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Impact of order set use on outcome of patients with sepsis

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Abstract

In an effort to improve outcome of patients with sepsis, we developed and implemented a disease-specific alert and order set for our computerized physician order entry system. This alert and order set were implemented in 2015. We have produced a progressive decrease in mortality for patients at our hospital with diagnosis of sepsis. We see a significant decrease in mortality for patients who had the sepsis order set used compared to those who did not have the order set used. We recommend use of an order set for patients with sepsis.

Keywords: Sepsis, Computerized order entry, Order sets, Decreasing mortality

Background

We evaluate the care of patients in our hospital in an effort to continuously improve. Sepsis is a major focus for patient care improvement. There are established standards of care (Novosad et al. 2016; <http://www.sccm.org/Documents/SSC-Guidelines.pdf> 2012). These standards include several acute care activities including clinical and laboratory evaluation, rapid implementation of treatment, and follow-up evaluations. These multiple and multiphase steps are an excellent opportunity for a checklist to remind physicians of required tests and treatments to provide safe, timely, and effective care (Gawande 2009). A computerized physician order entry (CPOE) system is an ideal system to present physicians in real-time evidence-based efficient checklists of orders to provide care for specific patients. (Winterbottom et al. 2011; Hanzelka et al. 2013).

With our CPOE implementation our clinicians developed order sets to allow physicians to provide ideal care in the most efficient manner. One order set (Fig. 1) is for patients with signs and symptoms of sepsis. We also developed a best practice alert (BPA) (Fig. 2) for nurses and physicians that is activated in the computerized medical record when a patient has vital signs and white blood count suggestive of systemic inflammatory response syndrome (SIRS) or sepsis. The alert would be seen when nurse or physician open the chart. Specific parameters of vital signs, white blood cells, and serum lactate levels are shown in Table 1. The alert has a link to the sepsis order set. Physicians can select to use the order set from the link to best practice alert (BPA) or not. The order set can also be selected without the BPA.

The screenshot shows a medical order set interface for 'Severe Sepsis Protocol'. At the top, patient information is displayed: Bed: S502-01, Allergies: Latex, Height: 5' 8" (1.727 m), Weight (kg): 81.6, BMI: None, Dx: None Found, Attend: FAMILY MEDI..., Code: Full Code, Pt Class: IPA (Inpatient), MRN: <E13827..., CVC Days: None, Admit Dt: 06/06/16, Isolation: None, Pref Lang: None, Ethnicity: None. The interface is divided into two main sections: 'General Orders' and 'Protocol'. The 'General Orders' section has 3 of 3 selected orders, including 'Complete patient assessment with vitals signs and document in flowsheet' and 'Nursing Order: Reassess patient perfusion status'. The 'Protocol' section has 4 of 7 selected orders, including 'Vitals (Sepsis)', 'Lab Panel (Sepsis)', 'CBC with differential', 'CMP - Complete Metabolic Panel', 'Fluid Bolus Infusion', and 'MEDICATIONS: Antibiotics - First Line'. The 'MEDICATIONS' section lists 'vancomycin (VANOCOIN)' and 'piperacillin-tazobactam (ZOSYN)' with specific dosages and frequencies.

Fig. 1 Order set used by physician

During the time period of our data collection, there were no other new evaluations, medications or therapies implemented for our physicians and nurses. A specialized nurse who is our sepsis coordinator would see each time a BPA was initiated and follow-up with the nurse and physician about patient assessment and treatment.

Results

We report patients with sepsis as a principal or secondary diagnosis. Our patient mortality has decreased from 25% in 2013 to 19.4% in 2015 and in the first quarter of 2016 to 15.05% ($P = 0.005$) (Table 2). In 2016 from May 1 2016 to August 16, 2016, we evaluated the use of the sepsis order set after the best practice alert was presented. In those patients with the BPA our sepsis order set was used in 111 of 183 (60.6%) patients in the emergency department and 233 of 592 inpatients (39.4%) ($P < 0.0001$). Overall sepsis order set utilization was 344 of 775 patients (44%) (Table 3). For our patients during the measured period of May 1, 2015 through April 30, 2016 where the order set was used ($n = 218$) our mortality was 11.57% (95% CI 7.32–15.82). During the same period, patients in whom the order set was not used ($n = 905$) the mortality was 18.19% (95% CI 16.3–20.1) ($P = 0.015$) (Table 4). Length of stay was 11.68 days (95% CI 10.03–13.33) in patients who had the order set used and 13.31 days (95% CI 12.2–14.41) in those who

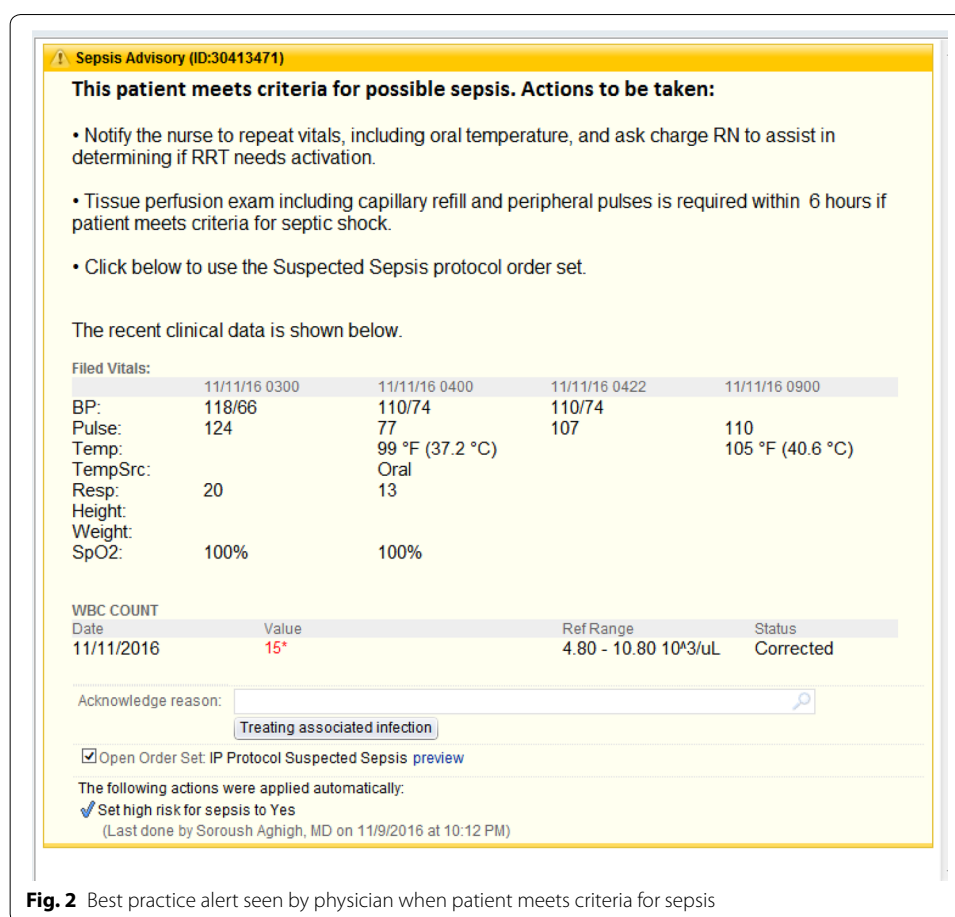


Fig. 2 Best practice alert seen by physician when patient meets criteria for sepsis

Table 1 Criteria for alerting physicians and nurses

1. Patient must have at least 1 true value from each category (A, B and C)
 2. Once it has fired it will not fire again for 12 h, per nursing and per physicians
 3. It fires even if the patient has sepsis on problem list
- A). Must have temperature greater than 100.9 F or less than 95.8 F
(Considers T max last 12 h lookback)
- AND
- B). White blood cell count (WBC) greater than 12,000 or WBC less than 4000 and Bands >10%, or lactic acid greater than 2
Considers last WBC look-back up to 24 h, and last lactic acid look-back up to 12 h
- AND
- C). Heart rate greater than 90 or respiratory rate greater than 25 or systolic blood pressure less than 90
Considers heart rate max & respiratory rate max & systolic blood pressure minimum with in past 6 h

Table 2 Patient mortality for all patients with sepsis diagnosis

Year	Total cases	Mortality %
2016 (quarter 1)	229	13.72
2015	622	15.15
2014	400	19.44
2013	296	25.08

Table 3 Use of sepsis order set after best practice alert May 1, 2016—August 16, 2016

	OS used	OS not used	Total
Emergency department BPA	111	72	183
Inpatient BPA	233	359	592
Total	344	431	775

Table 4 Sepsis order set utilization and patient outcome May 1, 2015– April 30, 2016

	Number of cases	Observed mortality %	Observed LOS (days)	Observed readmissions %
Order set used	218	11.57	11.68	11.7
Order set not used	905	18.19	13.31	16.69

did not ($P = 0.18$). Readmissions were 11.7% (95% CI 7.45–15.95) for those who had order set and 16.69% (95% CI 14.2–29.1) ($P = 0.097$) in those who did not.

Discussion

We evaluate the care of patients in our hospital in an effort to continuously improve. We measure, analyze, plan, implement, and then re-measure as processes for continuous improvement. Sepsis is a major focus for patient care improvement. There is a national focus to improve diagnosis, treatment, and outcomes. The assessment of patient's signs and lab tests can now reliably be done by computerized health record systems. Alerts can be generated to nurses and clinicians. The next phase for improvement is being sure that every patient receives complete and timely care. This should be done in the most efficient manner for nurses and physicians.

Conclusions

We report an improvement in mortality with use of an order set designed to be complete, timely, and easy to use. Length of stay and readmissions were improved in patients who had order set used but did not reach statistical significant difference. We believe we will see ongoing improvements in patient outcomes with clinician education, specific case reviews, nurse implemented protocols, and perhaps computer requiring use of the order set for all patients with sepsis. We recommend order sets be evaluated and used for sepsis and other diseases.

Methods

We use our electronic health record (EHR) to measure incidence and mortality. Patients who were coded as a principal or secondary diagnosis of sepsis were included. Coding is done by professionally trained, evaluated, coders who review every patient chart. Problem lists and physician notes are used to assign diagnostic codes. We analyzed the results for patients with sepsis coded for overall mortality, use of order set, and mortality based on use or non-use of the order set. We also analyzed major quality metrics including length of stay (LOS) and readmissions within thirty days. We compared outcome in

those patients in whom the order set was used to those in whom it was not. Results were expressed as number of cases and as mean percentages (rates) $\pm 95\%$ confidence intervals (CI) of the mean. Statistical significance for mortality, readmission, and use of sepsis order sets in Emergency Department vs. inpatients was analyzed with the Fisher Exact test. The Student *T* test was used to analyze differences in LOS. Chi-Square Statistic was employed to estimate reduction in mortality from 2013 to 2016. $P \leq 0.05$ was accepted as significant. No data was collected from humans or animals, only chart review was performed. This is a retrospective chart review of patients in an urgent clinical condition requiring rapid evaluation and management. We did not apply randomization as we believe the alert and order set should be applied to all patients.

Abbreviations

OS: order set; CPOE: computerized physician order entry; BPA: best practice alert; SIRS: systemic inflammatory response syndrome; CI: confidence intervals; EHR: electronic health record; LOS: length of stay.

Authors' contributions

RCG: Executive Sponsor for the team that implemented the order set and wrote initial draft and edits to the manuscript. KR: Mount Sinai Medical Center epidemiologist and head of Division of Infectious Disease. Provided information for establishing the metrics for Best Practice Alert. MC: Chief of Division of Critical Care. MC oversees care of the patients in our intensive care units. Participated in implementing the order set and data and manuscript review. NN: Head of Infection Prevention. Co-lead team to evaluate and implement sepsis best practice alert and order set. NN evaluated and provided input on the manuscript. CL: Sepsis Coordinator. Co-lead efforts to implement the order set. Reviewed manuscript and provided suggestions. LC is the Mount Sinai Medical Center education program statistician. LC does the statistical analysis of our data and wrote the section on statistical methods. Evaluated the project and provided suggestion on the manuscript. DF: Chairman of the Emergency Department. He provided input into best practice alert, sepsis order set, and reviewed and provided suggestions on the manuscript. AS: Director of our Project Management Office. AS provided the data from our electronic health record for analysis and reviewed the manuscript. TG: Chief Information Officer. TG and team developed the best practice alert and order set as well as producing the data from our electronic health record. All authors read and approved the final manuscript.

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Competing interests

All authors work together to improve quality of care of patients at Mount Sinai Medical Center. The authors declare that they have no competing interests.

Availability of data and materials

Data and materials are available in the office of principle author. Data is accumulated from our Mount Sinai Medical Center electronic health record.

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