# Adding Clinical Data Elements to Administrative Data for Hospital-Level Reporting: A Synthesis

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## Abstract

This synthesis provides a brief summary of an important new study[1] that will likely drive state administrative data collectors and their constituents to seek the addition of a "Present on Admission" indicator for secondary diagnoses and a limited number of electronic laboratory values, to enhance the capacity of administrative data for public reporting on mortality and other hospitalization-related complications. This study provides strong evidence that a present on admission indicator and electronic laboratory values can be added in a more cost-effective manner than expanding clinically abstracted data elements for inclusion in administrative data.


## Study Objective

The goal of the study was to examine and report on the most cost-effective clinical data elements to add to administrative data in order to reduce the impact of patient differences when comparing hospitals in public performance reports. Barbara A. Rudolph and Denise Love of The National Association of Health Data Organizations (NAHDO) synthesized this study for state health data organizations and their stakeholders in order to facilitate their planning and policy decisions about their public hospital performance reporting initiatives. The study referenced[2] was done under contract for Agency for Healthcare Research and Quality (AHRQ) by Abt Associates Inc. and Michael Pine and Associates, Inc. This synthesis was also funded by the Agency for Healthcare Research and Quality.

## Overview of Methods

The research team conducted two types of tests. The first test was to examine whether the addition of specific types of clinical data to the administrative data would result in better adjustment for patient risk at the time of admission, thus resulting in better predictions of mortality and care complications. This would lead to more accurate quality information for consumers, purchasers, and policy makers. The second test was to assess the cost of adding those specific data elements to administrative data. This information will inform state health data organizations and their stakeholders about the marginal cost-effectiveness of capturing clinical data as they explore options for improving reporting systems.

The data sources used for this study included hospital discharge data from July 2000 through June 2003 from 188 Pennsylvania hospitals. Case-level claims data were supplemented with clinical data abstracted from medical records using MediQual's® proprietary Atlas™ clinical information system. Administrative data from January 1998 through December 2000 from hospitals in California and New York that met screening criteria for the proper use of present-on-admission (POA) codes were used to craft potential risk factors based on the occurrence of secondary diagnoses at the time of admission.

[1] "Adding Clinical Data Elements to Administrative Data for Hospital-Level Reporting." Final Report AHRQ Contract #233-02-0088, Task Order 13, Vol. 1, July 3, 2006

[2] Ibid.

This first test focused on errors in predicting mortality rates (or rates of complications) (See Table 1.) These errors (bias) were computed in terms of standard deviations of the mortality rate (or complication rate) as predicted by the full clinical model (the reputed gold standard). The results are discussed in the Key Findings section below.

**Table 1: Comparison of the Effectiveness of Risk-Adjustment[1] Using Alternative Data Sets for Inpatient Quality Indicators**

| | Inpatient Quality Indicators (IQIs) | | |
|---|---|---|---|
| **Type of Data[2]** | **c-statistic** | **Range of Errors in Case-Level Predictions[3]** | **% hospitals with more than 0.5 std dev of bias[4]** |
| **Adm** | **0.791** ± 0.055 | **0.251** ± 0.149 | **45.96** ± 16.66% |
| **EnhAdm** | **0.832** ± 0.039 | **0.193** ± 0.129 | **37.09** ± 16.73% |
| **APR-DRG** | **0.870** ± 0.030 | **0.348** ± 0.165 | **57.14** ± 8.99% |
| **Adm+Lab1** | **0.842** ± 0.034 | **0.167** ± 0.099 | **32.30** ± 14.54% |
| **EnhAdm+Lab1** | **0.861** ± 0.027 | **0.123** ± 0.087 | **18.65** ± 13.87% |
| **EnhAdm+Lab2** | **0.869** ± 0.024 | **0.096** ± 0.083 | **6.56** ± 10.70% |
| **Chart Abst** | **0.877** ± 0.026 | **0.032** ± 0.051 | **1.83** ± 2.95% |
| **Full Clin** | **0.879** ± 0.026 | **0** | **0** |

[1] Values reported as **mean ±** standard deviation (std dev).

[2] Adm = administrative; EnhAdm = administrative data enhanced with a present-on-admission code; Lab1 = numerical laboratory data; Lab2 = Lab1 + vital signs, bacteriological cultures, and ejection fraction; chart abst = EnhAdm + Lab2 + key clinical findings abstracted from medical records; full clin = EnhAdm + Lab2 + key clinical findings + aggregate scores

[3] Range from 5th to 95th percentiles of differences between prediction using full clinical data and prediction using suboptimal data.

Note: Bias in Table 1 and 2 were measured in 0.5 std dev; generally public reports of hospitals use 2.0 std dev to provide thresholds for identifying good, average, and poor hospital performance. Researchers indicated they examined 0.5, 1.0, 1.5, 2.0 and 3.0 std dev.

The measures used for testing of the impact on inpatient mortality and complications were selected from the AHRQ Inpatient Quality Indicators (IQIs)[3] and the Patient Safety Indicators (PSIs)[4]; these measures were designed for use with administrative data. The Pennsylvania Healthcare Cost Containment Council (PHC4) inpatient discharge data[5] and the AHRQ measures of hospital performance were used together to test the extent to which adding increasingly more difficult to obtain sets of clinical data elements reduced the error in predicting hospital quality. Tests were conducted by adding to the "administrative data" varying types of elements and measuring the reduction of error in predicting mortality or complications; clinical elements include those elements that can be considered to impact on the risk adjustment beginning with number 2 below:

1. Administrative Data (includes age, gender, diagnoses, and procedures)
2. Enhanced Administrative Data (includes simulated Present on Admission Indicator for secondary diagnoses-developed from CA and NY POA indicators)
3. APR-DRG™ (Administrative data model plus APR-DRG™ risk-of-mortality groupings)
4. Administrative Data plus numeric laboratory values (LAB 1) which are available electronically in most U.S. hospitals
5. Enhanced Administrative Data plus vital signs and other lab values that were less accessible outside the medical chart (e.g., culture results) LAB2
6. Chart Abstraction (key clinical findings, or clinical impressions, that would require review of physician or nursing notes)
7. Full Clinical Record (summary clinical scores --Glasgow coma score and American Society of Anesthesiologists score)

The second test was to assess the cost of adding those specific clinical data elements. For this cost assessment, three cost scenarios were developed—alternative scenarios were best, average and worst case in regard to cost to collect depending on time to collect and type of staff used to collect information--for each type of clinical data based on marginal costs over the current data collection from hospitals without electronic health records. Using the results (errors and costs) from both types of tests together produces the relative cost- effectiveness for each type of additional clinical data. The cost-effectiveness of additional data collection was computed by dividing the estimated cost of obtaining new data elements by the decrease in percentage of hospitals with systematic biases greater than 0.5 standard deviations.

[3] AHRQ IQIs used to test risk-adjusted mortality rates: abdominal aortic aneurysm repair, coronary artery bypass graft surgery, craniotomy, acute myocardial infarction, congestive heart failure, acute stroke, gastrointestinal hemorrhage, and pneumonia.

[4] AHRQ PSIs used to test risk-adjusted rates of postoperative complications: postoperative physiologic and metabolic derangement, postoperative respiratory failure, postoperative pulmonary embolism or deep vein thrombosis, and postoperative sepsis.

[5] In order to test the impact of the clinical data elements using the Pennsylvania (PHC4) data, which did not have a Present on Admission (POA) indicator, the authors had to develop new inpatient complication rate estimates using data from CA and NY, where there are POA indicators.

## Key Findings

This section highlights the performance of specific clinical information on both the reduction of hospital-level bias and the cost-effectiveness of these data elements. A summary of the increase in effectiveness and the associated cost-effectiveness is found in Table 2. It should be noted that the goal of the study was not to develop the "best" risk adjustment methodology, but rather to see how adding various clinical data could improve the prediction of mortality or other complications of care.

**Table 2: Marginal Cost-Effectiveness of Supplementing Administrative Data with Increasingly Costly Data to Improve Risk Adjustment of IQIs and PSIs[6]**

| **Best Case Scenario** | | | |
|---|---|---|---|
| **Added Data** | **Increase in Cost per Abstracted Record** | **Increase in Effectiveness[1]** | **Cost-Effectiveness[2]** |
| **Present on Admission Code** | $0.33 | 8.44% | $0.04 |
| **Numerical Laboratory Data** | $0.67 | 16.68% | $0.04 |
| **Vital Signs; Other Laboratory Data** | $0.91 | 8.55% | $0.11 |
| **Key Clinical Findings; Aggregate Scores** | $4.80 | 8.72% | $0.55 |
| **Worst Case Scenario** | | | |
| **Added Data** | **Increase in Cost per Abstracted Record** | **Increase in Effectiveness[1]** | **Cost-Effectiveness[2]** |
| **Present on Admission Code** | $0.33 | 8.44% | $0.04 |
| **Numerical Laboratory Data** | $3.33 | 16.68% | $0.20 |
| **Vital Signs; Other Laboratory Data** | $9.86 | 8.55% | $1.15 |
| **Key Clinical Findings; Aggregate Scores** | $24.91 | 8.72% | $2.86 |

[1] Effectiveness = percentage of hospitals with less than 0.5 standard deviations of data-related bias.
[2] Cost-Effectiveness = cost per one percent increase in effectiveness.
Note: the costs shown are additive from the prior row, i.e., the cost for laboratory data contain the cost of adding present on admission. The present on admission cost is the cost added to the marginal cost of collecting administrative data.

[6] "Adding Clinical Data Elements to Administrative Data for Hospital-Level Reporting." Final Report AHRQ Contract #233-02-0088, Task Order 13, Vol. 1, July 3, 2006.

When reporting on mortality or complications, hospitals' ranking is dependent upon the accuracy of the risk adjustment and the risk adjustment methods are dependent upon the data having enough information to accurately reflect the patient population. Risk adjustment works by creating an expected rate of mortality for a hospital based on that hospital's patient population and their severity of illness; this expected mortality is compared to the actual observed rate of mortality in the hospital.
The final report on these performance measures includes detailed findings across all conditions studied. A summary of key findings from this study are summarized in the paragraph below and in Tables 1 and 2 above:

- The degree of bias (or systematic error) decreases as you move from the administrative (non-risk-adjusted) data to the gold standard clinical findings. The study documented changes in accuracy when clinical data elements are added to the administrative data.

- The percentage of bias (or systematic error) incurred by hospitals when using only administrative data with no supplemental data elements or enhancements was 46%, with >0.5% standard deviation of bias. That means that 46% of the hospitals may have a different "expected rate" than is reported and thus, a different risk-adjusted mortality rate. [It should be noted that the overall mortality rate may be better or worse than is appropriate; the direction of error in this case cannot be predicted.]

- Adding Present on Admission (POA) information to administrative data is a cost-effective enhancement. POA reduces the percent of hospitals with bias (or systematic error) of > 0.5 standard deviations to 37% and is the lowest in cost to capture.

- Adding 20 numerical laboratory values (LAB1) to administrative data is equal to POA in cost-effectiveness. While more expensive than POA collection, LAB1 enhancements reduced the percent of hospitals with bias or error (of >0.5 standard deviations) to 32% of hospitals. LAB1 data elements cost less to collect than other clinical data abstracted from the medical record. Clinical data elements that were tested and found significant in models are listed in the Appendix.

- Some states may not be able to justify the full LAB1 suite of 20 laboratory values, so these states may want to consult the Appendix to evaluate specific LAB1 values to enhance their administrative data. For example, blood acidity (pH) is one of the 20 numerical laboratory values used in all (8/8) IQI models and three PSI models, which makes it an important supplemental clinical/laboratory data element. On the other hand, blood hematocrit is a lab value use in only 1 IQI model and 1 PSI model, indicating that this data element plays a less critical role in discriminating hospital performance across the set of measured quality indicators.

- Adding both POA and numeric lab values to administrative data resulted in 19% of hospitals with a standard deviation of bias >0.5%.

- Adding vital signs and several abstracted summary clinical indicators to the enhanced administrative data would bring the percentage of hospitals with a standard deviation of bias >0.5 to below 7%, but with significant increases in cost per abstracted record.

- The APR-DRG™ grouper, used by many state and private organizations, groups patients by severity level based on administrative data. Without a POA indicator, hospital mortality results are distorted. The authors suggest that a given hospital's expected rate of mortality or complications would be higher than it should be given the population when the APR-DRG™ grouper is used (the severity indicator includes diagnoses that are the result of the care in the hospitals, and then treats these complications and conditions as if they were present on admission).[7] As a result, the APR-DRG™ grouper likely increases the aggregated patient risk in the reference or expected population and when this mortality risk is compared to the hospital's observed rate of mortality, it results in a lower than deserved overall hospital mortality rate.

- The authors noted that there are other ways to reduce error in hospital ratings, including improvement in the coding of certain diagnoses for which ICD-9-CM codes exist which are not currently recorded in administrative data as accurately as they could be (e.g., coma).

- POA and numerical laboratory values are the most cost-effective data elements, in terms of data collection and reporting complexity. Adding clinical data elements beyond Numerical Laboratory Data (LAB1) leads to significantly increased costs for two reasons: additional data is collected, and data must be abstracted by a medical professional (which is more costly than data collected by coding professionals).

- Finally, the study clearly suggests that administrative data combined with the addition of a POA code attached to principal and secondary diagnoses and numeric lab values is a cost-effective improvement over using simply administrative data. Using chart abstracted data is not cost-effective at this time.

[7] The study utilized version 15 of the APR-DRG™ software. Because the POA indicator has not been available in standard administrative databases, an admission APR-DRG™ cannot be assigned. According to the developer, 3M/Health Information Systems, updated versions of the APR-DRG™ software exclude diagnoses representing complications that may have been preventable from the risk of mortality determination in the models.

**Implications for state data organizations**

As the demand for health care accountability and transparency grows, organizations maintaining statewide hospital discharge data systems are challenged to respond. These organizations must balance the hospital reporting burden with the public good that the information provides. This landmark study is the first to provide evidence that strategic enhancement of existing hospital administrative data with select clinical data will improve the validity of risk adjustment by predicting hospitalized patients' risks of adverse outcomes. Further, this study demonstrates the marginal utility of various clinical data elements. This information will facilitate health data organizations' planning and policy decisions. This synthesis is intended to guide local health data initiatives evaluate the options for improving quality reporting and the underlying data sources that support reporting. State data organizations already collecting administrative data and publicly reporting on hospital performance recognize the following political costs:

- Adding new clinical elements to improve the risk-adjustment models is complex to explain to policy makers and the public.
- More complex risk adjustment models also impact "readers" of the reports who may not have statistical sophistication; reports that become too technical are often set aside by policy makers and the public.
- It is more costly for report producers to provide both a "public consumption" report and a technical report.

State health data organizations seeking the most cost-effective, high utility supplemental data elements can be confident that the proposed solution for adding POA and numeric lab values to the administrative data was adequately and thoroughly tested given:

- The models utilized in the study were robust and clinically plausible
- All methods were made explicit in the documentation
- Model significance tests were stringent, yet allowed new data elements to be added when they brought additional significant information to the model
- The effect of different levels of hospital performance in treating patients was removed from the models to assure that the tests were not biased by differing rates of mortality associated with a hospitals' performance rather than the addition of clinical variables.
- The larger study document is available as backup for those who want to delve deeper into the methods

State health data organizations seeking to add key clinical data elements beyond the POA and numeric laboratory values now can evaluate the marginal utility of adding clinical data, using the findings from this study to weigh the reporting burden against the enhancement value. To measure the marginal costs, just a simple calculation is needed, multiply the number of discharges by the total cost in the best and worst case scenario for the level of interest. The authors provide this example using Table 2 increases in cost per record abstracted:

> With the approximate 3,000,000 total discharges in the PHC4 3-year database and 188 hospitals, you can estimate roughly 5300 discharges per hospital per year; at $2 - $4 per discharge the annual cost would average $10,600 – $21,200 per hospital per year depending on best or worst case scenario.

The equation of cost-effectiveness must also include the benefit—in this case the benefits are better prediction of mortality and other complications of care. The study examines the bias resulting from using less than "gold standard data". As you move away from clinical data toward administrative data the amount of bias increases, which may result in some misclassification of hospitals when ranking according to mortality or complications of care. (The extent to which hospitals would change ranks given the addition of the clinical data elements was not reported and would depend on how states or others ranked hospitals). However, it is assumed that some hospitals would go up in the ranking and others would go down. Additional clinical information would reduce this bias in rankings.

Some efforts are already underway to increase use of a POA indicator; the National Uniform Claim Committee (UB-04) has approved Present on Admission coding fields for principal diagnosis (where appropriate) and all secondary diagnoses. POA can be collected at the same time as the discharge billing data are prepared, requiring no additional abstraction or data linkage. (It will likely, however, require training of medical coders and physicians to report whether the diagnosis was present on admission). Numeric laboratory values are generally already in electronic format for at least 80% of the hospitals according to a recent study by HIMSS Analytics, LLC. [8]

Two states (CA, NY) have already legislated and implemented the POA addition to their administrative data and have expanded the number of secondary diagnoses that are collected. According to a recent inventory by the National Association of Health Data Organizations (NAHDO), a growing number of states are planning to add POA to reporting requirements during the next two years. This study also confirms the value of collecting as many of the secondary diagnoses as possible. The ANSI X12 implementation guides allow for the reporting of 24 other diagnosis codes as well a principal diagnosis. Adding these additional secondary diagnosis codes is very useful when the data are accurate.

As a side analysis, this study illuminated limitations of the APR-DRG™ software applied to standard administrative data not containing POA. This software is used by many state and private health data organizations and hospitals, to group patient data according to severity based on co-morbidities and complications. The study suggested that the commingling of co-morbidities with complications was likely exaggerating the intrinsic mortality risk of patients at admission, and this resulted in invalid predictive mortality C-statistics. Updated versions of this software do exclude certain diagnoses representing a complication that "may have been preventable" from the intrinsic risk for mortality in the model; however, there are still some post-admission complications that are not routinely determined to be preventable that can still affect the validity of the risk of mortality determination. When a POA indicator is present, an admission APR-DRG™ can be assigned to further improve the model,

[8] HIMSS Analytics™ Database, 2006, ©HIMSS Analytics (derived from the Dorenfest IHDS+ Database™). www.himssanalytics.org

which will benefit many public and private reporting initiatives that rely on this tool. *NAHDO recommends that states continue to publicly disseminate risk-adjusted mortality rates using APR-DRGs™ and/or AHRQ Inpatient Quality Indicators (IQIs) (or other methods) as they work to expand reporting to include POA and other key variables.*

Lastly, while there has been much publicity around the "miracle" of electronic health records (EHRs), recent studies[9] report that the electronic health record is a long way from full implementation in most states. Even with full implementation of EHRs it is not expected that these systems will all have the capacity to report on performance information in the base models. Most EHR systems now in place require significant programming to collect clinical data elements for public reporting of hospital performance. Even as the EHR evolves, state health data organizations will need evidence to justify the capture of additional data elements in local reporting initiatives. Purchasers and other stakeholders will need to inform national standards deliberations as to the value of these data for consumer and quality reporting purposes.

Information from this study can assist states in filling the gap that exists between provider expectations for use of clinical information for performance reporting and the reality of the slow implementation of hospital EHR's, in which much of the clinical information resides.

[9] Ibid. HIMSS Analytics Report indicated that only 10% of US hospitals have reached the stage in which the EHR contains clinical documentation (e.g., Vital signs, flow sheets), nursing notes, care plan charting, or medical image access that is accessible using a software protocol.

Appendix. Number of Models for Which Each Variable was a Significant Predictor

| Clinical Data Element | Number of IQI models[1] | Number of PSI models[2] | Total number of models[3] |
|---|---|---|---|
| **Laboratory Values on Admission (Level 2)** | | | |
| pH | 8 | 3 | 11 |
| Prothrombin time | 7 | 2 | 9 |
| Na | 7 | 2 | 9 |
| White blood cell count | 6 | 3 | 9 |
| PO2.sat | 6 | 2 | 8 |
| Blood urea nitrogen | 6 | 2 | 8 |
| SGOT | 7 | 1 | 8 |
| Platelets | 6 | 1 | 7 |
| K | 6 | 1 | 7 |
| pCO2 | 6 | - | 6 |
| Albumin | 4 | 1 | 5 |
| CPK MB | 4 | 1 | 5 |
| Creatinine | 3 | 2 | 5 |
| Base Excess | 4 | - | 4 |
| Glucose | 4 | - | 4 |
| Troponin I | 3 | - | 3 |
| Partial thromboplastin time | - | 3 | 3 |
| Total bilirubin | 2 | - | 2 |
| Hematocrit | 1 | 1 | 2 |
| Alkaline phosphatase | 1 | - | 1 |
| **Vital Signs on Admission and Other Lab Values (Level 3)** | | | |
| Pulse | 6 | 2 | 8 |
| Systolic Blood Pressure | 6 | - | 6 |
| Temperature | 5 | 1 | 6 |
| Respiration | 5 | - | 5 |
| Diastolic Blood Pressure | 3 | - | 3 |
| Blood/Lymph Culture-Positive | 1 | 1 | 2 |
| Ejection Fraction | 2 | - | 2 |
| GI except Biliary Culture-Positive | 1 | - | 1 |
| **Detailed Abstraction of Clinical Variables (Level 4)** | | | |
| Coma/Stupor **(ICD)**[4] | 6 | - | 6 |
| Current Med: Immunosuppressive Agent | 4 | 1 | 5 |
| Severe Malnutrition **(ICD)** | 4 | - | 4 |
| Chest Effusion **(ICD)** | 3 | - | 3 |
| Respiratory Effusion | 2 | - | 2 |
| Lethargy | 2 | - | 2 |

| Clinical Data Element | Number of IQI models[1] | Number of PSI models[2] | Total number of models[3] |
|---|---|---|---|
| Acute Flaccidity | 2 | - | 2 |
| Current Med: Anticoagulant | 1 | 1 | 2 |
| Skin Edema **(ICD)** | - | 2 | 2 |
| Respiratory Lesion | - | 2 | 2 |
| Current Med: Insulin | - | 2 | 2 |
| Respiratory Inflammation/Infection **(ICD)** | 1 | - | 1 |
| Intraventricular Conduction Disturbance **(ICD)** | 1 | - | 1 |
| Previous CABG / Heart Valve Prosthesis **(ICD)** | 1 | - | 1 |
| History of Chronic Lung Disease **(ICD)** | 1 | - | 1 |
| Decubitus Ulcer **(ICD)** | 1 | - | 1 |
| History of Chronic Lung Disease **(ICD)** | 1 | - | 1 |
| Abdominal/GI except Biliary Mass | 1 | - | 1 |
| Cardiac Effusion | 1 | - | 1 |
| Systemic Edema | 1 | - | 1 |
| High Risk Acute Neurologic Disorder | 1 | - | 1 |
| Acute Paresis | 1 | - | 1 |
| Immunocompromised | 1 | - | 1 |
| History of CHF | 1 | - | 1 |
| Seizure **(ICD)** | - | 1 | 1 |
| Brain Stenosis **(ICD)** | - | 1 | 1 |
| CHF **(ICD)** | - | 1 | 1 |
| History of Cancer **(ICD)** | - | 1 | 1 |
| Chronic Lung Disease/ Apneic Episode **(ICD)** | - | 1 | 1 |
| Chronic Renal Disease **(ICD)** | - | 1 | 1 |
| Respiratory Stenosis | - | 1 | 1 |
| Chronic Neurologic Findings | - | 1 | 1 |
| Vascular Aneurysm/Bleeding | - | 1 | 1 |
| Skin tear | - | 1 | 1 |
| **Abstraction of Clinical Summary Scores (Level 5)** | | | |
| American Society of Anesthesiologists (ASA) Class | 2 | 4 | 6 |
| Coma Score | 4 | 1 | 5 |

[1] The maximum number of models for IQIs is 8.
[2] The maximum number of models for PSIs is 4.
[3] The maximum total number of models is 12.
[4] **(ICD)** indicates that these conditions could be coded using ICD-9-CM diagnosis codes.