

## Return on Investment Estimation

**What is the purpose of this tool?** When your hospital invests in a new program, quality improvement intervention, or technology, leaders often need to know what kind of financial return the investment will yield. A return on investment (ROI) analysis is a way to calculate your net financial gains (or losses), taking into account all the resources invested and all the amounts gained through increased revenue, reduced costs, or both.

This tool provides a step-by-step method for calculating the ROI for a new set of actions implemented to improve performance on one or more of the AHRQ Pediatric Quality Indicators (PDIs). It also provides a case study of ROI calculated by a hospital for implementation of computerized physician order entry (CPOE).

**Who are the target audiences?** Potential users of this tool include individuals who will contribute to ROI calculations, which may include hospital or health system financial, quality, or analytic staff, as well as statisticians, data analysts, and programmers.

**How can the tool help you?** Examining anticipated financial outcomes data can help hospital and health system leadership make more informed decisions when prioritizing resources for quality improvement initiatives. ROI also can be used as an evaluation tool to examine the cost of an initiative after implementation.

*Using ROI as a planning tool.* During the planning process that precedes implementation of improvement actions, projected ROI can be used to estimate how the planned intervention will affect revenue and operating costs and to adjust the intervention to better optimize both quality and financial performance. In addition, ROI can be used to show how long it will take for an intervention to break even—that is, for the returns of the practice improvement to offset the upfront and ongoing implementation costs. This analysis can be done using data from the literature.

*Using ROI as an evaluation tool.* Actual ROI can be calculated after a practice improvement has been implemented to assess its value and inform decisions on future improvement actions. This analysis can be done using actual data from your hospital.

**How does this tool relate to other tools in the Toolkit?** The ROI tool is used as a planning tool to develop cost and return information for use in setting priorities for improvements on the AHRQ PDIs, with the results of these analyses applied in the Prioritization Matrix (Tool C.1). It also can be used as an evaluation tool along with the Project Evaluation and Debriefing tool (Tool D.8) to assess financial effects of the improvements implemented.

## Calculating and Interpreting Return on Investment (ROI)

An ROI is calculated as the ratio of two financial estimates:

$$\text{ROI} = \text{Net financial returns from improvement actions} / \text{Financial investment in improvement actions}$$

Where the numerator and denominator of this ratio are defined as follows:

- *Net financial returns from improvement actions.* The financial gains from the implementation of the improvement actions, which are generated by net changes in quality, efficiency, and utilization of services, or in payments for those services.
- *Financial investment in improvement actions.* The costs of developing and operating the improvement actions.

**How does ROI differ from cost-effectiveness analysis (CEA)?** CEA and ROI share some common features, but they differ in the effects that are addressed. Both ROI and CEA are expressed as ratios, and they use the same dollar amounts for improvement investment costs. ROI shows how much financial gain a hospital or health system can obtain from each dollar it invests in a quality improvement program, while the results of a CEA indicate the costs to a hospital for each unit of effectiveness it achieves through quality improvement actions, such as the costs for each adverse event avoided. These differences are reflected in the formulas used to calculate the ratios.

$$\text{ROI} = \text{Financial gains} / \text{Improvement investment costs}$$

$$\text{CEA} = \text{Improvement investment costs} / \text{Effectiveness}$$

The step-by-step procedure described here can be used to perform ROI calculations to assess your financial return on improvement actions that you either are planning or have implemented. Additional information that may be useful to consider is provided in the section titled “Additional Guidance for Effective ROI Calculation.”

Throughout this document, the term “improvement actions” refers to any hospital program or initiative that aims to improve the quality or safety of hospital inpatient care, which may include a focus on improving performance on the AHRQ PDIs.

### Step 1. Determine the Basic ROI Design

Before you start to calculate ROI for any given improvement actions, you need to make four design decisions that will structure your approach to the analysis:

1. **Define the scope of services affected by the improvement actions.** Some actions will be limited to making improvements in one hospital unit (e.g., the emergency department), and others will have a broader scope (e.g., across all nursing units). Carefully define the scope of services to be included in the ROI calculation, and ensure that financial estimates are specifically related to that scope of services.

2. **Define the timeline for implementation of improvement actions.** When implementing improvement actions in your hospital, those actions will occur over a period that could be as short as a few months or as long as years. The ROI analysis needs to capture when those actions change the hospital's operating procedures over time, in order to estimate both the implementation costs and the financial effects of improvement actions. If changes occur over years, you will need to adjust the estimates for inflation and discount future costs and revenues.
3. **Define the comparison group.** To estimate the numerator (net return portion) for the ROI ratio, you need to compare the hospital's finances under two conditions—with the improvement actions implemented and without them. Typically, this will be a comparison over time, with the "before" condition being the service processes before improvement actions, and the "after" condition the service processes after implementation. Other possible comparisons are comparisons across units within the same hospital, or across hospitals. If you use other units or hospitals as comparisons, be sure to choose comparison groups that have similar characteristics to your service entity except that they did not implement the improvement actions.
4. **Capture complete information on financial contributors.** To obtain the most accurate ROI estimate, you will need to identify and quantify as many of the financial contributors as possible for both the numerator and denominator of the ROI formula (e.g., personnel costs, supplies, equipment). For a planning phase ROI, you will work with your best estimates of improvement action costs and of the components of net returns. For a post-implementation ROI, you will have actual data from your financial system on those contributors. See Table 1 for categories you can consider including.

## **Step 2. Calculate the Return on Investment**

To calculate the ROI for the improvement actions, you will develop estimates for both the numerator and denominator of the ROI ratio:

*Net returns from the improvement actions* (the ROI ratio numerator)  
*Implementation costs* (the ROI ratio denominator)

Worksheets are provided here for your use in developing these estimates. Worksheet 1 can be used to estimate the costs for your investment in the improvement actions, and Worksheet 2 can be used to estimate the net returns from those actions.

**Considerations When Calculating Implementation Costs.** Instructions for completing Worksheet 1 are provided at the top of the worksheet. You will use the same methods to estimate these costs that you would use for program budgeting or financial accounting of actual costs. The grand total of estimated implementation costs calculated in Worksheet 1 is the ROI denominator.

The costs involved in implementing improvement actions may be incurred at different stages of the implementation process. *Your hospital's financial staff will need to estimate these costs at all stages of the program from start to end if using the ROI tool for planning. If you use the ROI tool for evaluation purposes, you will need to track costs throughout implementation.*

Table 1 shows example categories of costs at each stage of program planning, implementation, and maintenance (see descriptions of these components in Appendix I). These broad categories are meant as suggestions. Not all costs included will apply to all types of programs or quality

improvement initiatives. In addition, you may identify other relevant costs that should be included but are not shown here.

**Table 1. Categories of Costs Incurred at Different Stages of Implementing a Practice or Quality Improvement Program**

Cost Category	Stages of the Improvement Actions				
	Planning and Development	Training	Startup	Ongoing Operation, Monitoring, and Maintenance	Shutdown
Personnel	X	X	X	X	X
Supplies	X	X	X	X	X
Equipment			X	X	
Training	X	X	X	X	
Information systems			X	X	X
Outreach and communication			X	X	X
External consultant costs		X	X	X	

**Considerations for Calculating Net Return.** Instructions for completing Worksheet 2 are provided at the top of the worksheet. The grand total financial effect derived in the worksheet is the estimate for the ROI numerator.

The estimation of these financial effects is more complex—and more subtle—than estimating the implementation costs. Implementation of improvement actions may have many positive effects on patients’ outcomes and health status. For example, improvement actions might reduce hospital-associated infections, rates of pressure ulcers, or patient mortality. Although these effects do not have a direct monetary value, many of them may affect a hospital’s revenues and expenses, which should be estimated in an ROI analysis. For example, reduction in adverse events can lead to reduced length of stay, which may affect finances either positively or negatively, depending on payment structures.

You will need to capture two types of financial effects: changes in the hospital’s revenues and changes in its operating costs. For example, by reducing its infection rates, a hospital could eliminate the costs it had been incurring to provide the extra care required to treat infections. It also could enhance or protect its revenues, if insurers offered incentives for infection control or imposed penalties for occurrences of infections.

When calculating the hospital’s net return for the ROI, it is necessary to take into account that the effects on revenues and effects on costs work in opposite directions. From the hospital’s perspective, an increase in revenues is good, so a **higher revenue** due to improvement actions should be a **positive** number. On the other hand, a decrease in costs is good, so a **lower cost** due to improvement actions is good. The instructions for calculations of net return are provided on Worksheet 2.

**ROI Ratio Calculation.** Once you have estimated the implementation costs and the net effects on revenues and costs, the actual calculation of the ROI ratio is easy. Simply divide the estimated total net returns by the total implementation costs:

$$\text{ROI} = \text{Worksheet 2 Total (returns)} / \text{Worksheet 1 Total (investment)}$$

**Cost Savings Calculation.** The two worksheets can also be used to calculate cost savings, another indicator of financial effects of the quality improvement program. The cost savings may be of interest to hospital managers to answer a basic question: “How much did we save?” The cost savings is the difference between returns and costs:

$$\text{Cost Savings} = \text{Worksheet 2 Total (returns)} - \text{Worksheet 1 Total (investment)}$$

### **Step 3. Interpret the ROI Ratio Obtained**

Once calculated, the ROI ratio needs to be interpreted. The following guidelines can be used to understand the meaning of the ROI ratio.

1. *ROI greater than or equal to 1:* When an ROI is greater than or equal to 1, the returns generated by improvement actions are greater than or equal to the costs for development and implementation. In this case, ROI is considered to be **positive**. For example, an ROI of 1.8 indicates that for every \$1 you invest in the quality improvement program, \$1.80 will be gained for the hospital.
2. *ROI less than 1:* With an ROI of less than 1, the improvement actions yield a net loss from changes in quality and utilization. In this case, ROI is considered to be **negative**. For example, an ROI of -1.5 indicates that for every \$1 invested, \$1.50 will be lost by the hospital. As another example, an ROI of 0.8 indicates that for every \$1 invested, 80 cents will be recouped by the hospital. In other words, the hospital loses 20 cents for every \$1 it spends on the quality program.

### **Additional Guidance for Effective ROI Calculation**

This section includes additional suggestions for how to prepare for your ROI calculation and work through some key measurement issues. See Appendix II for information about existing ROI calculators.

#### **Understanding the Point of View for ROI Calculations**

When performing the ROI calculations described here, you will develop estimates that represent the perspective of the hospital—both the investments and net returns are those of the hospital itself, as is the resulting ROI ratio. It is important to note that the implementation of improvement actions is likely to also have effects on other stakeholders with different points of view. For example, reducing infections will affect costs to insurers from changes in payments made to the hospital, which will depend on the nature of each insurer’s payment policy. At the start of each ROI analysis, it will be useful to consider what the effects may be for other stakeholders and to take possible responses on their part into account when designing the improvement actions.

## **Assembling the ROI Team**

Four groups of hospital staff, in particular, are likely to be involved in estimating the ROI, although others may be involved in some cases.

1. Initially, the quality improvement team needs to engage the *hospital's financial officers*, who can help track the investment/cost of the program.
2. *Clinical and other staff* (e.g., quality and patient safety staff at the hospital) running the quality improvement program should identify quality indicators that will be affected by the program.
3. *Statisticians, data analysts, and programmers* can help the clinical staff estimate changes in the identified indicators using data available from the hospital and relevant information from other sources (see details below).
4. Some hospitals may decide to hire *consultants for training and statistical analysis* related to quality improvement.

## **Getting Ready To Conduct an ROI Calculation**

To use this tool for calculating the ROI of an intervention, the hospital staff needs to know:

- Elements of the program (including practices, technology, process or product).
- Resources needed to implement the intervention.
- Target population.
- Measures of health care quality likely to be affected by the intervention.
- Measures of health care utilization likely to be affected by the intervention.

## **Using Existing Literature To Estimate ROI**

Although not ROI studies *per se*, many studies have reported on costs or hospital charges related to patient safety events (for example, Zhan and Miller using Healthcare Cost and Utilization Project data; Rivard, et al., using Veterans Affairs data; and Foster using MedPAR data). See details about these papers in the section “Other Information Sources To Assist With Calculating ROI.”) Their results might be useful for ROI calculation. Few ROI analyses have been published in the health-services literature because they are not typically performed as research studies.

## **Selecting the Time Horizon for ROI Calculation**

Because a quality improvement program may continue for a number of years, ROI can be calculated for part of the program period (e.g., the first year of a 5-year program) or for the entire program (e.g., the entire 5 years of a 5-year program). The choice of the time horizon for the ROI calculation will affect results of the calculation in two ways:

- First, the costs of a quality improvement program usually are incurred at the beginning of the program while the hospital has to wait for some time to see the return. So, if the ROI is calculated at the initial stage of the program, the result is likely to be negative. In comparison, if the ROI is calculated in the long run, the chance of having positive results will increase.
- Second, if the time horizon is only 1 year, the cost calculation may not need to consider the issues of inflation, discounting, and depreciation. In comparison, if the time horizon for an ROI analysis is 2 years or longer, the analysis has to adjust for these issues, as described in the next section.

## Making Adjustments for Future Costs and Savings

- *Inflation* refers to rises in the prices of goods and services over a period of time. The ROI calculation can adjust for inflation by using constant dollars to measure the costs of a program over time.
- *Discounting* is simply the difference between the original amount in the present and the same amount in the future. In other words, \$100 next year is worth less than \$100 this year. Thus, future money has to be discounted to be comparable to current money.
- *Depreciation of equipment* is the reduction in the value of an asset due to usage, passage of time, wear and tear, technological outdating or obsolescence, depletion, inadequacy, or other factors. Among the several methods for calculating depreciation, straight-line depreciation is the simplest and most often used technique, which can be expressed as:

$$\text{Annual depreciation} = [(\text{Original cost}) - (\text{salvage value})] / \text{Years of life}$$

Where the salvage value is an estimate of the value of the asset at the time it will be sold or disposed of; it may be zero or even negative.

## Determining Differences Between Costs and Charges

*Costs* represent the amount of resources the hospital needs to use to provide inpatient care services, while charges are the amount of money the hospital reports on the bill and expects the patient and the insurer to pay. It is increasingly rare for the insurer to pay the full charges since Medicare, Medicaid, and many private insurers can obtain discounts of 50 percent or more.

While charges appear on hospital discharge data, costs should be calculated for the ROI analysis. The charges can be translated into costs using the hospital's cost-to-charge ratio, which is usually available at the hospital financial department. Because hospitals need to know their own costs to assess the performance of departments and the merits of specific programs, they typically report a cost-to-charge ratio for the hospital as a whole and cost-to-charge ratios for individual departments. These ratios can be used to calculate the costs of the quality improvement program.

## Using Micro Costing Versus Gross Costing

Micro and gross costing are the two commonly used methods for estimating health care costs. In *micro costing*, a cost is derived for each element of an intervention: staff time, supplies and medications, and so on. In comparison, *gross costing* uses mathematical models to determine the mean cost of a day of inpatient care or an outpatient visit. With gross costing, there is no detail available on the cost of any component of the hospital stay or visit.

Some experts recommend that when detailed data are available, micro costing be used as the method of choice. Other experts suggest that the choice between micro and gross costing be carefully considered and driven by the needs of the analysis and the precision of the estimates.

## Worksheet 1. Calculating Implementation Costs (ROI Denominator)

**Instructions for completing Worksheet 1** (Note: These are costs for implementation, NOT the subsequent changes in service finances.)

1. Prepare these costs using the same methods used for program budgeting. When the ROI is calculated during planning for a set of improvement actions, it is in fact a budget for that set of actions. Use the same line items for calculating actual costs after implementation. Some costs might be drawn from your hospital financial statements; others you will need to calculate yourself.
2. Enter the estimated costs for each line item (personnel, supplies, etc.) that is relevant to the improvement actions for each implementation stage (planning, training, etc.).
3. Sum the costs across rows to obtain a total cost estimate for each line item.
4. Sum the costs down the columns to obtain a total cost estimate for each improvement stage.
5. Obtain the grand total costs by summing the line item total costs (the highlighted box). *This is the denominator for the ROI calculation.*

Category of Implementation Costs	Implementation Costs by Stage of Improvement Action Implementation					Total Costs
	Planning and Development	Training	Startup	Ongoing Operation and Maintenance	Shutdown	
Personnel						
Supplies						
Equipment and depreciation						
Training						
Information systems						
Outreach and communication						
External consultant costs						
<b>Total Costs</b>						<b>GRAND TOTAL</b>



## Worksheet 2. Calculating Net Returns (ROI Numerator)

**Instructions for completing this worksheet:** (Note: These are changes in service revenues and operating costs resulting from implementing the improvement actions.)

1. Identify items for which the improvement actions will have financial effects and list them in first column. The top set lists effects on revenues; the bottom set lists effects on costs. The ones listed here are examples; you may use different sets of items.
2. Estimate the costs for each item for the comparison group (e.g., before) and following implementation. If the comparison periods involve more than 1 year, you may need to adjust some of the costs for inflation or discount future costs to reflect time preference for money.
3. Calculate net change in revenues = B minus A (increase in revenue). Calculate net change in costs = A minus B (decrease in cost).
4. Sum the line item net changes to obtain the total net change (highlighted box). *This is the numerator for the ROI calculation.*

	(Real) Financial Effects of Improvement Actions			NOTES
	A Comparison Period	B Implementation Period	Net Change	(Description of Effects Involved in Revenue or Cost Changes)
<b>Changes in Revenues:</b>			(B minus A)	
Admissions, readmissions, length of stay				
Payments from insurers				
New services provided	0			
Avoidance of penalties from insurers for “never events”				
Other effects on revenues				
<b>Changes in Costs:</b>			(A minus B)	
Service operating costs: staffing, supplies, equipment, other due to _____				
Admissions, readmissions, length of stay				
Intensity of care				
Productivity/efficiency changes				
Avoidance of liability litigation				
Other effects on costs				
<b>Net Financial Effect (Total)</b>				

## Case Study: ROI Calculation for CPOE Implementation

This case study is summarized from a published journal article that evaluated the financial impact of implementing a computerized physician order entry (CPOE) system at Brigham and Women's Hospital (BWH).<sup>1</sup> Few ROI analyses have been published in the health services literature because they are not typically performed as research studies. Although it is not specific to a pediatric setting, the example helps identify the process and types of costs that should be considered in an ROI analysis.

**Calculating implementation costs (denominator).** Costs were determined for each stage of practice implementation from 1992 to 2002. First, the capital costs of developing and implementing the CPOE system were estimated to be \$3.7 million, based on internal documents and interviews with the developers. Sixty percent of this cost was attributed to the first year of the study period (development costs) and 20 percent was attributed to each of the next 2 years (startup).

Next, operational costs starting in year 2 of the study period were calculated. These costs included hardware (workstations and printers), software, network, leadership, and training. They did not include costs for the pharmacy system, medication administration system, or clinical data repository. Operational costs ranged from \$600,000 to \$1.1 million per year. Development, implementation, and operation of the CPOE system cost \$11.8 million over 10 years.

**Calculating net returns from the program (numerator).** To estimate the savings generated from the CPOE system, the ROI team retrospectively identified each way the practice saved money (for a detailed description of each element of the program and its method of cost savings, see Kaushal, et al., 2006). The benefits were determined using published literature, key informant interviews, and internal documents. For many components of the CPOE, the number of estimated adverse drug events (ADEs) averted was multiplied by an average cost per ADE.

Other types of cost savings identified included decreased drug costs (decreased use and shift from use of intravenous to oral medications, decreased laboratory tests, reduction in use of inappropriate radiology tests, savings in nursing and provider time by improved workflow). Drugs and tests were valued using charge amounts and applying a 0.2 cost-to-charge ratio).

Because different elements of the CPOE system were introduced in stages, benefits were only calculated for those elements starting on the first day of the month after the element was implemented. This process was repeated for every intervention and area of cost savings; they found that the system saved the hospital \$28.5 million over the 10 years. Note that cost savings identified in their net return analysis does not take implementation costs, the denominator, into account.

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<sup>1</sup> Kaushal R, Jha AK, Franz C, et al. Return on investment for a computerized physician order entry system. *J Am Med Inform Assoc* 2006;13(3):261-6.

**Selecting the time horizon.** The staff assessed the ROI of the CPOE system over a period of 10 years to allow enough time to see a return. Because the time horizon was longer than 2 years, they needed to make adjustments for the following issues:

- *Inflation:* Dollar values for costs and benefits were converted to a constant dollar basis to adjust for inflation. They used the Bureau of Labor Statistics’ Producer Price Index time series for General Medical and Surgical Hospitals to standardize values to 2002 currency.
- *Discounting:* All costs and benefits were discounted at a 7 percent annual percentage rate as recommended by the U.S. Office of Management and Budget for economic analyses performed for the Federal Government, representing a societal discount rate as opposed to a hospital-specific rate. Costs were discounted using a “beginning-of-period” convention and benefits were discounted using an “end-of-period” convention.
- *Annualization:* Annualized values were calculated by converting all the discounted costs and benefits into a series of equal annual payments.

**Interpreting the results.** The ROI analysis yielded a positive return on investment—the CPOE system saved the hospital about \$2.2 million per year over the 10-year period. It took more than 5 years for the system to have a net benefit.

**Table 2. Information BWH Used To Conduct an ROI Analysis for CPOE Implementation**

Element of Analysis	Measure(s) or Values	Description or Inclusions
Costs (denominator)	<b>\$11.8 million</b> total: \$3.7 million in capital costs; \$600,000 to \$1.1 million per year in operational costs	Workstations and printers, software, network, leadership, and training
Returns (numerator)	\$28.5 million	Averted adverse drug events; medication cost savings; decreased laboratory test usage for redundant or unnecessary tests; improved workflow (staff and resource savings); decreased length of stay; streamlined workflow; improved information access for patients at time of discharge; decreased radiological utilization
Discount rate	7% annualized rate	
Consumer Price Index	Bureau of Labor Statistics’ Producer Price Index time series for General Medical and Surgical Hospitals to standardize values to a 2002 base year	
Prospective Reimbursement Rate (cost-to-charge ratio)	80%	
Live date (returns)	First day of the month following activation of the intervention or midpoint of the year (July 1) when only annual data were available	This is the date when they started counting the number of cost-saving events and calculating the associated cost savings.
Live date (start of calculating operational costs)	January 1, 1993	This is the date when the practice began to accrue operational costs.
End date	December 31, 2002	This date signifies the end of the study period.

## Other Information Sources To Assist with Calculating ROI

### Books

Drummond M, O'Brien B, Stoddart G, et al. *Methods for the economic evaluation of health care programmes*. 2nd ed. New York, NY: Oxford University Press; 1997.

### Wage Rates

The U.S. Bureau of Labor Statistics provides information about wage rates of more than 800 occupations in 50 States and the District of Columbia (<http://www.bls.gov/oes/current/oesrst.htm>). The information is useful for calculating personnel costs, such as doctors and nurses, which is part of the ROI analysis.

### Inflation Rates

The U.S. Bureau of Labor Statistics also provides information about inflation rates across the Nation and over time (<http://www.bls.gov/CPI/>), including price index of medical care (<http://www.bls.gov/cpi/cpifact4.htm>).

### Pharmaceutical Prices

The Red Book by Thomson Reuters provides comprehensive drug product and pricing data (<http://www.micromedex.com/products/redbook/database/>).

### Literature Estimating Costs of Medical Errors and Adverse Events

Bates DW, Spell N, Cullen DJ, et al. The cost of adverse drug events in hospitalized patients. *JAMA* 1997;277:307-11.

Bishop CE, Gilden D, Blom J, et al. Medicare spending for injured elders: are there opportunities for savings? *Health Aff (Millwood)*. 2002 Nov-Dec;21(6):215-23.

Chen LM, Rein MS, Bates DW. Costs of quality improvement: a survey of four acute care hospitals. *Jt Comm J Qual Patient Saf* 2009 Nov;35(11):544-50.

Classen DC, Pestotnik SL, Evans RS, et al. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. *JAMA* 1997;277:301-6.

Kaushal R, Bates DW, Franz C, et al. Costs of adverse events in intensive care units. *Crit Care Med* 2007;35(11):2637-8.

Pappas SH. The cost of nurse-sensitive adverse events. *J Nurs Adm* 2008;38(5):230-6.

Rivard PE, Luther SL, Christiansen CL, et al. Using patient safety indicators to estimate the impact of potential adverse events on outcomes. *Med Care Res Rev* 2008;65:67-87.

Rothschild JM, Bates DW, Franz C, et al. The costs and savings associated with prevention of adverse events by critical care nurses. *J Crit Care* 2009 Sep;24(3):471.e1-7.

Swensen, SJ, Dilling, JA, McCarty, PM et al. The business case for health care quality improvement. *J Pat Saf* 2013 Mar;9(1):44-52.

Zhan C, Miller MR. Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization. *JAMA* 2003;290:1868-74.

## Appendix I. Components of Implementation Costs

### Stages of Improvement Action Implementation

Implementation of improvement actions may be divided into the following stages:

- **Planning and program development.** This is the first stage of any program. Right from the start, the hospital needs to spend money on planning and program development activities, such as conducting situational analysis, searching the literature, identifying target areas and populations for the quality improvement program, assembling a team to work on the program, purchasing equipment, and setting up an information system.
- **Training.** Some training sessions may be part of planning and program development while other training sessions may happen in later stages of program implementation. It is also common to have training sessions during the implementation process to refresh the knowledge or skills of hospital staff members. Therefore, training is listed here as a separate item.
- **Startup.** The hospital needs to pay for running the quality program, including costs of personnel, supplies, equipment, and information system.
- **Ongoing operation, monitoring, and maintenance.** During the implementation process, the hospital needs to make sure its quality program is functioning as planned. Data about quality, utilization, costs, and revenue indicators should be collected to monitor changes in these indicators. The hospital also needs to spend on maintenance services for both the information system and the equipment for the quality improvement program.
- **Shutdown costs for time-limited intervention or failures.** While some quality programs may last a long period and become routine operation for the hospital, other programs might just be temporary, or may fail and have to be shut down after a short time. In these cases, there may be costs associated with shutting down the program.

### Categories of Costs for Program Planning, Implementation, and Maintenance

- **Personnel** includes all the people involved in developing and implementing the practice or quality improvement program, such as doctors, nurses, assistants, and administrators.
- **Supplies** include both office and medical supplies needed for development and implementation of the program.
- **Equipment** includes medical equipment purchased for use by the program.
- **Training** includes training of clinical, financial, or other staff involved in the quality improvement initiative both before the program starts and during different stages of program implementation.
- **Information systems** include computers, software, network infrastructure, and information technology professionals to set up a database of clinical and financial records.
- **Outreach and communication** includes communications among different professional groups, such as doctors, nurses, and administrators, and across different hospital departments, such as clinical and financial departments, and the hospital's board of directors.
- **External consultant costs** may include external trainers for developing and implementing the program, or an external statistician for analyzing data to estimate the changes in quality and utilization of hospital inpatient care.

## Appendix II. Examples of Existing ROI Calculators

### ROI Forecasting Calculator for Quality Initiatives

The ROI Forecasting Calculator for Quality Initiatives was developed by the Center for Health Care Strategies, which is a nonprofit health policy center. It is a Web-based tool designed to help State Medicaid agencies, health plans, and other stakeholders assess and demonstrate the cost-savings potential of efforts to improve quality. It provides step-by-step instructions for users to calculate ROI for the proposed quality initiatives. It can be used online at <http://www.chcsroi.org/Welcome.aspx>. Users enter a variety of assumptions before starting the calculation, including target population characteristics, program costs, and expected changes in health care utilization, to estimate potential savings.

### Adverse Events Prevented Calculator

Developed by the Institute for Healthcare Improvement, this tool allows users to track the change in rate of any type of adverse event over time. When appropriate data are added, the user also can track the consequent change in unnecessary deaths (“lives saved”), real and additional potential cost savings, and ROI of quality improvement work targeting those adverse events. The tool and its user guides are free for download at <http://www.ihl.org/resources/Pages/Tools/AdverseEventsPreventedCalculator.aspx>.