Clinical Analytic Model

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May 28, 2008

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

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

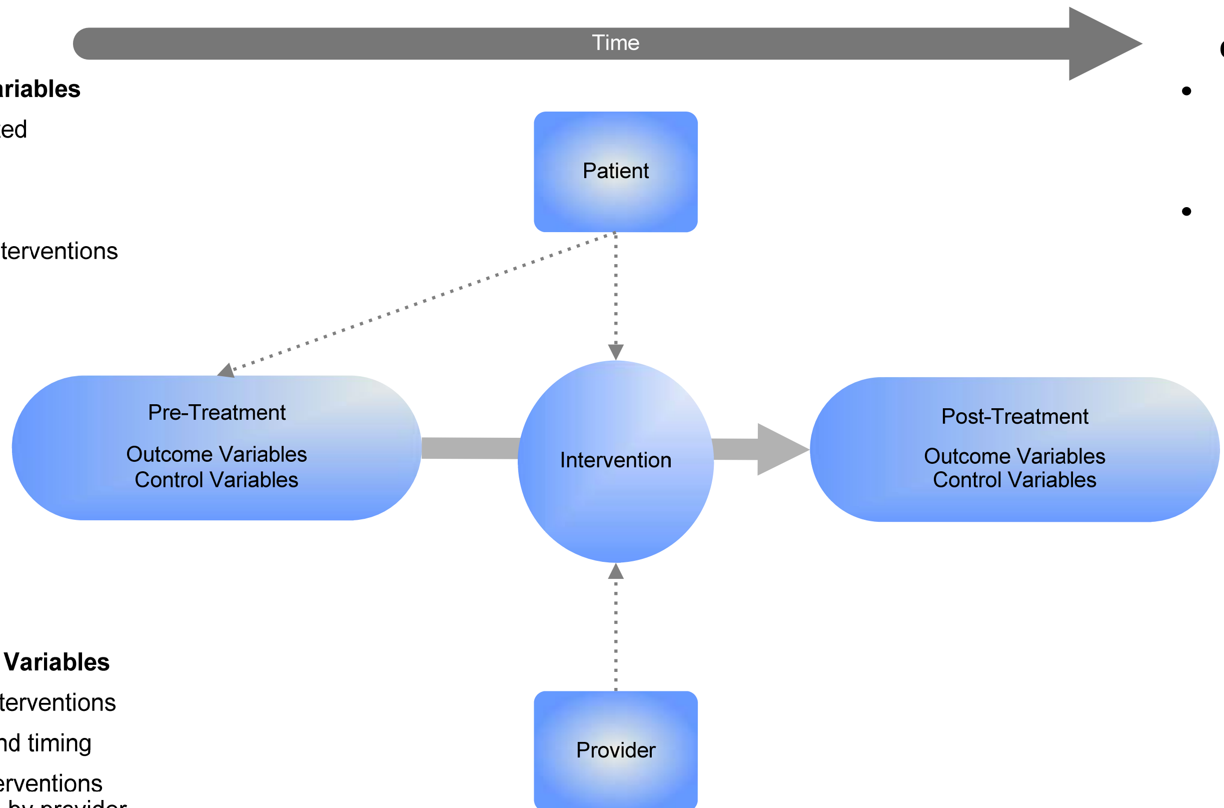
- Capable of addressing a myriad of relevant questions
- Does not assume that we already know what the issues are
- Will provide new clinical and epidemiologic insight
- Large-scale deployment makes aggregate impact more likely
- Low incremental cost for additional users / functions
- Assures consistency across domains / minimizes potential for confusing conflicts of results
- Supports near-term needs while providing guidance for future development

Conceptual Model

High-Level Conceptual Model

Control Variables

- Illness being treated
- Severity of illness
- Comorbidity
- Current or prior interventions



Outcome Variables

- Health Outcomes
  - Symptoms
  - Severity
  - Complications
- Costs
  - Utilization
  - Intensity
  - Price

Intervention Variables

- Selection of interventions
- Sequencing and timing
- ‘Quality’ of interventions
  - Execution by provider
  - Compliance by patient

- 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.

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")

Conceptual Model – Illness Relationships

Person

Illness Cluster – A primary illness plus related illnesses and complications. Example – congestive heart failure plus atrial fibrillation and embolic stroke

Illness – includes working diagnoses and symptom diagnoses as well as the “correct” diagnosis itself

Sub-episode – A flare or distinct phase of an illness reflecting severity. Example – an instance of pulmonary edema.

Severity

Symptoms and functional status, lab and clinical findings, pathology, etc.

Time Interval (month, week, etc).

- 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

Patient	Primary Illness	Related Illness	Relationship to Primary Illness	From	Thru
123	Congestive Heart Failure	Congestive Heart Failure	Same	1/1/2003	6/30/2006
123	Congestive Heart Failure	Dyspnea	Same - Symptom	1/1/2003	1/5/2003
123	Congestive Heart Failure	Asthma	Same - Dx Error	1/5/2003	1/5/2003
123	Congestive Heart Failure	Embolic Stroke	Disease Complication	7/8/2004	8/20/2004
123	Congestive Heart Failure	Hypokalemia	Treatment Complication	4/2/2003	4/3/2003
123	Congestive Heart Failure	…	…	…	…
123	Diabetes - Type II	Diabetes - Type II	Same	5/3/1998	6/30/2006
123	Diabetes - Type II	Diabetic Nephropathy	Disease Complication	4/5/2001	6/30/2006
123	Diabetes - Type II	…	…	…	…
123	Diabetes - Type II	…	…	…	…
123	Sinusitis - Acute	Sinusitis - Acute	Same	11/2/2001	11/16/2001
123	…	…	…	…	…

Intervention Model

- Organizes details of care into a 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 …

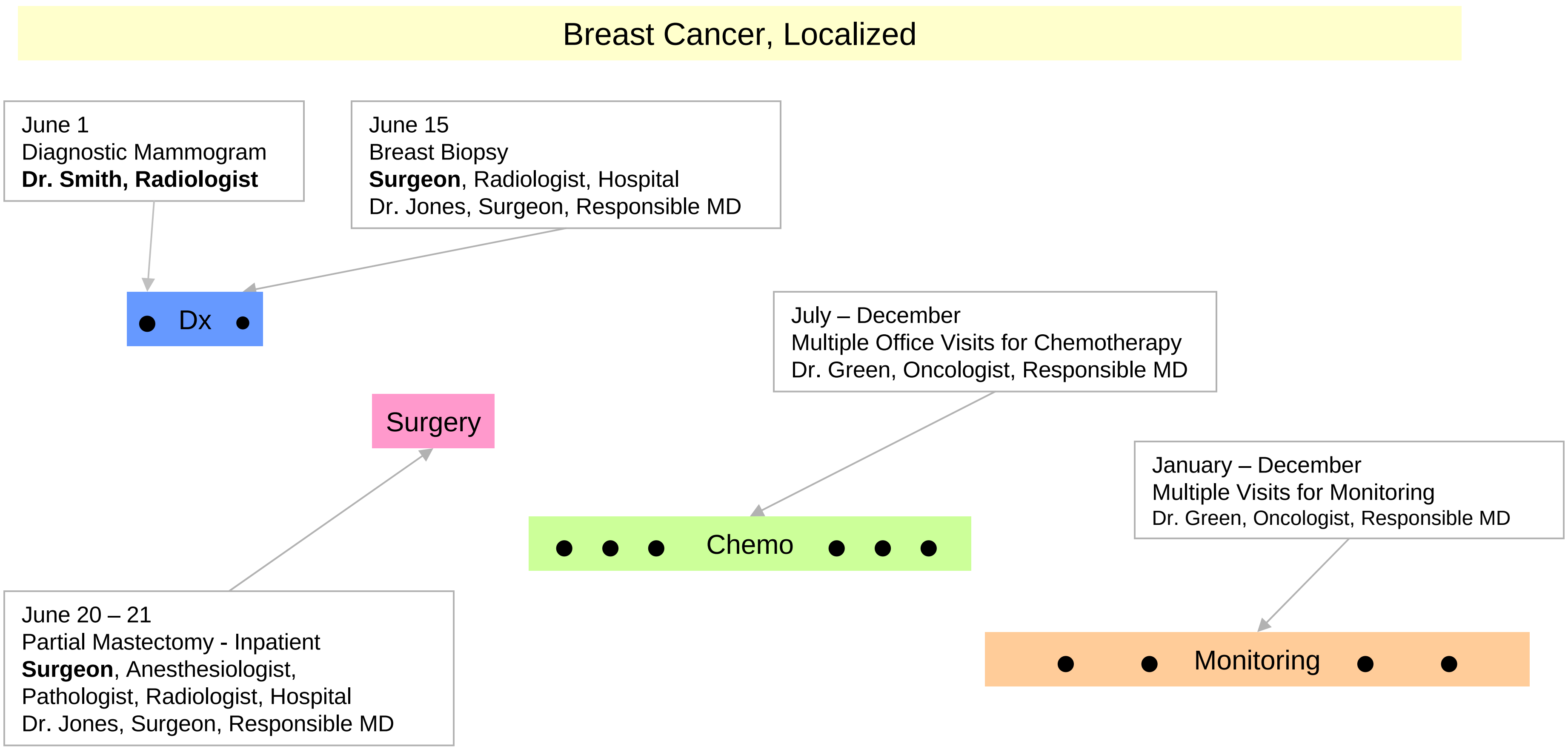
  … from complex details of the resources used for the intervention

Nesting of Interventions

- 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



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.

Conceptual Model - Interventions

- Person
  - Illness
    - Extended intervention – an intervention or related set of interventions provided over several weeks/months - example - chemotherapy
      - Clinical event – a hospital admission or ambulatory visit -- includes one or more clinical interventions
        - Clinical intervention – a distinct clinical service - example – a thallium scan
          - Step – a process required for an intervention – example prep of an op site is a step for surgery
          - Billing code – detailed billing codes from one or more providers that comprise an intervention
      - Specialty

- 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

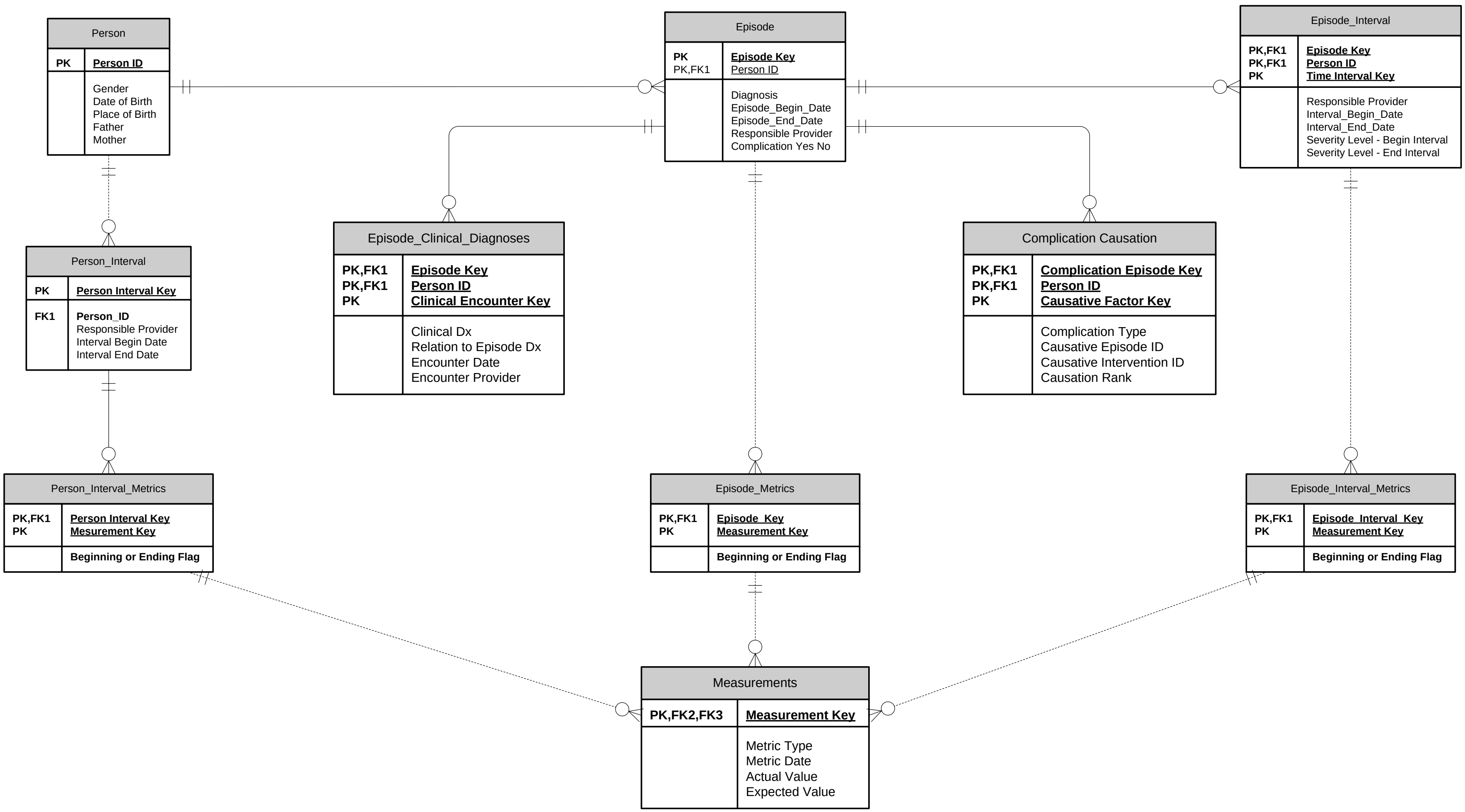
Next 1 to 3 years --

- 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

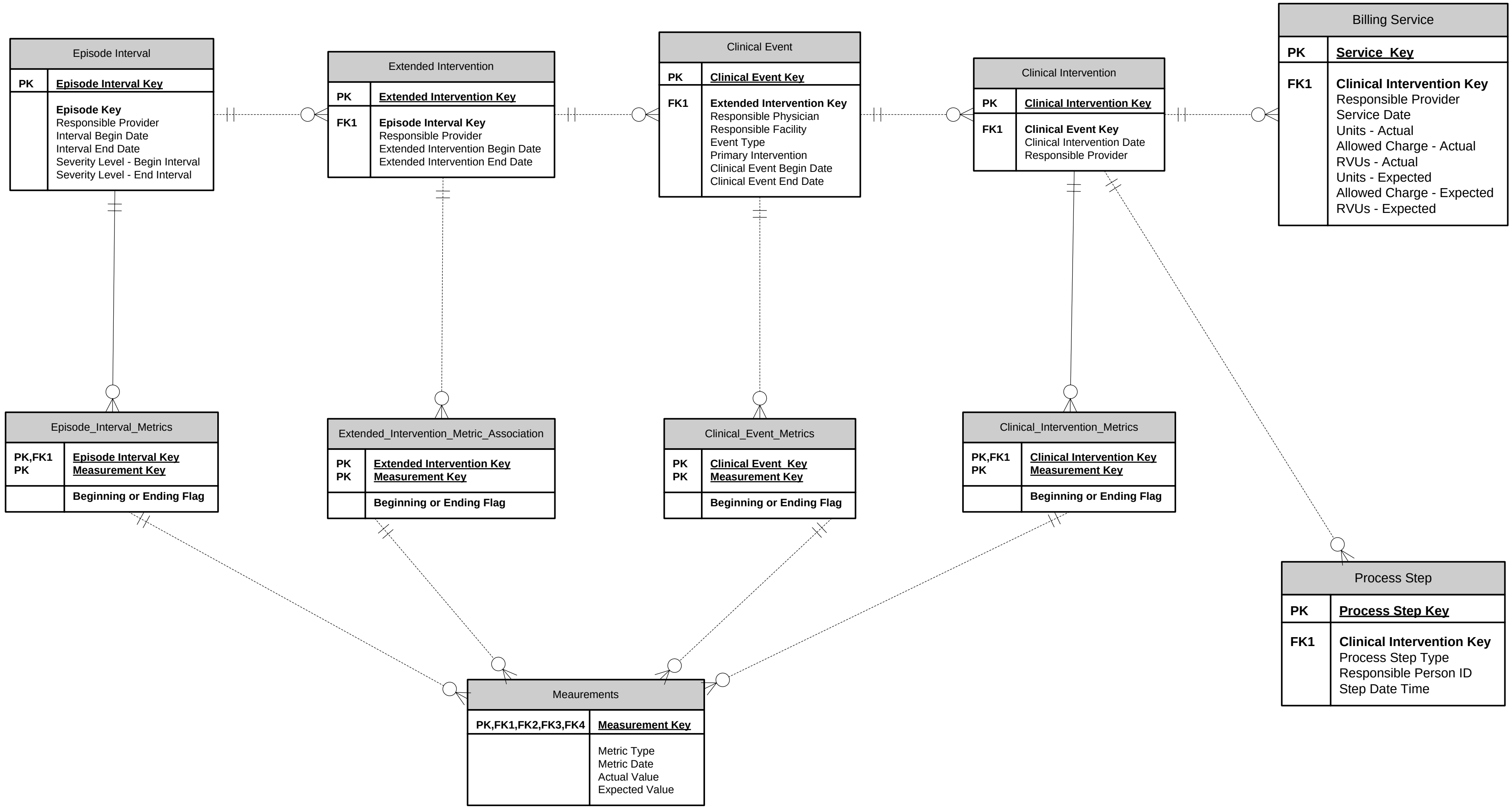
Appendix –Model Details

Illness Data Model



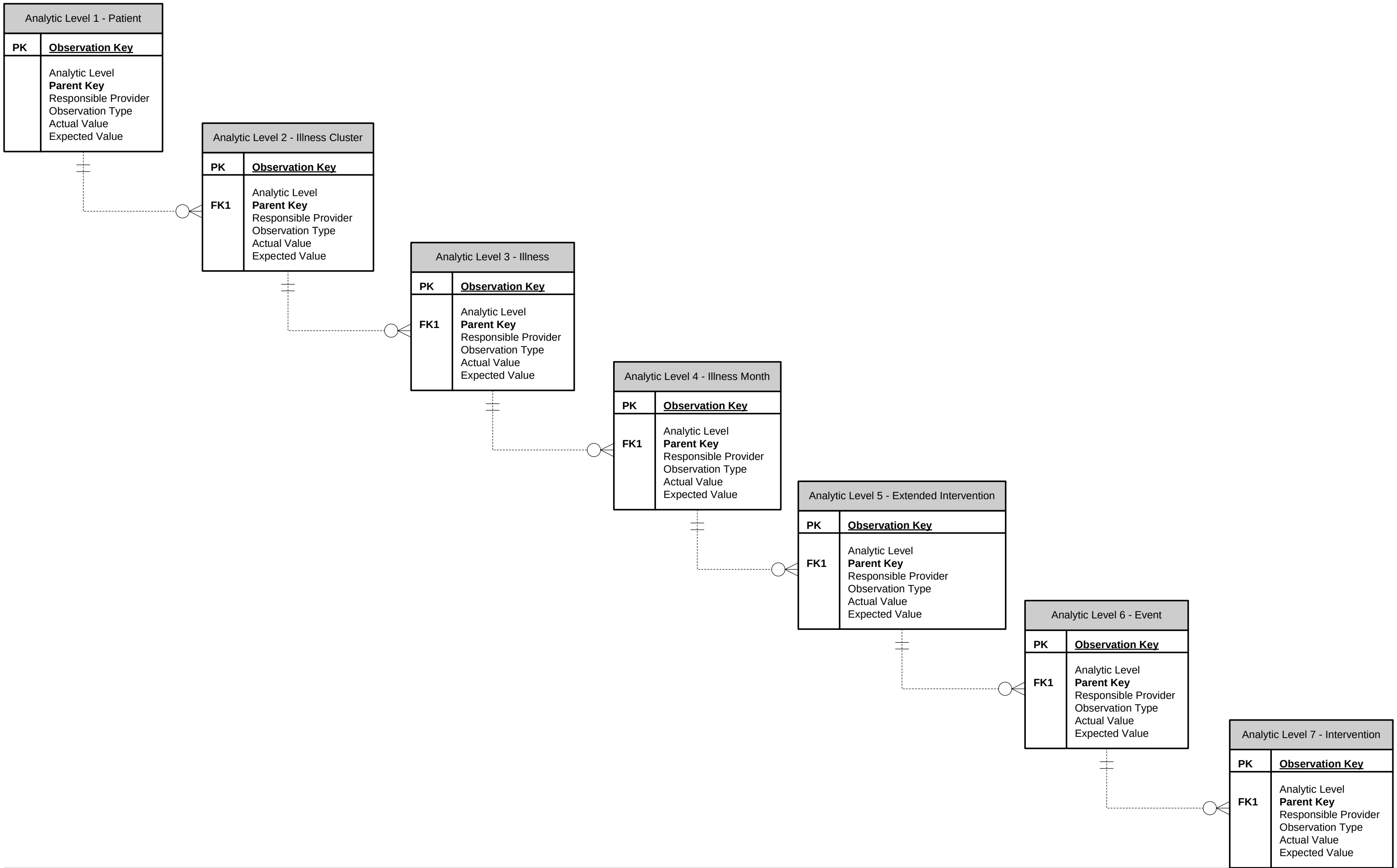
- The model assumes that data from individual patient – physician encounters would be merged into discrete illnesses. Similar diagnoses, symptom or clinical finding diagnoses, and working diagnoses or mis-diagnoses would all be sorted and linked to an appropriate illness episode.
- The model also identifies 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 a 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.

Intervention Data Model



- The model organizes diagnostic and therapeutic interventions into a series of nested structures. A 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 a intermediate association tables. Metrics can include costs, severity levels, symptom levels, lab results, etc.

Care Can Be Assessed At a Variety of Analytic Levels

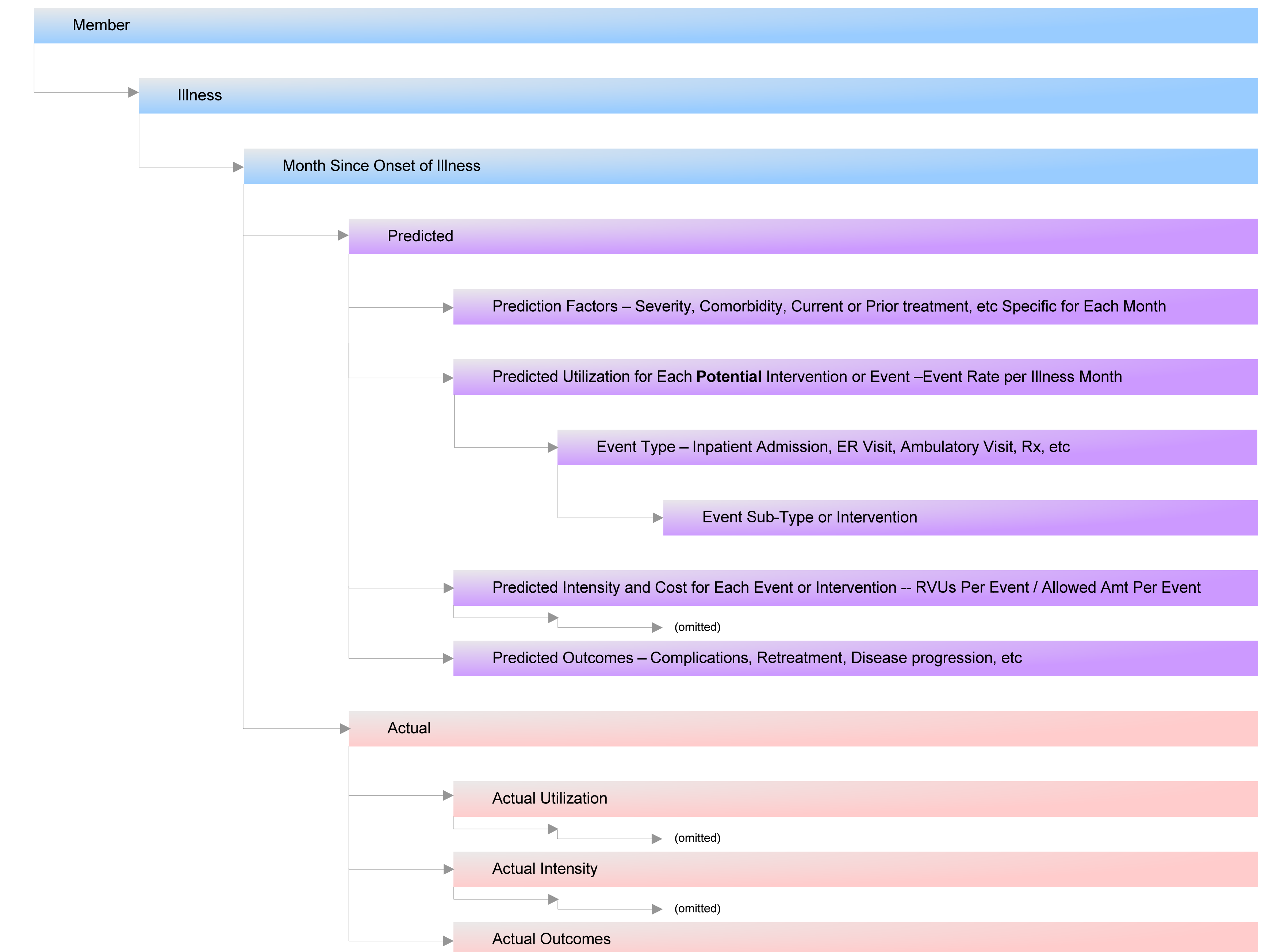


- Patients may receive a number of different types of interventions from a number of different types of providers. Each professional involved has some degree of clinical autonomy, responsibility, and accountability.
- The model reflects these considerations and can support a wide variety of comparisons. 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]

Integrated Analytic Model



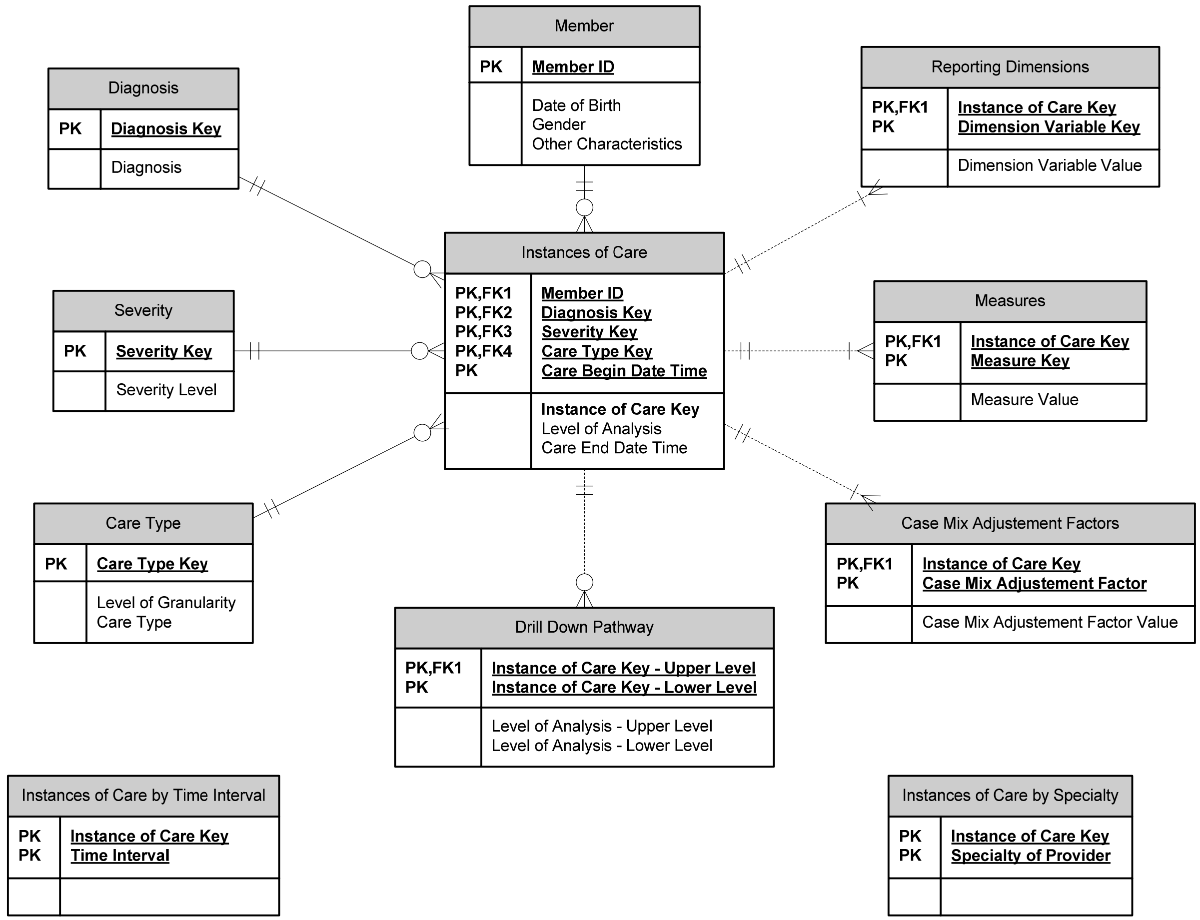
High Level Analytic Data Model

Levels of Analysis

- Patient
- Illness w/ complications
- Illness episode
- Illness sub-episode
- Extended intervention
- Clinical event
- Clinical intervention
- Billing code
- Step

Reporting Dimensions

- Member Attributes
- Family Attributes
- Provider Attributes
  - Name
  - Affiliation
  - Teaching Status
  - Specialty
  - Location
  - Other
- Illness Attributes
  - Severity
  - Duration
  - Complications
  - Other
- Service Attributes
  - Type of Care
  - Technology
  - Sequence and Timing
  - Efficiency Variance Type
  - Quality Standard Compliance
- Normative Comparison Groups



Measures

- Cost Components
  - Counts of Instance of Care
  - RVUs
  - Allowed Amount
- Outcomes
  - Δ in Symptom Index
  - Δ in Severity Index
  - Complication Rates
- Actual vs. Case Mix Adjusted
  - Alternative Norms Possible
- Rates can combine measures from different analytic levels
  - Admissions per episode
  - Visits per course of care, etc.
  - Plus other permutations

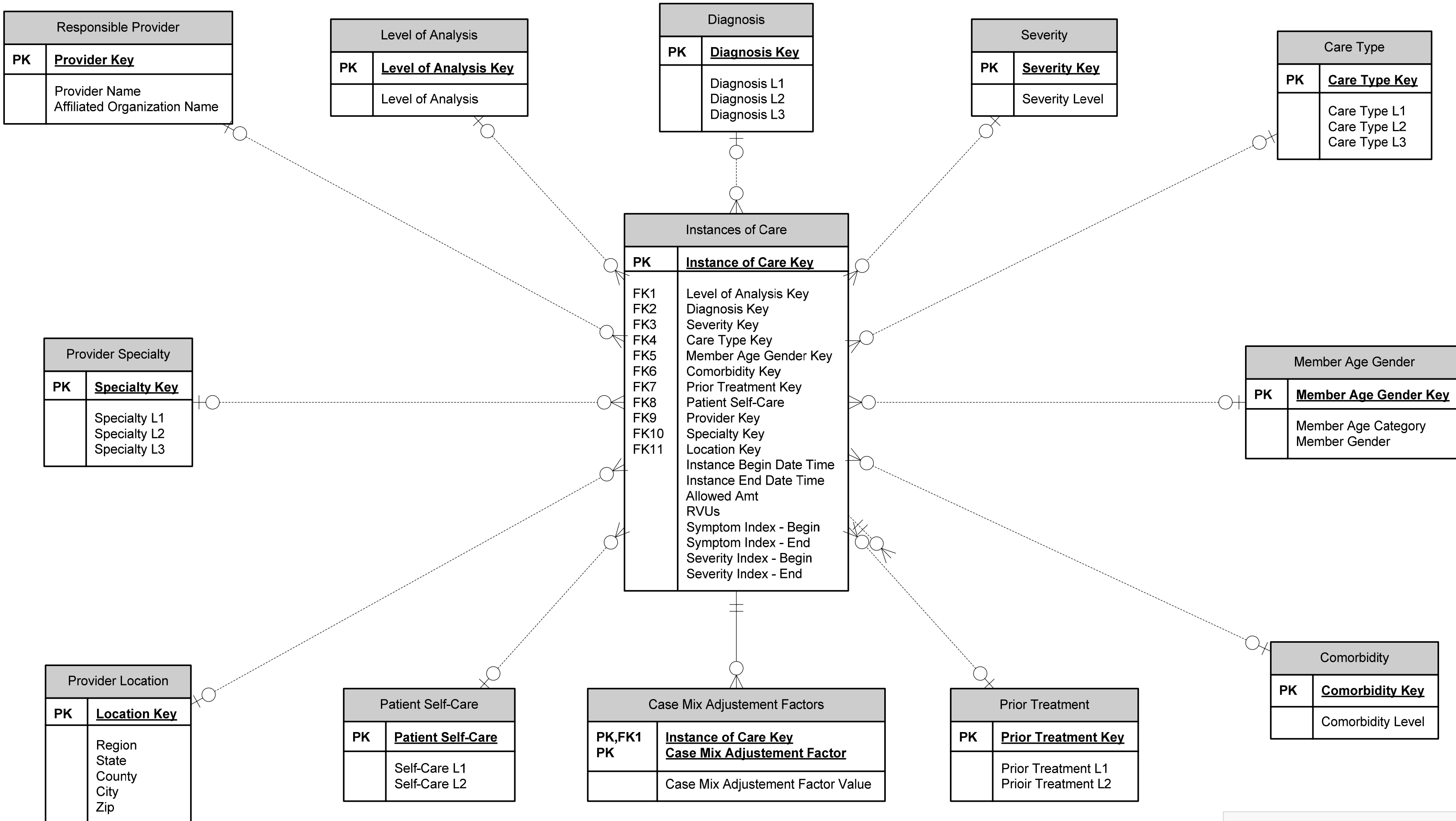
Possible Case Mix Factors

- Illness
- Care Type
- Severity
- Comorbidity
- Response to Prior Rx
- Compliance

(Specifics vary by report)

- 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.

Analytic Data Model



- 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.

Levels of Analysis

- Patient
- Illness w / complications
- Illness episode
- Illness sub-episode
- Extended intervention
- Clinical event
- Clinical intervention
- Billing code
- Step