Clinical Analytic Model

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Prologue

- Physicians have always been dedicated to improving care
- And, physicians agree that data is needed to improve care
- Yet, it is often very difficult for physicians to
  - Base patient recommendations directly on objective data, or
  - Identify and resolve process of care issues based on data
- Technologic progress will eventually close this gap
- The Clinical Analytic Model will help short- and long-term
Clinical Analytic Model

What Is It?
- A general purpose model to address a broad range of health care questions
- Initially based on claims data, but clinical data can be used when available
- Accompanied by self-service web-based information tools

What Can it Be Used For?
- Identification of system-wide opportunities for improving care
- Analysis of --
  - Care patterns, costs, and outcomes across time and populations
  - Relationships among illnesses and treatments and selected outcome markers
- Provider performance measurement – as a guide for
  - Clinicians seeking to monitor and improve care
  - Consumers, payers, and other purchasers seeking better value

Current Status
- Initial beta completed – developed / tested on commercial claims
- An initial application could be released for public use within a year
- Full realization of project goals will extend over a period of years
Relationship to Other Initiatives

*The CAM project* --

- Aims to support private and public sector efforts
- Is focused on analytic infrastructure
  - A *common analytic vocabulary and framework* to be used by specific, more focused care improvement initiatives
  - *General purpose analytic tools* that can be used to identify issues / monitor progress
The Challenge

- Better information can help improve the decisions and processes that determine quality and cost.
- Relevant information must be readily available and easily understood by diverse users.
- But, useful information is complex, difficult to get right, and very costly to produce.
Key Assumptions

- A wide range of metrics and a broad range of tools can be supported by a common framework.

- Cost, ‘time to market’, and usability can be optimized by shared analytic architecture and shared production process.
Technical Strategy

- Identify the range of questions / tools CAM should address / support
- Model complex relationships among illnesses / interventions faithfully
- Standardize key concepts, definitions, and methods
- Develop algorithms / populate the model with available data
- Identify key data gaps / update as better data becomes available
- Mass-produce analytics via database programming and OLAPs
- Create views appropriate for specific end-users
- Deploy through web-enabled self-service tools
Process Strategy

- Develop a tangible ‘first draft’ for groups to react to
- Engage clinical organizations and other stakeholders
- Solicit clinical input / advice / validation
- Implement recommendations
- Work with early adopters
- Iterate based on user feedback
Project Strategy / Design Goals

Questions CAM Should Address

● What are the strategic opportunities to improve care?
● What are the opportunities for providers to improve?
● What patients / populations are at risk of preventable morbidity / costs?
● *For specific patients*, what options make the most sense?
Information Tools CAM Should Support

● Automated clinical epidemiology
  – Interrelationships of illnesses and interventions
  – Systematic estimates of key probabilities

● Clinical process improvement tools for clinicians
  – Identifying process drivers of cost or quality variance

● Population management tools
  – Identifying patients at high risk of avoidable morbidity / costs
  – Targeting and improving interventions

● Clinical information tools
  – Estimated yield of diagnostic testing for matched patients
  – Likely outcomes of treatment options for matched patients
Advantages of Approach

- Capable of addressing a myriad of relevant questions
- Does not assume that we already know what the issues are
- Will provide new clinical and epidemiologic insight
- Large-scale deployment makes aggregate impact more likely
- Low incremental cost for additional users / functions
- Assures consistency across domains / minimizes potential for confusing conflicts of results
- Supports near-term needs while providing guidance for future development
Conceptual Model
Identification of the illness being treated is a key anchor point. This makes sense because treatments generally are illness specific.

Severity refers to differences in the extent or activity of an illness that affect outcomes or costs. With greater severity, more resource intensive interventions may be needed for equivalent outcomes. Severity integrates a variety of clinical parameters into one or more indexes for costs and for near-term and long-term outcomes.

Comorbidity refers to the impact of other illnesses on outcomes or costs for the illness being treated. For example, massive obesity has a predictable impact on the costs and outcomes of treatment for hip fracture.

Current or prior treatment may be predictive of outcomes. Moreover, if a less costly treatment has already failed, a more costly intervention may be the only option.

Under the suggested approach for outcomes, symptoms reflect current effects of illness, severity reflects future outcomes, and complications reflect the harms of care.

The patient’s status changes over time and interventions are provided over time. Thus, costs and outcomes need to be reassessed continuously.
Organizing Key Information

Illness Model

- Summarizes a patient’s medical problems
  - Links multiple diagnoses that correspond to a single illness
  - Links complications to a primary illness

- Defines resource needs and expected outcomes (accounts for diagnosis, “stage”, “acuity”)

- Identifies key outcomes
  - Potential diagnostic errors
  - Complications
  - Disease progression (“stage”)
  - Disease activity or control (“acuity”)

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Conceptual Model – Illness Relationships

- Resource needs and expected outcomes vary by illness, severity. Severity in turn reflects a series of underlying clinical parameters.
- Patient’s status changes over time. Expected resource needs and expected outcomes should therefore be reassessed periodically.
- Outcome markers include complications, misdiagnosis, disease progression, disease flares, as well as symptoms and functional status.
- The diagram does not show the impact of co-morbidities nor does it show how multiple illnesses can interact adversely.
### Illness Data Model

**Mock-Up: Illness Relationship Data**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Primary Illness</th>
<th>Related Illness</th>
<th>Relationship to Primary Illness</th>
<th>From</th>
<th>Thru</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>Congestive Heart Failure</td>
<td>Same</td>
<td>1/1/2003</td>
<td>6/30/2006</td>
</tr>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>Dyspnea</td>
<td>Same - Symptom</td>
<td>1/1/2003</td>
<td>1/5/2003</td>
</tr>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>Asthma</td>
<td>Same - Dx Error</td>
<td>1/5/2003</td>
<td>1/5/2003</td>
</tr>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>Embolic Stroke</td>
<td>Disease Complication</td>
<td>7/8/2004</td>
<td>8/20/2004</td>
</tr>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>Hypokalemia</td>
<td>Treatment Complication</td>
<td>4/2/2003</td>
<td>4/3/2003</td>
</tr>
<tr>
<td>123</td>
<td>Congestive Heart Failure</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>123</td>
<td>Diabetes - Type II</td>
<td>Diabetes - Type II</td>
<td>Same</td>
<td>5/3/1998</td>
<td>6/30/2006</td>
</tr>
<tr>
<td>123</td>
<td>Diabetes - Type II</td>
<td>Diabetic Nephropathy</td>
<td>Disease Complication</td>
<td>4/5/2001</td>
<td>6/30/2006</td>
</tr>
<tr>
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<td>Diabetes - Type II</td>
<td>...</td>
<td>...</td>
<td>...</td>
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</tr>
<tr>
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<td>Diabetes - Type II</td>
<td>...</td>
<td>...</td>
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<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Organizing Key Information

**Intervention Model**

- Organizes details of care into an easy-to-understand “story”
- Recognizes the complexity of how care is delivered
- Facilitates understanding of resource use by separating ... the decision to provide a clinical intervention ... ... from complex details of the resources used for the intervention
- Treatment of a patient can be thought of as involving a series of nested processes.
- A hospital admission for cardiac surgery is an “intervention” but consists of a series of nested interventions. And each each intervention consists of a series of steps to produce the intervention.
- Quality or cost problems can arise at any level of the intervention hierarchy.
- Thus, analytics must provide for analysis of care at varying levels of the hierarchy.
Intervention Model
Clinical Events and Multi-Week / Single Day Interventions

Breast Cancer, Localized

June 1
Diagnostic Mammogram
Dr. Smith, Radiologist

June 15
Breast Biopsy
Surgeon, Radiologist, Hospital
Dr. Jones, Surgeon, Responsible MD

June 20 – 21
Partial Mastectomy - Inpatient
Surgeon, Anesthesiologist, Pathologist, Radiologist, Hospital
Dr. Jones, Surgeon, Responsible MD

July – December
Multiple Office Visits for Chemotherapy
Dr. Green, Oncologist, Responsible MD

January – December
Multiple Visits for Monitoring
Dr. Green, Oncologist, Responsible MD

Each “●” represents a clinical service event, embedded in a course of care (the colored bar).
In an application, a user could click on the “●” symbol to see details of care provided during the event.
The service model organizes the details of care into a clinically meaningful narrative.

- Quality process standards may specify the selection, sequencing, and timing (of lower level) interventions that should occur within the level.
Summary of Outputs With Full Implementation

- Key measures
  - Cost -- utilization, intensity, and pricing
  - Selected outcome end-points
    - Complications / disease progression
    - Rescue care / retreatment
    - Time from presentation to correct Dx or initiation of correct Rx

- Analytic dimensions
  - Enrollee characteristics
  - Provider characteristics
  - Illness characteristics and relationships
  - Service characteristics and relationships

- Variances (actual vs. benchmarks)
  - Clinical events / interventions per illness month (admissions, ER visits, surgeries, etc.)
  - Resource use per event or intervention (specific services, RVUs, allowed charges, etc.)

- Attribution algorithms can --
  - Mirror changing physician roles over time or across settings
  - Reflect degree of “control” over specific sources of variance
  - Hold physicians accountable only for statistically significant variances
Next Steps
Future Directions

Next 3 to 6 months --
- Continue to implement planned functionality
- Extend to Medicare data
- Talk with potential end-users for input on overall approach
- Secure medical society input on clinical definitions / relationships

Next 6 to 12 months –
- Seek partners for pilot sites and for data
- Plan for nationally representative data sample
- Initiate roll-out

Next 1 to 3 years --
- Analyze national trends in utilization, costs and outcomes over a 10 year period
- Web site with public access to analytics (not provider specific)
- Build a range of prototype applications to assist providers
- Implement model with EMR data
Demonstration of Prototype
Appendix – Model Details
The model assumes that data from individual patient – physician encounters would be merged into discrete illnesses. Similar diagnoses, symptom or clinical finding diagnoses, and working diagnoses or mis-diagnoses would all be sorted and linked to an appropriate illness episode.

The model also identifies illness and treatment complications and associates these complications with causative episodes and/or treatments.

Severity, outcomes and costs be measured by a series of metrics. These metrics are stored in a general purpose measurements table linked to specific time intervals or episodes by an intermediate association tables. Metrics can include costs, severity levels, symptom levels, lab results, etc.

While not meaningful at the atomic level, comparisons between actual and expected values may be meaningful when aggregated over a series of similar cases.
The model organizes diagnostic and therapeutic interventions into a series of nested structures. At the finest level, a single clinical intervention is comprised of a series of distinct actions or process steps. Thus, an appendectomy requires a series of distinct steps.

An extended intervention – such as a course of chemotherapy – may consist of a collection of single day Interventions that comprise an integrated course of treatment.

Clinical events represent bundles of interventions occurring during a single hospital stay or single emergency department visit or ambulatory encounter.

The impact of interventions can be measured by a series of before and after metrics. These metrics are stored in a general purpose measurements table linked to specific interventions by intermediate association tables. Metrics can include costs, severity levels, symptom levels, lab results, etc.
Patients may receive a number of different types of interventions from a number of different types of providers. Each professional involved has some degree of clinical autonomy, responsibility, and accountability. The model reflects these considerations and can support a wide variety of comparisons. Key stakeholders and end-users of the model can decide what mix of measures works makes the most sense for their context. The diagram above represents a subset of the levels of analytic levels supported by the model. Each of the levels shown above can be further split by specialty or service.
Analytic Strategy

- Norms equal the within category average after excluding or adjusting for atypical cases
  - Regression models may be used in the future

- Per-episode variances are decomposed into variances
  - By events or interventions per illness month
  - By resource use per event or intervention

- Prototype physician resource use calculates norms based on --
  - Illness (~1100 categories)
  - Month since onset of illness
  - Specialty (~ 75 categories)
  - Event Type (4 categories) [per event norms only]
  - Service_L4 (~ 1600 categories [per event norms only]
The unit of analysis is an instance of care. An instance is defined by diagnosis, severity, and intervention at different levels of granularity.

The highest level of analysis includes all illnesses and all care for a person. The finest level is a discrete step in a health care intervention.

Care type defines the specific type of care provided, for example, a hospital admission for pneumonia.

Instances of care are nested. A drill down pathway permits examination of the lower-level elements that comprise a upper-level instance.

Each instance of care has associated reporting dimensions, measures, and case-mix adjustment variables.

Instances can be subdivided. An episode can be subdivided by month since onset. Or, a hospital admission can be subdivided by specialty.
- An ‘instance of care’ represents the care a patient received at different levels of granularity.
- Levels of analysis range from the most aggregated level (patient) to the finest level of detail (step).
- Each instance of care has associated cost and outcome variables.
- Some form of case mix adjustment is needed for valid comparisons between instances of care.
- Variables not included as reporting categories may need to be included in case mix adjustments.
- This base model shows case mix adjustment factors, but does not show adjusted measures.