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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6 **ABSTRACT**

7 Despite knowledge that EGDT improves outcomes in septic patients, staff education on EGDT

8 and compliance with the CPOE order set has been variable. Based on results of a resident survey

9 to identify barriers to decrease severe sepsis/septic shock mortality in the medical intensive care

10 unit (MICU), multifaceted interventions such as educational interventions to improve awareness

11 to the importance of early goal-directed therapy (EGDT), and the use of the Computerized

12 Physician Order Entry (CPOE) order set, were implemented in July 2013. CPOE order set was

13 established to improve compliance with the EGDT resuscitation bundle elements. Orders were

14 reviewed and compared for patients admitted to the MICU with severe sepsis/septic shock in

15 July and August 2013 (controls) and 2014 (following the intervention). Similarly, educational

16 slide sets were used as interventions for residents before the start of their ICU rotations in July

17 and August 2013. While CPOE order set compliance did not significantly improve (78% vs 76%,

18 p=0.74), overall EGDT adherence improved from 43% to 68% (p=0.0295). Although there was a

19 trend toward improved mortality, this did not reach statistical significance. This study shows that

20 education interventions can be used to increase awareness of severe sepsis/septic shock and

21 improve overall EGDT adherence.

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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(1)), costs ($16.7 billion

84 annually(1)), and burden of managing the morbidity and mortality associated with

85 mismanagement. Rivers et al. showed the benefit of early goal-directed therapy (EGDT), with a

86 decrease in overall mortality (46.9% vs 30.5%) and length of hospital stay (18.4 vs 14.6 days)(2).

87 Also, the recent ARISE and ProCESS trials again confirm the importance of early aggressive

88 management of patients with severe sepsis and septic shock(3, 4). Despite multiple educational

89 interventions from international societies and recommendations by the Surviving Sepsis

90 Campaign (5, 6) to institute EGDT in the management of severe sepsis/septic shock, all-or-none

91 compliance with the EGDT bundle elements remains poor and the early recognition of sepsis

92 remains a challenge.

93 Various quality improvement interventions showed significant improvement in the all-or-none

94 compliance with the EGDT bundle elements and even more importantly, an improvement in

95 mortality(7). Schramm et al. implemented weekly feedback to care teams regarding their

96 compliance in addition to starting a sepsis response team. Similarly, Coba et al. showed that

97 monitoring the implementation of the resuscitation bundle elements by a continuous quality

98 initiative, resulted in improvements in compliance and mortality(8).

99 Resident physicians play a significant role in the management of patients with severe

100 sepsis/septic shock in our medical intensive care unit (MICU). Though our overall compliance

101 with the resuscitation bundle elements in our MICU ranges from <50% to 80%, it could be

102 consistently better. Resident physicians do not routinely receive data on the importance and

103 elements of aggressive early resuscitation in patients with severe sepsis/septic shock. Also, a

104 severe sepsis-specific Computerized Physician Order Entry (CPOE) that encompasses all of the

105 resuscitation bundle elements is available to assist the physicians to comply with these elements.

106 The purpose of this quality improvement (QI) project was to identify barriers among resident

107 physicians to comply with the EGDT resuscitation bundle elements, identify and implement

108 interventions to improve compliance, and thereby reduce hospital/ICU LOS and mortality.

109 **METHODS**

110 **Settings and Participants**

111 This QI project was conducted in the 24-bed MICU at Saint Mary's hospital, Rochester. Given

112 the QI nature of the project, a waiver from the Institutional Review Board was obtained. All

113 Internal Medicine (IM) residents were contacted via email giving a brief description of the QI

114 problem statement and an attached survey. Their participation in the survey was voluntary.

115 **Intervention and Comparison**

116 All IM resident physicians placing orders in the computerized system for patients admitted to the

117 MICU were surveyed to identify barriers to the use of CPOE severe sepsis order set (Table 1).

118 Residents rotating through the MICU change at the beginning of each month. After identifying

119 the barriers to successful compliance with the resuscitation bundle elements, the week prior to

120 starting the rotation, all residents were provided with an education slide set that detailed the

121 importance of early aggressive resuscitation of patients with severe sepsis/septic shock, and in

122 using CPOE order sets to achieve compliance with EGDT measures. This slide set provided step-

123 by-step instructions on how to access the order set. Pocket cards with criteria for using the order

124   set were provided as an educational intervention, along with information regarding EGDT

125   components. Elements include time to antibiotics, obtaining cultures before antibiotic

126   administration, lactate measurement, appropriate and timely volume resuscitation, inotrope and

127   transfusion as appropriate. Pocket cards also included the definition of the systemic

128   inflammatory response syndrome (SIRS), sepsis, severe sepsis and septic shock to help residents

129   identify those in need of EGDT. These cards were enlarged and placed on the roaming

130   computers used during rounds and MICU admissions. Finally, residents were given a bi-

131   monthly feedback sessions, compared to the pre-intervention once-monthly feedback sessions

132   regarding their compliance with meeting EGDT measures. At these sessions, residents were

133   again reminded on the importance of EGDT and compliance with the resuscitation bundle

134   elements, along with the use of the CPOE order set for all patients admitted with severe

135   sepsis/septic shock. Additionally, residents were given compliance data on EGDT elements for

136   patients admitted during their service time who met criteria for severe sepsis/septic shock in

137   order to identify situations in which the order set should have been used.

138   The intervention was evaluated with a pre-post- test study design. To assess baseline compliance,

139   patients admitted to the MICU with severe sepsis/septic shock in July and August 2012 were

140   identified. Patients qualified as having severe sepsis/septic shock if systolic blood pressure

141   remained < 90 mmHg despite adequate fluid resuscitation, lactate > 4 mmol/L, or organ

142   dysfunction/failure ensued due to hypoperfusion attributable to sepsis. Overall compliance with

143   CPOE order set and EGDT bundle elements were determined by reviewing orders placed for

144   patient's admitted to the MICU with severe sepsis/septic shock. The interventions were

145   implemented on July 1, 2013. Compliance with CPOE order set use and EGDT bundle elements

146   for patients admitted in July and August 2013 was assessed for comparison. Following the

147   intervention period, the survey was re-administered to the IM residents, with additional questions

148   addressing which interventions were beneficial in improving compliance.

149   **Outcomes and Data Collection**

150   The MICU sepsis group keeps a database of patients admitted with severe sepsis/septic shock.

151   This database was used to identify patients in our timeframe of interest and to assess compliance.

152   Once identified, orders placed for each patient were reviewed. Use of the CPOE order set was

153   recorded, as well as whether 100% of EGDT bundle elements were met. Demographic data,

154   outcomes including MICU and hospital length of stay, APACHE II score, SOFA and mortality

155   were collected.

156   **Statistical Analysis**

157   Statistical differences in patient demographics, CPOE compliance, EGDT bundle elements

158   compliance and 30-day mortality were compared between pre- and post-intervention groups

159   using a chi square model. Statistical differences between median hospital and ICU length of stay

160   (LOS) were compared using ANOVA with JMP software version 10.0 (SAS Institute Inc; Cary,

161   North Carolina).

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163   **RESULTS**

164   **Survey Results**

165   In the pre-intervention period, 56 of 170 IM residents participated in the survey with 31 (55%) of

166   respondents being first year residents. In our MICU, it is the first year residents who are

167   primarily responsible for order entry. The majority of residents (89%) were familiar with the

168   order sets, however only 67% felt knowledgeable about when to use the order set. Additionally,

169   63% of residents identified at least one situation in which they later realized the order set applied

170   to their patient. Uncertainty as to whether the CPOE order set applied to a particular patient with

171   severe sepsis/septic shock (45% of respondents) was the largest barrier to order set compliance

172   according to survey results from IM residents (Figure 1A). They identified reminders from staff

173   as the most likely factor to promote order set use (Figure 1B).

174   In the post-intervention period, 44 of 170 IM residents participated in the survey with 41% of

175   respondents being first year residents. The greatest barrier to order set use remained uncertainty

176   about whether it applied to their patient (36% of respondents). Again, reminders from staff were

177   considered to be the most likely factor to improve compliance. The post-intervention survey

178   contained questions directed at the interventions themselves. Educational interventions (23%)

179   and bimonthly feedback (23%) were found to be most useful, while 25% of residents felt all of

180   the interventions were equally helpful in improving compliance. Thirty percent of residents felt

181   the interventions increased knowledge and awareness of severe sepsis/septic shock, while 11%

182   found that the interventions increased awareness about EGDT bundle elements and thus

183   increased CPOE order set compliance. Twenty seven percent of residents found increased

184   awareness of both severe sepsis/septic shock and EGDT bundle elements from these

185   interventions. Finally, 66% of residents reported using the CPOE order set always or most of the

186   time, while only 9% reported rarely using the order set.

187   There were 51 patients admitted to the MICU for severe sepsis/septic shock in the pre-

188   intervention period and 41 patients in the post-intervention period. Baseline characteristics are

189   shown in Table 2. There were no significant differences in age or BMI. The pre-treatment group

190 had a higher percentage of males (59%) while the post-intervention period had more female

191 admissions (56%); however these were not statistically different (Table 2).

192 Pre-intervention CPOE compliance was 78% while post-intervention compliance was 76%

193 (p=0.74). Compliance with meeting 100% of EGDT bundle elements was 43% in the pre-

194 intervention and improved significantly to 68% in the post-intervention period (p=0.0295). The

195 median hospital LOS pre-intervention was 7.76 (range 3.87-15.85) days and decreased to 5.38

196 (range 3.24-9.49) days post-intervention (p=0.16, Table 3). The median MICU LOS was 2.03

197 (1.35-3.95) day pre-intervention and decreased to 1.51 (0.92-2.67) days post intervention

198 (p=0.49). The 30-day mortality was 25% in the pre-intervention period and improved to 12% in

199 the post-intervention period (p=0.14) (Table 3).

200 **DISCUSSION**

201 Our QI initiative that used multifaceted educational and feedback interventions based on the

202 identified barriers, successfully improved the overall compliance with the EGDT resuscitation

203 bundle elements (43 to 68%, p=0.0295), decreased the ICU and hospital length of stay, and

204 decreased the overall mortality in patients with severe sepsis and septic shock, though the latter

205 outcomes were not statistically significant. These findings were reached despite a lack of

206 significant improvement in the CPOE order set compliance, emphasizing the important of

207 education, feedback and overall increasing the awareness of EGDT to treat patients with severe

208 sepsis and septic shock among resident physicians.

209 The primary barrier identified though the resident survey was the lack of understanding on when

210 to use the CPOE order set. We suspect that this lack of understanding stemmed from a deficiency

211 of knowledge regarding the definition of severe sepsis/septic shock and what parameters are used

212   to define and identify these patients. The education intervention not only provided information

213   regarding EGDT and its importance, but also definitions from SIRS to severe sepsis/septic

214   shock. Post-intervention surveys confirmed the increased awareness of when to use the order set.

215   Several studies have investigated educational interventions to improve compliance with

216   EGDT(7, 9, 10). A prospective study of severe sepsis in 54 ICUs in Spain noted an improvement

217   of overall compliance with the sepsis resuscitation bundle from 5.3% to 10% based on

218   educational interventions(11). Our study also shows that educational interventions alone can

219   improve compliance with meeting EGDT resuscitation elements. In addition to educational

220   interventions, this quality improvement project also provided bi-monthly feedback to residents

221   on their overall compliance. The study in Spain focused on all-or-none compliance, while our

222   study focused on order set compliance. The educational interventions in our study were similar

223   to those in Spain, which provided pocket cards, posters and educational slides with definitions of

224   severe sepsis and septic shock, appropriate management, and periodic feedback on

225   performance(11). Their intervention also included providing educational materials to emergency

226   department and surgical physicians.

227   Nguyen et al(10) showed increased compliance with EGDT from 0% to 51.2% using educational

228   interventions in addition to feedback on a quarterly basis. Our study differs in that feedback was

229   provided on a bi-monthly basis. Their study also differed in that interventions were initiated in

230   the Emergency Department, while our interventions were in the MICU. With quarterly feedback

231   to nurses and physicians, they saw an increase in sepsis bundle compliance from zero to 51.2% at

232   the end of two years. They noted no change in ED LOS or hospital LOS between patients with

233   and without bundle elements completed.

234   Though, all-or-none compliance improved significantly post intervention in our study, the

235   compliance with the use of the CPOE order set did not improve. There are various reasons to

236   explain this discrepancy. It is likely that some of the resuscitation bundle elements were being

237   done prior to the patient's admission to the MICU, particularly in the Emergency department

238   (ED). For example, many patients have central lines placed and initial laboratory evaluations

239   done in the ED. In those situations, some find it easier to place individual orders for elements

240   still needed to best coordinate timing of repeat labs rather than going through the entire order set.

241   Additionally, some elements of the CPOE order set may be omitted if the resident did not feel

242   that particular element was necessary. This was particularly true for patients who did not have a

243   central access for ScvO2 monitoring. The unchecking of certain elements of the CPOE order set

244   would have then resulted in non-compliance with the resuscitation bundle elements. Finally,

245   practitioners often have their own method of approaching patient management. Some prefer to

246   think about each element of the resuscitation bundle individually rather than ordering them as a

247   whole. This would be unlikely to change with our interventions, and therefore still contributes to

248   reduced compliance.

249   A study by Rubenfeld in 2004 categorized reasons for the discordance between guidelines and

250   practice into three groups: knowledge barriers, attitude barriers and behavioral barriers(12).

251   While our intervention was knowledge focussed, perhaps the most difficult to address, and likely

252   the cause for ongoing imperfect compliance, is attitude barriers. We can hope that through

253   continued education, these attitudes will change.

254   Rivers et al. found mortality of the control group to be 45.6% compared to 30.5% in the EGDT

255   group(2). Additionally, a study by Lin et al. showed a mortality rate of 71.6% in the control

256   group compared with 53.7% in the EGDT group(13). Compared with these trials, our baseline

257   mortality of 25% is lower, and more in line with the outcomes of recent trials, which showed 18-

258   21% mortality(3, 4). For several years, our institution has stressed the importance of identifying

259   patients with severe sepsis/septic shock and meeting EGDT standards. Several QI projects, such

260   as that by Schramm et al(7), have been aimed at this mission, contributing to our low baseline

261   mortality. Our study shows a decrease in mortality with increased EGDT compliance, suggesting

262   there are still opportunities to decrease mortality even with a low mortality at baseline.

263   There are several limitations to this study. This is a single-centered study with a distinct

264   organization and staffing, making generalizability difficult. Additionally, the pre- and post-

265   intervention time periods were only two months. The sample sizes of the patients that were

266   studied were small, which contributed to the lack of statistical significance in some of the

267   outcome measures.

268   **Conclusion**:

269   In conclusion, we have shown that a multifaceted intervention strategy of educational

270   intervention to our resident physicians to increase awareness of EGDT in patients with severe

271   sepsis and septic shock, along with continued feedback on performance on these measures,

272   resulted in significant improvements in all or none compliance with resuscitation bundle

273   elements and trended toward improved mortality among severe sepsis and septic shock patients

274   in our MICU. This method and success can be applied towards improving the attitude and

275   behavioral changes towards other disease specific order sets. We plan to sustain this

276   improvement with continued feedback along with the educational intervention.

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278   Figure 1. Survey of internal medicine residents revealed barriers to order set compliance to include lack
279   of knowledge about how to access order set and when to use the order set.
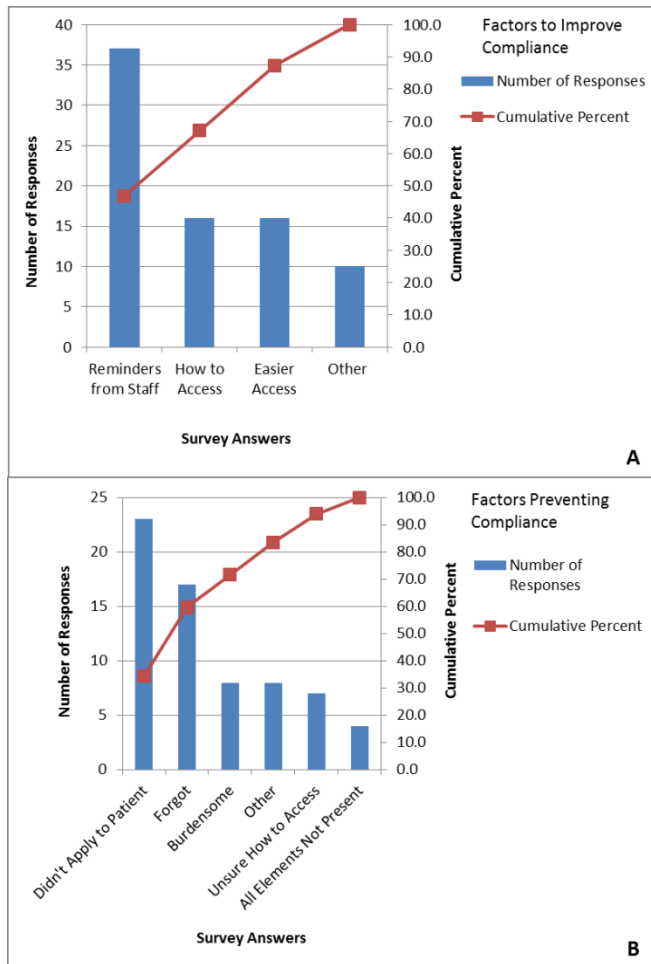
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288   Table 1. Pre- and Post-intervention survey questions

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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292 Table 2. Demographics

	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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294 Table 3. Outcomes

	Pre-Intervention (N=51)	Post-Intervention (N=41)	P value
Hospital LOS Median (IQR)	7.76 (3.87-15.85)	5.38 (3.24-9.49)	0.16
MICU LOS Median (IQR)	2.03 (1.35-3.95)	1.51 (0.92-2.67)	0.49
Mortality 30 day N(%)	13 (25)	5 (12)	0.14

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