of all the types of possible vital sign and fluid balance data available within the EHR. For example, heart rhythm (ie normal sinus rhythm or atrial fibrillation) and 24-hour urine output were not included in the audit, a decision that was collectively made by the researchers in balancing feasibility and scope of the research project.

**Supplementary Table 3: Data Elements within Respiratory Device Domain**

|  |  |
| --- | --- |
| **Data Domain** | **Audited Data Elements** |
| Respiratory Device | Device type (ex. Ventilator, nasal cannula) |
| Set FiO2 |
| Set oxygen flow rate |
| Ventilator Mode |
| Set IPAP or PS |
| Set tidal volume (VT) |
| Set respiratory rate (RR) |
| Set PEEP or CPAP |
| Measured Pplat |

FiO2 = Fraction of inspired oxygen, IPAP = inspiratory positive airway pressure (cm H2O), PS = pressure support (cm H2O), PEEP = positive end-expiratory pressure (cm H2O), CPAP = continuous positive airway pressure (cm H2O), Pplat = plateau pressure measured by inspiratory hold maneuver (cm H2O).

NOTE: Depending on the oxygen device type, not every data element listed above was relevant. For example, a patient on nasal cannula oxygen would only have entries for the “Device type” and “Set oxygen flow rate” (in liters per minute), whereas a patient on ventilator in volume control mode would have entries for “Device type,” “Set FiO2,” “Ventilator Mode,” “Set tidal volume,” “Set respiratory rate,” “Set PEEP” and “Measured Pplat.”

**Supplementary Table 4: Data Elements within Laboratory Test Domain**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Data Element Category** | **Sub-Category** | **Audited Data Elements** | | | | |
| Lab Elements part of an Order Set | CBC | WBC | Hb or Hct | | Platelets |  |
| Chemistry | Sodium | Potassium | | Chloride | HCO3 |
| BUN | Creatinine | | Glucose (no CBGs) | |
| Calcium | Anion gap | |  | |
| Liver panel | AST | ALT | | Alkaline phosphatase | |
| Total protein | Albumin | | Total bilirubin | |
| Venous blood gas | pH | PCO2 | |  | |
| Arterial blood gas | pH | PCO2 | | PO2 |  |
| Type and screen | Antibody screen | Antibody 1 | |  | |
| Lab Elements Individually Ordered | Hematology | INR | APTT | | Heparin | Fibrinogen |
| Transferrin saturation | Ferritin | | TIBC | Iron |
| Reticulocyte count | Vitamin B12 | | Haptoglobin | LDH |
| Methemoglobin | Mixing study | | Coombs | D-dimer |
| Factor IX activity | HLA Ab | | Immature platelet fraction | |
| Electrolytes | Ionized calcium | Magnesium | Phosphorus | |  |
| Gastrointestinal,  Other Metabolic | Direct bilirubin | CK | | Lipase | Uric acid |
| Serum ketone bodies | Ammonia | | Amino acid panel | |
| Hemodynamic  and Cardiology | Lactic acid | Co-oximeter panel (ScvO2) | | | Troponin I |
| NT-proBNP |  | | | |
| Endocrine | Hemoglobin A1c | CBG | | TSH | Free T4 |
| Triglycerides | HDL | | LDL | Cholesterol |
| Urine HCG | Prolactin | | Cortisol |  |
| Infectious Disease | CMV PCR (serum) | CMV genotype | | | CMV Abs |
| CMV PCR (BAL) | EBV PCR (serum) | | | EBV Abs |
| C difficile toxin | Rapid HIV | | Histoplasma Antigen | |
| Hepatitis A Ab | Hep B cAb | | Hep B sAb | Hep B sAg |
| Hepatitis C Ab | HSV-1 PCR | | Measles Ab | Monospot |
| G/C Probe | mTB PCR | | TB IGRA | |
| Influenza PCR | Respiratory pathogen panel (PCR) | | | |
| Urine legionella Ag | Urine S.pneumoniae Ag | | | VZV PCR |
| Rheumatologic | Anti-cardiolipin Ab | Anti-GBM | | ANCA | ANA |
| CRP | ESR | |  |  |
| Toxins and  Drug Levels | Acetaminophen | Ethanol | | Salicylate | 3OH cotinine |
| Urine drug screen | Carbon monoxide | | | Lithium |
| Gentamycin | Lamotrigine | | Phenytoin | Tacrolimus |
| Tobramycin | Vancomycin | | Voriconazole |  |
| Other Urine Studies | Osmolality | Urinalysis | | Creatinine | Eosinophils |
| Potassium | Sodium | |  |  |
| Other Body Fluid  Studies | Cell count | Cell count differential | | | LDH |
| Protein | Albumin | | Bilirubin | Glucose |
| Pathology | Chromosome report | | | Dermatopathology | |
| Hematopathology | | | Non-GYN cytology | |
| Surgical pathology | | |  | |

131 total unique lab elements. CBC = complete blood count, WBC = white blood cell count, Hb = hemoglobin, Hct = hematocrit, HCO3 = serum bicarbonate, BUN = blood urea nitrogen, CBG = capillary blood glucose, AST = aspartate aminotransferase, ALT = alanine aminotransferase, INR = international normalized ratio, APTT = activated partial thromboplastin time, TIBC = total iron binding capacity, LDH = lactate dehydrogenase, HLA Ab = anti-human leukocyte antigen antibody assay, CK = creatinine kinase, ScvO2 = central venous oxygen saturation, NT-proBNP = NT-proB-type natriuretic peptide, TSH = thyroid stimulating hormone, HDL = high density lipoprotein, LDL = low density lipoprotein, HCG = human chorionic gonadotropin, CMV = cytomegalovirus, PCR = polyermase chain reaction, Abs = antibodies, BAL = bronchoalveolar lavage, HIV = human immunodeficiency virus, Hep B = hepatitis B, sAb = surface antibody, sAg = surface antigen, HSV-1 = herpes simplex virus type 1, G/C = gonorrhea/chlamydia, mTB = mycobacterium tuberculosis, TB = tuberculosis, TB IGRA = tuberculosis interferon-gamma release assay, Ag = antigen, VZV = varicella zoster virus, anti-GBM = anti-glomerular basement membrane antibody, ANCA = antineutrophil cytoplasmic antibodies, ANA = antinuclear antibodies, CRP = C-reactive protein, ESR = erythrocyte sedimentation rate, GYN = gynecologic

NOTE: We assessed for the presence of every laboratory test but list here only the types of laboratory tests that were actually found in the EHR of patients we audited. Additionally, we did not audit to the level of “sub-data elements,” such as individual drug type components of the urine drug screen.

**Supplementary Table 5: Data Elements within Microbiologic Cultures Domain**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Domain** | **Culture Source** | **Audited Data Elements** | | | |
| Microbiologic Cultures | Ascites | - | Bacterial | - | - |
| Blood | AFB | Bacterial | Fungal | - |
| BAL fluid | AFB | Bacterial | Fungal | Nocardia |
| Pericardial fluid | AFB | Bacterial | Fungal | - |
| Pleural fluid | AFB | Bacterial | Fungal | - |
| Sinus | - | Bacterial | Fungal | - |
| Sputum | AFB | Bacterial | - | - |
| Stool | - | Bacterial | - | - |
| Synovial fluid | - | Bacterial | - | - |
| Tissue | AFB | Bacterial | Fungal | - |
| Urine | - | Bacterial | - | - |
| Vascular catheter tip | - | Bacterial | - | - |
| Wound | - | Bacterial | Fungal | - |

27 total unique microbiologic culture elements. AFB = acid fast bacilli, BAL = bronchoalveolar lavage

NOTE: We assessed for the presence of cultures from any kind of body fluid without any exclusions. Thus, as an example, cerebrospinal fluid cultures were sought in our audits. However, the body fluids listed above represent only the types of body fluid cultures that were actually found in the EHR charts of patients we audited, hence cerebrospinal fluid cultures and other possible body fluid cultures types are not listed.

**Supplementary Table 6: Data Elements within Continuous Infusion Medication Domain**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Domain** | **Medication Category** | **Audited Data Elements** | | | |
| Continuous Infusion Medications | Analgesic/Sedative | Dexmedtomidine | Fentanyl | Hydromorphone | Ketamine |
| Midazolam | Morphine | Propofol | - |
| Anticoagulation | Alteplase | Heparin | - | - |
| Antidote | NAC | Naloxone | - | - |
| Anti-arrhythmic | Amiodarone | - | - | - |
| Diuretic | Furosemide | - | - | - |
| Gastrointestinal | Octreotide | Pantoprazole | - | - |
| Glycemic | Insulin | - | - | - |
| Paralytic | Cisatricurium | - | - | - |
| Other | Ammonul | Arginine | - | - |
| Vasodilator or  BP lowering agent | Epoprostenil | Labetalol | Nicardipine | Nitroglycerin |
| Vasopressor or  Inotrope | Dobutamine | Epinephrine | Norepinephrine | Vasopressin |

27 total unique continuous infusion medication elements. NAC = N-acetylcysteine, BP = blood pressure.

NOTE: We assessed for the presence of all medications that would be considered by clinicians to be part of these categories. For example, dopamine would have been considered as a Vasopressor or Inotrope. However, the table displays only those medications that were actually found in the EHR charts we audited. Additionally, we excluded enteral feeding formulas and intravenous fluid solutions (ie lactated ringers, normal saline, 10% dextrose, etc) from this definition.

**Supplementary Table 7: Data Elements within Imaging Domain**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Domain** | **Imaging Category** | **Audited Data Elements** | | | |
| Imaging | X-ray | Abdominal | Chest | Elbow | Knee |
| Shoulder |  | | |
| CT | Abdomen and/or pelvis | Chest | Spine | Head or Facial |
| MRI | Abdomen | Brain | Spine |  |
| Ultrasound | Abdominal (including liver) | | Cardiac (echo) | Extremity |
| Fluoroscopy | Barium swallow | Venocavogram |  | |

17 total unique imaging elements. CT = computed tomography, MRI = magnetic resonance imaging, echo = echocardiography.

NOTE: We assessed for the presence of all imaging studies that would be considered by clinicians to be part of these “imaging categories.” For example, a vaginal ultrasound would have been included under the ultrasound imaging category. However, the table displays only those imaging studies that were actually found in the patient charts we audited.

**Supplementary Table 8: Data Elements within Consultant Domains**

|  |  |
| --- | --- |
| **Data Domain** | **Audited Data Elements** |
| Physician Consultants | Cardiac surgery\* |
| Cardiology |
| Dermatology |
| Ear/Nose/Throat (ENT)\* |
| Endocrinology |
| Family Medicine |
| Gastroenterology |
| General Surgery\* |
| Hematology and/or Oncology |
| Infectious diseases |
| Interventional Radiology |
| Medical Genetics |
| Nephrology |
| Neurosurgery\* |
| Ophthalmology\* |
| Orthopaedic Surgery\* |
| Palliative Medicine |
| Psychiatry |
| Pulmonary |
| Rheumatology |
| Thoracic Surgery\* |
| Trauma Surgery\* |
| Urology\* |
| Vascular Surgery\* |
| Non-Physician Consultants | Case management |
| Chaplain |
| Dietician |
| Lactation |
| Occupational therapy |
| Physical therapy |
| Patient advocate |
| Social Work |
| Speech Pathology |
| Wound and Ostomy Care |

26 total unique Physician Consult elements. 10 total unique non-physician consult elements.

\* denotes a surgical subspecialty

NOTE: We assessed for the presence of all consultant types, however only the types of consultant notes found in the patient charts we reviewed are listed. For example, although neurology would be a type of physician consultant, we did not find any neurology consult notes on our audited patients thus “neurology” is not included in the table above.

**Supplementary Table 9: Characteristics of Audited Rounds and Study Subjects**

|  |  |
| --- | --- |
| **Characteristic** | **Value** |
| **Rounds** | |
| No. rounding days audited | 13 |
| Mean rounds duration – hrs : mins | 3:22 |
| Team patient census – median (range) – no. of patients | 14 (11-16) |
| **Presentations** | |
| No. audited presentations | 157 |
| Mean presentation duration – mins | 12 |
| Duration ≤ 10 minutes – no. (%) | 61 (38.9) |
| >10-20 minutes – no. (%) | 79 (50.3) |
| >20 minutes – no. (%) | 17 (10.8) |
| ≥1 Disruptive interruption – no. (%) | 12 (7.6) |
| **Patients** | |
| Mean age – yrs | 54.0 |
| Male sex – no. (%) | 93 (59.2) |
| Admitted to ICU within last 24 hours\* – no. (%) | 40 (25.5) |
| Vasopressor/inotrope need within last 24 hours\* – no. (%) | 30 (19.1) |
| Mechanically ventilated within last 24 hours\* – no. (%) | 67 (42.7) |
| Renal replacement therapy within last 48 hours\* – no. (%) | 16 (10.2) |
| Ready to transfer out of ICU – no. (%) | 43 (27.4) |
| Mean hospital length of stay - days | 9.5 |
| **Presenters** | |
| Training level |  |
| Medical student – no. presentations (%) | 25 (15.9) |
| Intern (PGY-1) – no. presentations (%) | 65 (41.4) |
| PGY-2 – no. presentations (%) | 31 (19.7) |
| PGY-3 – no. presentations (%) | 36 (22.9) |
| **Attendings** | |
| No. of unique attendings | 7 |
| Concurrently viewing EHR – no. presentations (%) | 109 (69.4) |
| **Artifacts** |  |
| Presentations in which artifact used – no. (%) | 157 (100.0) |
| Presentations with an EHR-generated – no. (%) | 143 (91.1) |
| Presentations with more than one artifact type – no. (%) | 19 (12.1) |
| Format of artifacts\*\* |  |
| History & Physical note – no. times used (%) | 14 (8.9) |
| Daily progress note – no. times used (%) | 124 (79.0) |
| Patient sign-out list – no. times used (%) | 27 (17.2) |
| Other | 16 (10.6) |

ICU = intensive care unit, PGY = post graduate year, EHR = electronic health record, artifact = paper pre-rounding notes presenters created in preparation and as a presentation aid for daily ICU rounds

\* defined as since 8AM the preceding one or two days prior

\*\* percentages do not sum to 100% given on some presentations, trainees used more than one artifact type

**Supplementary Table 10: Types and Distribution of Audited Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Data Domain** | **Unique elements\*** | **Elements/patient, average (range)** | **Total elements,**  **n (%)** |
| Vital signs | 5 | 5 (5) | 785 (13.0) |
| Fluid balance | 5 | 5 (5) | 785 (13.0) |
| Respiratory device | 9 | 3 (0-9) | 477 (7.9) |
| Labs (no cultures) | 131 | 19 (0-35) | 3065 (50.6) |
| Microbiologic cultures | 27 | 2 (0-11) | 305 (5.0) |
| Continuous infusion medications | 27 | 1 (0-7) | 189 (3.1) |
| Imaging | 17 | 1 (0-12) | 137 (2.3) |
| Physician consultants | 26 | 1 (0-5) | 168 (2.8) |
| Non-physician consultants | 10 | 1 (0-5) | 144 (2.4) |
| **TOTAL** | **257** | **46 (20-72)** | **6055 (100%)** |

\* see *Supplementary Tables 2-8* for a full listing of data elements included in each domain

**Supplementary Table 11. Incompleteness of Extracted and Verbalized Patient Data by Domain and Specific Element Types**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Data Domain | Available values, n\* | Artifact Omission  (Trainee), n (%) | Verbal Omission  (Trainee), n (%) | Verbal Omission  (ICU team), n (%) |
| **TOTAL** | **6055** | **1385 (22.9)** | **2568 (42.4)** | **2320 (38.3)** |
| **Vital signs**  Temperature  Blood pressure  Heart rate  Respiratory rate  SpO2 | **785**  157  157  157  157  157 | **21 (2.7)**  2 (1.3)  2 (1.3)  1 (0.6)  7 (4.5)  9 (5.7) | **150 (19.1)**  12 (7.6)  14 (8.9)  11 (7.0)  60 (38.2)  53 (33.8) | **139 (17.7)**  12 (7.6)  14 (8.9)  11 (7.0)  56 (35.7)  48 (30.6) |
| **Fluid Balance**  24-hour input  24-hour output  24-hour net balance  Hospital stay net balance  Last bowel movement | **785**  157  157  157  157  157 | **287 (36.6)**  17 (10.8)  18 (11.5)  25 (15.9)  102 (65.0)  125 (79.6) | **529 (67.4)**  97 (61.8)  93 (59.2)  68 (43.3)  138 (87.9)  133 (84.7) | **514 (65.5)**  96 (61.1)  92 (58.6)  65 (41.4)  137 (87.3)  124 (79.0) |
| **Respiratory Device**  Device type  Set FiO2  Oxygen flow rate (lpm)  Ventilator Mode  Set IPAP or PS  Set tidal volume  Set respiratory rate  Set EPAP or PEEP  Measured Pplat | **477**  113  79  48  55  32  31  32  63  24 | **90 (18.9)**  17 (15.0)  10 (12.7)  18 (37.5)  4 (7.3)  5 (15.6)  5 (16.1)  13 (40.6)  6 (9.5)  12 (50.0) | **111 (23.3)**  13 (11.5)  21 (26.6)  16 (33.3)  7 (12.7)  6 (18.8)  6 (19.4)  16 (50.0)  9 (14.3)  17 (70.8) | **82 (17.2)**  10 (8.8)  13 (16.5)  13 (27.1)  5 (9.1)  2 (6.3)  4 (12.9)  16 (50.0)  6 (9.5)  13 (54.2) |
| **Laboratory**  CBC  Chemistry/electrolytes  Glucose/CBG  Liver panel  Blood gas (arterial/venous)  All other | **3065**  410  1343  150  488  182  492 | **647 (21.2)**  7 (1.7)  180 (13.4)  28 (18.7)  164 (33.6)  54 (29.7)  214 (43.5) | **1386 (45.2)**  76 (18.5)  555 (41.3)  80 (53.3)  319 (65.4)  91 (50.0)  265 (53.9) | **1282 (41.8)**  71 (17.3)  517 (38.5)  74 (49.3)  295 (60.5)  82 (45.1)  243 (49.3) |
| **Microbiologic cultures**  Blood cultures  All other cultures | **305**  159  146 | **122 (40.0)**  67 (42.1)  55 (37.7) | **132 (43.3)**  70 (44.0)  62 (42.5) | **116 (38.0)**  60 (37.7)  56 (38.4) |
| **Continuous infusion meds**  Analgesic/sedative/paralytic  Vasopressor/inotrope  Insulin  All other | **189**  54  55  39  41 | **6 (3.2)**  3 (5.6)  1 (1.8)  1 (2.6)  1 (2.4) | **46 (24.3)**  17 (31.5)  10 (18.2)  10 (25.6)  9 (22.0) | **10 (5.3)**  1 (1.9)  0 (0)  4 (10.3)  5 (12.2) |
| **Imaging Studies**  X-ray  CT  Ultrasound  All other | **137**  79  24  27  7 | **61 (44.5)**  40 (50.6)  7 (29.2)  12 (44.4)  2 (28.6) | **35 (25.5)**  22 (27.8)  3 (12.5)  7 (25.9)  3 (42.9) | **29 (21.1)**  18 (22.8)  3 (12.5)  5 (18.5)  3 (42.9) |
| **Physician consultants**  Surgical specialty  Non-surgical specialty | **168**  34  134 | **41 (24.4)**  6 (17.6)  35 (26.1) | **61 (36.3)**  15 (44.1)  46 (34.3) | **42 (25.0)**  10 (29.4)  32 (23.9) |
| **Non-physician consultants** | **144** | **110 (76.4)** | **118 (81.9)** | **106 (73.6)** |

Data audit is based on a sample size of 157 ICU patients. ICU rounding teams were composed of one attending physician, one critical care fellow, physician trainees (residents and medical students), the bedside ICU nurse, ICU pharmacist, and respiratory therapist. For patients with multiple values within the audit time period (e.g. multiple different oxygen devices), only the value closest to the start of rounds was included in the audit. For data types with multiple serial values (e.g. blood pressure) credit was given for describing or naming any blood pressure value. See *Supplementary Tables 4-8* for a listing of data elements included in lab, culture, medication, imaging and consultant data domains. “Chemistry” includes all lab elements in *Supplementary Table 4* except glucose. EHR = electronic health record; ICU = intensive care unit; SpO2 = oxygen saturation; FiO2 = inspired fraction of oxygen; lpm = liters per minute; IPAP = inspired positive airway pressure; PS = pressure support; EPAP = expiratory positive airway pressure; PEEP = positive end expiratory pressure; Pplat = plateau pressure as measured by inspiratory pause maneuver; CBC = complete blood count, CBG = capillary blood glucose, meds = medications, CT = computed tomography.

**Supplementary Table 12: Factors Associated with Data Omission By Physician Trainees (Multiple**

**Logistic Regression Analysis)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factors Included**  **in Multiple Logistic Regression** | **Artifact Omissions** | | **Verbal Omissions** | |
| **OR (95% CI)** | **p-value** | **OR (95% CI)** | **p-value** |
| **Patient Characteristics** |  |  |  |  |
| Remaining in ICU  vs. Ready to leave ICU | - | - | ref  0.92 (0.79-1.07) | -  0.27 |
| Vasopressor/inotropes  vs. None | ref  1.34 (1.14-1.58) | 0.0004 | ref  1.06 (0.90-1.23) | -  0.50 |
| **Rounding & Team Factors** |  |  |  |  |
| Presentation duration:  ≤10 minutes  >10 to 20 minutes  <20 minutes | ref  1.03 (0.89-1.19)  0.99 (0.81-1.23) | 0.65  0.96 | ref  0.71 (0.61-0.82)  0.75 (0.60-0.93) | -  <0.0001  0.0082 |
| **Presenter Training Level** |  |  |  |  |
| MS-4  PGY-1  PGY-2, 3 | ref  2.11(1.69-2.37)  1.85 (1.50-2.29) | <0.0001  <0.0001 | ref  2.07 (1.71-2.52)  1.80 (1.48-2.18) | -  <0.0001  <0.0001 |
| **Artifact Factors** |  |  |  |  |
| Manually-generated only  vs. Part/Entirely EHR-generated | ref  2.07 (1.64-2.60) | <0.0001 | - | - |
| Presence on artifact/export means:  Present/manually +/- macros  Present/macros only  Absent/not exported | - | - | ref  2.89 (2.52-3.32)  23.5 (19.6-28.1) | -  <0.0001  <0.0001 |

Reported values represent the results of a multiple logistic regression. Variables were selected for inclusion in the model based on a statistically significant association with the outcome variable in the bivariate analysis (Table 2). OR = odds ratio, 95% CI = 95% confidence intervals. Artifact omissions denote data elements not found on presenter artifacts. Verbal omissions denote data elements not verbalized during the rounds presentation by the trainee. ICU = intensive care unit, EHR = electronic health record, MS-4 = 4th year medical student, PGY = post-graduate year, ref = reference group thus OR = 1.

**Supplementary Table 13: Comparison of Outcome Predictors Between Per Data Element vs. Per-**

**Presentation\* Analyses**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factors Included**  **in Model** | **Predictive of**  **Artifact Omissions?** | | **Predictive of**  **Verbal Omissions?** | |
| **By Data Element** | **By Patient**  **Presentation** | **By Data Element** | **By Patient Presentation** |
| Remaining in ICU  vs. Ready to leave ICU | - | - | No | No |
| Vasopressor/inotropes  vs. None | Yes | No | No | No |
| Presentation duration:  ≤10 minutes  >10 to 20 minutes  <20 minutes | No | No | Yes | Yes  (Supplementary Figure 2) |
| Presenter training level:  MS-4  PGY-1  PGY-2, 3 | Yes | Yes (Supplementary Figure 3) | Yes | Yes  (Supplementary Figure 3) |
| Manually-generated only  vs. Part/Entirely EHR-generated | Yes | Yes | - | - |
| Presence on artifact/export means:  Present/manually +/- macros  Present/macros only  Absent/not exported | - | - | Yes | Yes  (Supplementary Figure 4) |

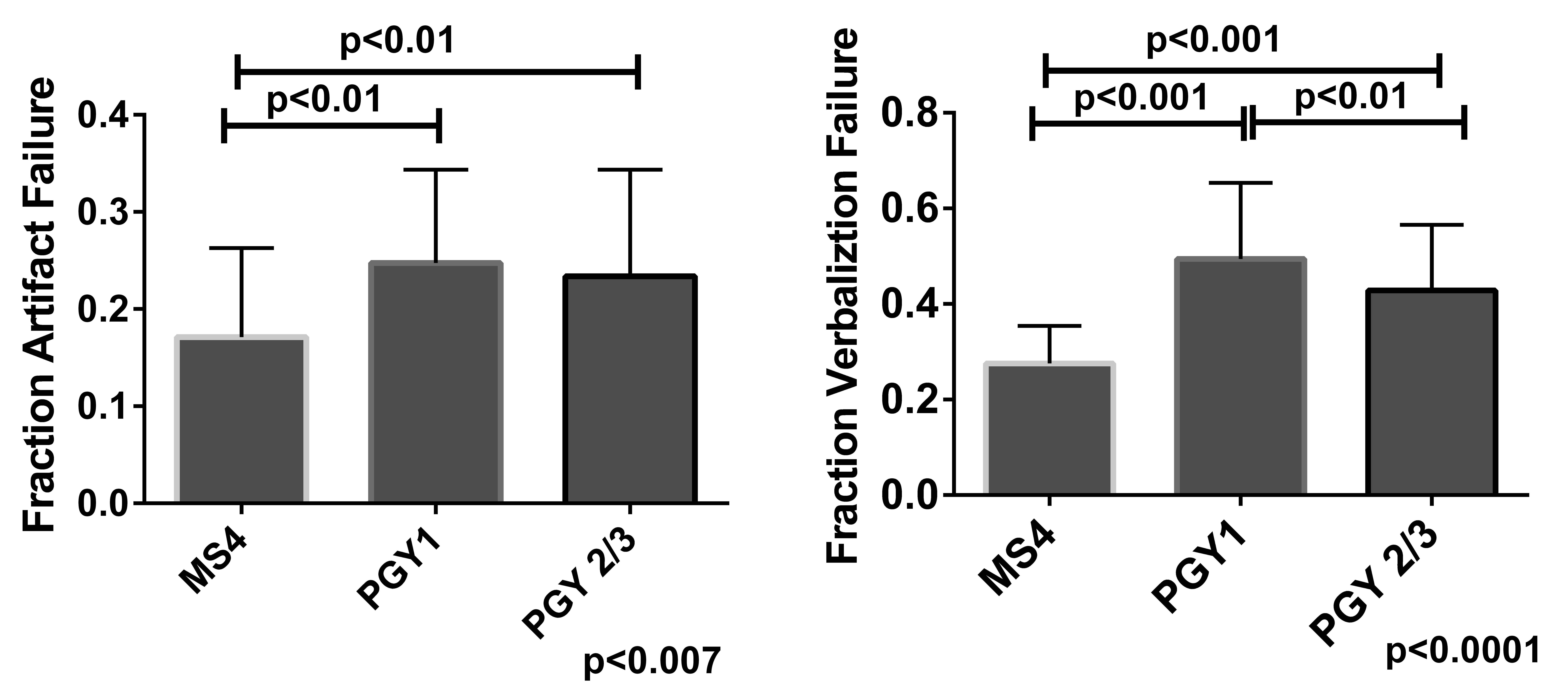
Analysis in the main body of the paper (Table 2) and Supplementary Table 12 were performed without clustering the 6055 data elements by potential groupings such as audit date, individual presentations, presenter training level, unique patient etc. We performed bivariate and multiple logistic regression analyses on the data set when grouped for individual presentations and show which variables remained significantly associated with outcomes as compared to the non-grouped analysis. With the exception of “(Patient is on)Vasopressors” as a predictor of fewer artifact omissions, all other predictor variables were similar between the non-grouped and analysis strategies. See Supplementary Figures 2-4 for graphical displays of the significant predictors in the grouped by patient presentation analysis strategy. ICU = intensive care unit, MS-4 = 4th year medical student, PGY = post-graduate year, EHR = electronic health record.

\*Data elements were grouped by patient presentation (n = 157 presentations)



**Supplementary Figure 2: Duration of Rounding Presentation as a Predictor of Verbal Omissions Using a Grouped Analysis.** The data elements were grouped by patient presentation (n = 157) and bivariate and multiple logistic regression analyses were performed. Similar to the non-clustered analysis (Table 2, Supplementary Table 12), there is a statistically significant association between duration of the rounding presentation and frequency of data omissions during rounds with shorter presentations associated with more verbal omissions.

A B



**Supplementary Figure 3: Presenter Training Level as a Predictor of Artifact Omissions (Panel A) and Verbal Omissions (Panel B) Using a Grouped Analysis.** The data elements were grouped by patient presentation (n = 157) and bivariate and multiple logistic regression analyses were performed. Similar to the non-grouped analysis (Table 2, Supplementary Table 12), there is a statistically significant association between presenter training level and both artifact and verbal omissions. MS4 = fourth year medical student, PGY1 = first year resident or “intern”, PGY2/3 = senior resident as defined by a resident in their second or third year of training.



**Supplementary Figure 4: Artifact Omission as a Predictor of Verbal Omission Using a Grouped Analysis.** The data elements were grouped by patient presentation and bivariate and multiple logistic regression analyses were performed. Similar to the non-grouped analysis (Table 2, Supplementary Table 12), there is a statistically significant association between absence of data elements from the artifact and verbal omissions during rounds.