Applying Cost of Quality in Health Care

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Overview

- Cost of Quality in Health Care
- Cost of Quality Template
- Case Studies
- Summary
Significance of COQ

- Can assist hospital leadership in prioritizing and strategizing change

An ounce of prevention is equal to a pound of cure.
- Ben Franklin
Why Hasn’t COQ Been Used In Healthcare?

- Difficulty in defining quality
- Health care financial model
- Language differences between quality professionals and health care professionals
Health Care Quality

- Outcomes
- Effectiveness
- Satisfaction

Accessibility

Process, Appropriateness, Efficiency

Conformance to Standards

Continuity and Coordination

Structure
Traditional COQ Model

- Conformance
  - Prevention Cost
  - Appraisal Cost
- Non-Conformance
  - Internal Failure Cost
  - External Failure Cost
Cost of Quality Model

**QUALITY COSTS**

- **CONFORMANCE**
- **TOTAL QUALITY COSTS**
- **NON-CONFORMANCE**

**QUALITY LEVEL**

- Low
- High

**QUALITY COSTS**

- Low
- High
Case Studies

- Emergency Department
- Medication Reconciliation
- Ventilator Acquired Pneumonia
Prevention Cost

- Developing systems, procedures, or communication systems to prevent errors and ensure high quality.
ED - Prevention

- Consultant hired to analyze patient assignment: $5,000 fee
- Project to reduce the number of patients leaving without treatment.
- Training staff in improvement methodology
Improvement Project Cost

10 hour total meeting time
$30 hourly rate
X 5 people

$1,500
Training Staff

$1,200 staff time spent in training
$1,000 training fee
+ $500 course materials

$2,700
ED Prevention = $9,200
Appraisal Cost

- Review to assess the level of quality or conformance
- Excludes evaluation portion of clinical care process.
ED - Appraisal

- External survey of patient satisfaction: $10,000 per year
- Compliance Reporting
  - Monthly chart reviews
  - Observation of hand hygiene compliance.
Data Collection Cost

4 hr/mo to collect data
× 12 mo/yr

48 hrs/year
× $30/hr wage for data collector

$1,440
Data Reporting Cost

10 hr/mo to report information
\times 12 \text{ mo/yr}
\hline
120 \text{ hrs/year}
\times $30/\text{hr wage for data collector}
\hline
$3,600
ED Appraisal = $17,920
Internal Failure Cost

- Correctable failures caught during the patient visit
- Non-correctable failures not resulting in harm to the patient beyond the patient visit
- System failures which did not result in harm to the patient.
ED - Internal Failure

- Avoidable delays resulting in an increased length of stay, including avoidable hospital admission.
- Medication errors caught and corrected during the patient visit.
Avoidable Days

4 occurrences/month
12 months/year
$6,000 per occurrence

$288,000
Corrected Medication Errors

Number of Errors

- 60,000 patients per year
- 20% Error Rate

\[ \times \]

12,000 Errors

Cost to Correct

- \( \frac{1}{2} \) hr to correct
- $30/hr wage

\[ \times \]

$15/error to correct
Corrected Medication Errors

12,000 errors
× $15 labor to correct

$180,000
+
$20,000 additional med cost

$200,000
ED Internal Failure = $488,000
External Failure Cost

- Correctable failures caught after the patient visit
- Non-correctable failures resulting in harm to the patient beyond the patient visit.
ED - External Failure

- Litigation Expense = $552,500
- Sentinel event investigation
- Additional treatment
- Patients leaving without treatment
  (lost customers)
Failure Investigation Cost

- 40 hour/investigation
- $30 hourly rate
- 8 people

\[ \times \quad 2 \text{ investigations/year} \]

\[ \text{\$19,200} \]
Additional Treatment Cost

$1,2000/event

10 patients/month

X 12 months/year

$144,000
Lost Customer Cost

- 60,000 patients per year
- 1% Leave without treatment

\[ x \text{ 600 lost customers} \]

- $500 lost/patient

\[ x \text{ $30,000} \]
ED External Failure = $1 mil

Cost of Quality

- Prevention
- Appraisal
- Internal Failure
- External Failure
### ED Cost of Quality

#### Table

<table>
<thead>
<tr>
<th></th>
<th>Prevention</th>
<th>Appraisal</th>
<th>Internal Failure</th>
<th>External Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thousands of Dollars</strong></td>
<td>9.2</td>
<td>17.92</td>
<td>488</td>
<td>1015.7</td>
</tr>
</tbody>
</table>
Medication Reconciliation

- Process of identifying accurately the medications a patient is taking at any point in time
- Six Sigma project
Med Rec Prevention

- Pre: No Activity
- Post: Improvement Project
  - Labor Cost of Project: $8,640
  - Staff Training: $15,000
  - New Forms: $1,300
Med Rec Appraisal

- Pre: No Activity
- Post: Monitor Compliance: $3,960
Med Rec Internal Failure

- It is estimated that 1% of med rec errors result in an ADE, which requires additional treatment.
  - Pre: 30% med rec errors
  - Post: 5% med rec errors
Internal Failure Cost of ADEs from Med Rec Error

How much does a Med Rec error cost?

1% med rec errors result in ADE

$4,685 cost per ADE

$46.85/Med Rec Error
Med Rec Internal Failure

Pre:
60,000 patients per year
\times 30\% Error Rate
\Rightarrow 18,000 Errors
\times $46.85/\text{Med Rec Error}
\Rightarrow $843,300 per year
Med Rec Internal Failure

Post:

\[ 60,000 \text{ patients per year} \times 5\% \text{ Error Rate} \]

\[ 3,000 \text{ Errors} \times $46.85/\text{Med Rec Error} \]

\[ $140,550 \text{ per year} \]
Med Rec External Failure

- **Activities**
  - Litigation and settlement expense from avoidable ADEs resulting from med rec on admission errors.

- **Measure**
  - Unavailable
Med Rec COQ Summary

- **COQ Pre:** $840 thousand
- **COQ Post:** $170 thousand
- **Reduction:** $670 thousand
Ventilator Acquired Pneumonia (VAP)

- Pneumonia is a common and deadly infection.
- Vented patients are at increased risk.
- Six Sigma project to reduce VAP rate
Prevention Cost

- Developing systems, procedures, or communication systems to prevent errors and ensure high quality.
VAP Prevention

- Pre: No Activity
- Post: Improvement Project
  - Labor Cost of Project: $10,800
  - Staff Training: $2,700
  - Supply Kit: $12,000
Appraisalal Cost

- Review to assess the level of quality or conformance
- Excludes evaluation portion of clinical care process.
VAP Appraisal

- Pre: VAP Rate Collection: $2,160
- Post: VAP Rate Collection & Monitor Protocol Compliance: $4,320
Internal Failure Cost

- Correctable failures caught during the patient visit
- Non-correctable failures not resulting in harm to the patient beyond the patient visit
- System failures which did not result in harm to the patient.
VAP Internal Failure

- Pre: Avoidable treatment with VAP rate of 6.5%: $208,000

- Post: Avoidable treatment with VAP rate of 4.6%: $144,000
External Failure Cost

- Correctable failures caught after the patient visit
- Non-correctable failures resulting in harm to the patient beyond the patient visit.
VAP External Failure

- **Pre:** Litigation & Settlement: $300,000
- **Post:** Litigation & Settlement: $60,000
Cost of quality is a very useful tool for evaluating an organization’s quality initiatives in terms of dollars, and it often points to areas that need improvement.

This is as true in health care organizations as it is in industry.
Thank you!
APPLYING COST OF QUALITY IN HEALTH CARE

By Bonnie Paris and K. S. Krishnamoorthi, PhD.

Abstract

Readers will learn why cost of quality (COQ) is not widespread in healthcare, a framework for conducting COQ analysis in health care, and be given case studies as to how to apply COQ principles in an Emergency Department, in the reduction of pneumonia in ventilated patients, and in the medication reconciliation function upon admission to a hospital. The model presented is based on traditional cost of quality principles, but the definitions differ from the standard industry definitions due to unique circumstances in health care.

Introduction

Cost of quality information is useful in identifying opportunities for improvement and in measuring the effectiveness of improvement projects. With rising costs and reduced reimbursement, the health care industry is in dire need of a uniform, reliable method for quantifying and evaluating performance in terms of cost of quality. In order for a model to be practical, it must be sound in principle and relatively easy to apply. However, developing a practical cost of quality framework for health care poses several problems.

First, defining health care “quality” in measurable terms is difficult at best. Attributes, such as quality of life and pain management are very important to the patient but are philosophical aspects of health care service that defy quantification in standard units, such as dollars. Second, the relationship between health care quality, however defined, is not easily related to the health care industry’s bottom line. As in other industries, cost, revenue, and quality are co-dependent. However, in the current health care environment, even the link between throughput and revenue is indirect. There is a disconnect between the provision of service and payment of service due to a myriad of factors, such as government intervention and ability to pay versus professional obligation to provide care.

Many of the past failures in applying cost of quality concepts in healthcare are a result of the disparity of language between the health care and quality fields. Depending upon the definitions used, one may end up counting all of the professional care giver labor cost (nurses, doctors, and other health care professionals) as quality cost. In order to accurately distinguish which costs rightly belong in the cost of quality, one must have insight not only into what is done but why it is done.

Some of what may be perceived as rework in the care delivery process is really designed-in redundancy. For example, a patient presents with certain symptoms and the attending physician decides to prescribe a medication, which is ordered through a hospital system to be given to the patient. A pharmacist reviews the order, and a nurse makes an independent assessment of the appropriateness of the drug. Whether these “extra steps” should be included as prevention or appraisal costs, or whether they should be included in operating expense only and not attributed to cost of quality can be debated. These designed-in redundancies can be viewed as preventive appraisal functions, but appraisal is also a basic step in the medical care process, as shown in the following model.

Our recommendation is to include only assessments done for the purpose of assessing quality of care from a global perspective (focused on a patient population), compliance with protocol or evidence-based-medicine, or systems specifically designed to detect internal errors (case management of “outlier” cases) in the appraisal cost. The costs associated with routine assessment and evaluation should be excluded from consideration as quality costs. Including these costs would open up the appraisal cost definition to include routine tests (lab work, X-rays, etc.) which can be done for the purpose of assessing and evaluating care as well as for diagnostic reasons.

A different way of explaining internal failure and external failure also is necessary in health care, due to differences in language between the health care and quality fields. Errors in health care are generally categorized as errors of omission or as errors of commission. Errors of omission are the result of not making a decision and allowing the default action (or inaction) to take place. Errors of commission are the result of deciding on a course of action that is later deemed to be wrong. To a lay person, the distinction may seem trivial, but it is of vital importance in a field where time plays an important role in decision making. The focus of many improvement efforts in the clinical arena is to assist care givers (decision-makers) in making the right decisions at the right time. System failures in providing the right information to the right care giver at the right time often contribute to errors in decision-making, as is the case in the reconciliation of medications upon admission, which is presented as a case study of quality costs. There are also occasions when negative effects result from following the evidence-based treatment for a given situation.
Approach

Cost of quality (COQ) can be a very valuable decision-making tool, but it is important to remember that, as the complexity of information collected and analyzed grows, so does the cost of the COQ system. When establishing any cost of quality system, one must refrain from becoming overzealous in a quest for perfect data. For most purposes, estimates of quality costs and allocations are sufficient. Complex systems to precisely capture and allocate various quality costs are difficult to establish and maintain and, more importantly, may not provide any additional benefit beyond what can be obtained with a less sophisticated measurement system.

Zimak describes four different methods of collecting cost of quality information along with the advantages and disadvantages inherent in each method. The Traditional Method uses standard accounting and finance department records, but it is difficult to get non-value-added costs and many failure costs can be missed. The Time and Attendance Method involves training every employee on cost of quality principles and having every employee record actual time by category, but this method requires high overhead and startup cost. The Defect Document Method uses a system to track defects as they occur, but if this method is used alone only failure costs are collected. The Assessment Method involves determining where the organization performs on the cost of quality curve and then performing detailed cost of quality analyses in focus areas, and although this method does not require a formal collection system the results are not always accurate. Most cost of quality systems use a combination of these methods, combining the Traditional Method and Defect Document Method.

In a healthcare delivery system, a myopic focus within departmental or “cost center” walls is not appropriate if one wants to obtain a true measure of the cost of quality for that area. This can be difficult, as hospital accounting is a tangled web of allocations. Bozanich-White observes that hospital accounting systems were developed to support cost reimbursement and not to assist managers in decision-making. When performing a cost of quality analysis, it is preferable to use an activity based cost (ABC) approach to gathering data because the ABC costs are analyzed in terms of work activities. Unfortunately, ABC has not been widely adopted in health care organizations.

The current reality of hospital cost accounting is a deterrent to COQ system implementation, but it is a condition which can be overcome. Consider an example of a general nursing unit, where the cost of labor and supplies used for patient stays on that nursing unit for prevention, appraisal, internal failure, and external failure are of interest. Cost of ancillary, support departments, and overhead related to the cost of quality for the patient stay on the nursing unit are accounted for separately and are not often charged back to the unit of origin. The quality costs that are attributable to the patient stay, and therefore the nursing unit under study, do not include the service area’s cost to meet the customer requirements of the unit being served. However, many departments maintain service quality logs to track failures, such as the number of late meal trays delivered by the Food Services Department, the number of interventional radiology procedures with late starts, or the number of misread radiology films. These quality logs assist with evaluation and decision-making.

The case studies presented here are realistic examples of quantifying cost of quality for a patient population (ventilated patients), medical service function (medication reconciliation at admission), and a hospital department (emergency department). Due to the sensitive nature of defect and financial data, permission to use actual data from a hospital could not be obtained. In order to perform a comprehensive cost of quality analysis of the entire hospital, one would examine either cost of quality by department or patient population. If these approaches were mixed in an attempt to provide a system-wide measure of cost of quality, some costs would invariably be double-counted. Each case study gives a model of the area of focus, proceeds through the cost of quality quantification template for healthcare given on the following pages, gives a cost of quality analysis, and concludes with a discussion of the results. The cost of quality analysis draws upon data obtained from literature and the professional experience of the authors. Two of the case studies look at the impact of Six Sigma projects on the cost of quality for ventilated patients and medication reconciliation at admission.

Cost of Quality Quantification Template

The definitions of cost of quality in health care and industry differ, but the principles are the same. Cost of quality analysis focuses on operating expense therefore capital expenditures, such as the purchase of computer equipment or information systems, are not included in the quality cost. The cost of quality curve which follows shows non-conformance or “poor quality” decreasing as conformance or “good quality” increases.
The cost of providing “good quality” comprises prevention cost and appraisal cost. The cost of providing “poor quality” comprises internal failure cost and external failure cost. The cost of good quality and poor quality combined is the total cost of quality, and the cost of quality curve demonstrates the tradeoff between conformance and non-conformance. A framework for conducting cost of quality analysis in health care follows.

**Prevention Cost**
Prevention cost is the cost of developing systems, procedures, or communication systems to prevent errors and ensure high quality, including the design and implementation of such systems. This includes developing and implementing standards and evidence-based practice, as well as time spent on “improvement projects” such as Six Sigma and Institute for Healthcare Improvement (IHI).
- What activities or projects are going on to increase quality/reduce failures?
- What are the direct costs (labor, supplies, etc.) associated with each of the improvement activities identified, including training?

Estimates of meeting times and average hourly wages can be used to develop an estimate for the related labor cost.

**Appraisal Cost**
Appraisal cost is the cost of review or inspection to assess the level of quality or conformance to standards, excluding the evaluation portion of routine patient care. Appraisal cost includes maintaining systems specifically to detect internal errors such as real-time and retrospective chart review to determine compliance with treatment protocols and internal standards.
- What activities are going on to collect data about compliance/non-compliance?
- What are the direct costs (labor, supplies, etc.) associated with each of these appraisal activities?

Time spent collecting data used for the purpose of determining compliance or to detect internal errors can be estimated and multiplied by an average hourly wage to develop an estimate for the related labor cost.

**Internal Failure Cost**
Internal failure cost is the cost associated with correctable failures caught during the patient visit, non-correctable failures not resulting in harm to the patient beyond the patient visit, and system failures which did not result in harm to the patient. Near-miss events are system failures which do not result in harm to the patient. An example of a near-miss is a wrong medication that would have been given to a patient due to an error in the ordering process, but if the error is caught and corrected by a pharmacist or nurse prior to administration, harm to the patient is averted. Internal failure cost includes additional time and resources to “rework” the patient experience and remedy the negative effect of the failure, such as prolonged length of stay (avoidable days), all medications and other interventions performed to reverse the effect of a medication or other medical treatment error. Costs incurred by the patient or other customers which do not occur within the health care delivery system (hospital) in question will be considered as external failure costs.
- What activities go on during the patient visit to investigate and correct problems which result from not following protocol/erors made during the patient visit?
- What are the direct costs associated with these internal failures or corrective action activities?

Time spent by management and staff can be estimated as described previously. Literature can also be reviewed and a published estimate of the cost of each untoward event (error) can also be used. Then the estimate can be multiplied by the number of errors, such as mis-read X-rays, to obtain the internal failure cost.

**External Failure Cost**
External failure cost is the cost associated with correctable failures caught after the patient visit and non-correctable failures resulting in harm to the patient beyond the patient visit. This includes readmission due to initial failure to properly diagnose or treat, or problems caused by a medical error, such as an additional surgery to remove surgical materials accidentally left in the patient during surgery. External failure cost also includes investigation and reporting activities related to sentinel events (failures resulting in severe harm to the patient, including death), litigation expense and lost customers.
- What activities go on to investigate and correct problems which result from not following protocol after the patient visit?
- What are the direct costs associated with external failure activities?

Time spent by management and staff can be estimated as described previously. Literature can also be reviewed and a published estimate of the cost of each untoward event (error) can also be used. Then the estimate can be multiplied by the number of errors, such as wrong site surgery, to obtain the external failure cost.

**Emergency Department**

Usually, when one thinks of an emergency department, thoughts of ambulances and fast-paced action soon follow. Aside from the miracles and tragedies that occur each day in emergency departments across the country, there are several factors which make the provision of emergency medical services different. Most service industries such as airlines and hotels can refuse to provide service when capacity is met, but emergency departments do not have that luxury. Some states also regulate when a hospital can divert patients to other hospitals, compounding situations where a capacity point has been reached. These requirements to provide service coupled with the unpredictability of demand for services make resource planning for emergency departments an interesting problem. Patients go to emergency
departments both for trauma care and for basic care. Since priority is given to patients with the most acute (trauma) problems first, patients using the emergency department for primary care often experience lengthy wait times.

The examination of cost of quality in the emergency department presented here focuses on the departmental “silo” of the emergency department within the hospital. There are many interrelations between the emergency department and other external emergency service providers, and the emergency department is a major source of patients for the operating room and inpatient care units at the hospital. Exploration of these relationships and their impact on the cost of quality are left to be considered in a system-wide analysis of cost of quality.

The approach to quantifying cost of quality in the emergency department presented here is a hybrid of the traditional and defect document methods discussed by Zimak. Thus, data used in the analysis is taken from the hospital accounting system and defect documentation relating to the emergency department. Collecting “defect data” in a clinical setting often requires a clinician to collect the data, in order to make a judgment as to whether or not a defect did indeed occur.

Defects can include lost customers, which is commonly referred to in the emergency department as patients who left without treatment (LWOT). Defects also include patients who were dispositioned incorrectly, meaning that a patient was admitted but did not require admission, or that the patient was not admitted when an inpatient stay was called for. An example of this is a patient with chest pain misdiagnosed as muscle strain who is sent home and subsequently has a heart attack. Defects are also any failure to meet service standards or follow protocol. In many service industries, timeliness of service is an important standard. This is perhaps more important in the care of patients presenting with acute problems, when the timeliness of treatment has an impact on the quality of the recovery.

The cost of quality analysis presented here is outcome based, meaning that the analysis looks at the financial outcome of these defects and is not concerned with process capability. In a manufacturing organization, if one were to perform a cost of quality analysis, the interest would be on the number and cost associated with customer orders not filled on time, not on the cycle times of the component processes which resulted in late deliveries. Due to the sensitive nature of defect and financial data, permission to use actual data from a hospital could not be obtained. The cost of quality analysis draws upon the professional experience of the authors. The type of COQ analysis presented here is for one period of time and would be used to develop an understanding of where the department was at in terms of the cost of quality curve. The tables which follow give a completed cost of quality quantification template for the emergency department.

### Emergency Department Cost of Quality Quantification

<table>
<thead>
<tr>
<th>Prevention Cost: $9,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>A local project is underway to reduce the amount of time to triage patients. Participants in the project include staff nurses and doctors, as well as one medical resident. The project is expected to help reduce the number of patients leaving without treatment.</td>
</tr>
<tr>
<td>Total meeting time of 10 hours * $30/hour wage * 5 people = $1,500</td>
</tr>
<tr>
<td>An external consultant was hired to examine the staffing model and consider the impact on patient throughput time of assigning staff to particular emergency rooms rather than the current negotiation of who is taking what patient on a case by case basis.</td>
</tr>
<tr>
<td>Flat fee of $5,000</td>
</tr>
<tr>
<td>Some staff are being trained in DMAIC methodology (define, measure, analyze, improve, control, which is the foundation of the Six Sigma methodology) in order to assist in identifying and carrying out future projects.</td>
</tr>
<tr>
<td>Course materials: $500</td>
</tr>
<tr>
<td>Training fee: $1,000</td>
</tr>
<tr>
<td>Staff time: 4 hours * $30/hour wage * 10 people = $1,200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appraisal Cost: $17,920</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency department nurses review charts each month to ensure that nursing documentation was completed correctly.</td>
</tr>
<tr>
<td>4 hours/month * 12 months * $30/hour wage = $1,440</td>
</tr>
<tr>
<td>Infection control and quality management nurses review emergency department charts each month to determine the number of pneumonia cases that were missed, as well as a direct observation of compliance with hand washing protocol.</td>
</tr>
<tr>
<td>Infection Control/QM review time 8 hours/month * 12 months * $30/hour wage = $2,880</td>
</tr>
<tr>
<td>External survey conducted to measure patient satisfaction.</td>
</tr>
<tr>
<td>Flat fee of $10,000 per year</td>
</tr>
<tr>
<td>Manager works with hospital decision support to get reports on other factors of compliance which are of interest, such as the percent of patients leaving without treatment.</td>
</tr>
<tr>
<td>Time to produce report 10 hours/month * 12 months * $30/hour wage = $3,600</td>
</tr>
</tbody>
</table>
Medication Reconciliation Function

Medication reconciliation refers to the process of identifying accurately the medications a patient is taking at any point in time. Medication reconciliation on admission refers to acquiring a complete list of the medications the patient was on prior to hospitalization and comparing it to the physician admission orders. For the reconciliation to be considered complete, information from the patient, person taking the medication history, doctor, and pharmacist must all match. The elements of information collected on each medication include the name of the drug, dose (amount), route (how taken), frequency (how often taken), and the date and time of the last dose. The physician decides whether each medication should be continued as before, the prescription modified in some way, or not ordered at all upon the patient’s admission.

Medication reconciliation is a function that has received little attention until recently. However, studies have shown that “most medication errors occur during physician ordering (39%)….However, of all physician ordering errors, up to 70% are intercepted by pharmacists and nurses prior to patient administration” (Brown). Some contributing factors to medication errors include miscommunication between caregivers, inadequate patient information, and unavailable drug information, all of which can be eliminated with a consistent medication reconciliation process.

A Six Sigma team at OSF Saint Francis Medical Center in Peoria, Illinois, developed a form to document medication reconciliation upon admission. The form is used by nurses, doctors, and pharmacists. Ideally all of this information would be collected and communicated electronically, but such a system was not yet in place. By moving the information to one form, transcription was eliminated in this function, reducing the likelihood of error. The roles of each care giver were clearly defined, with the patient, nurses, doctors, pharmacists, and clerks all playing a role in the medication reconciliation process.

A new process was developed by the Six Sigma team and implemented throughout the hospital. Prior to the development and implementation of this process, there was no formal process for medication reconciliation at admission. Prior to the project, the completeness of medication history, including all elements of information on medications taken by the patient prior to the patient stay, was very low as the relevant information was not recorded consistently and was not always recorded in the same place.

The cost of quality before the Six Sigma project on medication reconciliation and after the Six Sigma project on medication reconciliation are given in the tables below. This example shows how COQ analysis can be used as an evaluation tool to determine the impact of an improvement effort. Note that the cost of performing routine medication reconciliation is not included in the cost of quality as it is part of the evaluation portion of routine patient care.

Due to the sensitive nature of defect and financial data, permission to use actual data from a hospital could not be obtained. The cost of quality analysis draws upon data obtained from literature and the professional experience of the authors. Estimates of average adverse drug event (ADE) cost are taken from an Agency for

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### Internal Failure Cost: $488,000

| Avoidable delays resulting in an increased length of stay, including avoidable hospital admission. |
| 4 occurrences/month * 12 months * $6,000/occurrence = $288,000 |

| Medication errors caught and corrected during the patient visit. |
| 20% order error rate * 60,000 patients * ½ hr to correct * $30/hr wage = $180,000 |
| Cost of additional drugs to treat Adverse drug events from pharmacy = $20,000 |

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### External Failure Cost: $1,015,700

| A cross-disciplinary investigative board is formed for each Sentinel event (failure resulting in severe harm, including death). |
| 40 hr/investigation * $30/hr wage * 8 people * 2/year = $19,200 |

| Litigation expenses for these events are tracked in a separate account. |
| Actual litigation/settlement expense = $552,500 |

| Additional treatment is given when there are unplanned returns caused by a failure to diagnose correctly at the first visit, such as an X-ray call-back due to initial mis-read/missed fracture |
| 10 patients/month * 12 months * $1,200 per event = $144,000 |

| Patients leaving without treatment (lost customers) |
| 1% LWOT rate * 60,000 pts/year * $500 lost/patient = $300,000 |

The total cost of quality for the emergency department was found to be $1.5 million. Taken as a percent of total $35 million operating expense for the emergency department, cost of quality is 5% of total cost. The cost of quality for the emergency department is weighted heavily towards external failures. If more improvements were made in processes to eliminate sentinel events and other failures, the cost of quality as a percent of total cost would decrease dramatically. Generally, a roughly even balance between prevention and appraisal costs (the cost of producing “good quality”) and failure costs is desired.
Healthcare Research and Quality report (Markowitz, 2001). External failure costs, such as the litigation and settlement expense from avoidable adverse drug events (ADEs) resulting from errors in the admission medication reconciliation were not able to be captured.

### Medication Reconciliation Cost of Quality Quantification

<table>
<thead>
<tr>
<th>Prevention Cost</th>
<th>Prior to Project: $0</th>
<th>After Improvement Project: $24,940</th>
</tr>
</thead>
<tbody>
<tr>
<td>None. $0</td>
<td>Six Sigma improvement project, including implementation of new form.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Labor Cost of Project: 4 hrs/wk * 6 members * $30/hr wage * 12 weeks = $8,640</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Staff Training: ¼ hr/person * $30/hr wage * 2000 care givers = $15,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Forms: Form design and printing = $1,300</td>
<td></td>
</tr>
</tbody>
</table>

### Appraisal Cost

<table>
<thead>
<tr>
<th>Prior to Project: $0</th>
<th>After Improvement Project: $3,960</th>
</tr>
</thead>
<tbody>
<tr>
<td>None. $0</td>
<td>Individual department monitoring of compliance with using form.</td>
</tr>
<tr>
<td></td>
<td>▪ Compliance: ½ hr/mo/unit * 22 units * $30/hr wage * 12 mo/yr = $3,960</td>
</tr>
</tbody>
</table>

### Internal Failure Cost

<table>
<thead>
<tr>
<th>Prior to Project: $843,300</th>
<th>After Improvement Project: $140,550</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse drug events can occur when medication reconciliation (med rec) errors are made. Cost of $4,685 per adverse drug event (ADE) taken from an AHRQ report (Markowitz, 2001). It is estimated that 1% of med rec errors result in an ADE, which requires additional treatment.</td>
<td></td>
</tr>
<tr>
<td>▪ Adverse drug events: 60,000 patients/year * 5% med rec errors * 1%ADE/med rec error * $4,685/ADE = $843,300</td>
<td></td>
</tr>
</tbody>
</table>

The Six Sigma project on medication reconciliation is a good example of how improvement methodology can be successful in a clinical arena. Although failures continue to represent a large portion of the cost of quality for the medication reconciliation function, there was a significant reduction in the overall cost of quality from $843,300 prior to the project to $169,450 after the project. This is a difference of $0.67 million in cost of quality.

### Reduction of Ventilator Acquired Pneumonia

Nosocomial infections are infections acquired by a patient during a hospital stay, as opposed to community acquired infections which are acquired by a patient outside of the healthcare system. Pneumonia is a relatively common but serious illness, and it has been cited as the “second most common nosocomial infection, but the infection most frequently associated with a fatal outcome” (Roark). For this reason, the study and reduction of nosocomial pneumonia is very important. Although ventilated patients (patients on mechanical breathing machines) comprise a small number of nosocomial pneumonia cases, they are at the greatest risk of acquiring pneumonia. In order for infection to occur, a germ must have a mode of transmission and a host. Efforts to reduce nosocomial infections look at eliminating germs, breaking the modes of transmission and, when possible, increasing patient resistance.

The small contribution of ventilated patients to nosocomial pneumonia incidence is due to the relatively small population of vented patients. Ventilator acquired
pneumonia (VAP), or pneumonia which is acquired during the hospital stay by a patient who is on a mechanical ventilator, is of interest to more than infection control personnel. According to Roark, the incidence of VAP “ranges from 9 to 68 percent, and mortality ranges from 33 to 71 percent” (Roark, 14).

Recently, a Six Sigma project at OSF Saint Francis Medical Center in Peoria, Illinois, was conducted to reduce ventilator acquired pneumonia. The cost of quality before the Six Sigma project on reduction of VAP and after the Six Sigma project on reduction of VAP are given in the tables below. Due to the sensitive nature of defect and financial data, permission to use actual data from a hospital could not be obtained. The cost of quality analysis draws upon data obtained from literature and the professional experience of the authors. Estimates of supply kit cost and cost per infection are taken from literature (Roark, 2003), and the example assumes a case volume of 400 ventilated patients per year.

### VAP Cost of Quality Quantification

<table>
<thead>
<tr>
<th>Prevention Cost</th>
<th>Prior to Project: $0</th>
<th>After Improvement Project: $25,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>None: $0</td>
<td></td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Six Sigma improvement project, including implementation of new supply kit. Supply kit cost taken from literature (Roark, 2003)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Cost of Project: 4 hrs/wk * 9 members * $30/hr wage * 10 weeks = $10,800</td>
<td></td>
</tr>
<tr>
<td>Staff Training: $2,700 ½ hr/person * $30/hr wage * 180 vented pt. care givers = $2,700</td>
<td></td>
</tr>
<tr>
<td>Supply Kit: $12,000 $30/kit * 400 patients/year = $12,000</td>
<td></td>
</tr>
</tbody>
</table>

### Appraisal Cost

<table>
<thead>
<tr>
<th>Prior to Project: $2,160</th>
<th>After Improvement Project: $4,320</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection Control chart review to determine VAP rate, performed monthly.</td>
<td></td>
</tr>
<tr>
<td>VAP Rate Collection: 6 hrs/mo. * $30/hr wage * 12 mo/yr = $2,160</td>
<td></td>
</tr>
</tbody>
</table>

### Internal Failure Cost

<table>
<thead>
<tr>
<th>Prior to Project: $208,000</th>
<th>After Improvement Project: $144,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection results in increased hospital stay and treatments. Cost per infection taken from literature (Roark, 2003). Rate of 6.5%</td>
<td></td>
</tr>
<tr>
<td>Avoidable Treatment: $8,000/infection * 26 patients developing VAP = $208,000</td>
<td></td>
</tr>
<tr>
<td>Protocol Compliance: 6 hrs/mo. * $30/hr wage * 12 mo/yr = $2,160</td>
<td></td>
</tr>
</tbody>
</table>

### External Failure Cost

<table>
<thead>
<tr>
<th>Prior to Project: $300,000</th>
<th>After Improvement Project: $60,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litigation and settlement expense from avoidable VAP resulting in death.</td>
<td></td>
</tr>
<tr>
<td>Litigation: Actual records, 5 cases: $300,000</td>
<td></td>
</tr>
<tr>
<td>Litigation: Actual records, 1 case: $60,000</td>
<td></td>
</tr>
</tbody>
</table>

The Six Sigma project on the reduction of VAP is a good example of how improvement methodology can be successful in a clinical arena. Although failures continue to represent a large portion of the cost of quality for the treatment of ventilated patients, there was a significant reduction in the overall cost of quality from $510,160 prior to the project to $233,820 after the project. When this is viewed as percent of operating expense of $3.2 million for the care of ventilated patients, the reduction represents an overall reduction in operating expense of 8.6%.
Conclusions

Cost of quality is a very useful tool for evaluating an organization’s quality initiatives in terms of dollars, and it often points to areas that need improvement. This is as true in health care organizations as it is in industry. Future studies are called for to address the question of how health care organizations can integrate cost of quality analysis into their quality systems in order to assist in prioritizing which areas of improvement to address first. Also, the application of cost of quality to an entire hospital or health care delivery system would be of interest, as would a compilation of cost of quality information from different health care organizations. There is a great deal of work remaining in the comprehensive application and adoption of cost of quality techniques to health care. However, the work will provide valuable information to decision makers and therefore assist in improving the cost and quality of care provided.

Acknowledgements

The authors would like to thank OSF Saint Francis Medical Center and all of the people involved in the Six Sigma projects discussed. Particular thanks to Cassy Horack and Debbie Trau for sharing their insight and resources.

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Biographical Sketch

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