Towards a Framework for Data Quality in Healthcare

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**Executive Summary/Abstract:** Measuring and improving the quality of healthcare delivery are major goals at Partners HealthCare Systems, Inc. Information that can be derived from clinical and administrative information systems (i.e., order entry, electronic medical record, billing information) is core to achieving these goals. We present a Framework for Data Quality in the context of data uses in healthcare. The Framework lends itself to a set of potential solutions for insuring quality data for various healthcare measurements. Case studies were used to illustrate the applicability of the solution approaches in the context of the proposed Framework.

**Objectives**

- Current State of Healthcare
- Data Quality Issues within Healthcare
- A Framework for Data Quality in the Context of Healthcare
- Conclusions
Current State of Healthcare

What is the problem?

- Medical errors in 2.9-3.7% of hospitalizations
  - 1/2 preventable
  - 8.8-13.6% lead to death
- 8th leading cause of death
  - More than car accidents, breast cancer, AIDS
- Costs to society $17-$29B
  - 1/2 healthcare

Institute of Medicine, 1999
### Needs and Uses for HealthCare Information

<table>
<thead>
<tr>
<th>Needs and Uses</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Care</strong></td>
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<tr>
<td>• Patient/population management</td>
<td>• Clinicians at the point of care</td>
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<td>• Patient record look-up</td>
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<td>• Treatment decision</td>
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<td><strong>Quality Measurement</strong></td>
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<tr>
<td>• Quality and Safety measurement</td>
<td>• Clinicians</td>
</tr>
<tr>
<td>• Quality and Safety improvement</td>
<td>• Hospital Quality Manager</td>
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<tr>
<td>• Regulatory reporting (JCAHO, CMS)</td>
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<tr>
<td><strong>Research</strong></td>
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<tr>
<td>• Healthcare/Informatics research</td>
<td>• Informaticians</td>
</tr>
<tr>
<td>• Clinical Trials / Controlled</td>
<td>• Clinician researchers</td>
</tr>
<tr>
<td>• Academic researchers</td>
<td>• Academic researchers</td>
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<tr>
<td><strong>Business Management</strong></td>
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<tr>
<td>• Utilization reporting</td>
<td>• Executive business managers</td>
</tr>
<tr>
<td>• Cost reporting and analysis</td>
<td>• Department chairs</td>
</tr>
<tr>
<td>• Contract management</td>
<td></td>
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</tbody>
</table>

### Sources for HealthCare Data

- Clinical Data
- Administrative Data

- Customers
- Executives
Quality Measurement and Clinical Information Systems

Data from transaction systems is extracted for quality measurement

Transaction Systems
- EMR
- CPOE
- Billing

Quality Agenda

Quality Data Systems
- Query
- Analysis
- Benchmarking

Improvement

Inform design of transaction systems and processes

Reporting

Data Quality Issues Within Healthcare
Characteristics of high quality healthcare data

- Complete
- Accurate
- Source system context
- Codified and standard
- Sufficient level of detail (granularity)
- Data Reusability
  - e.g., data collected at the point of care is reusable for other purposes such as quality analysis

Characteristics of Healthcare Data

Data Quality

Admin Data

Billing Data

Clinical Data

Data Richness
Data Quality Dimensions in Healthcare

- Data Source Quality:
  - Administrative (high data quality, low data richness)
  - Billing (medium data quality, medium data richness)
  - Clinical (low data quality, high data richness)
- Characteristic:
  - Inherent incompleteness of Medical Knowledge
- Data Semantics:
  - Who are my patients?
  - How severely sick is my patient?
  - What was the reason for the treatment?
  - How do I know who had an eye exam?
  - Compared to whom (what benchmark)?
  - Differing local values/representations (e.g., Med or Lab names, Normal ranges, Abbrevs, etc.)

Data Quality Issues: Inherent Incompleteness of Medical Knowledge

- 250 Diabetes mellitus
  - 250.0 without mention of complication
  - 250.1 with ketoacidosis
  - 250.2 with hyperosmolarity
  - 250.3 with other coma
  - 250.4 with renal manifestations
  - ... with other specified manifestations
  - 250.9 with unspecified complication

- 790.6 Hyperglycemia NOS
- 790.2 Nonclinical diabetes
- 648.8 Gestational diabetes

All medical databases, and medical records, are necessarily incomplete because they reflect the selective collection and recording of data by the healthcare personnel responsible for the patient. -- Shortliffe and Barnett, 2000

Current level of coding accuracy and diagnostic precision is insufficient for population-based studies of outcomes of specific conditions or therapies.
Data Source Quality: Administrative and Billing Data

**Advantages**
- Readily available
- Easy to capture
- Codified/computer interpretable
- Describes large areas of population
- Standardized across healthcare industry

**Limitations**
- Purpose is for reimbursement, no intended for quality assessment!
- Limited Clinical Insight
  - Interpersonal/technical quality of care
  - Error determination, appropriateness
- Limited outcomes
  - E.g. in-hospital death
- Limited Nursing Information
  - E.g. smoking cessation
- Limited reporting of actions, results
  - E.g., Labs, Administration of Meds
- Limited insight on care processes/decisions
  - E.g., Meds administered because of some lab results
- Limited in temporal insights

Data Source Quality: Clinical Data

**Advantages**
- More accurate representation of patient care (as opposed to administrative data).
- Granular information in clinical data
- Complete account of patient care
  - Meds, Labs, Patient History, Longitudinal Patient Information, Co-morbidities, Family History, Genetic information
- Ability to piece clinical events better based on clinical data

**Limitations**
- Unstructured Notes
  - Information locked in Clinical Notes
- Lab values may be represented as free text
- Diagnoses and Findings not codified
- Not all orders have results or are captured
- Administration of Meds, Therapies
  - Unclear capture and representation of what was actually done
- Lack of causality representation in data
  - Did a patient get a test due to an indication?
  - Was a drug administered due to an indication
Data Semantics: Cohort Definition

Defining “My Patients” – what is the denominator?

- Who are your patients?
  - Visits (triage, cross coverage)
  - PCP (insurance, reality, ever seen)
  - Intervention and procedures

- Standard definitions are essential
  - Detailed, unambiguous
  - e.g. NCQA’s HEDIS measures (http://www.ncqa.org)

- Definition used at Brigham and Women’s Hospital:
  - A Patient is my patient if:
    - I am listed as the PCP in registration data
    - The patient has visited me more than once in the past 3 years
    - The patient is not known to be dead
A Framework for Data Quality and Solution Approaches

## Data Quality Framework for Healthcare

<table>
<thead>
<tr>
<th>Data Acquisition and Access</th>
<th>Cohort Definition</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical, Documentation, Unstructured Data</td>
<td>N/A</td>
<td>Clinical, Monitoring and Decision Support, Data Granularity, Unstructured Data</td>
</tr>
<tr>
<td>Clinical, Billing, Reporting and Documentation, Data Semantics</td>
<td>Clinical, Billing, Reporting and Documentation, Data Semantics, Missing Data Values</td>
<td>Clinical, Billing, Regulatory Compliance, Quality Enhancements, Comparative Analysis, Data Aggregation</td>
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<td>Clinical, Admin, Billing, Outcomes identification, Data Semantics, Definition</td>
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</table>
Set of Solutions

- Merge data
- Reuse dataset
  - Admin data
  - Non-transformed clinical data
- Merge dataset + Manual prospective entry
- Change process
- Restructure information model
  - Scale normalization

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Data Quality Framework for Healthcare

<table>
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<tr>
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Data Source, Functionality, Data Quality Issue
# Data Quality Framework for Healthcare

## Re-use Admin Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Functionality</th>
<th>Quality Issue</th>
</tr>
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<tbody>
<tr>
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## Reporting

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## Merge Data Set + Manual Prospective Entry

## Change Process

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Restructure Information Model</td>
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</tbody>
</table>

## Data Source, Functionality, Data Quality Issue
Case Study 1: Accuracy of Claims Data

- **Application Description**
  - Quality Measurement: Cohort Definition + Reporting
  - Of my cardiac patients, how many received Cardiac Catheterizations?
  - Billing Data (without change) is appropriate for this; Data Reuse

- **Solution Approach**
  - Reuse Administrative Data Set

- **Solution Characteristics:**
  - Administrative databases are a valuable resource collected at great expense
  - Interpret claims-based hospital comparisons with caution
  - Current level of coding accuracy and diagnostic precision is insufficient for population-based studies of outcomes of specific conditions or therapies

Data Quality Framework for Healthcare

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Case Study 1: Accuracy of claims data (Fisher 1992)

- DRG Validation Study 1985
  - Sample of 239 hospitals
    - Charts reviewed for 7050 discharges
  - Coders assigned ICD-9 diagnosis and procedure codes = GOLD STANDARD
  - Compared with Medicare claims data

- Agreement
  - Similar principal diagnosis 78.2%
  - Similar principal procedure 76.2%

- Sensitivity [principal or secondary dx]
  - 0.58 peripheral vascular disease
  - 0.97 breast cancer

- Procedures much better sensitivity
  - 0.88 cardiac catheterization
  - 0.95 many procedures

Case Study 2: Accuracy of Clinician entered data

- Application Description
  - Using diagnosis codes entered by physicians enhance (or detract) the ability to define and extract:
    - Patient co-morbidities
    - Quality Indicators
  - Quality Measurement: Cohort Definition + Reporting
  - Research: Cohort Definition + Reporting

- Solution Approach
  - Clinical Data and Claims Data; Merged Dataset
### Data Quality Framework for Healthcare

#### Data Acquisition and Access

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#### Quality Measurement

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#### Research

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</tbody>
</table>

#### Data Source, Functionality, Data Quality Issue

### Description

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ncase IP</th>
<th>Ncase HSF</th>
<th>% found</th>
<th>Ncase IP</th>
<th>% not found</th>
<th>Ncase HSF</th>
<th>% new cases</th>
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</thead>
<tbody>
<tr>
<td>HIV and AIDS</td>
<td>1192</td>
<td>1016</td>
<td>85.2</td>
<td>176</td>
<td>14.8</td>
<td>121</td>
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<tr>
<td>Lymphoma</td>
<td>2431</td>
<td>1883</td>
<td>77.5</td>
<td>548</td>
<td>22.5</td>
<td>566</td>
<td>23.3</td>
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<tr>
<td>Psychoses</td>
<td>10921</td>
<td>7269</td>
<td>66.8</td>
<td>3626</td>
<td>33.2</td>
<td>1878</td>
<td>17.2</td>
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<td>Congestive heart failure</td>
<td>18512</td>
<td>11185</td>
<td>60.4</td>
<td>7327</td>
<td>39.6</td>
<td>4463</td>
<td>24.1</td>
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<td>Solid tumor without metastasis</td>
<td>27986</td>
<td>16802</td>
<td>60.0</td>
<td>11184</td>
<td>40.0</td>
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<td>Liver disease</td>
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<td>78.3</td>
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<td>Weight loss</td>
<td>4047</td>
<td>2116</td>
<td>52.3</td>
<td>1931</td>
<td>47.7</td>
<td>6871</td>
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<td>Metastatic cancer</td>
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<td>5355</td>
<td>50.5</td>
<td>5241</td>
<td>49.5</td>
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<td>Other neurological disorders</td>
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<td>2224</td>
<td>64.7</td>
<td>1215</td>
<td>35.3</td>
<td>1203</td>
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<td>Valvular disease</td>
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<td>5169</td>
<td>44.5</td>
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<td>Peripheral vascular disease</td>
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<td>5169</td>
<td>44.5</td>
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<tr>
<td>Cardiac arrhythmias</td>
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<td>Renal failure</td>
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<td>44.5</td>
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<tr>
<td>Chronic pulmonary disease</td>
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<td>32.8</td>
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<tr>
<td>Drug abuse</td>
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<td>44.5</td>
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<td>Rheumatoid arthritis/hyperthyroidism</td>
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<td>Paralysis</td>
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<tr>
<td>Coagulopathy</td>
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<tr>
<td>Pulmonary circulation disorders</td>
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<td>5169</td>
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<tr>
<td>Fluid and electrolyte disorders</td>
<td>3.9</td>
<td>5169</td>
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<tr>
<td>Diabetes, uncomplicated</td>
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<td>44.5</td>
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<tr>
<td>Hypertension</td>
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<td>44.5</td>
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<tr>
<td>Diabetes, complicated</td>
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<td>44.5</td>
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<td></td>
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<td>Deficiency anemias</td>
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<td>12.2</td>
<td>1755</td>
<td>87.8</td>
<td>732</td>
<td>15.5</td>
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<tr>
<td>Blood Loss anemia</td>
<td>2087</td>
<td>332</td>
<td>15.9</td>
<td>1755</td>
<td>84.1</td>
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<td>Hypothyroidism</td>
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<td>9654</td>
<td>88.8</td>
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<td>2.2</td>
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<tr>
<td>Obesity</td>
<td>10560</td>
<td>1106</td>
<td>10.5</td>
<td>9454</td>
<td>89.5</td>
<td>183</td>
<td>1.7</td>
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<tr>
<td>Peptic ulcer disease including bleeding</td>
<td>4783</td>
<td>282</td>
<td>5.9</td>
<td>4501</td>
<td>94.1</td>
<td>618</td>
<td>12.9</td>
</tr>
</tbody>
</table>

### Additional cases identified with physician data

- CHF: 4453 (24%)
- Depression: 2543 (28%)
- Weight loss: 6871 (170%)
True variance?
This brings you closer to completeness, but not necessarily better quality (e.g., less accurate)

<table>
<thead>
<tr>
<th>Quality Indicator</th>
<th>Medical Records + Physician Diagnoses</th>
<th>Medical Records Diagnoses only</th>
</tr>
</thead>
<tbody>
<tr>
<td># Inpatient visits</td>
<td># with complication</td>
<td>Complication Rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td># with complication</td>
</tr>
<tr>
<td>Inpatient Wound Infection</td>
<td>234587</td>
<td>3878</td>
</tr>
<tr>
<td>Pulmonary Compromise after major surgery</td>
<td>38009</td>
<td>3224</td>
</tr>
<tr>
<td>Acute Myocardial Infarction after major surgery</td>
<td>39381</td>
<td>327</td>
</tr>
</tbody>
</table>

Case Study 3: Severity and Risk Adjustment

- Application Description:
  - To make meaningful comparisons among patients, payers, or institutions, must take patient-specific factors (age, sex, comorbid conditions, severity of illness, risk of death etc.) into account
  - Adjustment using only administrative data
    - e.g., Deyo-Charleston index, APR-DRG
    - Physicians don’t trust these measures
  - Adjustment that includes clinical data
    - e.g., ACC Risk adjustment for Cardiac patient
    - Physicians trust these measures

- Solution Approach
  - Merging Clinical and Administrative Data Sets
  - Restructuring Information Model/Scale Normalization
### Ongoing Work at Partners HealthCare: Clinical Dashboards for Reporting at Patient Care

- Implement an online dashboard that describes quality of care with regard to several quality indicators. The intended customer/user of the dashboard is the physician, who will be able to review his/her performance.
  - Ideally, dashboard provides information that is actionable ("population-based clinical decision support")
  - Touches upon the various data quality issues discussed in the talk.
Clinical Dashboard for Diabetes
Future Work:

- Quality and integration
  - Set and meet specific targets for IOM priority areas
  - Deploy electronic clinical programs system-wide
  - Improve pharmaceutical decision-making
  - Enhance “system-ness” and care coordination

Opportunity

- Measurement systems
- Registries and cohorts
- System-wide data and infrastructure
- Clinical Decision Support
- Population decision support
- Patient computing

Conclusions

- Leveraging the connections between enterprise information systems and the quality of healthcare delivery and practice
  - Clinical Information System
  - Billing and Administrative Information System
- Using data for various Healthcare initiatives (e.g., measure healthcare quality)
  - Administrative Data: Easy to extract, less accurate
  - Clinical Data: Difficult to extract, more accurate
  - Need to leverage both to estimate healthcare quality
- Proposed a Framework for Data Quality in Healthcare
- Proposed initial solution approaches in the context of the Framework to enhance data quality
- Presented Case Studies that exemplify the use of the Framework