

Evaluation Toolkit Health Information Exchange Projects

2009 Update

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HEALTH IT

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INTRODUCTION

This version of the Evaluation Toolkit is targeted towards health information exchange (HIE) projects. The intent of the toolkit is to help your team work its way through the process of creating an evaluation plan for this type of Healthcare Information Technology (Health IT) project.

Health Information Exchange is the process of sharing healthcare data among individuals, institutions and healthcare service providers in order to improve the process, quality, cost and safety of healthcare. Initially envisioned as a means to reduce the fragmentation of care delivery, it has quickly evolved into the sharing of *all types* of healthcare data, not just data for direct clinical care.

Data exchange projects are quickly evolving in definition and scope, and there is a small, but growing body of research about them. The project your team is carrying out represents an important step in the national effort to use electronic exchange of health care information to improve patient safety, quality, effectiveness and efficiency of care. Although the number of data exchange projects is growing, their impact on safety and quality remains to be fully defined. In conjunction with this, the increase in federal and state focus and funding for health information exchange projects indicates the significant need for evaluation; thus it is critical for your project to include an evaluation component.

Evaluation serves multiple important purposes. First, a continuous evaluation process serves to guide the project itself, as the thoughtful examination of impact will allow your project to fine-tune your approach to data exchange, and may even allow you to elucidate and address the unintended consequences of electronic data exchange. Second, by carefully documenting the barriers encountered and the lessons learned, other organizations will be able to better understand how to best approach their own data exchange projects in the future. In our experience, evaluation efforts have the best chance of fulfilling their promise when they are planned for during the early phases of the project.

This toolkit has been developed to help guide you through the process of devising a realistic and achievable evaluation plan. Section I walks you and your team step-by-step through the process of determining the goals of your project, what is important to your stakeholders, what needs to be measured to satisfy stakeholders, what is truly feasible to measure, and how to measure these items.

Sections II and III include lists of measures that may be used to evaluate your project. Each table in these lists includes possible measures, suggested data sources for each measure, potential

pitfalls, links to suggested resources and general notes. While these tables distill the various experiences of members of the National Resource Center, they should not be considered exhaustive, as there may be many opportunities to explore and learn from various aspects of your data exchange projects. However, you should not pick these measures without carefully considering whether each measure will help inform your implementation and approach, answer an important question for your stakeholders or whether you have the resources to evaluate and use the measure. The final section contains an example of a project and potential measures which could be used in an evaluation of that project.

SECTION I: DEVELOPING AN EVALUATION PLAN

I. DEVELOP BRIEF PROJECT DESCRIPTION

This may come straight out of your project plan or proposal.

II. DETERMINE PROJECT GOALS

What is it that you hope to gain from this implementation? What are the goals and expectations of your stakeholders (e.g. clinicians, laboratories, pharmacies, chief-level individuals, etc)? What would need to happen for the project to be deemed a success by you and your stakeholders? In thinking about your stakeholders, consider the entity which is responsible for the project, the structure of that entity and its governance. Are the goals being proposed in alignment with this entity?

Example:

To improve the quality of care provided to patients by successfully exchanging laboratory data (orders and results) between providers and laboratories.

III. SET EVALUATION GOALS

How will your evaluation results be used? To monitor your progress and inform your implementation and approach? Who is your audience for your evaluation? Do you need to present findings to your hospital board or IT staff? Do you intend to prepare a report for your stakeholders? If you have received federal or state funding, do you need to prepare a report in order to fulfill the funding requirements? Will you use the evaluation to convince late adopters of the value of your implementation? To share lessons learned? To demonstrate the project's return on investment? Or are your goals more external? Would you like to share your experiences with a wider audience and publish your findings? If you plan to publish your findings, it might affect the approach to your evaluation. In addition, look to your funding source, be it from your stakeholders, a grant or a contract. Are there required goals within this funding vehicle that must be met?

Example:

Goal: To prepare a report for our stakeholders and other groups considering undertaking a data exchange project.

IV. CHOOSE EVALUATION MEASURES

Take a good look at your project goals. What needs to be measured in order to demonstrate that the project has met those goals? Brainstorm with your team on everything that could be measured, without regard to feasibility. These can be around whether or not the ground work for the project has been successfully completed, such as developing a governance structure, coming to a consensus on how to handle privacy and security issues or developing a sustainability model. Perhaps you want to track whether or not the project was able to come up with a minimum data set to share, and the rate at which that data was able to be shared.

Because most HIE initiatives are still in their infancy, experts recommend using formative evaluation to examine these efforts¹. Formative evaluation, defined as an iterative assessment of a project's viability through meeting defined benchmarks², allows evaluators to continually use what is learned during evaluation and immediately apply those lessons. HIE implementations have many groups involved causing the implementation process of planning, developing, tool selection and design, data acquisition, and pilot testing, to be quite complex. Utilizing formative evaluation allows for the measurement of short-term goals so that evaluators are able to identify improvements and provide information about the HIE within the boundaries of time, place and value³. The following papers provide more detail on evaluating HIEs:

- Marchibroda JM. Health information exchange policy and evaluation. *J Biomed Inform.* 2007 Dec;40(6 Suppl):S11-6.
- Ash JS, Guappone KP. Qualitative evaluation of health information exchange efforts. *J Biomed Inform.* 2007 Dec;40(6 Suppl):S33-9.
- Shapiro JS. Evaluating public health uses of health information exchange. *Biomed Inform.* 2007 Dec;40(6 Suppl):S46-9.
- Johnson KB, Gadd C. Playing smallball: approaches to evaluating pilot health information exchange systems. *J Biomed Inform* 2007;40:S21-6.

¹ Ash JS, Guappone KP. Qualitative evaluation of health information exchange efforts. *J Biomed Inform* 2007 Dec;40(6 Suppl):S33-9.

² Sallas B, Lane S, Mathews R, Watkins T, Wiley-Patton S. An iterative assessment approach to improve technology adoption and implementation decisions by healthcare managers. *Inform Sys Manage* 2007;24:43-57.

³ Johnson KB, Gadd C. Playing smallball: approaches to evaluating pilot health information exchange systems. *J Biomed Inform* 2007;40:S21-6.

For those projects which are past the implementation phase, you may want to look at evaluating outcome and process measures, such as:

- Clinical Outcomes Measure
- Clinical Processes Measures
- Provider Adoption and Attitudes Measures
- Patient Knowledge and Attitudes Measures
- Workflow Impact Measures
- Financial Impact Measures

Sections II and III provide a wide range of these potential measures to give you and your team ideas about the kinds of measures to evaluate.

Example:

Goal: to successfully exchange laboratory data (orders and results) between providers and laboratories. Possible measures: track progress of completing the architecture necessary to exchange laboratory data, track progress of the actual exchange of data, track the percentages of orders or results that are exchanged out of total orders or results.

V. CONSIDER QUALITATIVE TECHNIQUES TO SUPPLEMENT QUANTITATIVE TECHNIQUES

Many people feel more comfortable in the realm of numbers and, as a result, frequently design their evaluations solely around quantitative data. This approach provides only a partial picture of a project. Quantitative data can lead to conclusions about your project that miss the larger picture, thus are often used in conjunction with qualitative methods to help interpret a quantitative outcome. Quantitative and qualitative data can effectively complement one another. For example in one practice the HIE started delivering results electronically which were then printed on paper. A quantitative satisfaction survey revealed that providers were unhappy with the system, but did not assess why they were unhappy. During a focus group, providers reported that the system impacted their workflow because it printed one result per page along with some ancillary information making it difficult to review results. These qualitative findings could be used to refocus the design of the intervention. However, lacking a qualitative evaluation, these insights are lost on the project team. Therefore, it is important to consider both quantitative and qualitative data in your evaluation plan.

There are several resources that provide strategies for using qualitative methods in informatics research.

- Ash JS, Guappone KP. Qualitative evaluation of health information exchange efforts. *J Biomed Inform.* 2007 Dec;40(6 Suppl):S33-9.
- Ash JS, Smith AC, Stavri PZ. In: Friedman Charles P, Wyatt Jeremy C, editors. *Interpretive or qualitative methods: subjectivist traditions responsive to users.* Chapter 10 in *evaluation methods in medical informatics.* 2nd ed. Springer-Verlag; 2005.
- Berg BL. *Qualitative research methods for the social sciences.* 6th ed. Pearson: Boston; 2007.

Qualitative techniques provide ways to measure the usability of systems and to help identify and understand the unintended consequences (both positive and negative) of HIE implementation. Identifying negative unintended consequences, like increasing workload or disrupting workflow for providers and staff, can help investigators understand why users may not be using a system or why a system may not be working as intended, and find solutions to address these issues. If feasible, conduct your evaluation over several phases of the project to identify issues and improvements as well as to inform decisions about the system. Qualitative results, in the form of quotations or anecdotal stories can provide immediate evidence of benefits to stakeholders long before long-term quantitative evaluations are completed.

Qualitative studies add another important dimension to an evaluation study: they allow evaluators to understand how users interact with a new system. In addition, qualitative studies can speak to a larger audience because they are sometimes easier to understand than quantitative studies. They often generate anecdotes and stories that resonate with audiences. Please add any qualitative measures you would like to consider.

VI. CONSIDER ONGOING EVALUATION OF BARRIERS, FACILITATORS, AND LESSONS LEARNED

Lessons learned are important measures of your project, and typically are captured using qualitative techniques. Lessons may reflect the barriers and facilitators you encountered at various phases of your project. Barriers may include organizational barriers, technology barriers, security and privacy barriers, financial barriers, or legal barriers, among many.

In addition to tracking barriers, track what steps were taken to overcome those barriers. For example, strong leadership, being impartial across the participants, good training, support in the early stages of implementation, and obtaining buy-in from your target community, may all serve as important facilitators to your efforts. This type of information is extremely valuable not only to you but also to others undertaking similar projects. Other lessons learned of great value to others include approaches to determining governance, legal, organizational, privacy and confidentiality policies, consumer and technical issues. In formulating a plan for capturing this information, consider scheduling regular meetings with your project team to discuss current issues and record these discussions.

If there are personnel assigned to support the early implementation stages, they may set up a mechanism, such as a secure website, that will facilitate early feedback on any issues raised so that they might be addressed. Also, the observers may suggest changes to the measures to better capture the intended data. In addition, focus groups could provide rich information from a variety of participants about the lessons learned from your project. For example, you could ask physicians who are using data exchange about what has gone well, what has gone poorly, and what the unexpected consequences of the project have been. Consider how you could incorporate these qualitative analysis techniques into your evaluation plan. Clearly state what you want to learn, how you plan to collect the necessary data, and how you would analyze the data.

Example of a 'lesson learned':

You observe early on in the project that the electronic exchange of test orders between ambulatory practices and commercial labs was consistently missing important usage milestones, (i.e. 60% of all orders transmitted electronically by 6 months post-implementation). You therefore decide to evaluate the barriers involved and try to understand ways to overcome these barriers. You decide to conduct semi-structured interviews with the stakeholders involved in the delay. You discover that several laboratories were concerned about the loss of control and the disruption of existing workflow patterns if they started accepting orders generated by different EMR vendors. You report this finding to the main project team and come up with a plan to ask the state medical society to convene a joint meeting with the major EMR vendors and commercial labs so that the two parties can better understand each other's requirements. This approach was a success and the project began meeting its milestones. A lesson learned was thus to convene the appropriate stakeholders early in the design process so that each stakeholder does not feel threatened by the others.

VII. SEARCH FOR OTHER EASILY MEASURED MEASURES

Clinicians, laboratory services, pharmacies, hospitals and other healthcare groups collect a tremendous amount of data for multiple purposes: to satisfy various federal and state requirements, to conduct ongoing quality assurance evaluations, or to measure patient and staff satisfaction, among many. Therefore, there are likely teams within the participating groups of your health information exchange that are already collecting data that might be useful to you. Reach out to these groups to learn what information they are currently collecting, and determine whether those data can be used as an evaluation measure.

In addition, contact the various groups you are working with to learn the reporting capabilities of their current software programs. There may be opportunities to leverage those reporting capabilities for your evaluation. For example, do your participant labs already track phone calls from clinicians looking for results? Are the participant pharmacies already evaluating customer satisfaction? Could your evaluation team piggy-back with another group to abstract a bit of additional information? Are there useful measurements that could be taken from existing reports? Likewise, you may find that activities you are planning as part of your evaluation would be helpful to groups participating in your health information exchange. Cooperation in these activities can increase goodwill on both sides.

Example:

The region's participating pharmacies are contacted and inquiries are made regarding reports generated on a routine basis. It is discovered that the pharmacies actively track calls they make to physicians to clarify information on prescriptions. It is hypothesized that the ability to electronically exchange data regarding patient medications will decrease these calls. Adding this measure to the evaluation plan is easy and helps to determine whether or not the regional project is having an impact.

VIII. CONSIDER PROJECT IMPACTS ON POTENTIAL MEASURES

Consider the potential measures on your list and whether and how your health information exchange project might impact those measures. Would your implementation truly impact these measures? You may find that this exercise eliminates some measures from your list because they will not be impacted by your project.

IX. RATE YOUR CHOSEN MEASURES IN ORDER OF IMPORTANCE TO YOUR STAKEHOLDERS

Now that your team has a list of measures to evaluate, rank each measure in order of importance to your stakeholders, i.e., clinicians, laboratories, pharmacies, chief-level individuals, etc. You could use a simple scale such as: 1 = Very Important, 2 = Moderately Important, 3 = Not Important. This will help you begin to filter out those measures that are interesting to you but will not provide you with information to inform the project or be of interest to your stakeholders. Another approach to determining importance of measures may be to consider your contract requirements. For instance if you are required to be exchanging a given percentage of data by a particular date, this may be prioritized as a 'very important' measure to evaluate.

1. Very Important: _____

2. Moderately Important: _____

3. Not Important: _____

Determining which measurements to use for your evaluation may be difficult for your team. Data exchange projects typically have a variety of stakeholders, across many types of facilities, all with seemingly different goals and priorities. It is best to recognize this up front, and maintain your impartiality as best as you can. If necessary, you can bring all the players to the table and together determine what is most important to the project as a whole.

X. DETERMINE WHICH MEASUREMENTS ARE FEASIBLE

Now examine your list to determine which measures are feasible for you to evaluate. Be realistic about the resources available to you. Teams frequently are forced to abandon evaluation projects that are labor-intensive and expensive. Instead, focus on what is achievable and on what needs to be measured to determine whether your implementation has met its goals. For example, you might want to know whether your implementation reduces adverse drug events (ADEs). That is a terrific evaluation project, but if you have neither the money nor the individuals needed for chart abstraction, the project will likely fail. Keep your eye on what can be achieved. Again, you can use a simple ranking scale: 1 = Feasible, 2 = Feasible with Moderate Effort, 3 = Not Feasible.

1. Feasible: _____

2. Moderate Effort: _____

3. Not Feasible: _____

XI. DETERMINE YOUR NEEDED SAMPLE SIZE

The feasibility of measuring a specific quantitative outcome or process measure often depends on the minimal sample size you need. In a typical evaluation project, you may be interested in examining whether your project has impacted a quantitative measure of interest. In general, if the measure is capturing rare events, you will need to make many observations in order to observe a sufficient number of events to draw meaningful conclusions. Also, if the impact of the project is small, then you will need to make more observations in order to say with confidence that any measured impact is truly due to the project itself and not to random chance. Needless to say, observations cost money, and you may find that some measures are out of reach given the resources you have at your disposal. Appendix A offers a hypothetical example.

With the help of a statistician or other statistical resources, estimate the number of observations you will need for each outcome or process measure. You may find this exercise eliminates further measures from being feasible.

XII. RANK YOUR CHOICES ON BOTH IMPORTANCE AND FEASIBILITY

Place your remaining measures into the appropriate box in the grid below.

		Feasibility Scale		
		1-Feasible	2-Moderate Effort	3-Not Feasible
Importance Scale	1-Very Important	-1	-2	
	2-Moderately Important	-3	-4	
	3-Not Important	-5		

Those measures that fall within the green zone (Very Important, Most Feasible) are ones you should definitely undertake; the yellow zones are ones you can undertake in the order listed; those in the red zone should be avoided.

XIII. CHOOSE THE MEASURES YOU WANT TO EVALUATE

You now have a list of measures ranked by importance and feasibility. Narrow that list down to four or five primary measures. If you want to evaluate other measures and you believe that you will have the required resources available to you, list those as secondary measures.

XIV. CONSIDER RETROSPECTIVE VS. PROSPECTIVE STUDIES

Now that you know which measures you are going to undertake, consider the study design you will use. Listed below are the types of study designs that may be used in your evaluation. Remember that each type of design has attributes of “timing” and “data collection strategy.” Timing can be either retrospective – looking at data from the past; or prospective – looking at new data as it is collected. The data collection strategies include chart reviews, interviews (phone, in-person), focus groups, data mining from electronic databases, observational data collection (time-motion studies), automatic data collection from EMRs, called “Instrumenting”, and expert-reviews. This section of the evaluation tool kit is not meant to be a substitute for hands-on guidance from a trained statistician. It is only meant to be a ten-thousand foot view of potential evaluation methods.

Retrospective studies typically involve reviews of charts or electronic data and make inferences about outcomes in groups that have been exposed to independent factors as compared with groups not exposed to the same factors. An example in health IT would be asthma guideline compliance in a group with an EMR compared to a group without an EMR.

In prospective studies, the observations occur forward in time where an exposure group and a control group are compared prospectively to the development of an outcome in question.

The types of study designs for retrospective and prospective studies along with relevant data collection strategies are provided below:

1. Retrospective Studies
 - A. Data Collection Strategies
 - i. Manual Chart Review
 - ii. Electronic Data Mining of EMR/Registry Data
 - iii. Instrument the EMR/Registry (Real-Time Data Collection)
 - iv. Surveys (Paper/Electronic)
 - v. Expert Review
 - vi. Phone Interview
 - vii. Focus Group
 - B. Typical Study Designs
 - i. Case Series
 - ii. Retrospective Case Control Study

2. Prospective Studies
 - A. Data Collection Strategies
 - i. Manual Chart Review
 - ii. Electronic Data Mining of EMR/Registry Data
 - iii. Instrument the EMR/Registry (Real-Time Data Collection)
 - iv. Surveys (Paper/Electronic)
 - v. Expert Review
 - vi. Phone Interview
 - vii. Focus Group
 - viii. Direct Observation
 - B. Typical Study Designs
 - i. Prospective Cohort Study
 - ii. Randomized Controlled Trial (RCT)
 - iii. Time-Motion Study
 - iv. Pre-Post Study
 - v. Meta-Analysis

XV. CONSIDER DATA SOURCES

As you think through your study design, you will need to consider where you will obtain your data. Potential sources of data include:

- A. Study Databases (data entered from surveys, focus groups, time-motion studies etc.)
- B. Paper Charts

- C. Electronic Data Repositories and EMR databases
 - i. Lab System
 - ii. Pharmacy System
 - iii. Billing System
 - iv. Registration System
 - v. Radiology Information System
 - vi. Pathology Information System
 - vii. Health Information Exchange
 - viii. Personal Health Record
 - ix. EMR data (ICD/Procedures)
 - x. Administrative Systems
- D. Pharmacy Logs
- E. Disease Registries
- F. Prescription Review Databases
- G. Direct Observation Databases
- H. Real-Time Capture from Medical Devices (Bar Coders etc.)
- I. Hospital Quality Control Program – Hospital may already be collecting this information for quality reporting.

XVI. CONSIDER THE IMPACT OF DATA COLLECTION STRATEGIES ON RELATIVE COST AND FEASIBILITY

How you have chosen to design your study and data collection strategy will impact the feasibility of evaluating a given measure in terms of both the relative cost and the challenges you are likely to encounter. Below we list known caveats around study designs and data collection strategies and their relative cost considerations, as well as alert you to possible solutions. You may find additional measures you will want to drop from your evaluation plan once you carefully consider these issues.

Issues Related to Your Data Collection Strategy

1. Developing your own survey can be time-consuming. If you are conducting rigorous evaluations, you also will need to validate the survey, especially if it is scored, which can add additional time and expense. Some resources on survey design can be found here:
 - A. Doyle, JK. Introduction to Survey Methodology and Design. Chapter 10 from the *Handbook for IQP Advisors and Students*, prepared by Douglas W. Woods.

- B. California Health Interview Survey: [Survey Methodology, California Health Interview Survey](#)
 - C. Hinkin TR. A brief tutorial on the development of measures for use in survey questionnaires. *Organizational Research Methods*, Vol. 1, No. 1, 104-121 (1998).
 - D. Consider using or amending an existing survey. The National Resource Center has developed a *Compendium of Health IT Surveys* that may be found on the NRC Web site at [Health IT Survey Compendium](#). This tool allows a user to search for publically available surveys by survey type, technology, care setting, and targeted respondent. These surveys can then be used as is, or can be modified to suit a user's needs.
2. Focus groups require planning and the logistics can become complicated when busy stakeholders are asked to convene. The methodology for data analysis from focus groups requires the expertise of a qualitative researcher to analyze free-text narratives for themes and common principles. A well-done focus group is much more than a group of individual interviews and facilitating these requires considerable skill. Focus groups can yield rich data in a short time, but it is important to have carefully selected the right participants, to encourage everyone to be heard, to carefully steer the discussion so that it stays on track, and to focus on just a few main questions.⁴ Some resources on focus groups include:
- A. Focus Group Fundamentals, Iowa State University. Methodology Brief PM 1969b. May 2004.
 - B. Kitzinger, J. Qualitative research: introducing focus groups. *BMJ* 1995 Jul 29;311(7000):299-302.
 - C. [Focus Groups, Robert Wood Johnson Foundation](#)
 - D. [A manual for the use of focus groups, methods for social research in disease](#)
3. Manual chart reviews are time consuming and expensive, depending on how many charts you need to review or how many data elements are abstracted. Common pitfalls with chart reviews include unintentional data omission, data entry problems or that the chart itself may be incomplete or have missing information. In addition, reviewers can fatigue easily from the tediousness of the work.

⁴ Ash JS, Guappone KP. Qualitative evaluation of health information exchange efforts. *J Biomed Inform* 2007;40:S33-9.

4. Data mining refers to the use of sophisticated statistical techniques in the analysis of *existing* data within a given database. You may need to have access to experienced programmers or statisticians to extract data and to model and analyze patterns within a dataset that can indicate certain conditions or outcomes. However, the use of clinical or billing data extracted from electronic records will provide evaluators with robust data for analysis.
 - A. Moore A. Statistical data mining tutorials.
 - B. Palace B. [Data mining](#), Technology Notes Prepared for Management 274A.

Issues Related to Choice of Study Design

1. Some prospective studies can be done fairly efficiently and quickly. For example, time-motion studies (also known as work-sampling or observational studies) can be quickly performed by motivated research assistants or students at reasonable costs. However, they require the development of the list of tasks that a subject will perform and that you have a data collection tool (personal digital assistant-based timer tool, paper-based tool, etc.) where you can record the times for the completion of each task. An AHRQ grantee developed time-motion observation instrument is publicly available on the [NRC Health IT Web site](#). Other resources include:
 - A. Finkler SA, Knickman JR, Hendrickson G, Lipkin M, Jr, Thompson WG. [A comparison of work-sampling and time-motion techniques for studies in health services research](#). Health Serv Res 1993 Dec;28(5):577–97.
 - B. Caughey MR, Chang BL. Computerized data collection: example of a time-motion study. West J Nurs Res 1998 Apr;20(2):251-6.
2. Other types of prospective studies (randomized controlled trials) and before-after type observational studies are more complicated and expensive. They require modeling of the outcome variables using advanced statistical techniques (generalized linear models, logistic regression, analysis of variance ANOVA, etc.). While they may provide the most accurate and valid data of all the study designs, they are also the most expensive to undertake.
 - A. Sibbald B, Roland M. Understanding controlled trials: why are randomized trials important? BMJ 1998;316(7126):201.
 - B. Green S, Raley P. What to look for in a randomized controlled trial. Science Editor. September – October 2000. Vol 23(5):157.

- C. Concato J, Shah N, Horwitz R. Randomized controlled trials, observational studies, and the hierarchy of research designs. *N Engl J Med* 2000;342:1887-92.
3. For retrospective data analysis or case-control studies, you will need cohorts of matched cases and controls, in order to evaluate the outcome in question. The challenge in these studies is trying to identify the matched cases and controls.
- A. Barlow WE, Ichikawa L, Rosner D, Izumi S. [Analysis of case-cohort designs](#). *J Clin Epidemiol* 1999 Dec;52(12):1165-72.
- B. Schenker M. Case control studies. Department of Public Health Sciences, UC Davis.
- C. Meirik O. [Cohort and case control studies, Meirik](#). Geneva Foundation for Medical Education and Research.
- D. Ernster VL. [Nested case-control studies](#). *Prev Med* 1994 Sep;23(5):587-90.

XVII. CHOOSE YOUR FINAL MEASURES

Based on your study design choice and their relative costs, you may have eliminated additional measures from your evaluation plan. You should now be left with a final list of measures that you want to evaluate as part of your evaluation plan.

XVIII. DRAFT YOUR PLAN AROUND EACH MEASURE

Map out how you will evaluate each measure. What is the timeframe for your study? What is your comparison group? If you are doing a quantitative study, what statistical analysis will you use? Having a statistician review your plan may save you time later in your evaluation. If you plan to deploy a survey as part of your evaluation, you may want to conduct a small pilot to address any issues ahead of time that may arise before full deployment. In developing your plan around each measure, we suggest that you use the following template to help you outline the details.

Measure	1st measure	2nd measure	3rd measure	4th measure
Briefly describe the project.				
Describe the intervention and the intended impact.				
What questions do you want to ask to evaluate this impact? These will likely reflect the expected impact (either positive or negative) of your intervention.				

Measure	1st measure	2nd measure	3rd measure	4th measure
What will you measure to answer these questions?				
How will you make your measurements?				
How will you design your study? For a quantitative study, you might consider what comparison group you will use. For a qualitative study, you might consider whether you will make observations or interview users.				
For quantitative measurements only: What types of statistical analysis will you perform on your measurements?				
For quantitative measurements only: estimate the number of observations needed to demonstrate that the measure has changed statistically.				
How would the answers to these questions inform future decision-making and/or implementations?				
What is the planned timeframe for your project?				
Who will take the lead for the project? For data collection? Data analysis? Presentation of the findings? Final write-up?				
Estimate the cost for evaluating the measures. Take into consideration planning, meetings, travel, analysis, consultation time with a statistician and time to prepare a final report or summary on your findings, if necessary.				

XIX. WRITE YOUR EVALUATION PLAN

You now have everything you need to write your evaluation plan: project description, goals, measures, and methodology for your evaluation. We suggest you follow the following structure:

1. Short Description of the Project
2. Goals of the Project
3. Questions to be Answered by the Evaluation Effort
4. First Measure to be Evaluated — Quantitative
 - a. Overview – General Considerations
 - b. Timeframe
 - c. Study Design/Comparison Group
 - d. Data Collection Plan
 - e. Analysis Plan
 - f. Power/Sample Size Calculations
5. Second Measure to be Evaluated – Qualitative
 - a. Overview – General Considerations
 - b. Timeframe
 - c. Study Design
 - d. Data Collection Plan
 - e. Analysis Plan
6. Subsequent Measures to be Evaluated in Same Format
7. Budget Justification
8. Conclusion

XX. CONSIDER YOUR EVALUATION BUDGET

Having mapped out the measures you intend to evaluate, take another look at the costs involved. Are there measures which will put your budget at risk? Are there ways to reduce the costs of these measurements? If it is clear that you cannot meet your budget with your planned measures, have your team work through the importance and feasibility matrix a second time. Are some measures too expensive and therefore drop in your team's estimation as to whether or not they are feasible? Are some measures expensive, but so important as to cause you to drop several of the less important ones in order to afford the more expensive, but necessary ones? The team must come up with an evaluation plan which falls within your planned budget. Your plan should have some discussion around budget justification, indicating that you have taken costs into consideration.

Some common-sense approaches may help you reduce your budget requirements. For example, instead of obtaining rigorous quantitative measures for certain items like “workflow efficiency” you could do simple surveys that could give you 80% of the information you need for a significantly lower cost. As previously mentioned, you could also work with others in your organization to find out what other types of measures are already being collected for other purposes (e.g., quality initiatives).

SECTION II: EXAMPLES OF MEASURES THAT MAY BE USED TO EVALUATE DATA EXCHANGE PROJECTS

Section II and Section III includes lists of measures that may be used to evaluate your project. Each table in these lists includes possible measures, suggested data sources for each measure, potential pitfalls, links to suggested resources and general notes. While these tables distill the various experiences of members of the National Resource Center, they should not be considered exhaustive, as there may be many opportunities to explore and learn from your data exchange projects. However, you should not choose these measures without carefully considering whether each measure will help you to answer an important question for your stakeholders and whether you have the resources to evaluate and use the measure.

Section II is divided into two subsections. Subsection II.A provides a set of measures for organizations to evaluate the process of creating a HIE. Subsection II. B provides details of specific measures based on the *kind of data that is flowing* in the HIE. Section III then provides a set of *clinical outcome* and *clinical process* measures for the value proposition of the HIE.

SUB-SECTION II. A

The following tables provide examples of measures based on the *structure* and *process* within the HIE. Most of these measures are simple yes/no measures and can be ascertained from strategic planning, legal, technical and other documents (i.e. meeting minutes, Gantt charts, Org-charts etc.)

Table-1: Measures of the Infrastructure Development Effort

Measure	Data Source(s)	Notes	Potential Pitfalls
Has a strategic plan or vision for the HIE been developed?	Planning and Executive Teams	A strategic plan is a document that lists the reasons for creating the HIE, the cost estimates, the stakeholders who will benefit or contribute data, the data types to be shared, the outcomes to be expected, and the legal infrastructure to accomplish data sharing.	Note that the strategic plan is a "living document". It <i>will</i> change as the project evolves and is implemented.
Have the appropriate stakeholders been identified (i.e. the institutions and individuals who will participate)?	Strategic or Business Plan Documents Surveys of implementation Team	Traditionally these will include institutions and individuals. Institutions may be labs, pharmacies, hospitals, clinics, long-term care, radiology offices, payers etc. Individuals may be providers, patients.	Be sure to include the "non-traditional" stakeholder – i.e. patients.
Has the legal climate for data sharing been ascertained?	Strategic Planning Documents Surveys of Stakeholders	Is there a data sharing agreement in place? Are stakeholders ready to share data? What are they asking for in return?	Beware of issues arising when the data to be shared crosses state boundaries, as the legal environment may be different from state to state.
Has a technical plan for data sharing been developed?	Strategic Plan Technical Architecture Documents	The technical plan includes the architecture, the specific hardware and software components to be used, and the standards to be adhered to.	The technical plan will change as the project evolves.

Measure	Data Source(s)	Notes	Potential Pitfalls
Has an implementation committee been selected?	Committee meetings, minutes, planning documents	The committee would oversee the implementation effort, troubleshoot processes and costs and provide overall guidance.	
Has a project plan been developed?	Project Plan Documents Gantt charts Strategic Planning Documents	Necessary as a blueprint to define the work groups, project teams, and costs, etc.	Will change over time as the project proceeds.
What specific data elements are to be shared and why?	Strategic Planning Documents	This will drive everything else, in particular the necessary technical components and the type of data sharing agreement developed.	Different places may define these data elements differently so need to have institution specific "versions" of these data sets.
Source of data elements identified?	Technical architecture discussions Meeting minutes Strategic Planning Documents	The source of the data elements could include the EMR, other databases and systems (registration/billing, PACS, etc.).	The source will vary from place to place and the data may need to be manipulated to correctly interpret it.
Is there a procedure in place to get permission from patients to share their data?	Strategic Planning Documents Legal documents	Some institutions ask patients for a blanket agreement while others have a granular (data element by data element) approach.	.
Have governance structures been established?	Strategic Plan		
Has an evaluation plan been developed (for the planning and implementation processes and for evaluating outcomes)?	Strategic Planning Documents	Necessary for evaluating the impact of the HIE on the indicators of importance to the stakeholder groups.	May evolve as the project develops.

Table-2: Measures of Process

Measure	Data Source(s)	Notes	Potential Pitfalls
Are stakeholders ready to share the specific data elements?	Committee meeting minutes/documents Signed Data Sharing Agreements	Do stakeholders understand what these data elements are, how they are represented in their databases and have a plan to share them electronically through interfaces built into their repository?	Have to be careful in defining how each stakeholder views these specific data elements. Some may share a partial set.
Do stakeholders agree with and/or have signed the data sharing agreement?	Querying the Stakeholders Data Sharing Agreement Signatures	There may be stipulations in the agreement that are specific to certain stakeholders.	
Do stakeholders know their roles and responsibilities on the project?	Governance Diagrams Charter Documents Legal Documents	This is important as roles and responsibilities are used to engender trust and settle disputes.	
Has the technical architecture been finalized?	Meeting Minutes and Documents	The technical architecture includes the data sharing model, the standards and interfaces between the systems, the patient matching scheme, the data aggregation scheme, messaging systems, security etc.	
Have any unforeseen barriers been encountered during implementation and how are they being addressed?	Meeting Minutes Quarterly Reports	Important to document these. Sometimes out of implementer's control – i.e. vendor delays delivery of promised product enhancements – but important for future planning and implementation.	
Is the project on target for time?	Project timelines Project plan Gantt charts	Need to keep track of project deliverables and timelines.	
Is the project on target for cost?	Project Cost Projections for Phases Project Plan Gantt charts	Need to keep track of project costs for each deliverable. May need to change direction if costs get prohibitive. Important to have backup plans.	Cost data is often hard to analyze but unforeseen costs always creep into such large scale projects.

Measure	Data Source(s)	Notes	Potential Pitfalls
Has the evaluation process started? If so, is it on time/budget and are there unforeseen barriers?	Evaluation Team	The Evaluation process starts from day 1 of the project. It should include the planning process and the implementation process. It will also include an outcomes assessment.	

SUB-SECTION II. B

The following tables in this sub-section provide examples of measures based on *5 types of data exchange*. Each table provides measures that speak to the value of the particular type of data exchange.

Table-1: Data Exchange between Providers and Laboratories

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Was electronic ordering of laboratory tests between outpatient providers and laboratories achieved?	Implementation Team	Requires an interface between the ambulatory EHR and the lab data system. Simple Yes/No question.		
Are providers using data exchange capability with laboratories?	Usage statistics from system's audit logs (order logs, result view logs, system log-on tracking, etc.)	There are several different ways you might want to measure this. First would be the number of discrete providers using the system as the numerator and the number of total providers as the denominator. A second approach might be how frequently individual providers are accessing the system with access hit rates as the numerator and the number of individual providers as the denominator. A third approach might be to look at access hit rates divided by total number of providers to get an overall average rate. Providers might be defined as nurses and/or physicians. Tracking this information over time and presenting this information visually would give stakeholders an understanding of adoption trends of your project. You could also track the number of paper transactions still being used, i.e., clinical staff putting labs into records.	Finding baseline provider rates might be difficult. For example, what is your sample of physicians who could be using the system? You could consider getting this information from local medical societies or Boards of Medicine.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 133 for detailed definition and evaluation method for this measure: Infoway Report.
What percentage of laboratory orders is sent electronically?	Usage statistics from system's audit logs	Denominator = all orders (electronic and paper) Numerator = electronic orders	May become costly if it requires counting paper orders.	See Canada Health Infoway's Benefits Evaluation Indicators

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
		Can do this on both the laboratory and provider side		Technical Report*, page 136 for detailed definition and evaluation method for this measure: Infoway Report.
Reduction in calls to providers to clarify an order.	Call Logs	Need to track call volume before and after.	Calls may not be for order clarification but to report other issues – i.e. improper specimen collection, unavailability of test, or new test version, etc.	See Canada Health Infoway’s Benefits Evaluation Indicators Technical Report*, page 64 for detailed definition and evaluation method for this measure: Infoway Report.
Costs to send orders to laboratory.	Pre- and Post-Implementation check of financial logs, time motion/workflow analysis in a sample of various settings	First, estimate what these costs are per order (labor costs to prepare forms, costs to send forms) and then multiply by the number of orders sent out. Using time motion studies: compare paper and electronic methods on how much time individuals spent looking for results, writing orders, transcribing, etc and then multiply time by mean staff hourly wage.	Make sure to track orders electronically – the cost of an “electronic transfer” is not zero – it includes the cost of developing and maintaining the infrastructure to send the information electronically.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on duplicate laboratory tests.	Pre- and Post-Implementation Chart Reviews, Claims Data.	If you are rolling out your project in stages, you could use those organizations or providers who have not gone live yet as your control group. This way, you could collect your data without needing to do a retrospective chart review. You may also be able to use billing data to help focus the search for redundant tests.	Need to define 'duplicate' for each type of tests. For example, the definition of duplicate would differ by blood tests (e.g. CA-125 versus a Hct,) and also be different if the initial test were normal versus abnormal. May be costly if you have to do a chart review. Remember that for claims, not all of the "claims" may be available as clinical results.	
Was electronic exchange of laboratory results between outpatient providers and laboratories achieved?	Implementation Team	Requires an interface between the ambulatory EHR and the lab data system. Simple Yes/No question.		
Impact on the number of calls to the laboratory for results.	Laboratory Call Logs	A reduction in the number of calls to the laboratory for results suggests that providers are able to find their results in a timelier fashion.	These measurements need to be adjusted for the volume of tests conducted by each of the participating labs. In addition, changes in market share by labs need to be considered.	
Decrease in time to report critical results by the lab.	Call logs Pre- and Post-Implementation	A great measure to consider given the interest that JCAHO has in this topic.	If this information is not already being collected it will be hard to collect.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 57 for detailed definition and evaluation method for this measure: Infoway Report.

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Costs avoided to receive results.	Financial Logs	Estimate costs associated with receiving a single result (labor to open mail, sort, distribute to clinicians, and post on patient chart) and multiply by the number of laboratory results received.	If users are still printing out electronic results to put in paper charts, this cost must be considered as well.	
Laboratory costs avoided to send results.	Financial Logs	Look at costs traditionally used to prepare mailings and send out results.		
Impact on the satisfaction of clinicians.	Survey or Focus Groups: perception of usability, ease to learn to use the system, efficiency as a result of the data exchange	You might consider sampling both your users as well as those who could be involved in the project but who have chosen not to participate. Going to state- or region-wide provider databases from local medical societies or board of registrations may be ways to determine your target survey group. Consider questions such as asking them how often they were able to find the result they were looking for in a timely manner. Could compare responses before and after (early/late) implementation. It may be helpful to conduct satisfaction surveys multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Satisfaction of laboratory personnel.	Survey or Focus Groups	Your survey could sample the laboratory technicians, or the administrative personnel including those who are responsible for taking phone calls. The survey would need to be designed to be distributed to all involved laboratories. It could be helpful to conduct the survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).	Be careful to only survey personnel affected by data exchange: it may be invisible to some staff. That is, they may not know to whom the data is being sent or is being accessed by. For example, if a laboratory result is viewed by a provider outside the laboratory's traditional service base, that lab technician may not know that and the data exchange process may not be evident to them.	Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
How much data were able to be exchanged?	Implementation Team, Data Exchange Logs, Numbers of Messages Sent or received	Look at the number of discrete HL-7/OBX elements that were exchanged.	Note that just because an HL7 message was sent properly, it does not mean that it was received and processed properly. If it is in an exception queue it may stay in that state for months before the "correct" individual has access to those results.	

Table-2: Data Exchange between Providers and Pharmacies

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Was electronic exchange of information about medication orders and prescriptions between providers and pharmacies achieved?	Implementation Team	<p>Could be accomplished through an ePrescribing system (i.e. via RxHub or SureScripts) or through an existing HIE.</p> <p>Simple Yes/No question.</p>		
Are providers using data exchange capability with pharmacies?	Usage Statistics from System's Audit Logs Implementation Team	<p>Could collect this information electronically in a number of ways. First, you could look at the number of electronic prescriptions received as the numerator and the total number of prescriptions received (both electronic and written) as the denominator. A second approach would be to look at the number of physicians submitting prescriptions electronically as the numerator divided by the total number of users of the system, as the denominator. The third approach would be using the number of physicians submitting prescriptions electronically as the numerator and the total number of physicians in the catchment area as the denominator.</p>		
How much data were able to be exchanged?	Implementation Team	Use the number of electronic prescribing orders sent as the numerator and the number of total prescriptions filled (from both written and electronic orders) as the denominator.	Be sure that the messages were correctly received and processed on the receiving end. Evaluators may need to contact the pharmacy to verify the numerator.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on calls to pharmacies	Provider Call Logs	Should also capture the nature of the call.		
Impact on calls to providers to clarify a prescription.	Provider Call Logs	Make sure the pharmacy call log has the requisite level of detail to capture the nature of the call.		See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 54 for detailed definition and evaluation method for this measure: Infoway Report .
Impact on calls to patients to clarify their information.	Pharmacy Call Logs	Make sure the pharmacy call log has the requisite level of detail to capture the nature of the call.		
Impact on costs due to improved formulary compliance.	IT Team or Chart Reviews	If the new system has decision support, the system may have the data to show how often a switch is made from a non-formulary choice to a formulary alternative. Evaluating formulary patterns may be more feasible if you focus on a single drug class or narrow down to a subset of patients.	Could be difficult to find the pre-implementation compliance rate. May be costly if chart reviews are required.	
Impact on costs by switching to generics.	IT Team or Chart Reviews	If the new system has decision support, the system may have the data to show how often a switch is made from a brand name choice to a generic alternative. Evaluating brand to generic patterns may be more feasible if you focus on a single drug class or narrow down to a subset of patients.	May be costly if chart reviews are required.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on adverse drug events (ADEs).	Chart Reviews	<p>Need to have longitudinal data in order to measure this.</p> <p>Could do active surveillance and build prompts in the system for clinicians to report ADEs under certain circumstances (i.e. when discontinuing a drug).</p>	This can be very difficult to define and measure. The teams must come together to decide what constitutes an ADE and how it is going to be measured. ADEs are relatively rare and it takes many chart reviews to be confident about the results.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 43 for detailed definition and evaluation method for this measure: Infoway Report.
Clinician Satisfaction.	Survey or Focus Groups	<p>You might consider sampling both your users as well as those who could be involved in the project but who have chosen not to participate. Going to state- or region-wide provider databases from local medical societies or board of registrations may be ways to determine your target survey group. It may be helpful to conduct the satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).</p>		<p>See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 121 for detailed definition and evaluation method for this measure: Infoway Report.</p> <p>Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.</p>

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Pharmacist Satisfaction.	Survey or Focus Groups	Your survey could sample the pharmacists, the technicians, or the administrative personnel including those who are responsible for taking phone calls. The survey would need to be designed to be distributed to all involved pharmacies. It may be helpful to conduct the satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Patient Satisfaction.	Survey or Focus Groups	Could include surveys with prescriptions.		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Table-3: Data Exchange between Providers

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Was electronic exchange of information between providers achieved?	Implementation Team, Data Exchange Logs	Simple Yes/No question.		
Are providers using data exchange capability with other providers?	Usage Statistics from System's Audit Logs, Surveys, Implementation Team	Need to consider how you define providers exchanging information with other providers. Would you define it as email communication? Or does it need to be something more? The ability to send referrals electronically? The ability to electronically send a chart of a patient for a referral?		
How much data were able to be exchanged?	Implementation Team	Look at the number of discrete HL-7/OBX elements that were exchanged.		
How much of the total health data was exchanged electronically versus other methods such as by fax, mail and courier?	Implementation Team, Logs		The measurement of the amount of data being exchanged by non-electronic means this might be difficult to determine.	
Impact on costs of chart pulls.	Logs, Time/Motion Analysis, Chart Reviews	Estimate the labor cost of a chart pull and multiply by number of referrals in a given time period. Could also review a sample of charts to determine the percentage of consultant notes that are captured electronically for a sample of patients. To do a time-motion study track the user time and then extrapolate the staff costs.	This assumes that the requisite data for a referral or other request is being exchanged electronically. In many cases, data such as notes are not available electronically because they are hand-written. In this case a chart pull may be required. Try to capture WHY the chart was pulled and then use that data to determine the actual impact of the HIE on chart pulls.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on costs of duplicating paper charts.	Logs, Time/Motion Analysis	Estimate cost of duplicating chart (finding and copying the chart, preparing for mailing and mailing charges) times the number of charts duplicated.		
Impact on inter-provider calls requesting results.	Logs, Time/Motion Analysis	Time-motion based logs of such calls would be one way to track this.	If this type of information has not been tracked this will be difficult to measure.	
Impact on costs for referral letters (time to write, sending).	Logs	Estimate labor cost (to review chart, dictate referral letter, transcribe letter, mail letter) and multiply by number of referrals.	Assumes that referrals are not being done electronically prior to the HIE being implemented.	
Satisfaction of providers.	Survey or Focus Groups	You might consider sampling both your users as well as those who could be involved in the project but who have chosen not to participate. Going to state- or region-wide provider databases from local medical societies or board of registrations may be ways to determine your target survey group. It may be helpful to conduct the satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Table-4: Data Exchange between Providers and Radiology Centers

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Was electronic ordering of radiology tests between providers and radiology centers achieved?	Implementation Team, Provider Surveys	Assumes that the providers are using an EHR.		
Was electronic exchange of radiology results between providers and radiology centers achieved?	Implementation Team, Provider Surveys	Need to know if the providers are using an EHR or are using some results display application.		
How much data were able to be exchanged?	Implementation Team, Data Exchange Logs (for orders and results)	Look at the number of discrete HL-7/OBX elements that were exchanged. Look at the number of DICOM images that were exchanged.		
Are providers using data exchange capability with radiology centers? (i.e. what is the usage rate of the new system)?	Usage Statistics from System's Audit Logs.	There are several different ways you might want to measure this. First would be the number of discrete providers using the system as the numerator and the number of total providers as the denominator. A second approach might be how frequently individual providers are accessing the system with hit rates as the numerator and an individual provider as the denominator. A third approach might be to look at all provider hit rates divided by the total number of providers to get an overall average rate. Providers might be defined as nurses and/or physicians. Tracking this information over time and presenting this information visually would give stakeholders an understanding of adoption trends of your project.	Finding baseline provider rates might be difficult, i.e., what is your pool of physicians who could be using the system? You could consider getting this information from local medical societies or Boards of Medicine.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on duplicate radiology tests.	Pre- and Post-Implementation Chart Reviews	If you are rolling out your project in stages you could consider using providers, units or organizations that have not gone live yet as your control group. Therefore you could collect your data without needing to do a retrospective chart review.	You have to define what is meant by a duplicate test. Sometimes a repeat radiology test in a short timeframe is the standard of care and not duplication. Another approach would be to measure test frequencies	
Impact on costs to send orders (provider).	Pre- and Post-Implementation check of Logs, Time Motion/Workflow Analysis	Estimate the labor costs needed to prepare and mail forms and then multiply by the number of orders.		
Impact on costs to receive orders (radiology).	Pre- and Post-Implementation check of Logs, Time Motion/Workflow Analysis	Estimate the costs to open and process forms and then multiply by the number of orders.		
Impact on results requests from providers.	Phone Logs	A reduction in the number of calls to the radiology center for results suggests that providers are able to find results in a timelier fashion.	These measurements need to be adjusted for the volume of exams done by each center so that one can compare the data in a meaningful manner.	
Impact on calls to providers to clarify an order.	Phone Logs	Assumes that the providers are using some electronic method of ordering a test – typically through an order entry system.	Many times providers may not use an appropriate indication for a test and the call to the provider may occur anyway.	

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on time to report critical results.	Call Logs Pre- and Post-Implementation	A great measure to consider given the interest that JCAHO has in this topic.		See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 25 for detailed definition and evaluation method for this measure: Infoway Report.
Satisfaction of radiology personnel.	Survey or Focus Group	Your survey could sample the radiologists, the radiology technicians and/or the administrative personnel including those who are responsible for taking phone calls. The survey would need to be designed to be distributed to all involved radiology centers. It may be helpful to conduct satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Satisfaction of clinicians.	Survey or Focus Group	You might consider sampling both your users as well as those who could be involved in the project but who have chosen not to participate. Going to state- or region-wide provider databases from local medical societies or board of registrations may be ways to determine your target survey group. It may be helpful to conduct satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
PACs				
Impact on film costs.	Finance Tracking (balance sheet, receipts etc), Pre- and Post-Implementation		In some places a backup may still be done on film, while in others the backup may be electronic (CD-ROM).	
Impact on chemical costs.	Finance Tracking (balance sheet, receipts etc), Pre- and Post-Implementation	Cost of the chemical to process the films.		
Impact on file room costs.	Labor costs, overtime costs, Pre- and Post-Implementation	These are the costs to maintain a file room and personnel to manage the films (pulling and filing).	This would be replaced by the cost of maintaining the same image data electronically (CD-ROM, servers, maintenance, security).	
Impact on duplication of films for referrals.	Duplication Logs	Includes the cost of the films, the chemicals, the personnel costs and time and the charge to use the processing facilities.	This would be replaced by the cost of duplicating the same image data electronically (CD-ROM).	
Impact on costs to receive films for review (provider).	Pre- and Post-Implementation check of Logs	Determine labor costs to open films, distribute to provider, collect films from provider, package for radiology, and return to radiology; multiply this cost by number of films received.	May not track films received.	
Impact on costs to send films (radiology).	Pre- and Post-Implementation Financial and Workflow Logs, Time Motion/Workflow Analysis	Determine labor costs to receive request, copy film, package film, and mail film; multiply this cost by number of requests received.		
Impact on costs to re-file films received after having sent films out.	Pre- and Post-Implementation check of Financial and Workflow Logs, Time Motion/Workflow Analysis	Determine labor costs to receive returned film and re-file; multiply this cost by number received.		

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Scheduling/workflow				
Impact on imaging studies performed due to more efficient scheduling.	Pre- and Post-review of Schedules	Online ordering and scheduling leads to increased efficiencies and an increase in the number of tests that can be done. Tests can be more easily grouped by type, and fewer errors are made in resource scheduling.		
Impact on time to schedule appointments.	Time/motion Studies	This can be measured on both the provider side and the receiving side of scheduling.		
Impact on lost films.	Logs	The post-PACS loss rate should be close to zero.	Assumes evaluators are archiving the films.	
Impact on cancelled exams due to better preparation (online instructions available to scheduler) and avoidance of contraindications (e.g., iodine allergy known at time of scheduling).	Pre- and Post-Review of Schedules	Cancellations may still occur even with an HIE system as some of the information needed for exams may not be available through the ordering process.	Groups may not have this information in their schedules depending on whether or not they are tracking cancellation reasons.	

Table-5: Data Exchange between Providers and Public Health Departments

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Was electronic exchange of public health information between providers and public health departments achieved?	Implementation Team, Data Exchange Logs for Reportable Health Conditions	Evaluators may want to consider bi-directional data flow (to public health for reportable conditions and from public health for treatment guidelines). Simple Yes/No question.	Evaluators may need to take into consideration that in many states this information transfer happens by other means already so need to determine how much of the information flow is occurring due to the new HIE system and not existing processes.	
How much data were able to be exchanged?	Implementation Team, Data Exchange Logs	Look at the number of discrete HL-7/OBX elements that were exchanged.	Evaluators may need to take into consideration that in many states this information transfer happens by other means already so need to determine how much of the information flow is occurring due to the new HIE system and not existing processes.	
Impact on costs to prepare reports manually.	Reports Prepared, Time/Motion Analysis	Estimate labor costs to find information and prepare report multiplied by the number of reports prepared.		
Impact on costs to send paper reports.	Reports Prepared, Time/Motion Analysis	Cost to send reports by fax or mail multiplied by the number of reports prepared.		
Impact on costs to receive reports (public health).	Logs, Time/Motion Analysis	Estimate the costs in receiving and opening a report multiplied by volume received.		
Impact on costs to process paper reports.	Logs, Time/Motion Analysis	Estimate costs in processing a report multiplied by the volume received. This includes the cost of transcribing the data into the health department's electronic registry system.		

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Impact on reportable diseases reported.	Logs	HIE systems may use diagnosis codes (ICD-9), procedures codes (CPT) or medications to identify cases that would otherwise go unreported. Pre-post study to demonstrate change in number of mandated reported diseases.	Have to be careful as the ICD-9 codes may be incorrect. A patient who is being "ruled-out" for syphilis may not actually have syphilis and still have that ICD-9 code generated.	
Impact on time to report events.	Logs, Report review	Pre- and Post-Implementation sample: track time interval from date of event to time logged into public health database. Reporting interval = Report generation time – Event detection time. Can be the time from providers or laboratories to public health department.		
Impact on time to detection of an adverse event or outbreak.	Logs, Report review	Pre-and post-implementation review of reports of adverse events or outbreaks to determine if there has been an improvement in the early detection of these events. Detection interval = Time of detection – time of event		

Measure	Data Source(s)	Notes	Potential Pitfalls	Links
Satisfaction of clinicians.	Survey or Focus Groups	You might consider sampling both your users as well as those who could be involved in the project but who have chosen not to participate. Going to state- or region-wide provider databases from local medical societies or board of registrations may be ways to determine your target survey group. It may be helpful to conduct satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Public health personnel satisfaction.	Survey or Focus Groups	Your survey could sample the clinicians, public health practitioners, or the administrative personnel including those who are responsible for collating paper reports. The survey would need to be designed to be distributed to all involved public health departments. It may be helpful to conduct satisfaction survey multiple times during different stages of project to monitor trends and potential unintended consequences (positive and negative).		Consider using or amending an existing satisfaction survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

SECTION III: EXAMPLES OF CLINICAL OUTCOME AND PROCESS MEASURES THAT MAY BE USED TO EVALUATE YOUR PROJECT

For those of you further along with your data exchange process, you may want to examine measures around care processes and patient outcomes affected by your data exchange. We have included this set of measures to give you ideas around what can be measured in the areas of: clinical outcomes, clinical processes, provider adoption and attitudes measures, patient knowledge and attitude measures, workflow impact, and financial impact. We understand that many of these measures may be expensive to evaluate; therefore you should tailor your evaluation plans according to the needs of your stakeholders and the resources at your disposal.

Table-1: Clinical Outcomes Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Preventable adverse drug events (ADEs)	Patient Safety Quality of Care	Chart review Prescription review Direct observations May also consider patient phone interviews Instrumenting the study database to the EMR	Need to distinguish between ADEs and MEs MEs can be divided by stage of medication process: Ordering Transcribing Dispensing Administering Monitoring Can be assessed in both inpatient and outpatient settings. ADEs are: Idiosyncratic reactions Drug-diagnosis interactions	Preventable ADEs are relatively common, especially if there is no clinical decision support (CDS) at the time of drug-ordering. Many drug-drug and drug-diagnosis interactions can be avoided if CDS tools are available at the time or ordering of medications. Keep track of alerts that fire in a system with CDS, understanding that in a system without CDS those alerts will not be available; we can get an upper bound for preventable ADEs. It is hard to define what is meant by a “preventable ADE.” Some idiosyncratic reactions are not preventable and it is impossible to predict who will get what reaction.	See Canada Health Infoway’s Benefits Evaluation Indicators Technical Report*, page 43 for detailed definition and evaluation method for this measure: Infoway Report.

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Inpatient mortality	Patient Safety Effectiveness	Medical records Billing data Discharge summaries Coroner's office records chart review EMR Data repository: administrative		Need to risk-adjust. May be very difficult to find statistically significant differences in mortality rates, since death rates tend to be relatively low. Need to distinguish between people who die in the ED and real inpatient mortality.	http://content.nejm.org/cgi/content/abstract/317/26/1674 http://www.thedeltagroup.com/Corporate/Pubs/RiskWhitePaper.pdf
Hospital complication rates	Patient Safety	Some can be obtained from ICD-9 codes, although a chart review sample is preferable. Some measures may already be collected for external reporting purposes (i.e. quality and HEDIS data) Instrumenting the EMR to automatically detect and keep count of key terms related to complication rates Chart Review EMR Check your facility's quality assurance team	Common targets: Nosocomial infections PE/DVT (post-op, or if develops in hospital in patient without external risk factors such as cancer, hyper-coagulable state etc.) PE/DVT Falls Pressure ulcers Catheter-related infections Post-op infections Operative organ/vessel/nerve injury Post-op MI Post-op respiratory distress Post-op shock Pneumothorax intracranial hemorrhage	Watch out for documentation effect (e.g., falls may become more reliably documented because the measure makes it easier to document falls) Make sure that the event is really a complication and not a predictable outcome of the patient's intrinsic disease process: for example, a pneumothorax in a patient who has bullous emphysema is not a hospital complication. But a pneumothorax in a patient who just had a thoracentesis done is a hospital complication.	http://www.thedeltagroup.com/Corporate/Pubs/RiskWhitePaper.pdf

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Length of stay	Patient Safety Efficiency	Medical records, especially discharge summaries Billing data Hospital quality measures data (HEDIS etc.) Chart review Data repository: administrative Check on data being collected by your facility's quality assurance team		Need to adjust for disease severity and diagnosis. Consider external issues, (e.g., financial pressures to discharge patients early, other concurrent QI programs, etc.).	
Readmission rates after discharge	Patient Safety Effectiveness Efficiency Patient Centeredness	Medical records Billing data ED visit histories Discharge summaries Chart review Data repository: administrative Check on data being collected by your facility's quality assurance team	Need to define the time period for the readmission. For many organizations, this standard is 7 days and/or 30 days after inpatient discharge.	Need to adjust for changes in patient diagnosis mix over time. Need to consider reason for readmission and correlate it with a previous diagnosis – i.e. whether it is a complication of or inadequate treatment of a previous diagnosis. This is quite difficult. For example, consider the following scenario: A patient is admitted for work up of a new tumor and had a biopsy and diagnosis made. Then the patient is discharged and readmitted a week later for initiation of chemotherapy. This has no bearing on patient safety, efficiency etc. It is a planned admission.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report, page 85 for detailed definition and evaluation method for this measure: Infoway Report.

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Inpatient admission rates/ED visits for populations with chronic diseases	Patient Safety Effectiveness Efficiency Patient Centeredness	Medical records Billing data Patient registries ER visit data Chart review Data repository: administrative Check on data being collected by your facility's quality assurance team	Common targets: CHF Asthma DM ESRD CAD COPD	Watch out for secular trends (e.g., change in admission criteria). Be mindful that chronic diseases invariably require extra ED visits, not because of primary care but because these diseases invariable will have symptoms that require clinical attention beyond current primary care settings.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report, page 88 for detailed definition and evaluation method for this measure: Infoway Report.

Table-2: Clinical Process Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Potential adverse drug events ("near misses")	Patient Safety	Chart review Prescription review Direct observations May also consider patient phone interviews Instrumenting EMRs Expert review	Errors can be divided by stage of medication use: Ordering Transcribing Dispensing Administering Monitoring Can be assessed in both inpatient and outpatient settings.	Chart reviews do not capture all errors (especially dispensing and administration errors). Therefore evaluators may need to conduct patient interviews to back up chart reviews, especially in the outpatient setting, as documentation of adverse events in the ambulatory setting typically is not very reliable.	
Medication errors	Patient Safety	Chart review Prescription review Direct observations May also consider patient phone interviews Instrumenting EMRs Expert review		Chart reviews do not capture all errors (especially dispensing and administration errors). Therefore evaluators may need to conduct patient interviews to back up chart reviews, especially in the outpatient setting, as documentation of adverse events in the ambulatory setting typically is not very reliable.	
Number of pharmacist interventions per medication order	Patient Safety Efficiency	Pharmacy intervention logs EMR verbal orders for providers	If you have CDS with ePrescribing you can reduce the number of pharmacy interventions. A pre-post design would be appropriate.	Might change threshold for pharmacy intervention. For example, if a pharmacist assumes a system is catching a particular type of error that pharmacist may not look as hard for those errors.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 51 for detailed definition and evaluation method for this measure: Infoway Report.

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Percentage of orders ordered verbally	Patient Safety	Medical records Pharmacy records EMR data	Health IT will likely not change this significantly, unless corollary orders are addressed; in this case you should test corollary orders specifically and not the number of verbal orders.	Evaluation, particularly for pre-implementation baseline, will depend on whether orders are documented clearly as verbal orders in the medical or pharmacy record. Any manual chart review is resource intensive in terms of space, time and costs.	See the NRC's Measure Briefing "Percentage of Orders Ordered Verbally" (Appendix C).
Time to complete co-signature of verbal orders	Patient Safety Efficiency	Medical records		Check reliability of time measurements on paper records. Time-to-co-signature should not be a surrogate for order completion. Some systems may allow providers to cosign orders months to years after they were ordered and potentially completed.	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Chronic disease management targets	Effectiveness Patient Centeredness	Electronic data repository (if available) Chart reviews Chronic disease registries EMR data	DM: A1c within goals, LDL within goals, annual foot exam, annual nephropathy screening, annual ophthalmological exam HTN: Percent of patients controlled, medication use within guidelines Depression: appropriate monitoring after starting SSRI ESRD/chronic kidney diseases: Care consistent with K-DOQI guidelines CAD: Aspirin use, beta-blocker use, smoking cessation counseling CHF: ACE inhibitor use, appropriate beta-blocker use Asthma: smoking cessation counseling Childhood ADHD Childhood obesity	Check for documentation effect of measure (e.g., smoking cessation might be better documented than before even though it is not more commonly performed). Check for inaccuracies in problem and/or medication lists. Common issue with problem lists is they are seldom up to date, even if a problem was resolved a long time ago. Therefore, be very careful to make sure a problem is "current" before assuming a target was not met. For example, a woman who had pregnancy-induced diabetes not diabetic now that she has had her baby. Thus, checking A1c's in these patients regularly is not indicated and can be misconstrued for suboptimal care.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 88 for detailed definition and evaluation method for this measure. Includes measures for asthma, diabetes, heart failure and hypertension: Infoway Report Also look at HEDIS measures: http://www.ncqa.org/tabid/784/Default.aspx
Health maintenance target	Patient Safety Effectiveness	HEDIS measures Electronic data repository Chart reviews	Immunizations (adult and childhood) Cancer screening (mammogram, Pap smears, etc.) Counseling (e.g., smoking cessation)	Watch out for documentation effect of measure. Billing data may be more resistant to this effect.	HEDIS measures: http://www.ncqa.org/tabid/784/Default.aspx

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
<p>Appropriate Actions/usage:</p> <p>Percent of alerts or reminders that resulted in desired action</p> <p>Percent of tests ordered inappropriately (for target tests)</p> <p>Percent of blood products used appropriately</p>	<p>Patient Safety</p> <p>Effectiveness</p>	<p>Electronic data repository</p> <p>CPOE Usage logs</p> <p>Medical Record Chart reviews</p>	<p>Best to let the alerts trigger equally for both the intervention and control groups, and then prevent the alerts from being displayed to users in the control group. By doing this, you can track opportunities to carry out the desired action equally between the intervention and control groups.</p> <p>What you should look for is documentation of exceptions, i.e. why an alert was not acted on?</p>	<p>Need to assess and monitor quality of data used to trigger the alerts and reminders.</p> <p>However, this is exceedingly hard to do. Be very careful of how you are defining appropriate and inappropriate actions. For example, what is meant by an "inappropriately ordered test"? There are no accepted definitions of this. In different settings, patient circumstances and diagnoses, an otherwise inappropriately ordered test may be appropriate to order.</p> <p>The same thing applies with percent of alerts that result in desired action. Clinician judgment supersedes all computer alerts.</p>	<p>See the NRC's Measure Briefing Sheet "Percent of Alerts or Reminders that Resulted in Desired Plan/Action"</p> <p>(Appendix C)</p>
<p>Documentation of key clinical data elements</p>	<p>Patient Safety</p> <p>Quality of Care</p>	<p>Likely will need chart reviews for paper-records group.</p>	<p>Examples include:</p> <p>Allergy on admission</p> <p>Follow-up plan on discharge</p> <p>Care plan for next phase of care</p> <p>Complete pre- and post-admission medication list</p> <p>Should also assess clinician perception of data quality.</p>	<p>May need to look in different places to get this, for example, paper charts versus EMRs. Some practices may enter orders online but hand-write a note in the paper chart.</p>	<p>See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 37 for detailed definition and evaluation method for this measure for medication information only: Infoway Report.</p>

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Medical chart/patient medication agreement	Patient Safety Patient Centeredness	Compare EMR data with patient report Compare EMR data with PHR data	Need to understand how patients manage medications via PHR –request refills, or report side effects. Need to understand what features of “patient portals” are useful – medication refills, documenting side effects, setting up appointments, etc.	Be careful here: accessing clinical data does not imply that the patient “understands” what is meant by it. There are many examples of slightly abnormal tests that clinicians would not pay attention to while patients may jump to incorrect conclusions about them.	

Table-3: Provider Adoption and Attitudes Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Percent of Orders Entered by Authorized Providers on CPOE	Patient Safety	CPOE usage logs (including laboratory and radiology orders) Pharmacy logs		This can get complicated because a physician may not be the one entering orders – it may be a nurse or a clerk. If the order the physician called in does not match the computer understood order exactly, errors may occur. Correlate with “verbal orders” and also look for discrepancies between orders “called in” and the actual order entered into a system.	See the NRC’s Measure Briefing Sheet “Percent of Orders Entered by Physicians on CPOE”.
Frequency of order set use	Efficiency Patient Safety Effectiveness	CPOE usage logs Order system logs	Would be helpful to present data in context of how many times order sets could have been used in the same period (e.g. number of patients admitted with CHF).	Order sets may not be electronic. In many hospitals, order sets are PDF files printed on paper. The clinician may check off the orders and a clerk enters them into a computer. Therefore, tracking them from the EMR data alone would be difficult.	
Percent of outpatient prescriptions generated electronically	Patient Safety Effectiveness	EMR data Chart reviews	Could do a pre-post study and estimate this by querying the pharmacist. Electronic prescriptions would be typed out.	Getting the denominator will require chart review.	
Percent of notes online	Patient Safety	EMR data Chart reviews		Getting the denominator may require chart review.	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Percent of practices or patient units that have gone paperless	Efficiency	EMR usage logs Training logs		<p>Likely a gradual progress that takes many months, if not years.</p> <p>The term “paperless” is hard to define. No one is ever “totally paperless” – you have to have very clear guidelines for what you mean by paperless.</p> <p>For example, paperless may mean: Use of CPOE for all orders Use of ePrescriptions Use of electronic notes</p>	
Percent of physicians and nurses who have undergone voluntary training for target IT intervention	N/A	Training logs	If training is mandatory, the percentages are not reflective of attitude or willingness to adopt.		
Use of help desk	N/A	Help desk logs		<p>May be confounded by quality of up-front training, continued support, or usability of application.</p> <p>Also may be confounded by the training level of the user: the novice user will require more support, while someone with more experience with technology may solve many problems on their own.</p>	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Time to resolution of reported problems	N/A	Help desk logs		<p>May be confounded by nature of reported problems.</p> <p>You have to adjust for reported problem types and the time it takes to solve them – some can be fixed quickly, while others are system wide issues that may take years to resolve.</p>	
Provider satisfaction towards specific interventions	N/A	<p>Satisfaction surveys and interviews that assess:</p> <p>Ease of use</p> <p>Usefulness</p> <p>Impact on quality and time savings</p> <p>Suggestions for improvement</p>		<p>Difficult to achieve good response rates from physicians.</p> <p>Creating satisfactions surveys is not easy and takes time.</p>	<p>See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 121 for detailed definition and evaluation method for this measure for medication ordering only: Infoway Report.</p> <p>Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.</p>
Provider satisfaction towards own job	N/A	<p>Direct surveys (human resources may administer already)</p> <p>Interviews and focus groups</p>		Many potential confounders.	<p>Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.</p>
Turnover of staff	N/A	Human resources log		Many potential confounders.	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
EHR adoption	Patient Safety Efficiency	Provider surveys, focus groups	Many surveys of EHR adoption exist. May wish to use one.	Need to be careful to document reasons for, and for not, adopting. There may be very legitimate reasons for failure to adopt.	Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Note: May be helpful to correlate patient clinical outcomes with adoption of measure, either at the physician or practice unit level. Need to collect baseline data for comparison.

Table-4: Patient Knowledge and Attitudes Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Patient knowledge	Patient Centeredness	Patient surveys and interviews Patient focus groups	Knowledge of own medications (regimen, indications, potential side effects), other prescribed care Knowledge of own health maintenance schedules Knowledge of own medical history Knowledge of own family's medical history Comfort level Barriers and facilitators for use	It is important to do iterative cognitive testing and piloting of surveys developed internally. Methodologies leading to good survey response rates may be expensive. On-line surveys might lower cost, but may bias results because on-line patients may be different from the general population. May be able to add customized questions to standard surveys such as Consumer Assessment of Healthcare Providers and Systems (CAHPS).	Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website
Patient attitudes	Patient Centeredness	Patient surveys Patient interviews Focus groups and other qualitative methodologies			Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Patient satisfaction	Patient Centeredness	External surveys (CAHPS, commercial) Internally developed survey			Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Patient use of secure messaging	Patient Centeredness	Patient surveys Focus groups Logs of EMR/PHR systems and RHIOs	Need to understand how messages are communicated to providers – for example via an EMR or PHR.		Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Patient utilization of the PHR portal	Patient Centeredness	Portal and PHR logs Focus groups Surveys	Would be helpful to identify what “functions” of the PHR are being utilized Need to consider differences between true PHR functions and those that are just “patient portals”	Looking at raw numbers may not give the type of information you are interested in. Collecting data on numbers of new users versus recurring users may be more informative.	Consider using an existing survey. Review existing surveys using The Health IT Survey Compendium on the AHRQ Health IT website.
Patient utilization of functions within a PHR	Patient Centeredness	Portal and PHR logs Focus groups Surveys	Would be useful to keep track of what functions patients are using or looking at.		
Patient compliance with medications.	Patient Centeredness	Pharmacy and billing logs: number of medications prescribed and number of medications dispensed or refills requested Focus groups Surveys		Just because a medication is documented does not mean it has been taken, or taken correctly. Patients often take their medications in ways not authorized by their providers. Therefore if you are looking for effects of “proper” medication reconciliation on quality and safety outcomes, make sure you question whether medications are being taken properly.	

Table-5: Workflow Impact Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Time measures: Spent per patient Placing orders	Efficiency	Time motion studies (PDA and Tablet programs are available from the National Resource Center) Instrumenting the EMR to automatically capture these times	Should focus on measuring time spent on activities that may be affected.	Observers need to understand basic clinician workflow, be familiar with applications, and careful with usage logs, since usage logs typically do not capture interruptions when users interact.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 48 for detailed definition and evaluation method for time spent per patient: Infoway Report.
Medication turnaround time	Efficiency	Time motion studies (PDA and Tablet programs are available from the National Resource Center)	You may need to adjust for patient care unit, severity of illness, time-of-day, or patient volume to account for possible confounding. You need to also consider the type of medication order placed (routine versus stat versus recurring) and stratify your results by these categories. For example, a medication administered on a recurring basis may have an order placed several days ago; if this is not considered, there will be a long interval between time of order and time of administration, but this is not due to a delay.	Confounding based on type of order. If conducting a time-motion study, observers need to understand basic provider workflow and their processes, as well as be familiar with the technology being used.	
Percentage of orders or prescriptions which require a pharmacy callback	Efficiency	Pharmacy logs		Observers need to understand the difference between a "callback episode" and a single callback. A callback episode is when there is some back-and-forth vetting and multiple callbacks occur.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 54 for detailed definition and evaluation method for this measure: Infoway Report.
Patient throughput	Efficiency	Billing and administrative data	Could be patient volume in ED, hospital, practice, or OR	Concurrent interventions may affect have an effect.	See Canada Health Infoway's Benefits

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
			turnover		Evaluation Indicators Technical Report*, page 92 for detailed definition and evaluation method for this measure: Infoway Report.
Patient wait time in ED	Efficiency Patient Centeredness	ED administrative data	This may already be captured in many ED settings; therefore you may be able to measure with minimal effort.	Confounded by many other factors, (e.g., patient volume or demand)	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, page 92 for detailed definition and evaluation method for this measure: Infoway Report.
End users' job tasks or Workflow	Efficiency	Process Redesign Templates, Time-motion studies Time-motion tool	Should have a preliminary phase where all workflow stages are documented.	Need to create taxonomies of workflows and time each one. Observers need to understand end users' workflow and be trained on workflow documentation.	
Nurses' Time Spent on Direct Patient Care	Efficiency	Time and date information from a direct observation study (e.g. time-motion study or work sampling). Time-motion tool	Observers need to understand basic nursing workflow and their processes in the setting of implementation, as well as be familiar with the technology being used.		Extensive work to categorize nurse tasks in inpatient settings has already been conducted and developed into a time-motion observation instrument; which is publicly available on the NRC Health IT website.
Documentation Time	Efficiency	Usage logs, time-motion studies	Could configure the EMR to record when a user enters and leaves a "note" field to estimate documentation time.	Need trained observers to record when documentation happens and if it occurs as a continuous activity or in a random fashion.	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
<p>Compliance rate for outpatient follow-up appointments:</p> <ul style="list-style-type: none"> - For all outpatients in a practice; <p>or</p> <ul style="list-style-type: none"> - For specific conditions or diagnoses where there is continued treatment and maintenance 	<p>Patient Centeredness</p> <p>Effectiveness</p>	<p>Registration system logs</p>	<p>This measure gives a sense of how well patients comply with scheduled or recommended follow-up appointments within recommended timeframe.</p> <p>This measure can be impacted by health IT because of patient reminders and clinical alerts for follow-up appointments. It can help monitor patient care utilization, such as whether compliance with follow-up appointments reduces hospitalizations and ED visits</p> <p>Compliance by specific condition/diagnoses (e.g. follow-up post-natal visit after delivery) is usually based on guidelines or protocols for continued care that specify number and timeline for follow-up visits.</p>	<p>Unavoidable missed appointments should be excluded from this measure, such as provider cancelled appointments, hospitalizations, or care provided in other settings. If possible, document "reason" for missed appointment, which can be challenging as there can be many potential reasons.</p>	
<p>Prescribing Patterns of Preferred or Formulary Medications</p>	<p>Efficiency</p>	<p>E-prescribing</p> <p>CPOE logs</p>	<p>You may want to consider the patient as the unit of analysis since the same physician may see a mix of patients supported by a myriad of payers and where the formulary for each payer will be different. Another way to understand this is to be sure to consider each patient's preferred formulary based on their payer when analyzing the data.</p>		

Table-6: Financial Impact Measures

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Percent claims denials	Efficiency (only from providers' perspective)	Billing data	Could measure this pre-post when implementing a CPOE system. Note that without a CPOE system this is likely not going to change	Watch for secular trend as payer policies change while you roll-out a CPOE system over several years.	
"P4P" (pay for performance) increments from payers	N/A	Billing and administrative data	Difficult to measure and have to account for things like inflation, and cost of care increases, etc.	Likely slow to react to interventions.	
Utilization: Prescribing Patterns of Cost-Effective Drugs Duplicate testing Radiology utilization	Efficiency	Billing and administrative data	Have to define what is meant by a duplicate test. In many cases repeat testing is necessary and the standard of care.	May not be easy to capture, especially if clinical information is on paper. Cost data is often very difficult to analyze properly and may need expert analysis for proper interpretation.	See Canada Health Infoway's Benefits Evaluation Indicators Technical Report*, for detailed definition and evaluation method for this measure. For laboratory testing, see page 68 and for radiology, see page 32: Infoway Report.
Cost of maintaining paper medical records	Efficiency	Administrative data from medical records	Measure the cost of pulling charts, medical records office costs This cost is the sum of the costs of FTEs for medical records, etc.		

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Forms costs	Efficiency	Administrative data	Cost of paper forms is what is being addressed here.	Likely to be overwhelmed by other cost-savings. EMRs may not reduce paper forms. In some settings a CPOE system only allows providers to enter orders which are then taken "out of a system" by a clerk and "filled in a paper based form."	
Staffing costs: Nursing Pharmacy Physician	Efficiency	Billing and administrative data	Have to relate these specifically to your Health IT implementation	Many concurrent initiatives might confound this measure. Not very elastic.	
FTE measures: Training physicians Support applications Manage medical knowledge (rules, order sets) Subject matter experts	Efficiency	Training logs IS administrative data	Realize that any Health IT implementation incurs additional costs for maintenance that otherwise would not be there if there was no Health IT system in place.	May be influenced by quality of vendor or the tools provided by vendor. May also be influenced by the resources at your disposal and your funding for the implementation process.	
Risk reduction measures CMS fines for readmission	Patient safety Efficiency	Billing and administrative data		Very hard to define what is meant by "readmission". For example, in many cases a readmission may be the result of the natural history of a disease and not because of the health IT system	

Measure	Quality Domain(s)	Data Source(s)	Notes	Potential Risks	Links
Financial indicators Accounts receivable HARA measures	N/A	Financial accounting systems	The Hospital Accounts Receivable Analysis (HARA) is a published synopsis of statistical data related to hospital receivables. Improved billing compliance and reduced claims denial may improve the accounts receivable on the balance sheet.		

Note: Some measures in other categories may spill over here (e.g., effect on length of stay in Table 1)

SECTION IV: EXAMPLE OF A PROJECT

Example: Data Exchange Between Labs and Providers				
Brief Project Description: Our project allows for the exchange of laboratory data from commercial labs to providers via the internet.				
	Example Measures			
Example of questions to consider	1	2	3	4
Describe the expected impact of the intervention and briefly describe how you think your project will exert this impact.	Laboratory data will be able to be exchanged.	Laboratory data will be exchanged in a timely fashion.	Providers will use the system to review their patient's laboratory results.	Providers will perceive benefit from the data exchange project.
What questions do you want to ask to evaluate this impact? These will likely reflect the expected impact (either positive or negative) of your intervention.	How much data was moved? How many elements were available? How many elements did people look at?	How much time elapsed between the time of lab result generation at the laboratory and the time when the result was available to be viewed by a provider?	What percentage of clinicians in the catchment area participates in the project?	How satisfied are the clinicians with the system? How does the system affect their ability to deliver care? Do clinicians spend less time tracking data down on their patients or more time?
What will you measure in order to answer your questions?	Examine number of HL-7 (OBX) elements exchanged.	Look at time-date stamps throughout the implementation.	Look at usage statistics. How often do clinicians access the system? How many patients' data were accessed?	Satisfaction surveys.
How will you make your measurements?	Review logs.	Review time-stamps for different result types generated by different laboratories for different types of providers.	Denominator = number of clinicians in the catchment area Numerator = number of discrete clinicians accessing the system Denominator = number of patients in the catchment area with results captured by the data exchange network Numerator = number of patients for whom data was accessed	Develop clinician satisfaction survey. Administer pre-implementation, then 6 and 12 months post-implementation.
How will you design your study? What comparison group will you	Will not use comparison group,	Monitor this time throughout the implementation process.	Will not use comparison group; assume zero exchange of data	Pre-implementation versus post-implementation comparison.

Example: Data Exchange Between Labs and Providers

Brief Project Description: Our project allows for the exchange of laboratory data from commercial labs to providers via the internet.				
use?	assume zero exchange of data at start and will look at trends over time.		at start.	
For quantitative measures only: What types of statistical analysis will you perform on your measurements?	Graph ongoing trends.	Graph ongoing trends.	Graph trends over time, for different provider types at different locations.	Graph trends. T-test comparison for satisfaction levels (analyzed as continuous variable) across different time points.
How would the answers to your questions inform future decision-making and/or implementation?	Look at what was done to bring the system from zero exchange up to 100% exchange.	Pinpoint trouble spots in the data exchange network and use the data to drive improvement.	If clinicians not using the system, would want to consider how to increase that participation. Might interview clinicians to see what the barriers are to usage.	Want to understand how the ability to better locate data on a patient impacts professional satisfaction.

APPENDIX A

Following is a simple, hypothetical example to illustrate the importance of sample size:

Before implementation of an e-prescribing tool in the outpatient setting, 5 prescribing errors per 100 prescriptions written are noted. After implementation of the e-prescribing tool, the rate drops to only 2.5 errors per 100 prescriptions. If you select 100 prescriptions at random for review both before and after the implementation of e-prescribing, you might observe the following:

	BEFORE	AFTER
Number of Errors in 100 sampled prescriptions	5	3
Observed Error Rate	5%	3%

Would you feel confident concluding that the error rate actually fell? Most people would answer “no”. Statistics show us that repeated samples of 100 would reveal slightly different rates. Since the number of observed events (prescription errors) is so small, the errors may have shown up in the sampled prescriptions by chance. Random events might even result in one or two fewer errors before implementation, creating the appearance that the system was causing errors rather than preventing them.

The picture changes, however, if you could afford to examine 100,000 prescriptions before and after implementation of the e-prescribing system. Instead, you might observe:

	BEFORE	AFTER
Number of Errors in 100,000 Sampled Prescriptions	4,932	2,592
Observed Error Rate	4.9%	2.6%

Looking at the observed data now, would you feel more confident that the drop in the error rate is real and not due to random chance? Most people would say “yes”. Even if, by chance, the observed data are a few errors off from the “true” error rate, you still would conclude that the prescribing error rate was very different after implementation of e-prescribing.

The actual number of observations required in this example (i.e., the minimal sample size), falls somewhere between 100 and 100,000. To determine the exact number required, you need to do a “sample size calculation”. A full discussion of sample size calculations is beyond the scope of this toolkit, but resources are readily available to you to help you carry out a sample size calculation. Statistics textbooks cover this topic when they discuss statistical power. Many free tools are available on the Internet and may be found through a simple search. You may consult a statistician, either locally or through the AHRQ National Resource Center; or you may use one of the many software programs available to do these calculations.

No matter how you perform the sample size calculation, it is important to do it before you embark on an evaluation. Many evaluation projects have failed after the investigators found that insufficient data were collected to show a statistically significant difference. A sample size calculation can be a sobering experience: You may learn that your team cannot answer the desired question because the required sample size is too large. In that case, you may need to address a question that is less interesting but feasible to answer.