Performance Improvement

Kaiser Permanente's Performance Improvement System, Part 3: Multisite Improvements in Care for Patients with Sepsis

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In 2008 Kaiser Permanente initiated a nationwide performance improvement (PI) system designed to align efforts of frontline teams with strategic organizational priorities in top-down, bottom-up improvement activities that pervade the entire organization. The PI system's key elements, development, and implementation, as described in the first of four articles,[1] include (1) a data dashboard known as "Big Q," which distills hundreds of performance measures into a vital few, high-level measures, such as medical center standardized mortality ratios (HSMRs), a performance metric that adjusts for multiple variables at the patient, medical center, and regional levels[2]; and (2) benchmarking external health care organizations to identify six capabilities of high-performing organizations—leadership priority setting, a systems approach to improvement, measurement capability, improvement capacity, culture of improvement, and organizational learning. The second article presented the value framework for the PI system, including return on investment.[3] The current article illustrates top-down and bottom-up PI to reduce sepsis mortality throughout the Northern California region of Kaiser Permanente (KPNC). One of Kaiser Permanente's eight regions in the United States, KPNC has 3.25 million members, 21 medical centers, and 226 clinics, and employs approximately 64,000 staff. The Permanente Medical Group, which contracts with the Kaiser Foundation Health Plan to provide comprehensive care to members, includes more than 7,000 physicians representing all specialties. The fourth and final article will describe our strategy for creating the systemic capacity for continuous improvement that characterizes a learning organization.[4]

Beginning the Sepsis Care Performance Improvement Initiative

In 2007, senior executives at KPNC noted persistent variations in HSMRs among the region's 21 medical centers despite previous PI efforts that included evidence-based care related to Joint Commission core measures[5] and interventions related to the Institute for Healthcare Improvement (IHI) 5 Million Lives Cam-

Article-at-a-Glance

Background: In 2008, Kaiser Permanente Northern California implemented an initiative to improve sepsis care. Early detection and expedited implementation of sepsis treatment bundles that include early goal-directed therapy (EGDT) for patients with severe sepsis were implemented.

Methods: In a top-down, bottom-up approach to performance improvement, teams at 21 medical centers independently decided how to implement treatment bundles, using a "playbook" developed by rapid cycle pilot testing at two sites and endorsed by a sepsis steering committee of regional and medical center clinical leaders. The playbook contained treatment algorithms, standardized order sets and flow charts, best practice alerts, and chart abstraction tools. Regional mentors and improvement advisers within the medical centers supported team-building and rapid implementation. Timely and actionable data allowed ongoing identification of improvement opportunities. A consistent approach to performance improvement propelled local rapid improvement cycles and joint problem solving across facilities.

Results: The number of sepsis diagnoses per 1,000 admissions increased from a baseline value of 35.7 in July 2009 to 119.4 in May 2011. The percent of admitted patients who have blood cultures drawn who also have a serum lactate level drawn increased from a baseline of 27% to 97% in May 2011. The percent of patients receiving EGDT who had a second and lower lactate level within six hours increased from 52% at baseline to 92% in May 2011.

Conclusion: Twenty-one cross-functional frontline teams redesigned processes of care to provide regionally standardized, evidence-based treatment algorithms for sepsis, substantially increasing the identification and risk stratification of patients with suspected sepsis and the provision of a sepsis care bundle that included EGDT.

Early Recognition of Sepsis

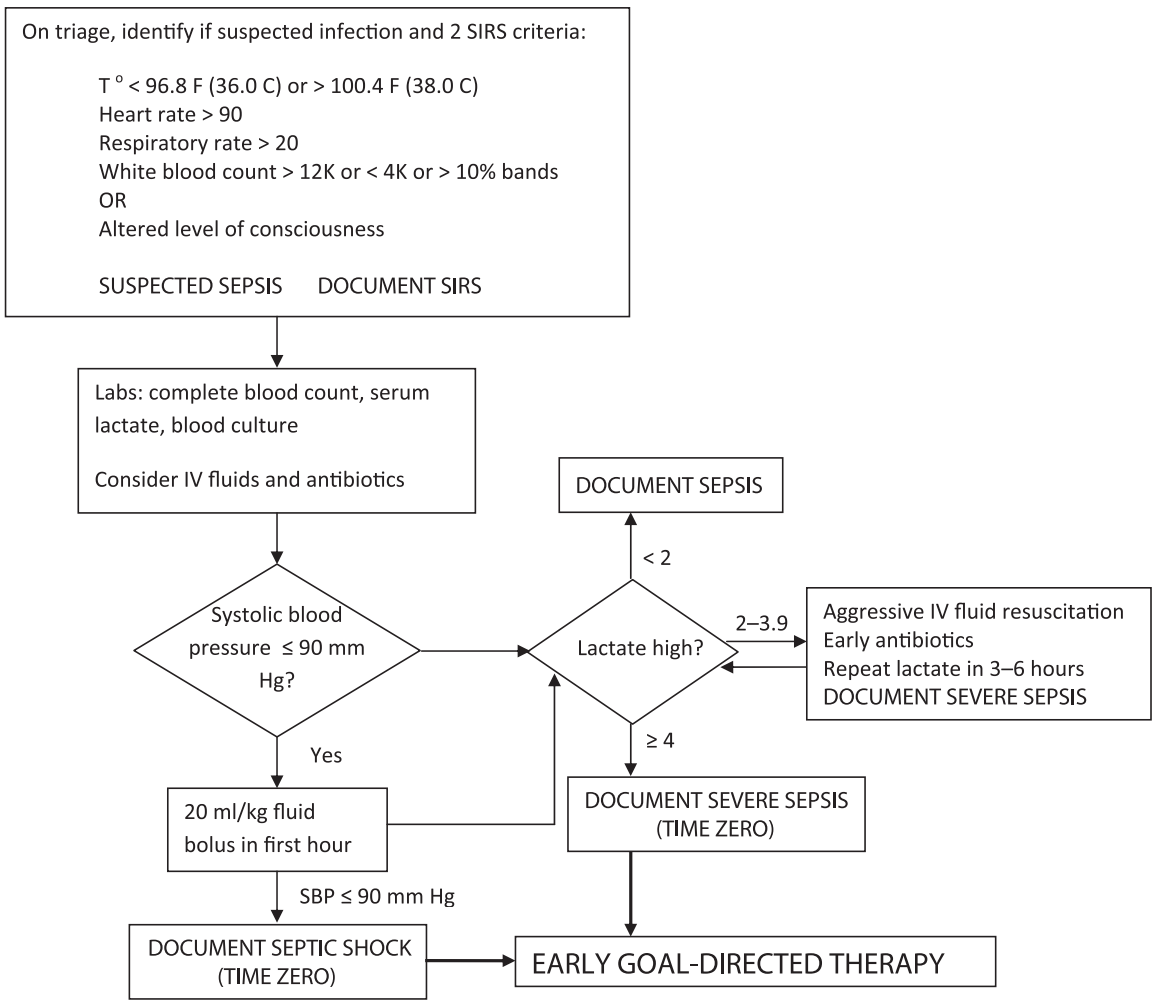

Figure 1. *This tool facilitates the identification, documentation, and stratification of sepsis on admission. SIRS, systemic inflammatory response syndrome; T, temperature; IV, intravenous; SBP, systolic blood pressure.*

paign, such as central line bundles (for central line–associated infections), ventilator bundles (for ventilator–associated pneumonia), and rapid response teams (at the first sign of patient decline).[6] Consequently, they initiated a comprehensive mortality review process to identify improvement opportunities. An in-depth review of the last 50 consecutive inpatient deaths at each medical center (19 at the time) identified factors contributing to adverse events and mortality.[7] Mortality related to infection arose as a general area of concern, and further analysis identified sepsis as a key factor. As shown in Figure 1 (above), sepsis is defined here as the following:

> Suspected infection and the presence of two or more signs of the systemic inflammatory response syndrome (SIRS) or altered level of consciousness. SIRS signs include body temperature < 36° C (96.8° F) or > 38° C (100.4° F); heart rate > 90 beats/ minute; respiratory rate > 20 breaths/minute; and white blood cell count > 12,000/ml, < 4,000/ml, or with < 10% "bands" (immature neutrophils).[8]

Among 205,548 medical center admissions in 2007 for the entire region, 2.7% (5,588) of patients had sepsis present on admission as a primary or secondary diagnosis. However, sepsis caused 24% (1,364) of all inpatient deaths. Senior regional executives identified reducing sepsis mortality as a key performance improvement goal.

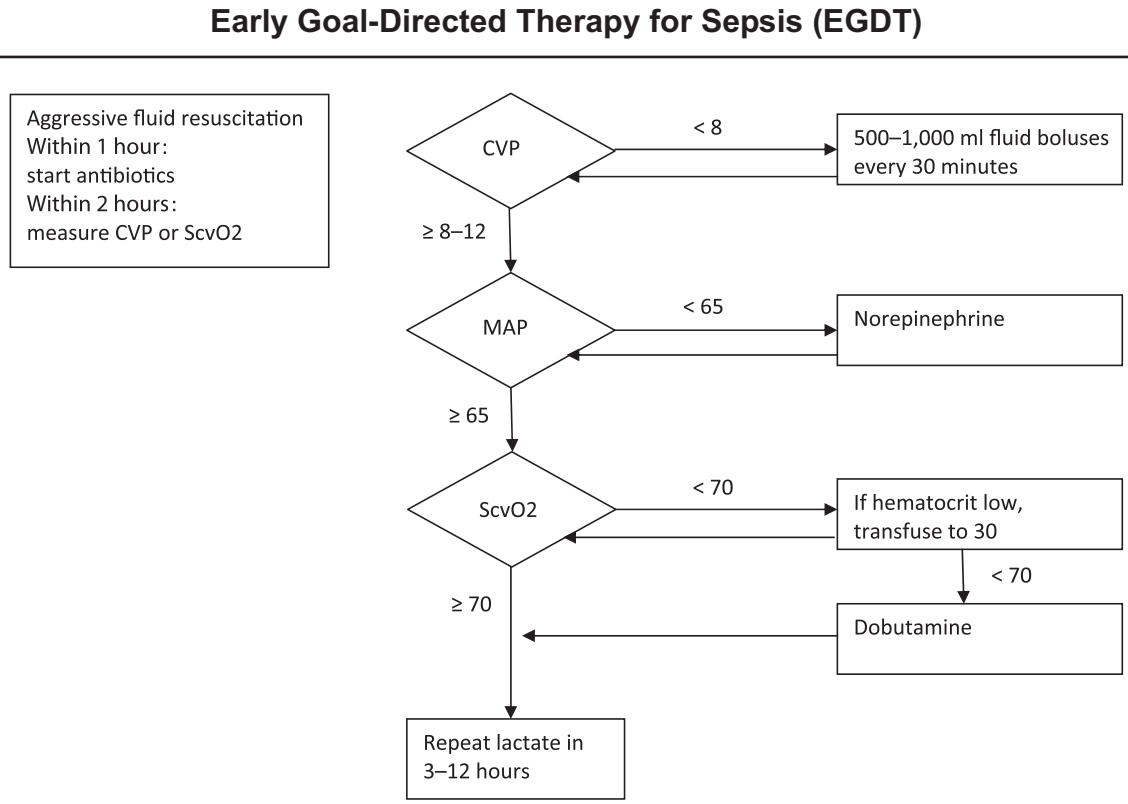

Figure 2. *This treatment algorithm uses specific hemodynamic goals to guide fluid resuscitation and the use of vasopressors. EGDT consists of hemodynamic support for at least six hours to achieve and maintain central venous pressure (CVP), mean arterial pressure (MAP), and central venous oxygen saturation (ScvO2).*

Early Goal-Directed Therapy (EGDT)

Across health systems, sepsis is a leading cause of inpatient deaths, with increasing incidence and reported mortality rates in excess of 30%.[9–11] The crux of reducing mortality is earlier recognition of sepsis and more aggressive resuscitation in the first hours. Early recognition relies on blood cultures and measurement of serum lactate before administration of antibiotics. Treatment for septic shock consists of a six-hour resuscitation bundle that includes administration of broad-spectrum antibiotics within the first hour of diagnosis of septic shock and EGDT.[12,13] Initiation of EGDT is based on low blood pressure or abnormal serum lactate levels. A treatment algorithm that uses specific hemodynamic goals to guide fluid resuscitation and the use of vasopressors, EGDT consists of fluid resuscitation and hemodynamic support for at least six hours to achieve and maintain central venous pressure, mean arterial pressure, and central venous oxygen saturation (Figure 2, above).[9]

In the hallmark study of EGDT, Rivers et al. reported an absolute reduction in inpatient mortality of 16% (relative reduction of 34%) among patients with sepsis present on admission following management for six hours in the emergency department (ED) before transfer to the ICU.[9] Other studies report relative reductions in mortality of 8% to 56%.[14–17] An international collaborative consisting of The Surviving Sepsis Campaign and IHI, which began in 2004, seeks to improve the management, diagnosis, and treatment of sepsis; a recent study of its impact on more than 15,000 patients at 165 sites documented a 6% decrease in inpatient mortality.[18,19]

Most of the KPNC medical centers had instituted EGDT before the start of the 2008 initiative but had primarily done so in ICUs—to which patients were admitted from the emergency department (ED). ED physicians and staff did not consistently measure serum lactate levels in patients who might be septic. In addition, delays inherent in ICU admission meant that the critical window for intervention was sometimes exceeded.

Standardized provision of EGDT requires significant additional work in the ED and coordinating activities between medical center units.[20] ED physicians and nurses who are accustomed to stabilizing patients and transferring them for treatment in ICUs need to place central lines and monitor hemodynamics, in addition to monitoring serum lactate levels, drawing blood cultures, and administering fluids, antibiotics, and other medica-

tions. Effectively handing off patients receiving critical cardiovascular support requires a systems view to reframe working relationships between the ED and the ICU in ways that take local variations into account.

The goal of the sepsis care PI initiative was to develop and implement a comprehensive program at all KPNC medical centers that would (1) quickly and consistently identify patients presenting with sepsis among 800,000 annual ED visits, (2) stratify risk by lactate testing, (3) reliably execute effective EGDT when indicated, and (4) aggressively treat and monitor patients at intermediate risk.

Planning for Change

KPNC had an established track record of successful change, with numerous regional and local staff completing improvement adviser (IA) training, as offered both by IHI[21] and Kaiser Permanente's internal Improvement Institute,[1] and training in the IHI Breakthrough Series collaboratives.[22] IAs serve operational roles devoted to helping identify, plan, and execute improvement initiatives; training includes systems thinking, statistical process control, and Lean and Six Sigma skills. They support cross-functional frontline teams' implementation and testing of changes.

In early 2008, using the principles of the six capabilities of high-performing organizations, senior KPNC clinical and operational leaders [including A.W., M.S., and B.C.] established a foundation for improvement in sepsis care, using an internally developed "four-wheel drive" approach as an execution strategy. In this approach, four elements are engaged to propel organizational change—(1) leadership alignment; (2) standardization of evidence-based practices; (3) project management; and (4) collection and use of timely, actionable data that are ideally available at the practitioner level. The objective of the four-wheel drive approach is to create uniform, reliable, sustainable performance improvements that are owned by teams on the front line of care.

Compelling data from the mortality review facilitated early alignment of senior regional leaders and the development of a robust cadre of physician advocates, many of whom had a longstanding interest in EGDT. The region also engaged a trained performance improvement expert in the role of mentor [C.A.] to the region and facilities.

In May 2008, the region held a mortality summit attended by approximately 350 representatives from the region and its medical centers. Drivers and focus areas for mortality reduction efforts were identified (Figure 3, page 487) on the basis of the results of the mortality chart review. Breakout sessions focused on the drivers of end-of-life care; the avoidance of needless harm; and evidence-based care for several conditions, including sepsis. The breakout session on sepsis was well attended, reflecting strong grassroots interest within medical centers for reducing mortality by improving the identification and treatment of sepsis.

Implementing Change

Pilot Testing

At the time of the mortality summit, the Kaiser Foundation Hospital (KFH; Vallejo, California) was independently planning to implement EGDT in its ED. Regional leaders invited physicians and staff from KFH Vallejo to join a sepsis steering committee that also included regional quality staff. Representatives from the pilot site consisted of physicians from the ED, the ICU, and hospitalist services; a nurse educator; nurses from the ED, ICU, and quality departments; a project manager; and data analysts. A second pilot site in San Jose was also invited to participate. At each site, a multidisciplinary team, headed by a physician and a registered nurse, who served as co-chairs, engaged frontline staff and physicians as key stakeholders. Team members and regional leads agreed to pilot a sepsis care algorithm based on published international guidelines for sepsis identification and treatment (Figures 1 and 2).[18]

During the pilot phase in summer and fall 2008, the mentor and regional clinical leaders supported frontline teams at two sites as they conducted multiple rapid plan-do-study-act (PDSA) cycles to do the following:

1. Develop and refine a screening tool for sepsis.
2. Refine the treatment algorithm.
3. Develop additional tools to enhance the likelihood of achieving desired outcomes.
4. Design and implement multidisciplinary education strategies for staff.
5. Design a tool to abstract performance improvement data from the medical record.

The implementation tools developed and tested at the pilot sites through PDSA cycles were organized into a "playbook" containing treatment algorithms, standardized order sets and vital sign flow charts, a best practice alert in the electronic health record (EHR) to prompt an order for serum lactate, nursing documentation tools—the Sepsis "Time Zero" tool (Appendix 1, available in online article) and the ED Admission Handoff Report (Appendix 2, available in online article), the Sepsis EGDT Charge Nurse Checklist (Appendix 3, available in online article), chart abstraction tools to gather data that could be used for provider-specific feedback, and physician and nurse training resources. During pilot testing and the development of the play-

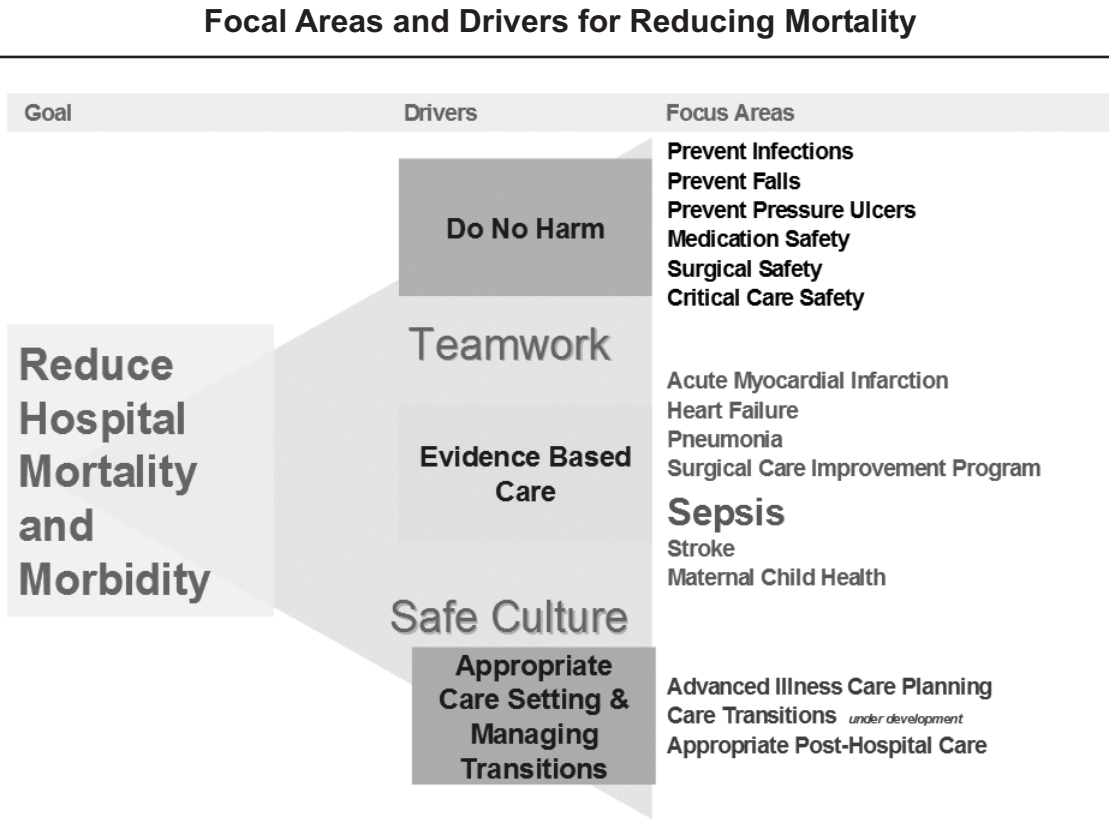

Figure 3. *At the May 2008 regional mortality summit, drivers and focus areas for mortality reduction efforts were identified.*

book, the authors of the original study on EGDT[9,17] provided unpaid consultation regarding the treatment algorithms. (Nguyen received compensation for a presentation at a follow-up sepsis summit in 2010.)

Spreading for Success

During fall 2008, the steering committee planned a sepsis summit to occur in November. Unlike the previous mortality summit, it focused exclusively on evidence-based care for sepsis and was intended to launch the sepsis care PI initiative region-wide. Simultaneously, regional clinical and operational leaders focused on aligning leaders within and across facilities: ED and ICU chiefs of staff and nursing managers, medical and operational medical center leadership, and nursing leadership. With the additional work that EGDT entailed for ED physicians and staff, it was imperative that medical center executives and clinical chiefs strongly support it. The chair of the ED chiefs—the most senior clinical position for emergency medicine in the region—was a vocal supporter of the initiative.

The format of the sepsis summit reflected leadership priorities and was designed to follow a collaborative model, in which a learning system periodically brings together teams from medical centers to seek improvement in a particular area.[22] Teams from each KPNC medical center attended, and clinical experts presented the bulk of the material on sepsis care. The PI initiative was presented as a multimonth process, during which each medical center was responsible for developing a team for implementing improved sepsis care, assembling necessary tools and equipment, adopting the treatment algorithms, planning the handoff of patients between the ED and the ICU, training physicians and staff, measuring performance, and conducting PDSA cycles to continuously improve performance. The playbook developed during pilot testing was then regionally distributed.

Between November 2008 and January 2009, regional medical centers assembled sepsis care performance improvement teams with a specified composition: ED and ICU chiefs or their designees, a physician hospitalist, a nursing educator, nurses from the ED, ICU, and quality departments, and a designated project lead. Each team decided how to implement care processes of care, train and oversee staff, and monitor improvement. Sidebar 1 (page 489) presents the process of implementing EGDT at one medical center.

Ongoing Support and Training the Trainers

The mentor visited all 21 medical centers in the first quarter of 2009, helping them identify additional staff training and support needs and build bridges to other medical centers to take advantage of lessons from other sites, in keeping with the collaborative model. In March 2009, a regional learning session on ultrasound-guided central venous catheterization was attended by two physicians and a nurse from each medical center. Its purpose was to enable each medical center to have an ongoing simulation training program to support safe and timely central line placement. In addition, the region designated champions who were available to facilities on request.

In August 2009, a grant provided by the Gordon and Betty Moore Foundation (http://www.moore.org/) funded the hiring of IAs (0.6 full-time equivalent [FTE]) at each of 12 facilities within the foundation's service area. The IAs functioned as project leads; medical centers located outside the foundation's service area independently funded this role.

Physician champions and IAs from all facilities meet by phone monthly for "barrier-busting" sessions, during which they discuss the barriers experiencing and jointly problem solve to overcome them. Rather than being vested in a single methodology for change, they apply a variety of approaches that can be implemented and rapidly tested using PDSA cycles.

Ongoing Regional Support and Data Collection

The KPNC region provided support to the sepsis care PI initiative on an ongoing basis by creating and solidifying leadership alignment and by providing resources for the mortality and sepsis summits, the training session, the sepsis steering committee, and mentorship—as well as by ensuring that appropriate equipment, as follows, was available at each medical center:

- At least one hemodynamic monitor* was purchased for each ED and ICU department to enable continuous monitoring of central venous pressure and oxygenation and mean arterial pressure.
- A central venous catheterization ultrasound-guided insertion simulator to enable ED physicians and nurses to become adept at inserting central lines, a procedure that was rarely performed in the ED before this PI initiative.

The region also provided support and infrastructure for organizational learning in the collaborative model, as follows:

- Annual sepsis summits
- Twice-monthly sepsis faculty calls for clinical champions
- Monthly collaborative calls and site visits
- A monthly sepsis newsletter
- A designated intranet site providing access to tools, journal articles, and performance data.

A planning and implementation timeline is presented in Table 1 (page 490).

Assessing Progress

In July 2009, KPNC started systematically collecting data on sepsis care and EGDT and feeding it back to medical center sepsis care teams. Although the medical centers independently decided where treatment would be provided, who would place the central lines, and how care teams from different parts of the hospital would coordinate their care, each monitored performance using standardized measures identified by the sepsis steering committee and tested at the pilot sites. Monthly sepsis scorecards and quarterly reports identified progress and opportunities for further improvement.

Results

As shown in Table 2 (page 490), the number of sepsis diagnoses per 1,000 admissions increased from a baseline of 35.7 in July 2009 to 75.6 after 12 months and to 119.4 in May 2011. The percent of admitted patients for whom blood cultures were drawn who also had serum lactate levels drawn increased from a baseline of 27% to 95% after 12 months and to 97% in May 2011.

Among sepsis patients who met criteria for EGDT, the percent who successfully met all elements of the EGDT bundle increased from 7% at baseline to 37% in one year and to 61% in May 2011. Substantial increases also occurred in the percent of patients receiving elements of the sepsis care bundle. As of May 2011, the proportion of patients who received antibiotics within an hour of diagnosis of sepsis increased by almost 20 percentage points, the proportion who had a central line placed within two hours of diagnosis increased by 44 percentage points, and the proportion of patients with central lines placed who achieved target hemodynamic values increased by 41 to 45 percentage points. The proportion of patients diagnosed with sepsis who showed decreases in lactate levels within six hours increased by 40 percentage points. These results are summarized in Table 2.

In addition, among patients with initial intermediate lactate levels (2–3.9 mmol/liter), the proportion for whom a second level was drawn increased from 26% at baseline to 85% after a year; the proportion whose second lactate levels showed improvement increased from 20% to 76%.

* Information regarding the commercial brand is available by request from the authors.

Sidebar 1. Implementing Sepsis Improvement at Kaiser Permanente South Sacramento Medical Center

Early Institution of Early Goal-Directed Therapy

In 2004—four years before the start of the Sepsis Care Performance Improvement Initiative—the Kaiser Permanente South Sacramento Medical Center (Caluso, California) instituted early goal-directed therapy (EGDT) for severe sepsis in the ICU. The treatment protocol was identical to the one later developed in 2008 by the sepsis steering committee of regional and medical center clinical leaders. However, delaying the initiation of EGDT until patients reached the ICU sometimes meant exceeding optimum windows for resuscitation, no matter how promptly physicians and staff responded after the patient was under their care.

Participating in the Sepsis Performance Improvement Initiative

Initial Responses

When medical center representatives [G.M., J.B.] received the playbook from the sepsis steering committee in 2008, they and other leaders recognized that implementing EGDT would now require major changes in the emergency department (ED). Nurses needed to triage patients differently to be able to recognize the often subtle indications that a patient might be septic and quickly bring him or her to the attention of a physician. They needed new skills in reading central venous pressure waveforms using an unfamiliar piece of equipment (hemodynamic monitor) and in titrating fluids to the patient's central venous pressure. Physicians needed to consider that patients with infections who looked relatively good—but whose serum lactate levels were significantly elevated—would benefit from invasive hemodynamic monitoring.

The Sepsis Team and Its Work

The formation of the sepsis team, which, by early 2009 consisted of two ED physicians, the ED clinical manager, the quality coordinator, and a few ED nurses, got off to a slow start; there was little interest and some resistance within the medical center. The group spent most of their time retrospectively troubleshooting rather than setting goals for implementation.

The arrival of an improvement advisor [M.A.] in August 2009 galvanized the team; she was persistent about adding a hospitalist, an intensivist, a leader from the ICU, an infectious disease physician, several more nurses, and a representative from the clinical laboratory as team members. Her strategies for gaining commitment to implementing EGDT were to use existing data on sepsis care and outcomes at the hospital to create a compelling, evidence-based story about the need for improvement and to involve a large group, not just a committee, in the work.

With the IA's assistance, the sepsis team reached a new level of engagement and cohesiveness. Nurses who participated became "cheerleaders" for EGDT in the ED. Key physicians regularly attended meetings. Senior leadership at the medical center was unwavering in its support. The clinical laboratory created a full-time phlebotomy position in the ED to ensure timely and accurate collection of concurrently drawn serum lactates and blood cultures. Intensivists from the ICU came to the ED to place central venous catheters when requested, and the ICU nurses helped ED nurses with the catheter care and monitoring of central venous pressures until they were comfortable doing it independently.

The team created tools, including an internal sepsis intranet site, so that key information would be readily available. The ED physician champion and frontline nurses partnered to organize sepsis simulations (mini-drills) to increase staff awareness and management of sepsis patients. Clinical educators created a dedicated Sepsis Skills Station, offered every other week, as part of ongoing competency training for frontline staff. The IA assisted the nurses in fine-tuning a tool for handing off patients from the ED to the ICU. She also created a spreadsheet displaying monthly performance data for the medical center; this information is fed back to the ED physicians and nurses.

Sustainability

Sustainability is monitored by the sepsis team. The flow of data drives continual improvement. By July 2010, compared to baseline, the number of patients diagnosed with sepsis had more than doubled. Compliance with the sepsis care bundle, at approximately 80%, substantially exceeded regional targets, and sepsis mortality, at half the baseline rate, was also below the regional target.

Discussion

Cross-functional frontline teams at each of 21 medical centers redesigned processes of care to provide regionally standardized evidence-based treatment algorithms. They substantially increased the identification and risk stratification of patients with suspected sepsis and the provision of a sepsis care bundle that included EGDT. Multiple process of care measures indicate substantial improvements in sepsis care.

Comparing compliance rates is challenging because of slight variations in treatment protocols, but the 64% of patients meeting EGDT criteria who successfully met every element of the EGDT bundle, reflecting an increase of 57 percentage points in 22 months, compares favorably with results from the largest study to date, in which compliance with a comparable bundle increased in a two-year period from 10.9% to 31.3% among 15,022 patients at 165 sites.[19]

The pre-post design of the current study does not support definitive conclusions about the impact of the initiative on outcomes. However, it is encouraging that sepsis mortality decreased as sepsis diagnosis increased (Figure 4, page 491); risk-adjusted sepsis mortality also decreased, suggesting a real improvement rather than a dilution of disease severity as rates of diagnosis increase.[23] In addition, length of stay for sepsis as a principal diagnosis decreased by 3.5 days by January 2010, with 0.4 of those days explained by a decrease in expected length of stay.

Table 1. Timeline for Sepsis Performance Improvement Planning and Implementation*

Spring 2008	May 2008	Early Summer 2008	Summer/ Fall 2008	Nov. 2008	Nov. 2008– Jan. 2009	Mar. 2009	Jun.–Jul. 2009
Mortality chart review	Mortality summit	Sepsis steering committee convenes and develops treatment algorithms.	Pilot at two sites	Sepsis summit	Medical centers assemble sepsis teams	Train-the-trainer session	Data collection begins on EGDT processes and outcomes.

* EGDT, early goal-directed therapy.

Table 2. Impact of a Sepsis Care Performance Improvement Initiative on Process of Care Measures, July 2009–May 2011*

Process of Care Measure	July 2009	July 2010	Dec 2010	May 2011
Sepsis diagnoses per 1,000 admissions	35.7†	75.6‡	98.5	119.4
Admitted patients with blood culture who had serum lactate drawn in the ED	27%§	97%‡	97%	97%
Patients with sepsis who received antibiotics within 1 hour of diagnosis	69.5%	87%	90.4%	88.6%
Patients with sepsis who had a CVP or ScvO2 recorded within 2 hours of diagnosis	41.5%	74%	78.6%	85.1%
Patients meeting clinical criteria for EGDT who met all 6 bundle elements	7.3%	36.7%	55.1%	60.5%
Patients receiving EGDT with hemodynamic values at target				
Mean arterial pressure	52%	85%	90.4%	93.9%
CVP	41.5%	69%	83.8%	86%
ScvO2	30.8%	66%	74.3%	75.4%
Patients receiving EGDT who had a lower serum lactate level within six hours	52%	85.8%	91.9%	92.1%

* ED, emergency department ; CVP, central venous pressure; ScvO2, central venous oxygen saturation; EGDT, early goal-directed therapy; n/a, data not available.
† Data are from 2006 through early 2008.
‡Data are from November 2009 through July 2010.
§ Data are from early 2008.

Success Factors

The top-down, bottom-up approach of the sepsis PI initiative was pivotal. Regional operational and clinical leaders identified the goal and provided support, and frontline teams implemented evidence-based care in ways that were sensitive to variations between settings. The involvement of IAs to support cross-functional teams and provide initiative leadership was also important, as was the participation of pilot sites to determine what processes made the most sense to the frontline physicians and nursing staff treating patients with sepsis. Their engagement in rapid-cycle improvement activities and honest feedback about the usability of tools and training needs was pivotal to the rapid spread of the initiative to other facilities.

The impact of senior leadership support cannot be overstated. Particularly when work flows that cross disciplines and departments are redesigned, aligned support from operational and clinical leaders is critical. Without it, even the most engaged, enthusiastic, and skilled champions will be unable to effect change. Sepsis continues as a leadership priority; senior leaders at the KPNC region and its medical centers continue to closely monitor the impact of sepsis improvement activities and pursue opportunities for further improvement. The oversight of regional leadership added an element of accountability for implementing EGDT that is not often present in multi-institution collaboratives; senior regional executives frequently check in with medical centers, and some compensable personnel performance goals are tied to improvement in sepsis care.

The region's May 2008 mortality summit and November 2008 and November 2009 sepsis summits, attended by representatives from all 21 medical centers, were designed to facilitate collaborative learning across sites. In addition to providing tools and knowledge, the summits are intended to tell a story so compelling as to jolt providers "out of the status quo." For example, at the 2008 sepsis summit, a woman whose sepsis had been successfully treated spoke of how her life had been saved—putting an unforgettable human face on a pervasive problem.

Regional training sessions allowed representatives from sometimes-distant medical centers to network, learn from one another, and feel part of a much larger movement. KPNC also invested in infrastructure to keep communications about sepsis

Sepsis Diagnosis/1,000 Medical Center Admissions and Sepsis Mortality Rates, May 2006–August 2010

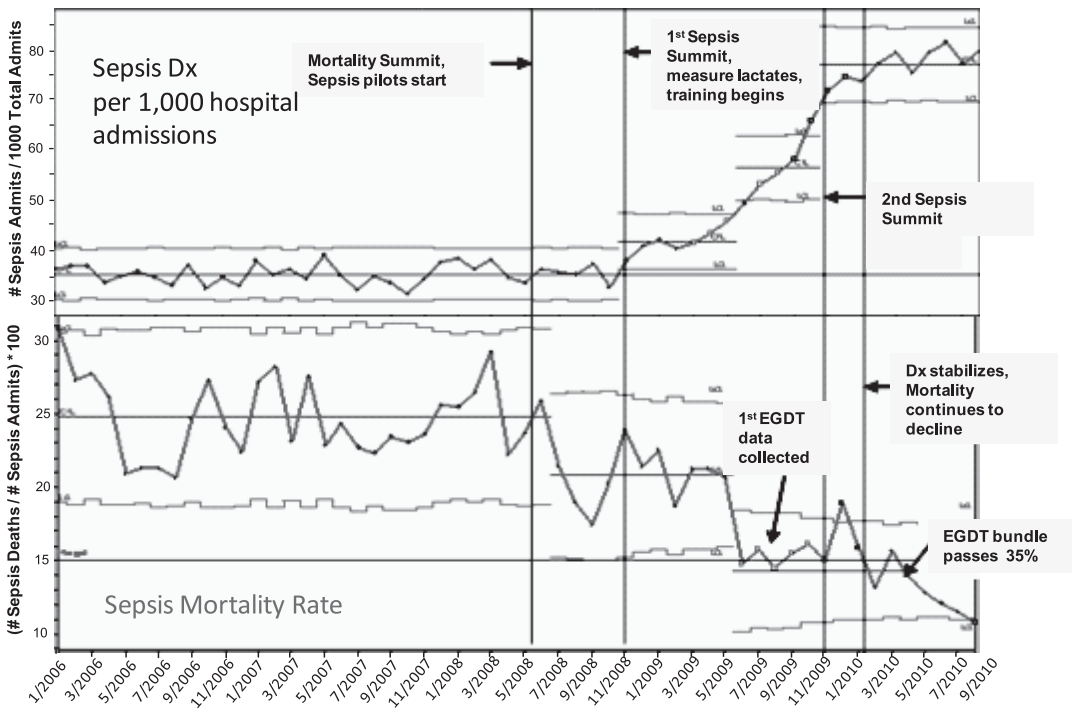

Figure 4. *Sepsis mortality decreased as sepsis diagnosis increased; risk-adjusted sepsis mortality also decreased, suggesting a real improvement rather than a dilution of disease severity as rates of diagnosis increase. Dx, diagnosis; EGDT, early goal-directed therapy.*

care flowing between stakeholders from frontline clinicians to regional leaders.

What We Learned

Data from early 2009 indicated that patients with intermediate lactate levels of 2–3.9 mmol/liter were an important population. Although their mortality risk was much lower than that of patients with a serum lactate level > 4 mmol/liter, it was substantially higher than that of inpatients without sepsis. In addition, more patients had serum lactate levels in this range, so more deaths occurred in this group than among patients with the highest lactate levels.

Effective treatment to lessen the risk of deterioration for these patients included the use of fluid resuscitation, timely antibiotic administration, and a repeat lactate level three to six hours after the initial lactate. Ongoing pilot projects at medical centers are intended to fine-tune the treatment of patients with initial lactate levels of 2–3.9 mmol/liter.

Numerous additional process improvements are under way. For example, in 2010, one medical center used the EHR to identify all patients who had low blood pressure and measurement of a serum lactate and to track parameters such as central venous pressure and oxygen saturation rather than waiting for sepsis patients to be identified by *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) coding. Also in 2010, regional analysts built a similar intranet tool that enables immediate feedback on the quality of sepsis care and is being put into use throughout the region. The tool also provides a rich source of data for further refining the identification, stratification, and treatment of patients with sepsis. This transition from a paper-based system to an EHR-based system for data collection through KP HealthConnect™ allowed for more efficient data abstraction to monitor performance improvement.

With the more rapid feedback, providers and facilities can assess care and outcomes for patients treated as recently as the day before, enriching organizational learning. KP HealthConnect also facilitates analysis of outcomes for subgroups of patients across 21 KPNC medical centers; it holds promise as a tool for refining care for patients with sepsis.

Challenges and Barriers

Previous studies have identified barriers to implementing EGDT in EDs, such as difficulty in identifying patients with sepsis, nursing staff requirements, and difficulty in obtaining central venous pressure monitoring.[24] We did not experience these to a significant degree. Our focus on early identification obviated the first challenge. Skills sessions for ED and ICU nurses improved their ability to manage complex sepsis patients, and nursing staff from the two units often worked collaboratively to manage patients in the ED. We have already noted the regional investment in providing equipment for central venous pressure monitoring in each medical center.

KPNC medical centers did encounter challenges in convening sepsis performance improvement teams. Team assembly was not always a straightforward or easy process, as described in Sidebar 1, and some facilities had to make adjustments to the specified team composition.

In our experience, there are barriers to achieving 100% adhere rates for bundle compliance. For instance, central line placement may be contraindicated in patients who are at risk for excessive bleeding, are receiving cardio-pulmonary resuscitation, or are unable to tolerate a potential pneumothorax—or patients may simply refuse to give consent. In addition, patients may be receiving comfort care only. In addition, as noted by a KPNC ED physician, placing a central line—an invasive procedure—is the most controversial element of the bundle for physicians because it may be particularly difficult to implement in a timely way in patients who meet clinical criteria for sepsis but do not appear to be in distress. This difficulty highlights the fact that EGDT algorithms do not replace the clinical judgment of physicians. Feedback on performance for nurses and physicians helps shape sepsis care (Sidebar 1).

Spread of Improvement in Sepsis Care

Currently, another Kaiser Permanente region has launched a similar sepsis PI initiative, and a third is in the process of developing one; both of these regions have benefited from our experience and learnings. Participants from other regions participate in KPNC performance improvement processes, such as collaborative calls, monthly scorecards that detail medical centers' sepsis care performance, and physician champion/IA meetings. In addition, KPNC regional leaders have reported our experience at numerous external meetings. J

The authors thank the physicians and staff throughout the Kaiser Permanente Northern California medical centers for the dedication and engagement they brought to performance improvement in sepsis identification and treatment, making possible the saving of more than a thousand lives to date.

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Online-Only Content

See the online version of this article for

Appendix 1. Sepsis "Time Zero" Tool

Appendix 2. Emergency Department Handoff Report

Appendix 3. Sepsis Early Goal-Directed Therapy (EGDT) Charge Nurse Checklist

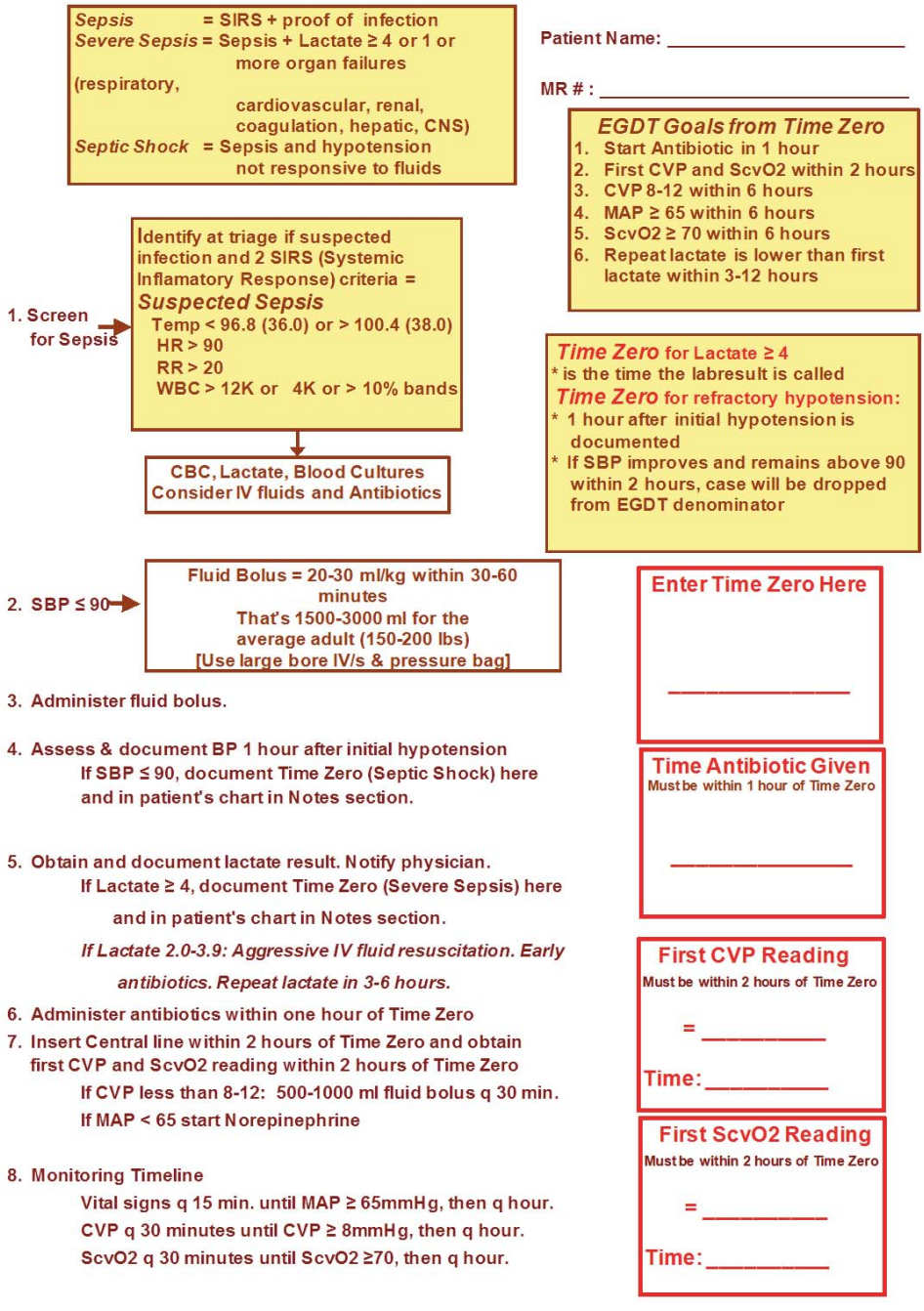
References

1. Schilling L., et al.: Kaiser Permanente's performance improvement system, Part 1: From benchmarking to executing on strategic priorities. *Jt Comm J Qual Patient Saf* 36:484–498, Nov. 2010.
2. Jarman B., et al.: Explaining differences in English hospital death rates using routinely collected data. *BMJ* 318(7197):1515–1520, Jun. 5, 1999.
3. Schilling L., et al.: Kaiser Permanente's Performance Improvement System, Part 2: Developing a value framework. *Jt Comm J Qual Patient Saf* 36:552–560, Dec. 2010.
4. Schilling L., et al.: Kaiser Permanente's Performance Improvement System, Part 4: Creating a learning organization. *Jt Comm J Qual Patient Saf,* forthcoming.
5. The Joint Commission: *Core Measure Sets.* http://www.jointcommission.org/core_measure_set/ (last accessed Sep. 12, 2011).
6. Institute for Healthcare Improvement (IHI): *Protecting 5 Million Lives from Harm.* http://www.ihi.org/offerings/Initiatives/PastStrategicInitiatives/5MillionLives Campaign/Pages/default.aspx (last accessed Sep. 12, 2011).
7. Lau H., Littman K.C.: Saving lives by studying deaths: Using standardized mortality reviews to improve inpatient safety. *Jt Comm J Qual Patient Saf* 37:400–408, Sep. 2011.
8. Bone R.C., et al.: Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. *Chest* 101:1644–1655, 1992. http://chestjournal.chestpubs.org/content/101/6/1644.full.pdf (last accessed Sep. 12, 2011).
9. Rivers E., et al.: Early Goal-Directed Therapy Collaborative Group: Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 345:1368–1377, Nov. 8, 2001.
10. Bernard G.R., et al.: Recombinant human protein C Worldwide Evaluation in Severe Sepsis (PROWESS) Study Group: Efficacy and safety of recombinant human activated protein C for severe sepsis. *N Engl J Med* 344:699–709, Mar. 8, 2001.
11. Martin G.S., et al.: The epidemiology of sepsis in the United States from 1979 through 2000. *N Engl J Med* 348:1546–1554, Apr. 17, 2003.

12. Dellinger R.P., et al.: Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008. *Crit Care Med* 36:296–327, Apr. 2008.
13. Surviving Sepsis Campaign®: *Severe Sepsis Bundles.* http://www.survivingsepsis.org/Bundles/Pages/default.aspx (last accessed Sep. 12, 2011).
14. Focht A., et al.: Early goal-directed therapy: Improving mortality and morbidity of sepsis in the emergency department. *Jt Comm J Qual Patient Saf* 35:186–191, Apr. 2009.
15. Otero R.M., et al.: Early goal-directed therapy in severe sepsis and septic shock revisited: Concepts, controversies, and contemporary findings. *Chest* 130:1579–1595, Nov. 2006.
16. Cardoso T., et al.: Reducing mortality in severe sepsis with the implementation of a core 6-hour bundle: results from the Portuguese community-acquired sepsis study (SACiUCI study). *Crit Care* 14:R83. Epub May 10, 2010.
17. Nguyen H.B., et al.: Implementation of a bundle of quality indicators for the early management of severe sepsis and septic shock is associated with decreased mortality. *Crit Care Med* 35:1105–1112, Apr. 2007.
18. Surviving Sepsis Campaign®: *About the Campaign.* http://www.survivingsepsis.org/About_the_Campaign/Pages/default.aspx (last accessed Sep. 12, 2011).
19. Levy M.M., et al.: The Surviving Sepsis Campaign: Results of an international guideline-based performance improvement program targeting severe sepsis. *Crit Care Med* 38:367–374, Feb. 2010.
20. Jones A.E., et al.: Implementing early goal-directed therapy in the emergency setting: The challenges and experiences of translating research innovations into clinical reality in academic and community settings. *Acad Emerg Med* 14:1072–1078, Nov. 2007.
21. Institute for Healthcare Improvement: *Improvement Advisor: Professional Development Program.* http://www.ihi.org/offerings/Training/ImprovementAdvisor/2011AugImprovementAdvisor/Pages/default.aspx (last accessed Sep. 12, 2011).
22. Institute for Healthcare Improvement: *The Breakthrough Series: IHI's Collaborative Model for Achieving Breakthrough Improvement.* IHI Innovation Series white paper. Boston: Institute for Healthcare Improvement, 2003 (available at http://www.IHI.org).
23. Escobar G.J., et al.: Risk-adjusting hospital inpatient mortality using automated inpatient, outpatient, and laboratory databases. *Med Care* 46:232–239, Mar. 2008.
24. Carlbom D.J., Rubenfeld G.D.: Barriers to implementing protocol-based sepsis resuscitation in the emergency department: Results of a national survey. *Crit Care Med* 35:2525–2532, Nov. 2007.

Online-Only Content

Appendix 1. Sepsis "Time Zero" Tool



This tool is intended to ensure the timely delivery of Early Goal-Directed Therapy.

Online-Only Content

Appendix 2. Emergency Department Handoff Report

KAISER PERMANENTE
Santa Teresa Community Hospital

ED Admission Hand-off Report

Situation

CHIEF COMPLAINT:

Interpreter: ☐ Yes ☐ No Language/Communication Barriers:

Current HBS MD: MD Diagnosis:

Imprint Here

Background

Medical History: ☐ Asthma/COPD ☐ Diabetes ☐ CAD ☐ HTN ☐ CHF ☐ CVA/TIA ☐ Seizures ☐ ESRD ☐ CA ☐ Other:

Code Status: ☐ Full or ☐ Limited ☐ DNR ☐ Unknown ☐ Advance Directive ☐ Psych/Social ☐ Restraints

Isolation Type: (check one) ☐ Respiratory (TB) ☐ VRE/MRSA ☐ Neutropenic ☐ Draining Wound

Allergies:

Labs (include critical values):

Troponin #1	/Time	Troponin #2	/Time	CK #1:	/Time

Procedures/Interventions Done in ED

☐ NG ☐ Foley ☐ R.T. ☐ CXR ☐ CT ☐ Tap: _____

☐ CPR ☐ BS _____

MEDICATION GIVEN IN THE EMERGENCY DEPARTMENT

Medication:	Total Dose:	Time of Last Dose:	Route:		**HIGH RISK MEDICATIONS:**			
Medication:	Total Dose:	Time of Last Dose:	Route:		Medication:	Total Dose:	Time of Last Dose:	Route:
Medication:	Total Dose:	Time of Last Dose:	Route:		Medication:	Total Dose:	Time of Last Dose:	Route:
Medication:	Total Dose:	Time of Last Dose:	Route:		Medication:	Total Dose:	Time of Last Dose:	Route:
Medication:	Total Dose:	Time of Last Dose:	Route:		Medication:	Total Dose:	Time of Last Dose:	Route:

I.V.	Rate:	Site:	I.V.	Rate:	Site:
I.V.	Rate:	Site:	I.V.	Rate:	Site:

Current Vital Signs: BP: HR: Rhythm: Respiratory: Temp: O2SAT:

Pain Scale Rating: Intake: Output:

Assessment

CURRENT ASSESSMENT:

Neurological	**Respiratory**	**Cardiovascular**	**Gastrointestinal**	**Genitourinary**	**Skin**	**Musculo/Skeletal**
☐ No problems	☐ No problems	☐ No problems	☐ No problems	☐ No problems	☐ No problems	☐ No Problems
☐ Confused	☐ SOB	☐ Edema	☐ Nausea	☐ Hematuria	☐ Decubitus:	☐ Weakness/Paralysis
☐ Lethargic	☐ Wheezing	☐ Diaphoresis	☐ Vomiting	☐ Output:_____	_____	☐Right ☐ Left
☐ Unresponsive	☐ Rales/Rhonchi	☐ Cyanosis	☐ Diarrhea	☐	Location:	☐ Amb
☐ Agitated	☐ Cough	☐ Rhythm:	☐ NPO	_____	_____	☐ Yes ☐ No
☐ Modified NIH Score	☐ Other:	_____	☐ Other:		Dressing:	
_____	_____	☐ Other:	_____		_____	
☐ Other:_____		_____			☐ Picture Taken	

Recommendation

ADDITIONAL PERTINENT INFORMATION/COMMENTS/UPDATES:

Needs of patient: ☐ O_2: ☐ Suction: ☐ Monitor: ☐ Pumps:

Potential Safety Issues: ☐ Fall Risk ☐ Skin Care ☐ Aspiration Risk ☐ Pt. on Hover Mat

Family members with patient: ☐ Yes ☐ No If -No, where:

☐ Order scanned to Pharmacy: ☐ Patient Property Record Completed ☐ To Surgery

Signature of RN that completed this report sheet: RN Ext 6140	Date:	Time:
Name of ED RN that gave verbal/phone report: RN	Name of FLOOR RN that received verbal/phone report RN	

Concerns from receiving staff:

K:\misc forms\7 SBAR Hand-Off Tool.doc

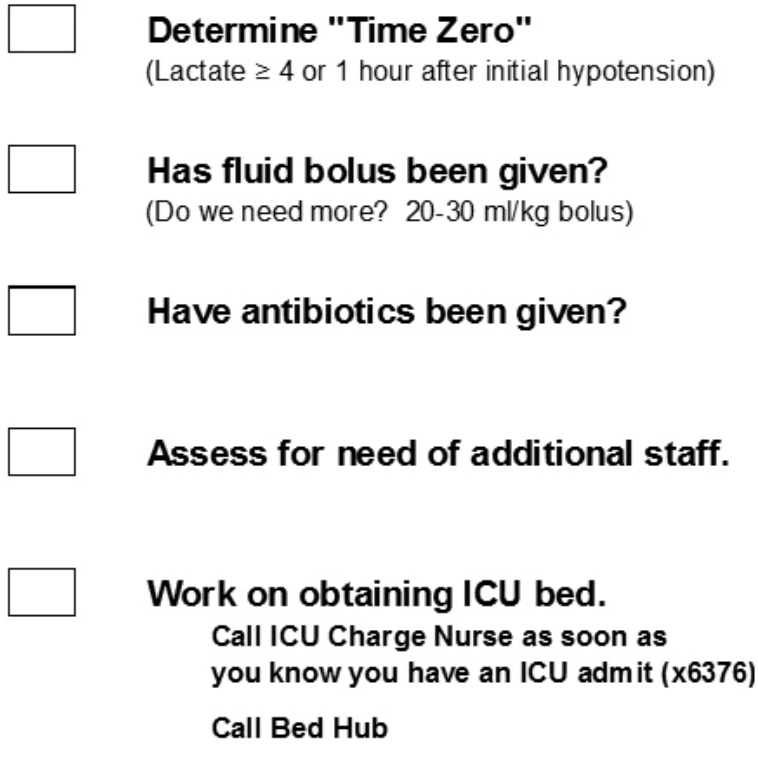
Admit Tool on reverse side

11/5/2008

The tool is intended to increase the quality of transfers from the emergency department to the ICU.

Online-Only Content

Appendix 3. Sepsis Early Goal-Directed Therapy (EGDT) Charge Nurse Checklist



Sepsis EGDT
Charge Nurse Check List

☐ **Determine "Time Zero"**
(Lactate ≥ 4 or 1 hour after initial hypotension)

☐ **Has fluid bolus been given?**
(Do we need more? 20-30 ml/kg bolus)

☐ **Have antibiotics been given?**

☐ **Assess for need of additional staff.**

☐ **Work on obtaining ICU bed.**
Call ICU Charge Nurse as soon as you know you have an ICU admit (x6376)

Call Bed Hub

The emergency department charge nurse uses the checklist to ensure the appropriate triage, treatment, and transfer of patients with sepsis on admission.