



Infrastructure for quality transformation: measurement and reporting in veterans administration intensive care units

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ABSTRACT

Background: Veterans Health Administration (VA) intensive care units (ICUs) develop an infrastructure for quality improvement using information technology and recruiting leadership.

Methods: *Setting* Participation by the 183 ICUs in the quality improvement program is required.

Infrastructure includes measurement (electronic data extraction, analysis), quarterly web-based reporting and implementation support of evidence-based practices. Leaders prioritise measures based on quality improvement objectives. The electronic extraction is validated manually against the medical record, selecting hospitals whose data elements and measures fall at the extremes (10th, 90th percentile). Results are depicted in graphic, narrative and tabular reports benchmarked by type and complexity of ICU.

Results: The VA admits $103\,689 \pm 1156$ ICU patients/year. Variation in electronic business practices, data location and normal range of some laboratory tests affects data quality. A data management website captures data elements important to ICU performance and not available electronically. A dashboard manages the data overload (quarterly reports ranged 106–299 pages). More than 85% of ICU directors and nurse managers review their reports. Leadership interest is sustained by including ICU targets in executive performance contracts, identification of local improvement opportunities with analytic software, and focused reviews.

Conclusion: Lessons relevant to non-VA institutions include the: (1) need for ongoing data validation, (2) essential involvement of leadership at multiple levels, (3) supplementation of electronic data when key elements are absent, (4) utility of a good but not perfect electronic indicator to move practice while improving data elements and (5) value of a dashboard.

INTRODUCTION

Ferlie and Shortell argue that until health-care systems implement a comprehensive

multi-level change (incorporating leadership at all levels, supporting a learning culture, emphasising the team, and using information technology), substantive sustained improvements in healthcare quality cannot succeed.¹ The Veterans Health Administration (VA) is uniquely suited to adopt these elements to transform quality since the VA holds regional leaders accountable for specific processes with an annual performance measurement contract, has invested in a national system for learning, uses an electronic medical record and has a common goal to improve veterans care.^{2–4}

The intensive care unit (ICU) is a perfect target to test such a change given its (1) high costs as a result of higher nurse to patient ratio, (2) high risk population, (3) reimbursement at or below costs and (4) increasing demand.^{5–7} Such a system might track and provide benchmarks for evidence-based practices, complication rates, and risk adjusted mortality and length of stay.⁸ This paper describes how a centralised infrastructure, the VA Inpatient Evaluation Center (IPEC), involved leadership and benchmarks ICU processes and outcomes. The infrastructure for learning and implementation tools for improving quality in VA ICUs will be discussed in future papers.

METHODS

The project has been reviewed by the Institutional Review Board of the University of Cincinnati.

Setting

The 123 VA hospitals with ICUs are grouped into 21 regions across the USA (online

appendix, table A Hospital Characteristics). VA's 183 ICUs average 10 ± 4 beds (range 2–24 beds) and are categorised into 5 ICU types and 4 levels (LVL) of complexity. LVL 1 ICUs provide the most complex services, accounting for 60% of VA ICUs and 65% of ICU beds. LVL 3 and 4 ICUs provide more limited evaluation and treatment, representing 25% of ICUs, and 18% of VA ICU beds.⁹ For comparison, ICUs are assigned to a single peer group (Cardiac Care Units, Medical ICUs, Surgical ICUs, Medical/Cardiac ICUs, Mixed ICUs [LVL1/2], and Mixed ICUs [LVL 3/4]).

Involving leadership

VA leaders at four levels (national, regional, facility and ICU) coordinate the ICU quality improvement program. The IPEC executive board meets quarterly by teleconference, and includes eight people—(1) a national VA ICU and Quality leader; (2) a regional director, chief medical officer and quality manager and (3) a hospital director, chief of staff and nurse executive. An ICU nurse, manager and physician director from each of the 21 regions participate in the quarterly clinical advisory panel. The clinical advisory panel proposes new improvement projects—scanning recommendations from quality, safety, regulatory or ICU organisations.^{10–14} They also review measurement strategies, recruit ICUs to participate in pilot improvement projects and lead the regional quality initiatives. Region directors control his/her report access, but universally decided that hospitals in the region would see each other's results. The information generated by the program is protected under Quality Assurance legislation (CFR 38.U.S.C. 5705). VA program leaders (Cardiology, Nephrology, etc) propose new metrics/improvement projects to the IPEC director, which are then presented to the clinical advisory panel and executive board.

Assembling the data

Data sources

A computer programmer developed a computer program customised for each hospital that finds and drops data elements quarterly from the electronic medical record of each medical centre into an analytic file. This program uses the treating specialty field in the VA discharge database (VA Patient Treatment File; PTF) to identify patients with ICU. The program for those patients, then extracts the diagnosis ICD-9-CM codes (International Classification of Disease 9th revision—Clinical Modification codes), results of specific laboratory tests, vital signs, and medication orders for a time period surrounding the whole hospital admission (online appendix, table B and C detail data elements).

Diagnostic grouping

In a previously validated strategy, programming assigns each patient to one of 84 mutually exclusive categories using the ICD-9-CM code facilitated by Clinical Classification Software.^{15 16} Operative patients, those with operating room (OR) stays within 24 h of ICU admission, are grouped by ICD-9-CM procedure codes from the OR. Non-operative patients are grouped by ICD-9-CM diagnostic codes representing the primary reason for the ICU stay. Where possible, IPEC diagnostic groups match those defined by others. For example, the IPEC ICD-9-CM code groups for congestive heart failure, pneumonia and acute myocardial infarction (AMI) match those used by the Center for Medicaid and Medicare Services.¹⁷ Diagnostic groups are used in risk adjustment and to create appropriate pools for process measurement. The classification strategy is available on request.

Data validity (table 1)

As part of data validation policy, analysts at IPEC assume first that hospital outlier status in any data element is related to incomplete or inaccurate data extraction. Data errors could result in false positives (when the electronic extraction incorrectly reports results which are not present) or false negatives (when the electronic extraction fails to pull results which are present). To determine data accuracy, analysts (master's statisticians) rank order the hospitals by a measure of interest, identifying five hospitals at the top and bottom of the list. In each hospital, a program manager (nurse) reviews 10 charts missing the indicator of interest to determine if the electronic extraction matches that of chart review. For example, the program manager reviewed cases with the diagnosis of hip fracture, who electronically did not appear to receive pharmacologic prophylaxis for deep venous thrombosis, selected from sites with the lowest proportion of prophylaxis in hip fracture. Where chart review reveals inaccurate electronic extraction (eg, the presence of a laboratory value or delivery of an evidence based process counted as 'missing'), the extraction program is reviewed and the site queried for anomalies in data entry. Our rules require that the electronic data matches in 95% of the chart reviews before the measure can be released and reported or the measure is dropped. Mortality is determined from the vital status file in the national VA database linked to benefits.¹⁸

Analysing and interpreting the data

Internal VA and external experts in risk adjustment, intensive care and implementation science form the centralised methodology workgroup. This group reviews statistical issues in model development, process measurement, result presentation, implementation strategies and methodological limitations for emphasis.

Mortality and risk adjustment

Table 2 defines the five different mortality measures that facilitate interpretation.

The logistic (mortality) and linear (length of stay) regression models that account for differences in patient

characteristics have previously been described and validated.^{19–22} Predictors are described in the online appendix, table D.^{17–23} The risk adjustment models compares (1) ICU mortality rates, (2) determines physiologic case severity index (CSI, the predicted mortality

Table 1 Data validation issues and solutions

Class	Variation in data entry	Effect on measures	Solutions to minimise distortion of measures
Identification of ICU patients	CCU patients (PTS) were classified as cardiology treating specialty not as ICU PTS	CCU patients were not included in ICU cohort, Distorted image of ICU care	Add CCU to ICU treating specialty fields, scan each ICU quarterly for variation in proportion of major diagnoses benchmarked to type of ICU
	SICU PTS after discharge to medical step down unit electronically remained in SICU treating specialty (to track workload)	Treating specialty dates determined length of stay (LOS) in ICU, this prolonged SICU length of stay	Add surgical step down to treating specialty fields. Monitor with # patient days/ maximal # days (>100% is impossible)
	PTS in a step-down ward were assigned an ICU treating specialty	Artificial reduction in severity of illness in ICU cohort that included step-down patients	1. Communicate with local ICU managers to validate each individual ward assigned to an ICU treating specialty. 2. Track quarterly variation by ICU in severity of illness
Duplicate deaths	PTS were electronically moved out of the ICU location when ready for ward but physically remained in ICU when no acute care bed was available.	Artificial shortening or length of stay	1. Use two sources to determine LOS, one with treating specialty, the other with ward location. Feedback differences to local leadership and managers
	PTS readmitted and died within 24 h of index hospital discharge may be counted dead twice.	Inflates risk adjusted and unadjusted mortality rates	Add screening for duplicate deaths
Capture of medication orders	Medications orders are captured by dispensed status. Those meds dispensed from ward stock were invisible (subq heparin, insulin)	Underestimates adherence to deep venous prophylaxis, treatment for hyperglycemia	Revise extraction program
	Satellite pharmacies used different procedures for completing orders	Same	Use data from bar coded medication administration
Laboratory data location	Location of lab values varied across the country	In the risk model, a normal value is inserted for 'unmeasured' labs—could underestimate severity of illness, or adherence (proportion of patients with therapeutic INR on Coumadin)	Map initial laboratory value locations, track proportion of missing labs for each lab value for each quarterly report
	Change in lab value location occurs with addition of new reagents and new testing machines commonly		Developed system to allow identification of changes in the laboratory maps each quarter
Laboratory normal values	Normal range of newer laboratory tests varies (ex. Troponin 10% coefficient of variation ranges from 0.03 to >5)	Inability to use laboratory test in risk model	Categorise data (troponin normal, high, abnormal) Determine lab test manufacturer quarterly Classify type of instrument (point of care)

CCU, cardiac care unit; SICU, surgical care unit; ICU, intensive care unit; PTS, patients.

Table 2 Dashboard elements

Measures	Denominator/cohort	Numerator/definition	10th and 90th percentile range of values at ICU level
<i>Outcomes</i>			
Mortality at hospital discharge			
Unadjusted mortality	All first ICU admissions, excluding transferred patients	Number of patients in denominator that died at discharge from the hospital	4.2–11.8%
Adjusted mortality	Sum of the predicted hospital mortality of each patient	Observed number of deaths at hospital discharge	0.66–1.25
Unadjusted mortality of patients transferred from the ward to the ICU (reflects ability of hospital to rescue patients)	Number of patients transferred from the ward to the ICU excluding those transferred to another hospital at discharge.	Of patients in the denominator, those that die at hospital discharge	8.9–26.2%
Mortality at 30 days from admission			
Unadjusted	First ICU admissions for any hospitalisation, assigns patients transferred at discharge to the transferring hospitals	Number of patients in denominator that died at 30 days from hospital admission	7.1–13.8%
Adjusted	Sum of the predicted 30-day mortality of each patient	Observed number of deaths at 30 days from admission	0.76–1.19
<i>Throughput</i>			
Observed minus predicted length of stay	COHORT: Survivors to 32 days, LOS truncated to 32 days for those with LOS >32 days	CALCULATION: Sum of the Observed minus predicted length of stay for each patient divided by the total number of patients	–0.99 to 0.57 days
Mean Length of stay	First admissions to the ICU	Date and time of discharge minus date and time of admission divided by 24 h to convert to days	2.14 to 3.93 days
<i>Hospital acquired infections</i>			
Central line associated blood stream infections	Number of central line days where each patient can have a maximum of 1 line day each day, CDC central line definition used	Number of central line infections using CDC definitions	0–3.85/1000 line days
Ventilator associated pneumonia	Number of ventilator days; counted once daily at the same time	Number of ventilator associated pneumonias using CDC definitions	0–5.28/1000 vent days
<i>Process measures</i>			
<i>Glycaemia management</i>			
Hypoglycaemia (cut point 45 mg/dl)	Count of patient days in ICU on hypoglycemic agent per time period	# patient days with a Glucose <cut point among patients included in denominator (on hypoglycemic agent)	0–1.9%
Hypoglycaemia (cut point 60 mg/dl)	Total number of patients (PTS) with at least two glucose measurements excluding those admitted with diabetes	# patients with a mean glucose > 180 mg/dl (mean glucose=sum of all glucose measures in ICU divided by the number of glucose measures)	1.4–4.7%
Proportion of patients with mean glucose < 180 mg/dl			11–27.6%
			Continued

Table 2 Continued

Measures	Denominator/cohort	Numerator/definition	10th and 90th percentile range of values at ICU level
<i>Deep venous thrombosis (DVT) pharmacologic prophylaxis</i>			
Mechanical ventilation	# patients with mechanical ventilation ICD-9-CM codes	# PTS in denominator with MD order for heparin, LMW heparin, Aprotroban, fondaparinux, or coumadin	63–93%
Operative	# patients with procedure codes (GI surgery, hip fracture/replacement) at high risk for DVT		53–100%
Non-operative	# patients with primary admission diagnosis codes for non-operative cases (CHF, COPD, pneumonia, malignancy, acute renal failure, sepsis) at high risk for DVT		67–89.5%
<i>Adherence to evidence based practices for devices</i>			
Central line insertion	Total number of audits (entered monthly) of central line insertion	Number of times in audits each practice used (chlorhexidine skin prep, femoral site, maximal sterile barriers, bed sized drape)	89–100%
Ventilator	Audited cases of ventilator practices	# times each practice used (HOB > 30°, sedation vacation, spontaneous breathing trial, VTE prophylaxis, SUD prophylaxis)	64–100%
<i>Throughput</i>			
Bed turns	Number of operating beds in the ICU	Number of patients admitted (rolling 12 months)	45–91
Adjusted bed turnover	The number of operating beds in the ICU All patients admitted to the ICU	Number of patients admitted (rolling 12 months) time the case severity index Number of patients who return to the ICU after discharge to the ward	36–94 2–26%
Readmissions to the ICU during same hospitalization	All patients admitted to the ICU (first ICU admission to avoid counting patients twice)	Number of patients in denominator who are admitted to the ICU within 30 days from discharge from the hospital	8.6–14.2%
30-day readmission rate—all cause			

ICU, Intensive care unit; CDC, Center for Disease Control (US); VTE venous thromboembolism prophylaxis; SUD stress ulcer disease prophylaxis; HOB, head of bed.

of index ICU divided by the predicted mortality of all VA ICU patients) and (3) throughput—adjusted bed turnover (number of ICU patients annually divided by number of ICU beds times the CSI) and observed minus expected length of stay.

Process indicators

The relevant population, numerators and denominators are defined using diagnosis, treatment, pharmacy and/or laboratory data. For example, in AMI, the number of patients with AMI and a physician order for aspirin within 24 h of admission forms the numerator and the total number of patients admitted with AMI the denominator. Patients with contraindications are excluded from both the numerator and denominator (eg, patients with ICU diagnosis of diabetes are excluded from the measure of mean glucose). Determination of indicator validity was described previously. Others have reported similarity of electronic quality measures compared to chart review.²⁴

Feedback

Quarterly reports are retrieved from a secure website. They contain results depicted in graphic, narrative and tabular form, reported at the national, regional, hospital and ICU level benchmarked to peer group results. Given that all quality is local and that ICU directors are the best judges of the information needed to make process improvements, the IPEC benchmarks create a context for the process and outcome measures of local ICUs.

RESULTS

Demographics

This is the largest continuous quality improvement initiative reported to date. The database includes 880 547 first admissions, averaging $103\,689 \pm 1156$ (\pm SD) ICU patients annually. The scope of the project is unusual since it includes patients housed in all types of ICUs including 48 smaller ICUs (17% of VA ICU patients/year), a group rarely included in ICU analyses and reports.

Data validation

Validation proved unnecessary in hospitals with a high (90th percentile) rate of cases with electronic measured values present, since these results were invariably correct. We found three types of problems in electronic data (table 1). First, variation in local use of the database altered capture of ICU patients and measures of medication adherence. Next, the database location of laboratory test values varies across the country and continues to move as new reagents or machines are added in the clinical laboratories. Third, the normal values of more recent laboratory tests (troponin or β natriuretic protein)

from different manufacturers differ significantly and change over time, a problem not seen in older lab tests.

Because the data in electronic health record determine location for delivery of diet and medications or lab draw, gaming length of stay is difficult. When a hospital experiences an abrupt change in a measure, the IPEC program managers contract the hospital to identify possible important changes in practice. To assure data integrity, a running checklist tracks strategies to eliminate known problems prior to report release (online appendix, figure A). These problems are not unique to VA. They exist to a greater or lesser extent in all healthcare information systems but are infrequently described in the literature.

Mortality measurement and reporting

We have previously reported variation in risk adjusted mortality across VA ICUs.²⁰ In addition to patient characteristics managed with the risk model, differences in admission and discharge practices likely influence ICU mortality. For instance, smaller ICUs transfer a larger proportion of patients to another hospital at discharge (LVL4 vs LVL1, 17% vs 2%, $p \leq 0.05$). Availability of long-term acute care units (principally for ventilator dependent patients) varies widely as does access to step-down units staffed with nurses at a ratio between that of the ICU and ward. Comparing outcomes among similar peer groups and reporting 30 days as well as hospital mortality allows a more meaningful evaluation. Finally, to avoid wild goose chases related to random movements in point estimates due to small samples and large confidence intervals, a minimum of 200 cases and 20 deaths are required in reports of risk adjusted mortality (online appendix, figure B).

Electronic access to measures

Because no electronic sources existed for some measures of ICU performance, IPEC built a data management website to allow national roll-up and benchmarking of manually collected process and outcomes. Training assures use of standardised definitions. Local hospital staff, generally infection control practitioners, enter information about central line associated bloodstream infections (CLAB) and ventilator associated pneumonia rates (VAP), including device days and adherence to practice bundles (online appendix, table C).

Reports

Reports are issued quarterly by region and average 169 ± 51 pages (range 106–299 pages). Hospital committees can review a single summary page (eg, Critical Care Committees). More than 3700 people nationwide who have access to IPEC reports include quality and safety managers, ICU directors and nurse managers, health systems specialists, infection control

practitioners, and regional and local hospital leadership. For each region, the IPEC director highlights the improvement opportunities from their data in a biannual webinar. Leadership interest is elicited by presentation of important variation and inclusion of ICU improvement goals in the performance contract of the regional directors. For instance, the CLAB performance contract linked bonuses to a 25% reduction in CLAB rates (where reference rate was $>2.0/1000$ line days) or to <2.0 (where 25% of reference rate would be $<2.0/1000$ line days) or 9/11 months without a CLAB (for ICUs <1000 line days). Survey results found 83% regional and hospital leaders (directors, chief medical officers), 95% of ICU nurse managers and 85% of ICU physician directors had reviewed their IPEC data (Internal VA survey results from 2007). Computer tools to facilitate use of the data include a dashboard (figure 1, table 2) and business intelligence software (figure 2, Proclarity, Microsoft, Boise, Idaho, USA). An example of a report is provided in the online appendix.

Senior leaders and the clinical advisory group selected improving hospital acquired infection rates, rates of hypoglycaemia and hyperglycaemia, throughput, and deep venous thrombosis prophylaxis. Thus, these elements were included in the dashboard. National benchmarks are reported at the mean, 10th and 90th percentile. ICU measures ≥ 90 th or ≤ 10 th percentile are bolded and in red or green font colours. This strategy allows viewers to

quickly identify quality issues with the greatest need for improvement. Business intelligence software allows user-generated stratification useful for identifying a focus for local improvement (figure 2). Dashboard content is revised annually based on current improvement priorities in setting of limited real estate.

DISCUSSION

Hospitals that monitor internal quality and safety indicators, use national benchmarks, and hold healthcare executives accountable to quality improvement have better performance in process measures and lower mortality.²⁵ The measurement and reporting infrastructure provided by the VA Inpatient Evaluation Center provides these tools for the ICU. Few healthcare systems provide reliable benchmarked measures in multiple domains in the ICU. Several factors contribute to use of ICU measures—(1) piloting IPEC in six regions first, (2) selection of relevant measures, (3) leadership buy-in at all levels of the organisation, (4) the assumption that variation first stems from incorrect data, increasing the clinicians' sense of transparency and (5) consolidation of information in a dashboard identifying movable targets.

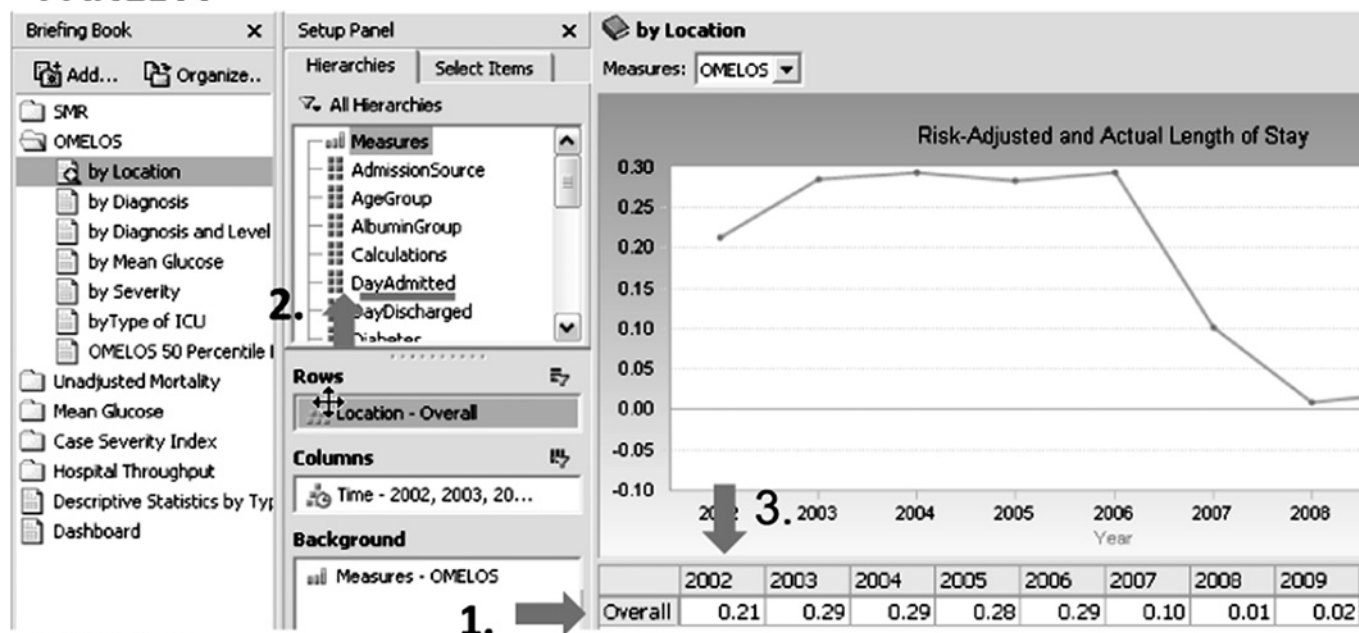
Individual ICUs in Britain, Australia and the USA participate in large scale efforts to measure and compare ICU performance. Such projects include the Intensive

VISN 97 FY2009 through Q2 ICU Process Measures

	IPEC ICU										OQP	RSMR (FY2008)	
	% Gluc Days with Hypo Episode	1. b.	2.			3.		4.		5.		6.	
	1. a.		DVT Prophylaxis			Throughput		Infection				AMI	
	<=45 mg dL	< 60 mg dL	% Patients w Mean Glucose >180	Mech Vent	Non Op	Op	OME LOS	LOS	CLAB Rate	VAP Rate	AMI	IPEC Acute Care	Hospital Referral Region
National Aggregates													
Facility Level 15th %tile	0.5	1.6	10.7	63.1	62.5	61.8	-0.77	2.12	0.00	0.00		14.68	15.79
Facility Level Mean	1.2	3.3	17.0	74.3	73.7	81.2	-0.08	2.84	1.54	2.78		14.91	16.12
Facility Level 85th %tile	2.1	5.0	23.6	88.9	84.5	100.0	0.54	3.57	3.19	5.78		15.13	16.46
National Aggregates													
Site 8	2.1	5.0	9.8	60.3	78.7	81.3	0.57	3.76	3.97	1.81	✓	14.92	16.46
Site 9	1.4	2.6	15.0	78.7	80.4	100.0	0.10	3.18	2.75	10.14	✓	15.25	16.77
Site 10	2.5	4.8	17.5	71.1	64.7	80.0	0.32	3.09	1.39	2.53	✓	14.99	16.42
Site 11	0.6	2.6	18.0	61.7	78.2	85.7	0.06	2.98	0.69	0.00	✓	15	15.47
Site 12	1.9	5.1	22.4	78.6	77.0	90.0	0.49	3.16	1.36	4.77	✓	14.88	16.3
Site 13	0.0	5.3	12.1	66.7	83.8	100.0	-0.62	1.84	0.00	0.00		14.91	16.27
Site 14	1.6	1.6	5.1	100.0	100.0		2.04	4.26	0.00	0.00		14.97	16.32
Site 15													16.42

Figure 1 Quarterly VA ICU Dashboard for an imaginary region (VISN 97). National benchmarks in the first three rows depict the range of measure values at the 15th, mean, and 85th percentile. Process measures address 1. Glycaemic control (a) hypoglycaemic rates (number of days in patients receiving a hypoglycaemic agent with a serum glucose <45 mg/dl or <60 mg/dl divided by the total number of patient days during the time period on hypoglycaemic agents) and (b) proportion of patients with a mean glucose >180 mg/dl. 2. Deep venous thrombosis pharmacologic prophylaxis in patients receiving mechanical ventilation, those with high risk non-operative (COPD, CHF, pneumonia, renal failure, sepsis, cancer) and operative (major gastrointestinal surgery) diagnoses. 3. Throughput (a) observed minus predicted length of stay (OMELOS) and mean length of stay (LOS). 4. Hospital acquired infection rates (a) central line associated blood stream infections (CLAB) and ventilator associated pneumonia (VAP) expressed in infections divided by device days. 5. Compliance with Acute myocardial infarction (AMI) process measures. 6. Comparative VA risk adjusted mortality rates (RSMR) in AMI to hospital referral region using a Medicare mortality model.

PANEL A



PANEL B

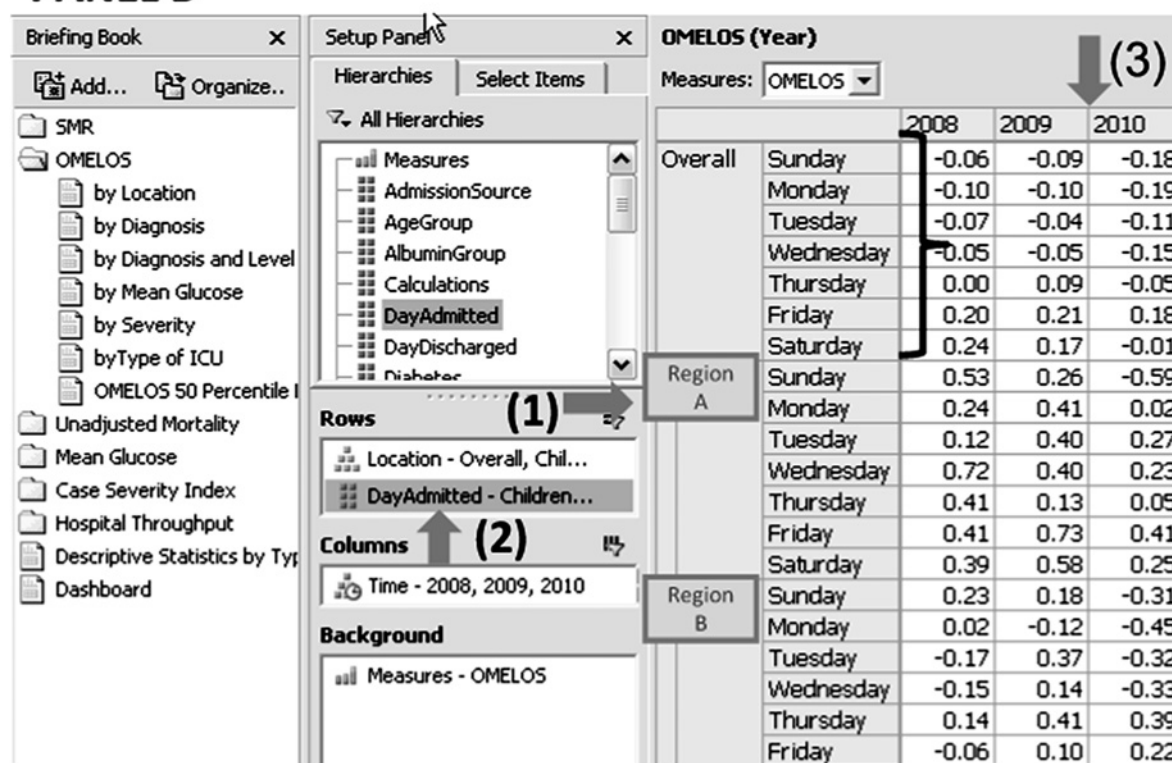


Figure 2 Business intelligence software allows hospitals to explore results in a more granular fashion. Panel A: 1. Depicts overall (VA national) Observed minus predicted length of stay (OMELOS) in tabular and graphic form. 2. Highlights day admitted. 3. Shows 8 years of results 2002–2009. Panel B shows results when the operator clicks on ‘overall’ (1) expanding view to the region level; (regions A and B shown), (2) drags day admitted to the row box resulting in stratifying the OMELOS by day of the week, (3) to decrease clutter, the operator ‘hid’ years 2002–2007.

Care National Audit and Research Center (ICNARC, Britain),²⁶ the Australian and New Zealand Intensive Adult Patient Care (ANZIC) database and Critical Care Research Center^{27–28} and Project Impact in the US²⁹ now folded into a private company. These programs differ

from IPEC in that their reports generally include only throughput, severity of illness and risk adjusted outcomes; portions of data collection rely on manual entry, and participation is voluntary. Universal required participation, leadership support and access to the VA

electronic medical record have been the key for wider measurement and reporting in VA ICUs.

The selection of quality measures recommended by external regulatory and quality organisations assures clinical relevance. Use of benchmarks stratified by type and complexity of ICU reduces arguments that 'my ICU is different' and produces regional competition. These elements drew clinicians into the quality improvement efforts. The persistent findings of only a weak association between mortality and process-based quality measures in observational studies suggest that mortality rates are unlikely to detect moderate differences in quality.^{30 31} However, we report them because (1) the public has a strong interest in mortality rates as an outcome, (2) providers and management are interested in their mortality rates relative to peers and (3) because other reporting initiatives in the United States continue to report risk adjusted mortality.^{17 30}

The IPEC approach has limitations. Data elements not present in electronic databases limit measurement. The data management website supplements electronic data collection, permitting roll up of manually collected data for hospital acquired infections. Important data elements such as left ventricular ejection fraction and use of mechanical compressive devices in DVT prophylaxis were less easily managed. Application of this infrastructure to another healthcare system likely requires development of leadership support, influence in the ICUs and communication strategies similar to that used by IPEC. Using imperfect measures balances the ability to improve quality with a good available indicator against the goal of perfect measurement. National targets for improvement must take into account the measure's flaws. Next, the delay in feedback, even quarterly, is far from ideal.

A dashboard helps to manage the data overload when there is too much data, time to review the data is limited and/or the volume precludes finding the informative pieces of data.³¹ But dashboards display information simply, inevitably losing some context and nuance. Commonly, dashboards present performance indicators graphically and are limited to a single page.³² The IPEC dashboard is a work in progress, adding links to primary data sources, and moving to web-based design to allow drill down capability.³³

Lessons from this report apply to non-federal institutions, particularly as utilisation of electronic medical records increase. Such lessons include (1) building a flexible infrastructure that allows electronic data collation, (2) data element validation, (3) communication with sites to promote use of the information, (4) the essential involvement of leadership at multiple levels in crafting the product, (5) supplementing electronic data with other forms of data collection when key elements

are absent from the databases and (6) being prepared to accept the potential for a good but not perfect electronic indicator to move practice while continuing to work towards improvement of the data elements.

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Competing interests None declared.

Ethics approval This study was conducted with the approval of the University of Cincinnati IRB.

Provenance and peer review Not commissioned; externally peer reviewed.

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