

Multifaceted interventions to decrease mortality in patients with severe sepsis/septic shock - A quality improvement project

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Despite knowledge that EGDT improves outcomes in septic patients, staff education on EGDT and compliance with the CPOE order set has been variable. Based on results of a resident survey to identify barriers to decrease severe sepsis/septic shock mortality in the medical intensive care unit (MICU), multifaceted interventions such as educational interventions to improve awareness to the importance of early goal-directed therapy (EGDT), and the use of the Computerized Physician Order Entry (CPOE) order set, were implemented in July 2013. CPOE order set was established to improve compliance with the EGDT resuscitation bundle elements. Orders were reviewed and compared for patients admitted to the MICU with severe sepsis/septic shock in July and August 2013 (controls) and 2014 (following the intervention). Similarly, educational slide sets were used as interventions for residents before the start of their ICU rotations in July and August 2013. While CPOE order set compliance did not significantly improve (78% vs 76%, $p=0.74$), overall EGDT adherence improved from 43% to 68% ($p=0.0295$). Although there was a trend toward improved mortality, this did not reach statistical significance. This study shows that education interventions can be used to increase awareness of severe sepsis/septic shock and improve overall EGDT adherence.

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2 **Multifaceted interventions to decrease mortality in patients with severe**
3 **sepsis/septic shock - A Quality Improvement Project**

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6 **ABSTRACT**

7 Despite knowledge that early goal directed therapy (EGDT) improves outcomes in septic
8 patients, staff education on EGDT and compliance with the Computerized Physician Order Entry
9 (CPOE) order set that lists the components of early aggressive management with the
10 resuscitation bundle elements, have been variable. Based on results of a resident survey to
11 identify barriers to decrease severe sepsis/septic shock mortality in the medical intensive care
12 unit (MICU), multifaceted interventions such as educational interventions to improve awareness
13 to the importance of EGDT, and the use of the CPOE order set, were implemented in July 2013.
14 CPOE orders were reviewed and compared for patients admitted to the MICU with severe
15 sepsis/septic shock in July and August 2013 (controls) and 2014 (following the intervention).
16 Similarly, educational slide sets were used as interventions for residents before the start of their
17 ICU rotations in July and August 2013. While CPOE order set compliance did not significantly
18 improve (78% vs 76%, $p=0.74$), overall adherence to the resuscitation bundle elements improved
19 from 43% to 68% ($p=0.0295$). This study shows that education interventions can be used to
20 increase awareness of severe sepsis/septic shock and improve overall adherence to the
21 resuscitation bundle elements.

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70 **Conflict of interest – NONE**

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81 **INTRODUCTION**

82 Aggressive and timely management of severe sepsis/septic shock is essential particularly with
83 the increasing incidence (over one million cases projected in 2020(Angus et al. 2001)), costs
84 (\$16.7 billion annually(Angus et al. 2001)), and burden of managing the morbidity and mortality.
85 Rivers et al. showed the benefit of early goal-directed therapy (EGDT), with a decrease in
86 overall mortality (46.9% vs. 30.5%) and length of hospital stay (18.4 vs. 14.6 days)(Rivers et al.
87 2001). The recent ARISE and ProCESS trials again confirm the importance of early aggressive
88 management of patients with severe sepsis and septic shock (Investigators et al. 2014; Mouncey
89 et al. 2015; Pro et al. 2014). However the role of all components of EGDT elements have been
90 questioned. Despite multiple educational interventions from international societies and
91 recommendations by the Surviving Sepsis Campaign (Dellinger et al. 2004; Dellinger et al.
92 2013) to institute resuscitation bundle elements in the management of severe sepsis/septic shock,
93 all-or-none compliance with these bundle elements remain poor and the early recognition of
94 sepsis remains a challenge (Djurkovic et al. 2010).

95 Various quality improvement interventions showed significant improvement in the all-or-none
96 compliance with the resuscitation bundle elements and even more importantly, an improvement
97 in mortality(Schramm et al. 2011). Schramm et al. implemented weekly feedback to care teams
98 regarding their compliance in addition to starting a sepsis response team. Similarly, Coba et al.
99 showed that monitoring the implementation of the resuscitation bundle elements by a continuous
100 quality initiative, resulted in improvements in compliance and mortality(Coba et al. 2011).

101 Resident physicians play a significant role in the management of patients with severe
102 sepsis/septic shock in our medical intensive care unit (MICU). Though our overall compliance
103 with the resuscitation bundle elements in our MICU ranges from <50% to 80%, it could be
104 consistently better. Resident physicians do not routinely receive data on the importance and
105 elements of aggressive early resuscitation in patients with severe sepsis/septic shock. Also, a
106 severe sepsis-specific Computerized Physician Order Entry (CPOE) that encompasses all of the
107 resuscitation bundle elements is available to assist the physicians to comply with these elements
108 (Table 1). The purpose of this quality improvement (QI) project was to identify barriers among
109 resident physicians to comply with the resuscitation bundle elements, identify and implement
110 interventions to improve compliance, and thereby reduce hospital/ICU LOS and 30 days
111 mortality.

112 **METHODS**

113 **Settings and Participants**

114 This QI project was conducted in the 24-bed MICU at Saint Mary's hospital, Rochester. Given
115 the QI nature of the project, a waiver from the Institutional Review Board was obtained. All
116 Internal Medicine (IM) residents were contacted via email giving a brief description of the QI
117 problem statement and an attached survey. The QI problem statement to the residents stated the
118 following: To decrease mortality of severe sepsis/septic shock to 10% in ICU patients by
119 increasing compliance with early aggressive management of these patients using the
120 resuscitation bundle elements by the use of the CPOE order set between 2013 and 2014 by the
121 Internal Medicine residents. Their participation in the survey was voluntary.

122 **Intervention and Comparison**

123 CPOE is the only way to place orders at our institution. The components of the CPOE order set
124 for severe sepsis/septic shock are listed in table 2. All IM resident physicians rotating through the
125 MICU during the phase of the QI project were surveyed to identify barriers to the use of CPOE
126 severe sepsis order set (Table 3). Residents rotating through the MICU change at the beginning
127 of every month with the number of residents rotating in MICU each month being the same. After
128 identifying the barriers to successful compliance from the pre-intervention survey with the CPOE
129 order set and resuscitation bundle elements, the week prior to starting the rotation, all residents
130 were provided and educated with an education slide set that detailed the importance of early
131 aggressive resuscitation of patients with severe sepsis/septic shock, and in using CPOE order sets
132 to achieve compliance with the resuscitation bundle elements. The rationale for choosing
133 education interventions along with feedback was based on the pre-survey results (in result
134 section) and discussion among the team members using the priority grid matrix to identify
135 interventions with high impact with low effort. The education interventions along with feedback
136 tools were identified to be low effort with medium impact with minimal cost to implement.
137 Compliance with resuscitation bundle elements was the major interested outcome. This slide set
138 provided step-by-step instructions on how to access the order set. Pocket cards with criteria for
139 using the order set were provided as an educational intervention, along with information
140 regarding the resuscitation bundle element components were provided to every resident rotating
141 through the ICU during the intervention period. Elements include time to antibiotics, obtaining
142 cultures before antibiotic administration, lactate measurement, appropriate and timely volume
143 resuscitation, inotrope and transfusion as appropriate (Table 1). Pocket cards also included the
144 definition of the systemic inflammatory response syndrome (SIRS), sepsis, severe sepsis and
145 septic shock to help residents identify those in need of early aggressive management of severe

146 sepsis/septic shock. These cards were enlarged and placed on the roaming computers used
147 during rounds and MICU admissions by each resident. Finally, residents were given a bi-
148 monthly feedback sessions, compared to the pre-intervention once-monthly feedback sessions
149 regarding their compliance with meeting CPOE order set and resuscitation bundle elements. At
150 these sessions, residents were again reminded on the importance of early aggressive management
151 of severe sepsis/septic shock and compliance with the resuscitation bundle elements, along with
152 the use of the CPOE order set for all patients admitted with severe sepsis/septic shock. The
153 compliance was checked by the physician data entry in the computerized system. Additionally,
154 residents were given compliance data and feedback on the resuscitation bundle elements for
155 patients admitted during their service time who met criteria for severe sepsis/septic shock in
156 order to identify situations in which the order set should have been used.

157 The intervention was evaluated with a pre-post- test study design. To assess baseline compliance,
158 patients admitted to the MICU with severe sepsis/septic shock in July and August 2012 were
159 identified. All IM residents rotating through the MICU were administered the initial survey
160 within one week of starting their ICU rotation. Similarly, the post survey administration
161 happened within 1 week of the IM residents starting their ICU rotation following the
162 interventions. The number of IM residents rotating through each month remained the same.
163 Patients qualified as having severe sepsis/septic shock if systolic blood pressure remained < 90
164 mmHg despite adequate fluid resuscitation, lactate > 4 mmol/L, or organ dysfunction/failure
165 ensued due to hypoperfusion attributable to sepsis. Overall compliance with CPOE order set and
166 the resuscitation bundle elements were determined by reviewing orders placed for patients
167 admitted to the MICU with severe sepsis/septic shock. The interventions were implemented on
168 July 1, 2013. Compliance with CPOE order set use and resuscitation bundle elements for patients

169 admitted in July and August 2013 were assessed for comparison. Following the intervention
170 period, the survey was re-administered to the IM residents who had rotated through the MICU,
171 with additional questions addressing which interventions were beneficial in improving
172 compliance.

173 **Outcomes and Data Collection**

174 The MICU sepsis group keeps a database of patients admitted with severe sepsis/septic shock.
175 Patients with severe sepsis were initially identified by screening criteria using the sepsis alert
176 software in our MICU. Our quality coach nurses subsequently screened these patients to confirm
177 the diagnosis of severe sepsis/septic shock before the data were manually entered in the MICU
178 database. The team leaders performed periodic checks to check the validity. This database was
179 used to identify patients in our timeframe of interest and to assess compliance. Once identified,
180 orders placed for each patient were reviewed. Use of the CPOE order set was recorded, as well
181 as whether 100% of the resuscitation bundle elements were met. Our experienced and ICU
182 trained nurses were the quality coaches who collected all the relevant outcome data. The two
183 nurses who were the quality coaches underwent rigorous training in data collection and analysis.
184 They had a trial run of collecting and analyzing data in the QI project that was subsequently
185 supervised by a quality expert in ICU for reliability and validity before they started this project.
186 The two nurses conducted and collected the pre and post intervention data. Though the quality
187 coach nurses were not blinded, the consistency of collection of data were reliable and valid as
188 periodic checks were performed independently by the MD quality expert. Demographic data,
189 outcomes including MICU and hospital length of stay, Acute Physiology and Chronic Health
190 Evaluation II (APACHE II) score, Sequential Organ Failure Assessment (SOFA) score and
191 mortality were also collected by our quality coaches.

192 **Statistical Analysis**

193 Statistical differences in patient demographics, CPOE compliance, resuscitation bundle elements
194 compliance and 30-day mortality were compared between pre- and post-intervention groups
195 using a chi square model. Statistical differences between median hospital and ICU length of stay
196 (LOS) were compared using Mann-Whitney test using R Statistical Software (Foundation for
197 statistical computing, Vienna, Austria).

198

199 **RESULTS**

200 **Survey Results**

201 First and third year residents rotated in our MICU. In the pre-intervention period, 56 of 170 IM
202 residents who had rotated in our MICU during the QI project, participated in the survey with 31
203 (55%) of respondents being first year residents. In our MICU, it is the first year residents who
204 are primarily responsible for order entry. The majority of residents (89%) were familiar with the
205 order sets, however only 67% felt knowledgeable about when to use the order set. Additionally,
206 63% of residents identified at least one situation in which they later realized the order set applied
207 to their patient. Uncertainty as to whether the CPOE order set applied to a particular patient with
208 severe sepsis/septic shock (45% of respondents) was the largest barrier to order set compliance
209 according to survey results from IM residents (Figure 1A). They identified reminders from staff
210 as the most likely factor to promote order set use (Figure 1B).

211 In the post-intervention period, 44 of 170 IM residents who rotated in our MICU participated in
212 the survey with 41% of respondents being first year residents. The greatest barrier to order set

213 use remained uncertainty about whether it applied to their patient (36% of respondents). Again,
214 reminders from staff were considered to be the most likely factor to improve compliance. The
215 post-intervention survey contained questions directed at the interventions themselves.
216 Educational interventions (23%) and bimonthly feedback (23%) were found to be most useful,
217 while 25% of residents felt all of the interventions were equally helpful in improving
218 compliance. Thirty percent of residents felt the interventions increased knowledge and awareness
219 of severe sepsis/septic shock, while 11% found that the interventions increased awareness about
220 the resuscitation bundle elements and thus increased CPOE order set compliance. Twenty seven
221 percent of residents found increased awareness of both severe sepsis/septic shock and the
222 resuscitation bundle elements from these interventions. Finally, 66% of residents reported using
223 the CPOE order set always or most of the time, while only 9% reported rarely using the order set.

224 There were 51 patients admitted to the MICU for severe sepsis/septic shock in the pre-
225 intervention period and 41 patients in the post-intervention period. Baseline demographics are
226 shown in Table 4. There were no significant differences in age or BMI. The pre-treatment group
227 had a higher percentage of males (59%) while the post-intervention period had more female
228 admissions (56%); however these were not statistically different (Table 4).

229 Pre-intervention CPOE compliance was 78% while post-intervention compliance was 76%
230 ($p=0.74$). Compliance with meeting 100% of the resuscitation bundle elements was 43% in the
231 pre-intervention and improved significantly to 68% in the post-intervention period ($p=0.0295$).
232 The median hospital LOS pre-intervention was 7.43 (range 3.85-16.09) days and decreased to
233 5.54 (range 3.31-9.62) days post-intervention ($p=0.11$, Table 4). The median MICU LOS was
234 2.03 (1.34-3.83) day pre-intervention and decreased to 1.55 (0.92-2.96) days post intervention

235 (p=0.085). The 30-day mortality was 25% in the pre-intervention period and 12% in the post-
236 intervention period (p=0.14) (Table 5).

237 **DISCUSSION**

238 Our QI initiative that used multifaceted educational and feedback interventions based on the
239 identified barriers, successfully improved the overall compliance with the resuscitation bundle
240 elements (43 to 68%, p=0.0295), decreased the ICU and hospital length of stay. These findings
241 were reached despite a lack of significant improvement in the CPOE order set compliance,
242 emphasizing the important of education, feedback and overall increasing the awareness of early
243 aggressive management of patients with severe sepsis and septic shock among resident
244 physicians.

245 The primary barrier identified through the resident survey was the lack of understanding on when
246 to use the CPOE order set. We suspect that this lack of understanding stemmed from a deficiency
247 of knowledge regarding the definition of severe sepsis/septic shock and what parameters are used
248 to define and identify these patients. The education intervention not only provided information
249 regarding early aggressive management with the use of resuscitation bundle elements and its
250 importance, but also definitions from SIRS to severe sepsis/septic shock. Post-intervention
251 surveys confirmed the increased awareness of when to use the order set.

252 Several studies have investigated educational interventions to improve compliance with the
253 resuscitation bundle elements as outline by the surviving sepsis campaign guidelines (Levy et al.
254 2010; Nguyen et al. 2007; Schramm et al. 2011). A prospective study of severe sepsis in 54 ICUs
255 in Spain noted an improvement of overall compliance with the sepsis resuscitation bundle from
256 5.3% to 10% based on educational interventions (Ferrer et al. 2008). Our study also shows that

257 educational interventions alone can improve compliance with meeting the resuscitation bundle
258 elements. In addition to educational interventions, this quality improvement project also
259 provided bi-monthly feedback to residents on their overall compliance. The study in Spain
260 focused on all-or-none compliance, while our study focused on order set compliance. The
261 educational interventions in our study were similar to those in Spain, which provided pocket
262 cards, posters and educational slides with definitions of severe sepsis and septic shock,
263 appropriate management, and periodic feedback on performance(Ferrer et al. 2008). Their
264 intervention also included providing educational materials to emergency department and surgical
265 physicians.

266 Nguyen et al(Nguyen et al. 2007) showed increased compliance with the resuscitation bundle
267 elements from 0% to 51.2% using educational interventions in addition to feedback on a
268 quarterly basis. Our study differs in that feedback was provided on a bi-monthly basis. Their
269 study also differed in that interventions were initiated in the Emergency Department, while our
270 interventions were in the MICU. With quarterly feedback to nurses and physicians, they saw an
271 increase in sepsis resuscitation bundle elements compliance from zero to 51.2% at the end of two
272 years. They noted no change in ED LOS or hospital LOS between patients with and without
273 bundle elements completed.

274 Though, all-or-none compliance improved significantly post intervention in our study, the
275 compliance with the use of the CPOE order set did not improve. There are various reasons to
276 explain this discrepancy. It is likely that some of the resuscitation bundle elements were being
277 done prior to the patient's admission to the MICU, particularly in the Emergency department
278 (ED). For example, many patients have central lines placed and initial laboratory evaluations

279 done in the ED. In those situations, some find it easier to place individual orders for elements
280 still needed to best coordinate timing of repeat labs rather than going through the entire order set.
281 Additionally, some elements of the CPOE order set may be omitted if the resident did not feel
282 that particular element was necessary. This was particularly true for patients who did not have a
283 central access for ScvO₂ monitoring. The unchecking of certain elements of the CPOE order set
284 would have then resulted in non-compliance with the resuscitation bundle elements. Finally,
285 practitioners often have their own method of approaching patient management. Some prefer to
286 think about each element of the resuscitation bundle elements individually rather than ordering
287 them as a whole. This would be unlikely to change with our interventions, and therefore still
288 contributes to reduced compliance.

289 A study by Rubenfeld in 2004 categorized reasons for the discordance between guidelines and
290 practice into three groups: knowledge barriers, attitude barriers and behavioral
291 barriers(Rubenfeld 2004). While our intervention was knowledge focused, perhaps the most
292 difficult to address, and likely the cause for ongoing imperfect compliance, is attitude barriers.
293 We can hope that through continued education, these attitudes will change.

294 Rivers et al. found mortality of the control group to be 45.6% compared to 30.5% in the EGDT
295 group(Rivers et al. 2001). Additionally, a study by Lin et al. showed a mortality rate of 71.6% in
296 the control group compared with 53.7% in the EGDT group(Lin et al. 2006). Compared with
297 these trials, our baseline mortality of 25% is lower, and more in line with the outcomes of recent
298 trials, which showed 18-21% mortality(Investigators et al. 2014; Pro et al. 2014). For several
299 years, our institution has stressed the importance of identifying patients with severe sepsis/septic
300 shock and meeting EGDT standards. Several QI projects, such as that by Schramm et

301 al(Schramm et al. 2011), have been aimed at this mission, contributing to our low baseline
302 mortality.

303 There are several limitations to this study. This is a single-centered study with a distinct
304 organization and staffing, making generalizability difficult. Additionally, the pre- and post-
305 intervention time periods were only two months. The sample sizes of the patients that were
306 studied were small, which contributed to the lack of statistical significance in some of the
307 outcome measures.

308 **Conclusion:**

309 In conclusion, we have shown that a multifaceted intervention strategy of educational
310 intervention to our resident physicians to increase awareness of early aggressive management
311 using the resuscitation bundle elements in patients with severe sepsis and septic shock, along
312 with continued feedback on performance on these measures, resulted in significant
313 improvements in all or none compliance with resuscitation bundle elements and trended toward
314 improved mortality among severe sepsis and septic shock patients in our MICU. This method
315 and success can be applied towards improving the attitude and behavioral changes towards other
316 disease specific order sets. We plan to sustain this improvement with continued feedback along
317 with the educational intervention.

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Figure 1 (A & B)

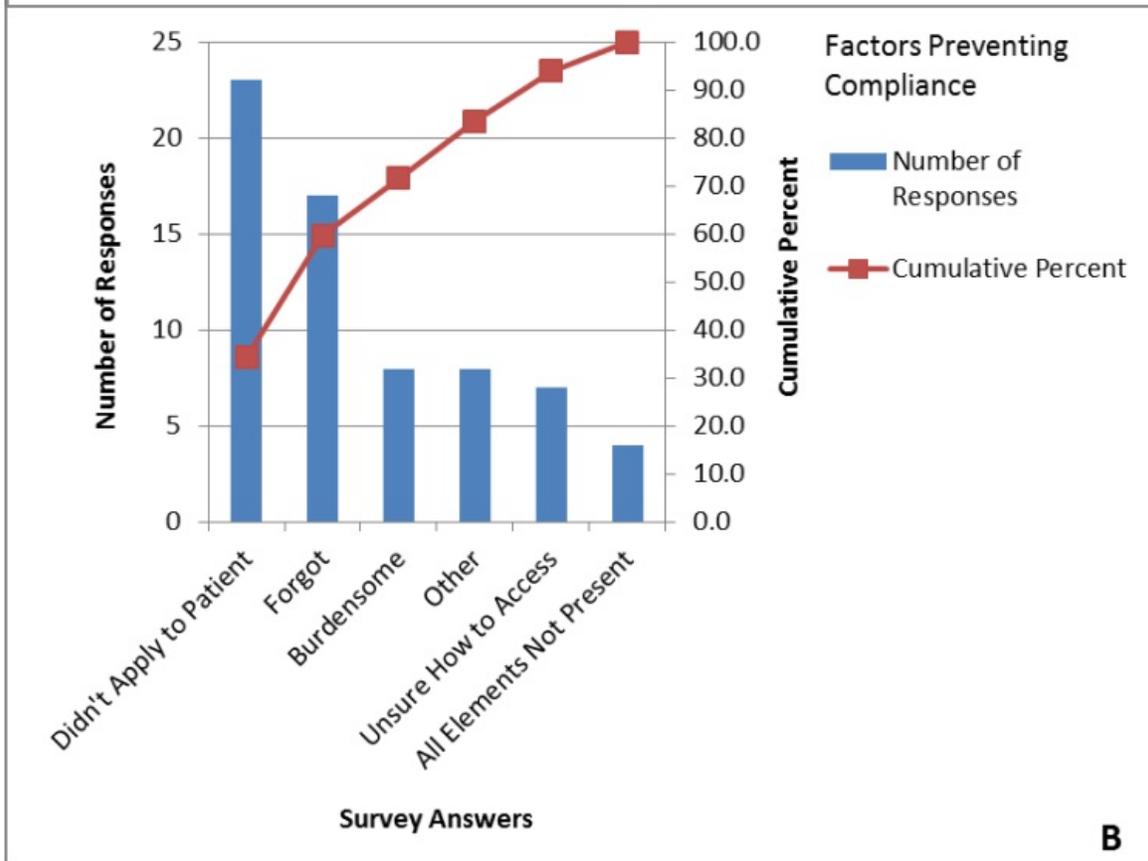
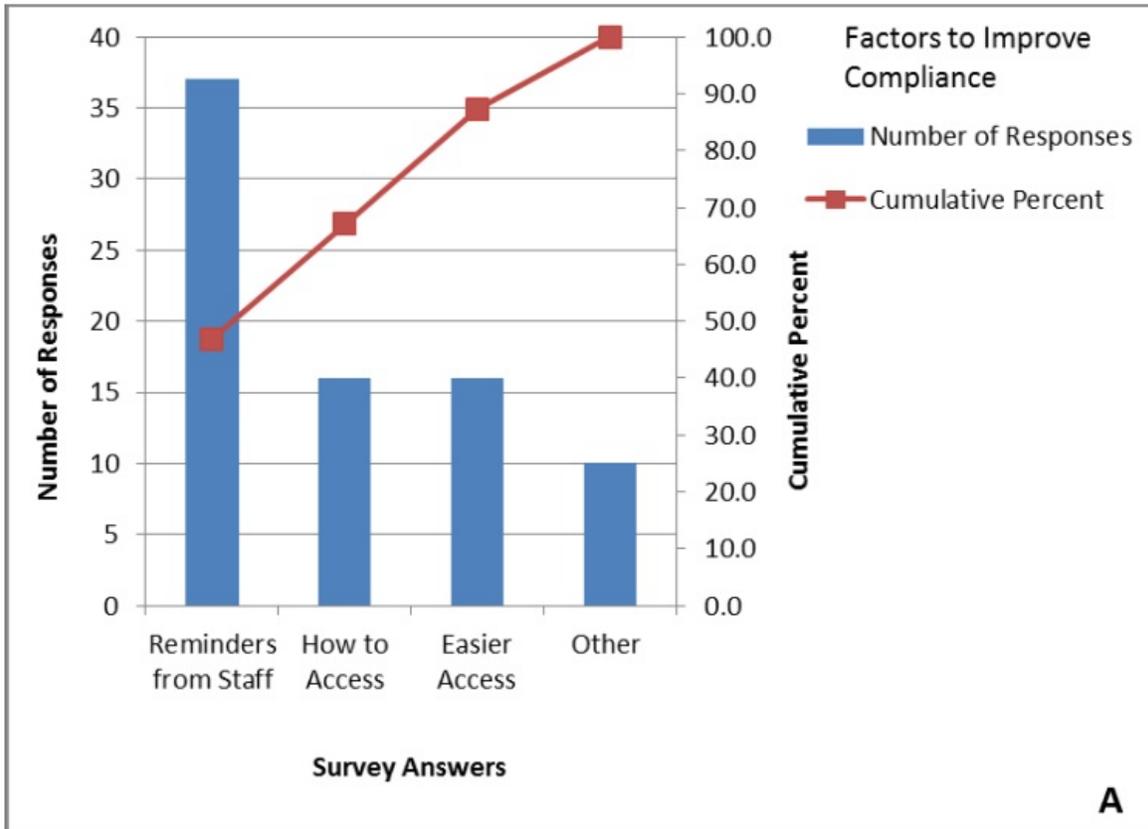


Table 1 (on next page)

Table 1

Quality parameters in the elderly resuscitation bundle

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1	Lactate: Measured before or within 1 h after blood culture
2	Blood culture: Drawn before antibiotics
3	Antibiotic: Administered within 1 h of severe sepsis onset
4	Fluid: Fluid given until one of the following <ul style="list-style-type: none"> a. CVP \geq 8 (on MV 12) mm Hg b. MAP \geq 65 mm Hg and lactate $<$ 2.5 mmol/L and UO $>$ 0.5 mL/kg.h c. 12 L of crystalloid equivalent
5	Vasopressor: Administered for 1 of the following <ul style="list-style-type: none"> a. MAP $<$ 65 mm Hg despite fluid challenge b. MAP $<$ 50 mm Hg for \geq 15 min
6	RBC: Transfused if Hct $<$ 30% and ScVO ₂ $<$ 70% or mixed venous O ₂ sat $<$ 65% despite fluid resuscitation (RBC before adequate fluid resuscitation is inappropriate)
7	Inotrope: Started if Hct \geq 30% and ScVO ₂ $<$ 70% or mixed venous O ₂ sat $<$ 65% despite fluid resuscitation (Inotrope before adequate fluid resuscitation is inappropriate)

2 CVP: Central Venous Pressure; MAP: Mean arterial pressure; RBC: Red blood cell; Hct: Hematocrit.

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Table 2 (on next page)

Table 2

Components of the severe sepsis/septic shock management CPOE order set

ALERT

- Administer appropriate parenteral antibiotic within 1 hour of sepsis recognition. The choice of antibiotics will depend on likelihood of specific infection, the patient immune status and allergies.
- Consider the following consults (if sepsis source known): • Infectious Disease. • General Surgery. • Interventional Radiology.
- Activate Sepsis Response Team (if applicable to area) or appropriate resuscitation personnel is not available

Components of the order set checked by the provider:

1. Organ Perfusion:
 - a. Obtain arterial blood gas every ____ hour(s) for ____ hours.
 - b. Obtain central venous saturations (ScvO2 or SvO2) every *_(1-2 hours) place as guide under line* ____ hour(s) for *__6 (pre-filled)*__ hours.
 - c. Obtain Point Of Care serum lactate STAT. (should be a pre-checked box electronically)
 - d. Obtain serum lactate every *_(1-2 hours) place as guide under line* ____ hour(s) for *__6 (pre-filled)*__ hours. (should be a pre-checked box electronically)
2. Lab: Serum fasting glucose (not pre-checked).
3. Blood type and screen.
4. Vascular Access:
 - a. Insert central line (do not have pre-checked).
5. Antibiotics
 - a. (Various choices of antibiotics are listed and appropriate check boxes are present to be clicked)
6. Volume resuscitation: (At least 30ml/kg liters of fluid of one of the following)
 - a. Lactated Ringers 1000 mL IV PRN over 15 minutes up to a maximum of _____ mL until

one of the following are achieved:

- b. 0.9% NaCl 1000 mL IV PRN over 15 minutes up to a maximum of _____ mL or for 24 hours until one of the following is achieved:
 - c. Albumin 5% 500 mL IV PRN over 15 minutes up to a maximum of _____ mL until one of the following is achieved:
 - i. To keep central venous pressure (CVP) at 12–15 mmHg (mechanically ventilated) or 8–12 mmHg (not mechanically ventilated).
 - ii. Central Venous Pressure (CVP) \geq 8 (on Mechanical Ventilation \geq 12) mmHg
 - iii. MAP \geq 65 mmHg and lactate $<$ 2.5 mmol/L and UO $>$ 0.5 ml/kg/hr
 - iv. Lack of fluid responsiveness based on dynamic or static variables assessment
7. Vasopressor infusion: Note: Recommend use only with central line, but in extreme emergency, vasopressors may be given for a brief period of time via peripheral site with constant monitoring for extravasation. Vasopressor should be administered for MAP $<$ 65 mmHg despite fluid challenge (30 ml/kg) (OR) MAP $<$ 50 mmHg for \geq 15 min
- a. Norepinephrine infusion 0.05 mcg/kg/minute, titrate by 0.05 mcg/kg/minute every 5 minutes to keep MAP \geq 65 60–80 mmHg.
 - b. Vasopressin 0.03 units/minute, do not titrate.
 - c. Phenylephrine infusion 0.5 mcg/kg/minute, titrate by 0.1 mcg/kg/minute every 5 minutes to keep MAP \geq 65 60–80 mmHg.
 - d. Epinephrine infusion 0.05 mcg/kg/minute, titrate by 0.05 mcg/kg/minute every 5 minutes to keep MAP \geq 65 60–80 mmHg.
8. Target ScVO₂ \geq 70 (or SvO₂ less than 65%) and downward trending Lactate towards normal values by considering (one or more of the following):
- a. If ScvO₂ less than 70% or SvO₂ less than 65% (decreased oxygen delivery in spite of

adequate volume replacement and preload):

- i. Dobutamine infusion 5 mcg/kg/minute titrate by 2.5 mcg/kg/minute every 10 minutes up to a maximum of 15 mcg/kg/minute to keep ScvO₂ greater than 70% or SvO₂ greater than 65%.
 - ii. Milrinone 0.375 mcg/kg/minute titrate up to a maximum of 0.75 mcg/kg/minute to keep ScvO₂ greater than 70% or SvO₂ greater than 65%.
- b. If anemia present, consider transfusing packed red blood cells for a hemoglobin level less than 710 mg/dL.

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Table 3 (on next page)

Table 3

Pre- and post intervention survey questions

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Question	Answer Choices
Indicate year of training	PGY-1 PGY-2 PGY-3
Number of months spent in MICU	0 months 1 month 2 months > 2 months
Are you familiar with the severe sepsis order set in MICS?	Yes No
Were you knowledgeable/aware of when to and when not to use the order set?	Yes No
Did you have occasions when you later realized you should have instituted the severe sepsis order set?	Yes No
What factors prevented you from using the severe sepsis order set? (please select all that apply)	Forgot Didn't think it applied Burdensome to use order set Did not know how to access order set Did not think order set had all elements needed
What factors are likely to promote the increased use of the severe sepsis order set? (Please select all that apply)	Easier accessibility in MICS Demonstration on how to access order set Reminders from seniors/fellows/staff to use the order set
* Post intervention questions only Which among the below interventions has helped you the most to comply with the severe sepsis order set?	Educational interventions Bimonthly feedback to the team Reminders posted on the computers All of the above
* Post intervention questions only How have the above interventions helped?	Improve CPOE order set compliance Increased knowledge and awareness of severe sepsis/septic shock Increased awareness to be compliant with the resuscitation bundle elements All of the above
* Post intervention questions only While in the MICU, have you been using the severe sepsis/septic shock CPOE order set?	Always Most of the time Some of the time Rarely

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Table 4 (on next page)

Table 4

Demographics

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	Pre-Intervention (N=51)	Post-Intervention (N=41)	P value
Mean Age Years (SD)	66 (13.7)	68 (16.3)	0.61
Gender N (%)	F 21 (41) M 30 (59)	F 23 (56) M 18 (44)	0.09
BMI Mean (SD)	30.7 (9.26)	29.2 (6.39)	0.46
APACHE Mean (SD)	85.5 (26.9)	78.2 (29.0)	0.19
SOFA Mean (SD)	7.61 (4.17)	7.49 (4.13)	0.89

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Table 5 (on next page)

Table 5

Outcomes

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	Pre-Intervention (N=51)	Post-Intervention (N=41)	P value
Hospital LOS Median (IQR)	7.43 (3.85-16.09)	5.54 (3.31-9.62)	0.11
MICU LOS Median (IQR)	2.03 (1.34-3.83)	1.55 (0.92-2.96)	0.85
Mortality 30 day N(%)	13 (25)	5 (12)	0.14

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