Methods, Tools, and Strategies

Using the Integrated Nurse Leadership Program to Reduce Sepsis Mortality

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Article-at-a-Glance

Background: The Integrated Nurse Leadership Program (INLP) is a collaborative improvement model focused on developing practical leadership skills of nurses and other frontline clinicians to lead quality improvement efforts. Sepsis is a major challenge to treat because it arises unpredictably and can progress rapidly. Nine San Francisco Bay Area hospitals participated in a 22-month INLP Sepsis Mortality Reduction Project to improve sepsis detection and management.

Methods: The INLP focused on developing leadership and process improvement skills of nurses and other frontline clinicians. Teams of trained clinicians then implemented three strategies to improve early identification and timely treatment of sepsis: (1) sepsis screening of all patients, with diagnostic testing according to protocol; (2) timely treatment on the basis of key elements of Early Goal-Directed Therapy (EGDT); and (3) ongoing data review. Each hospital agreed to pursue the goal of reducing sepsis mortality by 15% by the end of the project.

Results: In the data collection period (baseline, July–December 2008 and project completion, January–June 2011), team members showed strong improvement in perceived leadership skills, team effectiveness, and ability to improve care quality. During this period, sepsis mortality for eight of the participating hospitals (Hospital 9 joined the project six months after it began) decreased by 43.7%—from 28% in the baseline period to 16% at project completion. Sepsis mortality rates trended downward for all hospitals, significantly decreasing ($p < .05$ at one hospital, $p < .01$ for four hospitals).

Conclusions: In addition to improvement in safety culture and management of septic patients, hospitals participating in the INLP Sepsis Mortality Reduction Project achieved reductions in sepsis mortality during the study period and sustained reductions for more than one year later. The INLP model can be readily applied beyond sepsis management and mortality to other quality problems.

The Integrated Nurse Leadership Program (INLP), developed by the University of California, San Francisco and funded by the Gordon and Betty Moore Foundation, leads an interprofessional group of nurses, physicians, pharmacists, and support staff through a comprehensive process of quality improvement (QI), during which participants learn to innovate, test innovations, diffuse innovations throughout the hospital, and embed innovations in hospital policies and daily practice. The INLP uses a collaborative improvement-oriented approach[1,2] and emphasizes developing individual and organizational capacity to "learn how to learn."* In 2005 the INLP model of QI demonstrated durable and sustained organization-wide improvements in medication error reduction.[3] In this article, we describe implementation of the INLP model in a QI project and on the impact on sepsis mortality.

Sepsis is a serious medical condition caused by an overwhelming immune response to an existing medical condition such as a urinary tract infection or pneumonia. It is a major challenge to treat because it arises unpredictably and can progress rapidly. Every year, severe sepsis strikes about 750,000 Americans, of whom an estimated 28% to 50% die—far more than the number of deaths from prostate cancer, breast cancer, and AIDS combined.[4] Data from the National Hospital Discharge Survey, 2008, indicated that the number and rate per 10,000 population of hospitalizations for septicemia or sepsis more than doubled from 2000 through 2008.[5]

Factors driving the problem of sepsis include an aging population with more chronic illnesses; growing use of invasive procedures, such as vascular catheterization; broader use of immunosuppressive drugs and chemotherapy; and increasing microbial resistance to antibiotics.[4,6]

Sepsis poses many care management challenges. First, optimal treatment of sepsis is time sensitive, requiring a variety of therapeutic interventions to occur within three to six hours of diagnosis. Many clinicians do not regard sepsis as a "time

* The name "Integrated Nurse Leadership Program" originated from the funder's intention to improve nursing-related patient outcomes. Over time, INLP became known regionally as an improvement collaborative.

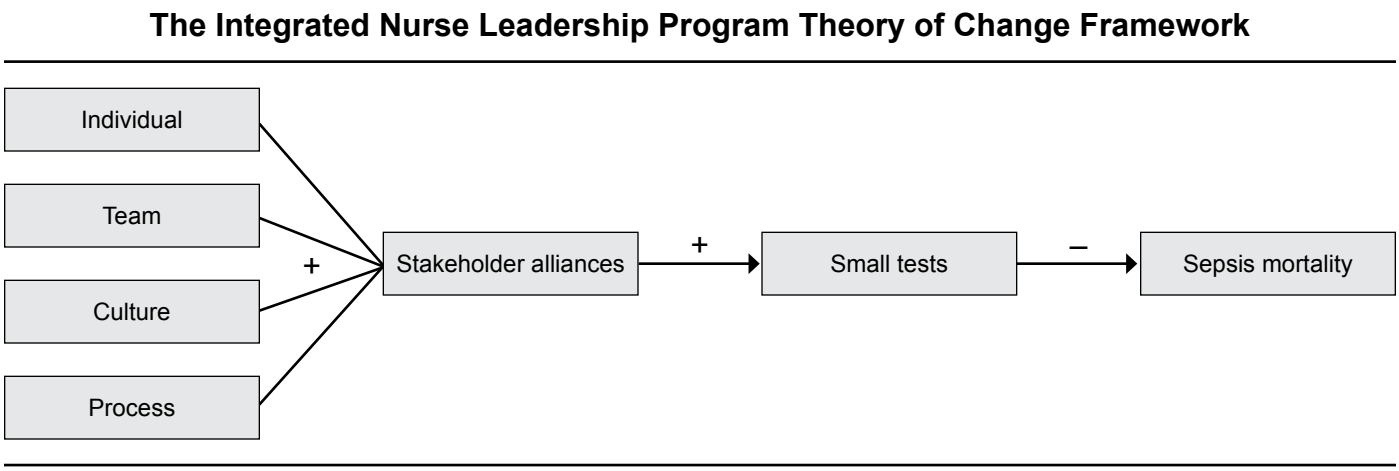

Figure 1. *The Integrated Nurse Leadership Program Theory of Change framework emphasizes the development of frontline clinicians' skills in each of four core elements of quality improvement (QI): Individual, Team, Culture, and Process. These skills come together to facilitate stakeholder alliances and expedite more small tests of change, both intended to result in lower sepsis mortality.*

bound" clinical problem such as stroke or acute myocardial infarction.[7] Second, the ideal therapeutic interventions require extensive interprofessional and inter–service line coordination, involving laboratory services, pharmacy, and nursing. Finally, many hospitals lack unit-specific data on how quickly and effectively sepsis patients are identified and treated, impeding managers' ability to develop tailored improvements in care processes.

Attention in the United States has been focused on sepsis management through the recently ratified National Quality Forum measures for the treatment and management of patients with severe sepsis and septic shock.[8] In California, the management of sepsis patients received additional attention through the state's Delivery System Reform Incentive Pool (DSRIP), a component of the state's approved Medicaid waiver, "Bridge to Reform." The DSRIP offers funds to California's 21 public hospitals to improve processes of care (as well as system infrastructure), and sepsis mortality is one of the DSRIP's specific indicators.[9]

Methods

The Integrated Nurse Leadership Program Collaborating Improvement Model

As described previously, the central tenet of the INLP is that placing frontline nurses (and other health care providers, identified throughout this article as "clinicians") in fundamental roles in an improvement effort is necessary to achieve successful outcomes.[3] The INLP emphasizes the development of frontline clinicians' skills in each of four core elements of QI: Individual, Team, Culture, and Process (Figure 1, above). These four core factors are taught through a dedicated curriculum that combines 12 days of off-site skills seminars, on-site training sessions and mentoring at participants' hospitals, and a specific hospital-based QI project—in this case, the care and management of sepsis patients.

In the recognition that individuals must believe in their ability to accomplish change within their organization and must have leadership skills to influence others and to manage process change, the Individual component of the curriculum includes topics on communication, personal leadership, professional efficacy, critical thinking, and clinical professionalism. To customize this training, each participant completes the Myers-Briggs Type Indicator® (MBTI) assessment instrument[10] to help identify natural leadership strengths and weaknesses. INLP staff then help each individual use these results to target her or his training and role on the hospital-based QI team.

The Team component of the curriculum focuses on team building, project management, effective team meetings, project accountability, leveraging the team, and understanding others. In the hospital, each participant assumes responsibility for some aspect of team meetings (for example, note taking, time keeping). In addition, each team agrees on an acceptable rate for attendance and team member responsibilities. If a team member attends at a lower rate or fails to perform her or his team duties, the team can collectively agree to release a member.

The Culture component highlights the importance of understanding organizational dynamics, power (both formal and informal), and strategic communications in advancing the program. Off-site seminars include sessions on change management, stakeholder analysis, political savvy, organizational awareness, and strategic communications and marketing. A case study is provided in Sidebar 1 (page 266) to show how culture training was put into practice at one hospital.

Sidebar 1. Addressing Culture Challenges: Developing a Standing Order for Blood Test

Culture Challenge
Changing the process for identifying and managing sepsis patients involves a number of different stakeholders in the hospital, many who might be resistant to nurse-driven initiatives.

Integrated Nurse Leadership Program (INLP) Training Intervention
During an off-site educational sessions, teams created a stakeholder map of individuals who would be critical to the process of caring for sepsis patients. For each key stakeholder, participants developed a goal-based request (for example, asking the lead hospitalist physician to develop the protocol for inclusion into medical staff meetings, or asking the laboratory director to support identifying lactic acid blood test as a critical laboratory value). Each participant then used this stakeholder map at the hospital to guide his or her conversations with key individuals. These conversations were recorded on paper and sent back to the INLP director for review.

Hospital Safety Intervention
Nurses at one hospital wanted to have a standing order for a lactic acid blood test when a sepsis screen was positive. To accomplish this change, the nurses first persuaded the hospitalists that this was the right thing to do. Next, this combined group of nurses and physicians had to persuade the laboratory director that a standing order in these cases was appropriate. After the laboratory director agreed (after several months), this group had to persuade the hospital's administration to establish this change as part of the hospital's formal medical standards.

Sepsis Management Result
The nurses now have a standing order and their compliance with obtaining a lactic acid blood test for patients who screened positive for sepsis increased 35%.

Finally, the Process component helps participants develop a set of technical skills for conducting QI, as well as ensuring that participants understand the evidence and best practices regarding the specific QI target—in this case, the care and management of the septic patient. Off-site training includes sessions on systems thinking, process improvement methods, reliability science, use of data, and evidence-based practice. For the on-site work, each team addresses and tries to reform the hospital's process for identifying and managing sepsis patients. INLP staff consisted of subject matter experts in the fields of improvement science, change management, team building, and use of MBTI assessment and clinical management of sepsis in the acute care setting.

Integrated Nurse Leadership Program Sepsis Mortality Reduction Project

Integrated Nurse Leadership Program Teams. Beginning in September 2009, all nine hospitals in the San Francisco Bay Area participated in the 22-month-long INLP Sepsis Mortality Reduction Project, including seven hospitals that had participated in the first INLP project (July 2006–March 2008) on reducing medication errors.[3] The remaining two hospitals, which had not previously worked with INLP, asked to participate. All hospitals volunteered to participate in the project. There were no fees associated with or charged to the hospital for their participation. All training costs were paid for through the grant provided by the Gordon and Betty Moore Foundation.[11] Each participating hospital had to obtain senior leadership commitment to participate fully and stay with the program until its conclusion. All hospitals were required to sign a memorandum of understanding (MOU) acknowledging and agreeing to the requirements of the grant, including releasing time for staff training and improvement work, collecting data, and sharing their data with the rest of the cohort. The MOU had to be signed by a member of the senior leadership. The project included all the general medicine units, step-down units, ICUs, and emergency departments (EDs) in the hospitals.

Each hospital established an interdisciplinary team of nurses, pharmacists, administrators, physicians, and laboratory directors to serve as the Steering Committee for the project. This team of 10 to 12 was responsible for overseeing the work done at the unit level and driving the project hospitalwide and met every two weeks. In addition, each hospital established multiple unit-based teams (one per unit involved in the improvement effort) composed of unit-based nurses, frontline physicians (for example, hospitalist or intensivist), and rapid response respiratory therapists, and they met every week on their unit. The size of each unit's team varied between six and eight members. This team was responsible for carrying out the rapid cycle testing; developing and implementing changes in work flow, such as adding nurses screening each patient on every shift for possible sepsis; adapting, adopting, or abandoning policies and procedures, such as changing the medical/surgical sepsis medical order set to include every element of the sepsis bundle; and producing process-level data. Each unit-based team designated a unit team lead, who attended Steering Committee meetings. In total, 172 hospital staff participated in the INLP project—133 nurses, nurse managers, and nurse educators; 5 respiratory therapists; 15 physicians; 6 pharmacists; 3 laboratory managers; 2 medical records directors, and 8 administrators—ranging from 15 to 30 participants per hospital. These staff members all participated in the INLP trainings. Each staff member spent approximately two hours per week on this project during the grant. Each hospital agreed to pursue the goal of reducing sepsis mortality by 15% by the end of the project.

Integrated Nurse Leadership Program Strategies

Each participating hospital implemented three strategies to reduce sepsis mortality: (1) sepsis screening of all patients, with diagnostic testing according to protocol; (2) timely treatment on the basis of key elements of Early Goal-Directed Therapy (EGDT)[12,13]; and (3) ongoing data review. Key elements of EGDT include obtaining a lactic acid level and, if elevated or if the patient is hypotensive (or believed by the medical staff to be severely septic), then obtaining blood cultures, administering fluids and antibiotics, and inserting a central line to measure patient response to therapies. (Inserting a central line was left up to the discretion of the physician and considered an "optional" measure for this grant.[12,13])

The first critical management strategy required hospitals to screen 100% of patients for sepsis. Any patient presenting through the ED, regardless of complaint or symptoms, received a screening test as part of the triage process. On inpatient units, a sepsis screen was required within four hours from the start of every nursing shift. In addition, a nurse could repeat the screen at any time if he or she felt a patient's condition warranted a repeat assessment. The screening assessment included standard vital signs, as well as organ-dysfunction measures and white blood cell count; nurses also gathered or reviewed relevant patient history, including any history of infection (such as productive cough), and identified any potential for infection such as a surgical site wound. Implementing the sepsis screen was a key work process for the unit teams. Identifying processes for routine use of the screens took several months to implement reliably due to the multifactorial complexities of daily clinical work patterns.

The second strategy focused on reducing the time lags between EGDT bundle elements by designing and building changes into daily work processes so that required interventions would be initiated sooner for any patient diagnosed as being severely septic or in septic shock. For example, participating hospitals developed specific nurse-driven protocols that allowed the treating nurse to order the lactic acid on the basis of a positive sepsis screen or initiate selected elements of the EGDT bundle. Another example included working with pharmacists and infectious disease physicians to determine an "anchor" list of antimicrobials for use in this patient population. Having a short list of anchor antimicrobials allowed each unit to house these medications locally. This process change eliminated the need to place orders that the pharmacy department would have to fill, thus enabling the units to administer more reliably these medications within the ideal time frame.

The final strategy involved regularly collecting and presenting unit-based, process-level data on each element of the bundle. These data included the percentage of time that the screening tool was used and the percentage of time that a lactate was ordered when a sepsis screen was positive. If a patient was deemed to require the remaining EGDT bundle, additional data were collected, including timeliness of antibiotics and blood cultures and the amount of fluid given and during what period. These data were collected by each unit every month and presented to both the Steering Committee and unit-based teams.

An explicit goal of the INLP was for each hospital to achieve a 15% relative reduction in sepsis mortality rate between the baseline (July–December 2008) and project completion (January–June 2011) periods.

Data Collection

Survey Measure

To understand how effective our change model was at creating clinical leaders and improving clinical outcomes, we developed the INLP Impact Survey. The survey assesses changes in individual and hospital capacity for improvement and incorporates elements from existing instruments measuring psychological safety, organizational learning, teamwork, implementation, and hospital culture.[14–18] The Impact Survey consists of 25 questions that map to the INLP factors of Individual, Team, Culture, and Process, with 6 to 7 questions for each factor (Appendix 1, available in online article). Most of the questions were intended to address aspects of each factor considered most salient to the INLP intervention. When other surveys contained questions that addressed certain issues, we adapted them for the survey. For the Individual factor, the survey included questions on the individual's belief in his or her leadership ability and self-efficacy within his or her clinical domain, ability to influence or persuade others and to understand and manage processes, and ability to achieve clinical goals. Several items in this section were derived from Edmondson's scale on psychological safety.[18]

Questions on the Team factor, which included the extent to which team members shared values, worked together, experienced effective decision making, accomplished team goals, and achieved buy-in as a result of teamwork, included items inspired by the Safety Attitudes Questionnaire[17] and the Hospital Survey on Patient Safety Culture.[19]

Some of the Process questions, which included whether team members felt they had the necessary skills to improve process and the ability to replicate processes on their own, were based on those developed by Tucker et al.[14] Finally, the Culture factor included questions assessing the hospital's history of innovation, support for change, evidence-based practice, cross-disciplinary

Table 1. Interscale Correlations and Reliability for the Four Factors*

Scale	Individual	Team	Process	Culture
Individual	0.82			
Team	0.56	0.89		
Process	0.61	0.76	0.87	
Culture	0.56	0.61	0.69	0.88

* The diagonal entries display Cronbach's alphas for each factor; off-diagonal entries represent interscale correlations.

and organizational coordination capabilities, and learning-orientation. The questions address the four key improvement habits described by Horbar et al., in their study of improvement in neonatal ICUs: habits for change, evidence-based practice, systems thinking, and collaborative learning.[16]

We tested the original items in a convenience sample to ensure that their meaning was understood as intended. All items used a five-point Likert scale, with response options ranging from "strongly disagree" to "strongly agree" and a neutral midpoint of neither agree nor disagree.

Survey Administration. The INLP Impact Survey was issued three times throughout the course of the project: within three months of the project's beginning (in December 2009), again in February 2010, and at the project's conclusion in June 2011. In each instance, the survey was administered online, with a survey link e-mailed to each participating hospital's team members. The survey was administered as part of the regular intersession homework package each participant received. No specific incentives were provided. Each participant received up to three e-mail reminders to complete his or her homework assignments.

Survey Validation. We examined the internal consistency of our model by assessing the Cronbach's alpha coefficients for each theoretical construct using combined data from the February 2010 and April 2011 survey results (Table 1, above). The reliability estimates (alpha coefficients) obtained for the Individual, Team, Process, and Culture scales were 0.82, 0.89, 0.87 and 0.88 (median, 0.88), respectively, exceeding the conventional 0.7 cutoff. We also assessed discriminant validity by comparing the Cronbach's alpha with correlations between the factors in the survey.[20] As shown in Table 1, the correlations between factors, which ranged from 0.56 to 0.76 (median, 0.61), were all lower than the alpha coefficients, suggesting that factors measured distinct albeit related constructs. To further validate our model, we performed a confirmatory factor analysis (CFA) on our sample. Loadings for all 25 items were greater than 0.65. Model fit was adequate, except for the goodness-of-fit index, with .83 not meeting the .90 criterion (Table 2, page 269).

Survey Analysis. We evaluated the change in survey results over time for the entire cohort. We also segmented the cohort into respondents from hospitals with higher sepsis bundle compliance and hospitals with lower sepsis bundle compliance in order to test for heterogeneous treatment effects.

Sepsis Measures

Throughout the project, each participating hospital tracked four types of measures and reported each measure quarterly, except for the mortality measure, which was reported every six months. The same methods, measurements, and definitions were used throughout the project, consistent with a pre-post study design. The first, screening compliance, measured the percentage of patients screened for sepsis from a random sample of patients, 60 patients per month seen by the ED (30 patients per month in some of the smaller hospitals), plus 30 patients per month from all other departments (for example, ICU, medical/surgical). Second, hospitals tracked the percentage of patients with a positive sepsis screen who received a lactic acid blood test.

The remaining elements of the EGDT bundle were measured separately and reported as a group; this cluster included the portion of patients who had blood cultures obtained prior to administration of antibiotics; broad spectrum antibiotics administered within one hour of diagnosis of severe sepsis or septic shock; the required amount of fluids administered within one hour; and a central line placed (for eligible patients only).

The final measure was sepsis mortality. Hospitals used a list of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) classifications to identify patients with severe sepsis or septic shock. Every six months, participating hospitals submitted their incidence of severe sepsis/septic shock patients for that period, as well as the number of mortalities among these patients per month. Those six months of data were aggregated to establish one mortality number for that time period to minimize seasonal variation in mortality and smooth mortality rates for hospitals with very small numbers of septic patients. Participating hospitals began submitting mortality data in 2008, and improvement work began in 2009, with data reporting beginning in January 2010. Hospitals then submitted data on a quarterly basis beginning in January 2011, in accordance with reporting requirements from the Gordon and Betty Moore Foundation. For the sake of consistency, we performed our analysis in six-month intervals. Because INLP ended in April 2011, the final data collection period—January–June 2011—was half during the project and half after its conclusion. Sepsis mortality data were initially captured every

Table 2. Confirmatory Factor Analysis (CFA)*

	χ^2	df	χ^2/df	RMR	GFI	AGFI	RMSEA	CFI
Default Model	644.502	269	2.40	0.03	0.83	0.80	0.07	0.90

df, degrees of freedom; RMR, root mean square residual; GFI, goodness-of-fit index; AGFI, adjusted goodness-of-fit index; RMSEA, root mean square error of approximation; CFI, comparative fit index.

* For χ^2/df, values < 3 are regarded as indicative of good fit; for the RMSEA, values < .08 are regarded as indicative of adequate fit, and values < .05 as exceptional fit; for the GFI, values > .90 are regarded as adequate fit; for AGFI, values > .80 are regarded as adequate fit; for RMR, values < .10 are regarded as adequate fit; and for CFI, values > .90 are regarded as adequate fit.

six months until January 2011, when they were captured every three months for tighter project management. For consistency, the data were analyzed every six months. Reporting periods for sepsis mortality data were designated as Periods I through VIII.

Analysis of Change in Sepsis Mortality. We compared the ICD-9-CM coded sepsis mortality rate during the baseline period to the INLP project's completion (January–June 2011), and at 16 months after the conclusion of the project for the entire cohort and each participating hospital. During the baseline period (July–December 2008), mortality rates were collected by month and then aggregated into one data point to reduce mortality variation from seasonal trends. During this baseline period, 1,195 positively screened patients with severe sepsis/septic shock were identified. Data were collected by personnel at participating hospitals and reported to INLP staff. We compared the relative percentage change in mortality rates among the three periods. To account for low numbers of severe sepsis/septic shock patients per period, we tested for statistical significance, using two-sample *t*-tests. We assessed change in sepsis mortality only for Hospitals 1 through 8 because Hospital 9 joined INLP six months after the project started.

Results

Staff Survey

Of the 172 project participants surveyed in February 2010, 114 responded (response rate, 66%), and 159 (86%) of 184 participants responded to the April 2011 survey, reflecting the addition of Hospital 9. However, the 49 respondents for the December 2009 survey represented a response rate of < 50%, reflecting insufficient time for the INLP teams to respond to the survey. As these administrative processes improved, response rates increased. As shown in Appendix 1, results improved for most of the areas in the survey between February 2010 and April 2011. Overall, the organization culture questions showed significant improvement, with a 45% increase in individuals' agreement or strong agreement with statements regarding their team's cultural competencies. For example, 22% more respondents said that their fellow team members know how to work with organizational leaders to get things done following the INLP compared to baseline. INLP participants also indicated strong improvement in competencies related to process improvement, with the largest overall increase in respondents agreeing or strongly agreeing to statements related to competencies in this area. Most survey items related to individual and team competencies also showed overall improvement but often to a lesser degree than process and culture competencies. Hospitals with greater compliance with the sepsis bundle (and greater decreases in sepsis mortality) also experienced more improvement in the staff survey. The higher-performing hospitals improved less on culture questions than lower-performing hospitals, reflecting the former's higher baseline scores.

Sepsis Bundle Compliance

Throughout the duration of the project, the participants showed improved compliance with almost every EGDT bundle element. In addition, sepsis screening compliance increased from 90% in January 2010 to 92% in June 2011. The proportion of patients screening positive for sepsis who received a lactic acid blood test increased from 58% to 77% between January 2010 and June 2011. (Participating hospitals began consistently measuring compliance of the EGDT bundle in January 2010.) During the same period, the percentage of severe sepsis/septic shock patients who received antibiotics and fluid resuscitation increased from 48% to 67%, and 34% to 72%, respectively. Blood culture compliance remained unchanged at 89% for the same duration, while the proportion of severe sepsis/septic shock patients receiving all bundle elements showed a relative increase of 172%, from 18% to 49%.

Sepsis Mortality

The eight hospitals that joined the project at baseline recorded a 43.7% decrease in sepsis mortality, from 28% in the baseline to 16% in the project completion period. As shown in Table 3 (page 270), sepsis mortality rates trended downward for all participating hospitals and significantly decreased at Hospitals 1, 2, 3, 4, and 8 during this period (p <. 05 for Hospital 1,

Table 3. ICD-9-CM Coded Mortality Rates at Eight Hospitals, Periods I–VIII (July 2008–December 2012)*

Hospital	Mortality Rates (No. of Septic Patients Who Died + No. of Patients Who Survived)								% Change Between I and V	% Change Between I and VIII
	I. Jul–Dec 2008 (Baseline)	II. Jul–Dec 2009	III. Jan–Jun 2010	IV. Jul–Dec 2010	V. Jan–Jun 2011	VI. Jul–Dec 2011	VII. Jan–Jun 2012	VIII. Jul–Dec 2012		
Hospital 1	32.4% (179)	23.5% (119)	31.8% (107)	29.0% (124)	22.9% (157)	15.0% (206)	16.0% (194)	9.6% (230)	-29.3†	-70.4‡
Hospital 2	29.7% (202)	19.1% (439)	20.3% (503)	15.9% (460)	19.1% (507)	14.9% (490)	16.6% (483)	15.3% (503)	-35.7‡	-48.5‡
Hospital 3	24.0% (121)	14.3% (301)	12.1% (348)	11.5% (262)	10.8% (352)	10.2% (374)	12.0% (415)	10.9% (413)	-55.0‡	-54.6‡
Hospital 4	34.8% (184)	16.0% (332)	17.5% (320)	13.6% (374)	12.0% (483)	10.9% (487)	13.5% (577)	11.8% (559)	-65.5‡	-66.1‡
Hospital 5	25.4% (130)	20.4% (201)	24.4% (176)	23.5% (213)	24.2% (215)	14.5% (220)	16.4% (342)	11.3% (506)	-4.7	-55.5‡
Hospital 6	32.1% (112)	30.6% (62)	16.9% (71)	23.3% (60)	23.8% (63)	16.9% (65)	22.6% (53)	24.6% (57)	-25.9	-23.4
Hospital 7	4.4% (90)	8.5% (47)	3.8% (52)	7.4% (27)	2.2% (45)	0.0% (50)	6.0% (50)	14.8% (54)	-50.0	236.4
Hospital 8	31.6% (177)	15.5% (219)	11.2% (223)	14.6% (253)	13.9% (202)	17.0% (200)	18.8% (208)	23.1% (169)	-56.0‡	-26.9†
Overall§	27.7% (1,195)	18.3% (1,720)	17.8% (1,800)	16.6% (1,773)	16.1% (2,024)	13.0% (2,092)	15.0% (2,322)	13.2% (2,491)	-41.9‡	-52.3‡

ICD-9, International Classification of Diseases, Ninth Revision, Clinical Modification.

* September 2008–June 2011, Integrated Nurse Leadership Program Sepsis Mortality Reduction Project; July 2008–December 2012 includes baseline and postproject data. Reporting periods for sepsis mortality data are designated as Periods I through VIII. The data were collected every six months, until January 2011, when they were collected every three months for tighter project management. For consistency, the data were analyzed data every six months. Changes in sepsis mortality were assessed only for Hospitals 1 through 8 because Hospital 9 joined the project six months after the project began.

† $p <$. 05, two-sample *t*-test.

‡ $p <$ .01, two-sample *t*-test.

§ Overall percentages computed by taking the sum of patients from all hospitals divided by the sum of all septic patients from all hospitals. It is not the average of all hospitals' percentages.

$p <$.01 for Hospitals 2, 3, 4, and 8). Although Hospitals 6 and 7 evidenced mortality decreases between baseline and January–June 2011 of 26% and 50%, respectively, these reductions were not statistically significant because of the relatively small number of septic patients in the final reporting period. These cohortwide mortality decreases were sustained, and in some cases expanded upon, after the INLP's conclusion in Period V (Table 3, above). For the July–December 2012 reporting period, hospitals reported a 13% mortality rate, a 52% relative decrease from the baseline period. Although the reported mortality rate decreased in each six-month period throughout the project's duration, the number of severe sepsis/septic shock patients increased.

Discussion

In addition to improvement in safety culture and management of septic patients, hospitals participating in the INLP Sepsis Mortality Reduction Project achieved reductions in sepsis mortality during the study period and sustained reductions for more than one year later. With average mortality of 28% at baseline, participating hospitals were already well below the national average. They nevertheless improved dramatically over the study period. The project hospitals also achieved a major increase in compliance with the EGDT bundle.

From the perspective of return on investment, the hospitals were also successful. Total investment in the INLP was approximately $2.5 million. (This investment represents the cost of running the program, including providing the educational and data analytics support to each of the participating hospitals.) During the study period, sepsis mortality decreased by 44%. The project also achieved substantial costs savings, realizing approximately $1.1 million in net savings by reducing mortality and utilization of high-cost resources (for example, fewer ICU

days). This represents a 56% return on the original investment. Because benefits of improved safety culture and clinical management of septic patients also accrued beyond the study phase of our grant, the return on investment could be even greater than stated here.

Achieving policy goals of lower cost and higher quality requires deeper understanding of programmatic approaches for improving clinical care management. The INLP collaborative improvement model can be readily applied beyond sepsis management and mortality to other quality problems. Our results suggest that participating hospitals experienced improvement in safety culture, clinical management of septic patients, and sepsis mortality.

Organizations are dynamic and complex social systems. INLP recognizes that in situations requiring interdisciplinary coordination, such as reducing sepsis mortality, barriers to improvement are often more organizational and cultural than technical (for example, not knowing the clinical evidence). Thus INLP focuses on training frontline clinicians to bring teams together in a participatory manner to solve clinical problems that cut across units and disciplines. Other successful collaboratives, such as Patient Safety First,[20] share with the INLP common constructs, such as facilitated learning sessions, use of a reliable improvement method, and using data to track and trend progress.

Prior to the INLP, participants were unclear as to how to create change and improve care. Through the INLP training, participants learned the steps required to resolve problems and achieve improvements. The INLP focused on formal knowledge acquisition but also experiential knowledge acquisition. Team members needed to "practice what was preached" to develop skills from the educational training. New daily norms emerged only after embedding new practices into routines so that they become a habitual part of the new "normal."

The INLP staff survey makes a novel contribution to improvement in and of itself, in that it measured factors closely aligned with the goals of the INLP and enabled participants to track progress over time. The INLP staff survey may be useful in future research, in which initiatives include aspects of Individual, Team, Culture, and Process. Survey results showed the greatest improvements in the competencies related to Culture and Process, which was expected, given that the INLP focused its change model on understanding how to work with and through others in order to advance complex patient care management issues. In addition, the INLP curriculum included rigorous training on using data to improve care and on understanding the steps required to implement new processes and change existing processes.

Limitations

Our findings should be considered in light of a number of study limitations. Of note, we had a small sample size of hospitals, and the study hospitals may not be representative of all hospitals, as their starting sepsis mortality rates were better than average.

Also, our study lacked a control group. Therefore, we cannot rule out the possibility that secular time trends toward improvement explain our findings. In addition, during the program period, we observed an increase in severe sepsis cases, suggesting that the study may suffer from unintended selection or measurement biases. For example, as part of the project, the strategy included screening all patients presenting through the ED as part of the triage process. As a result, it is likely that clinicians found more cases of sepsis, adding to our denominator over time. If these newfound cases tended to be healthier patients who nevertheless met our criteria for inclusion, this could have explained some of the observed improvement in sepsis mortality.

In addition, because the project was designed primarily as a quality improvement initiative rather than a research study, our analysis did not include severity adjustments to mortality. As we have noted, our mortality review criteria did not change throughout the project. However, in reviewing the ICD-9-CM condition codes of sepsis data, we noted a shift toward identifying patients who previously had not been identified as septic even though they fit the medical criteria for severe sepsis as per the ICD-9-CM taxonomy used in this project. This suggests a trend towards identification of healthier sepsis patients.

These changes in practice likely explain a portion of the improvement we observed. However, the level of improvement achieved during the intervention period exceeded national trends in sepsis mortality.[21] In addition, the marginal decrease in mortality we observed outpaced the marginal increase in screening compliance, suggesting improvement among project participants.

While we believe in the importance of perceptual measures of safety culture as an outcome of the INLP, we acknowledge that the subjective nature of the survey responses is another limitation of this study. This is why we also consider changes in sepsis mortality a more objective measure—before and following the INLP, despite the limitations as described.

Challenges

A key challenge of the INLP collaborative improvement model is its time intensiveness, requiring many hours of training and regular meetings, staff release time, and department commitment. Providing adequate time to teach new skills and

embed new behaviors is critical to the initial success of the program and to sustaining new practices for an extended period beyond the conclusion of the formal program. In addition, sepsis is an organizationwide issue that requires continued focus on the organizationwide response. Providers were apt to feel that the work was done if their particular unit managed sepsis well, even if, for example, the transition from the ED to the ICU was replete with care gaps. Another challenge was getting licensed clinical team members such as nurses and physicians to value input from nonlicensed team members such as laboratory technicians and environmental services staff, whose contributions were often ignored.

Conclusion

This is the second large-scale improvement effort operationalized using the INLP collaborative improvement model. Like the first, the project demonstrated significant improvements in its selected outcome targets and sustained the improvements for more than a year after the active INLP ended, the point at which tracking stopped. The INLP Sepsis Mortality Reduction Project suggests that the best way to build capacity for a better health care system is to fully leverage the nursing and frontline clinical workforce by expanding their skill sets and providing them with the time and resources to undertake successful improvement projects. J

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Appendix 1. Program Impact Survey Results and Question Set

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Appendix 1. Program Impact Survey Results and Question Set, February 2010 and April 2011

	February 2010 Agree or Strongly Agree (%)	**April 2011** Agree or Strongly Agree (%)	**Relative Improvement:** Agree or Strongly Agree (%)
Q3: Achieving my professional goals is well within my reach.	92	95	3.3
Q4: With focus and effort, I can do anything I set out to accomplish.	92	96	4.3
Q5: I am effective at influencing the way others work.	88	89	1.1
Q6: I can overcome obstacles that prevent me from reaching my goals.	90	89	-1.1
Q7: Whatever goals I set, I know I can achieve them.	89	90	1.1
Q8: I am comfortable leading quality improvement efforts of this team.	88	87	-1.1
Q9: Our team members work collaboratively rather than independently to achieve goals.	90	94	4.4
Q10: Our team members work together to suggest and test solutions to identified problems.	96	97	1.0
Q11: Our team has a shared purpose.	94	98	4.3
Q12: We are good at resolving conflict in our team.	89	89	0.0
Q13: Our team tasks are coordinated effectively to meet our goals.	85	88	3.5
Q14: On our team, there is respect among our various professional disciplines.	95	97	2.1
Q15: When project challenges arise, team members have the skills they need to fix the problem.	88	91	3.4
Q16: Team members understand the key processes associated with caring for this condition.	93	95	2.2
Q17: Team members know the steps to take to improve care.	83	95	14.5†
Q18: Team members take time to examine evidence and test results before designing and implementing changes.	86	95	10.5†
Q19: When problems are identified, team members follow through until solutions are implemented.	87	91	4.6
Q20: Studying, measuring, and improving care are essential parts of team members' daily work.	83	93	12.0†
Q21: Team members often use quality improvement tools and technology (i.e., PDSA cycles) to improve performance in our units.	73	85	16.4†
Q22: People on our team know how to work well within our hospital culture.	90	97	7.8*
Q23: People on our team know who to turn to in this hospital for help.	88	91	3.4
Q24: People on our team know who has the power to get things done in our hospital.	86	88	2.3
Q25: People on our team anticipate negative responses from some people and find a way to work around those obstacles.	87	89	2.3
Q26: People on our team know how to work with organizational leaders to get things done.	74	90	21.6
Q27: People on our team know which individual providers we need to convince first to meet our change goals.	86	93	8.1
Individual (Q3–Q8)	90	91	1.3
Team (Q9–Q14)	92	94	2.6
Process (Q15–Q21)	85	92	8.8*
Culture (Q22–Q27)	85	91	7.2

* $p < .05$.
† $p < .01$.