HCn3D Topology Text Reduction

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Ripley Version 7.6.1
Hall Version 7.4

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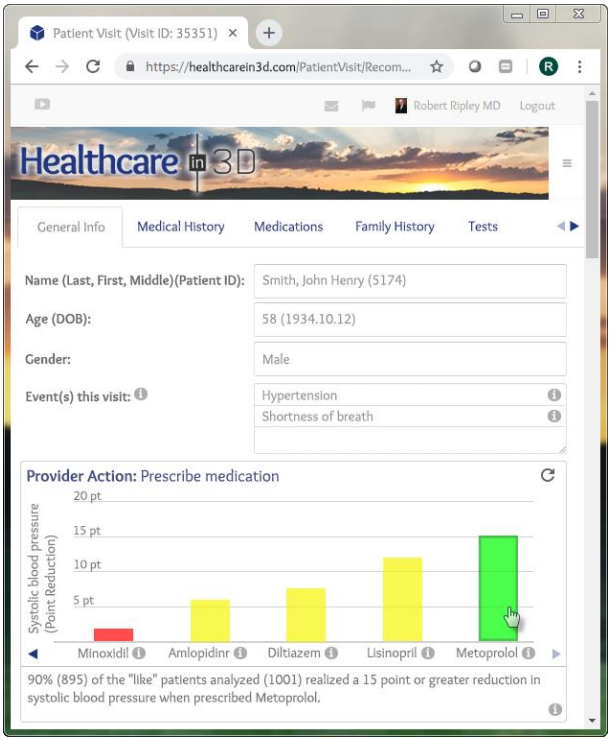
Introduction



Health care cost control requires transformation of health care delivery and financing. High costs are as much cultural as technology driven. Health Care in 3 Dimensions is designed to capture the broad reach in society of medicine and health care as we know it today. By assisting in achieving the Quadruple Aim: enhance patient experience, reduce costs, improve health outcomes, and improve clinician experience, HCn3D identifies and motivates change drivers in the health care ecosystem. Reminded by Arnold Toynbee, the philosopher and historian, understanding society requires both a myopic and panoramic view, the same is true for healthcare. HCn3D is primarily a classification system starting with the ecosystem as a whole using Topology and Logic, breaking this down to innumerable parts and processes defined by Donabedian, the managed care theorist, to structure, process and outcomes. Dividing this White Paper into sections will show a progression of assessing an ecosystem into categories that show scale, and dimensionality, explained in the text and graphics that classifies any entity in the ecosystem. The first section is Why?, explaining terminology that is theoretic. The next is Brief, which names entities and their relations in health care and their detailed operational characteristics; then Scenario Planning, which is a program for change specified by and for each entity; and the last is Reinforcement Learning, which targets performance for each entity in its path to optimization and transformation.

Section 1 Theory

Why Ecosystem?

An ecosystem means the totality of the health care world, which is complex and stratified. Framing a world as a large space that includes everything, gives a way to locate any health care organization both broadly with many entities, and locally with few entities. This context gives structure for measuring change over time of an entity within a stable ecosystem. The overall complexity when structured by place and time opens the door to other levels of complexity; network relations among entities, motion of patients in journeys, and importantly outcomes. Conceiving all this as an ecosystem allows the complexity and stratification to be systematically built into a framework that includes a broad enough view to make cost effective decisions possible. The ecosystem as a whole, including perceived relationships of how the health care world effects each entity in the system, and

significantly the balance of public and private interests, benefits from envisioning the entire health care collectively to make description and transparency possible. This collective as a general term for each entity is a good way to start understanding and analyzing change. The levels of the collective establish a hierarchy of entities that vary by scale, visualized as a pyramid of strata showing the hierarchy of individual stakeholders. These stakeholders need a view of their place in the ecosystem within the context of the entire ecosystem framed for each stakeholder one at a time. The importance of stratification of the ecosystem will become clear in the discussion of the Moment below where the difference of extrinsic and intrinsic information will be discussed.

To describe a hierarchy, a topology of health care is a good place to start. To put it simply, a topology includes naming and placing stakeholders as entities in the ecosystem. This strange notion of topology is apparent as a graphic that visualizes a pyramid that contains strata. Visualizing a hierarchy as well each stratum stacked in the pyramid, with each strata representing an entity, the hierarchy may then show their relations. The collections of pyramids thus make new abstractions possible, such as evolution of patients and entities in time, relations in networks, and a more complex and realistic view of Value. To put it simply a topology allows a roadmap for a pathway of information from the largest population directly to the smallest entity, the N of 1. The roadmap assists in finding solutions to infinitely many problems of the ecosystem to unlock potential value. Most importantly, the pathway is not a conduit for unedited and uncurated data, but a systematic application of semantics and technology where each entity is subject to a translation device to make disparate data understandable to extrinsic (to an individual entity) entities.

Why Topology?

Regarding the ecosystem as a monolithic, amorphous arrangement of a vast number of connected or independent entities impairs health care reform. To elicit change towards efficiency, market-based pricing, more coordination, transparency of information, and other objectives of reform, structuring reference for entities geographically in space will give change a start. This is a topology, a spatial framework if you will, in addition to an information framework. A key to adding additional features to topology is to name the moment of the patient in space and time as the fundamental unit, the ultimate in-patient centering within the ecosystem. This centering is really a boundary enclosing the composite of the high dimensionality of the Moment. The hierarchical framework of the ecosystem allows centering not just in the moment, but by networks and populations as well. This flexible aspect of centering creates a basis for information transparency across scales and logical abstractions. Topology is therefore not only geographical for placing entities by scale, but also stratified with information centering as well. More discussion on hierarchical centering will follow in sections to come, where the topology of information allows a high dimensional scope of information.

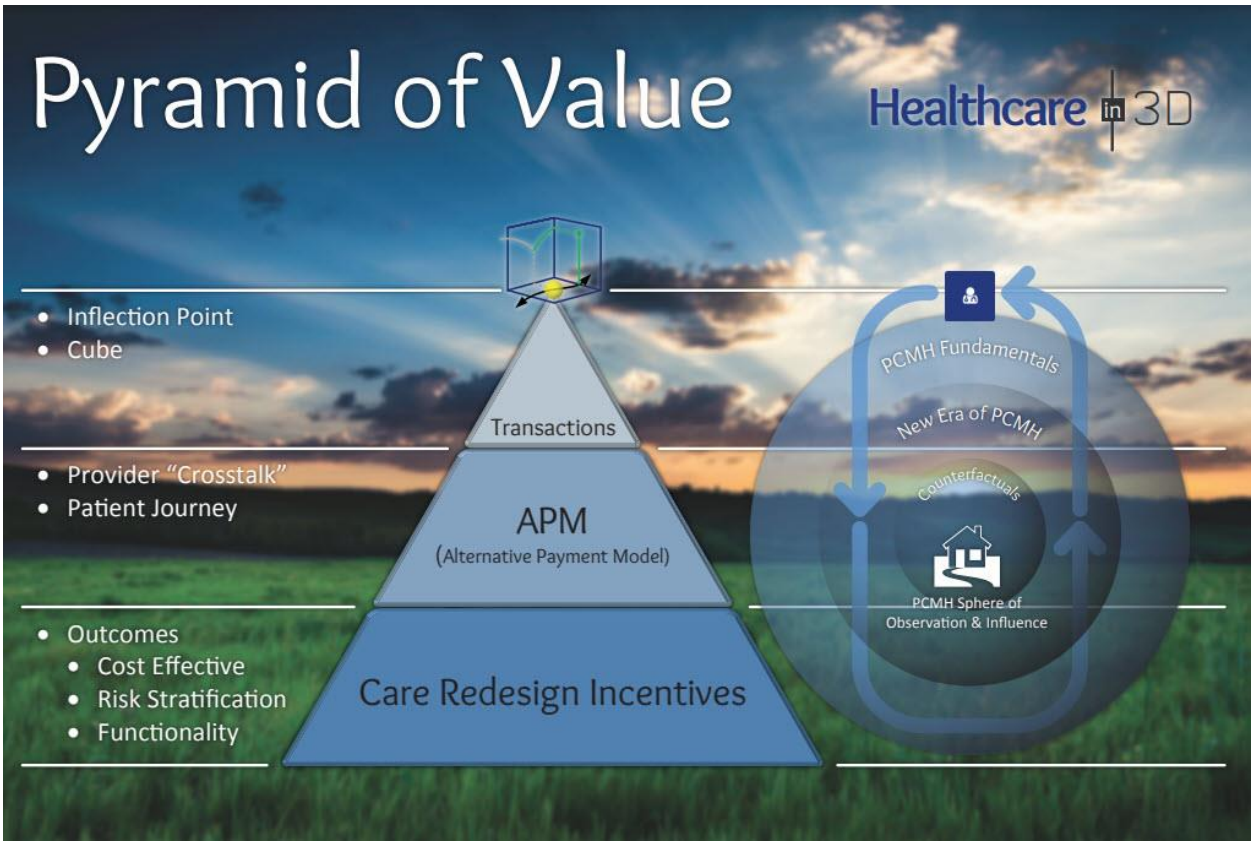
Strata

Strata signifies scale of entities. Strata can be broad, as in network, which includes entities of various scales. Or strata can have a narrow scale as in the moment, where at the same time the moment is

high dimensional. By the topology scheme used here, the largest scale is a population, N of many, which again may have many entities. The dimensionality of entities grouped by scales refers to information, stratified independently of these entities. This will be discussed further in the Brief sections when logic interacts with topology to separate networks of physical entities from information generated by these entities.

Pyramids as Metaphor for Hierarchy of Strata

Strata when arranged hierarchically congregate in a pyramid. The width of the strata shows the number of units of one or more entities in the strata. When the units are more abstract than physical entities, the shape of the strata and thus the pyramid reflect whatever the unit of measurement is. This can be information, such as outcomes, provider relations, value based interventions and others.



Pyramids Represent Information Flow of Hierarchy

The shape and orientation of pyramids will graphically show the connection of different types of information, and will show linkages of these types. For example, geographic entities link to information. Thus, proximity of patients to urban versus rural facilities correlate with provider access and importantly to spheres of influence that are provider based. Information flow originates with the patient in a geographic sense, and flows as directed by provider access and support. Value base

purchasing presumes centering information on providers, and when the metaphor of the pyramid with its strata is used, it is clear value passed purchasing is an oversimplification.

Networks, Real and Virtual

Networks are represented by strata hierarchically between the patient in the moment and the larger scale of the region or population however defined. The networks are real when linked to the fundamental unit of measurement, the patient in the moment. These links create groupings of various kinds, provider based, or insurance based. These links among entities are real in the sense they are concrete and measurable as transactions. They are real when the patient as the unit of measurement coalesces as journeys involving multiple facilities and providers. These are real and transactional, and clearly hierarchical in that insurance plans direct and enable the journeys that involve the patient and the networks.

Networks are virtual when groupings originate from transactions linked by information that is not directly measured. For example, informal referral networks prominently figure in patient journeys and information flow. Other factors such as social determinants of health, psychosocial issues, and patient and or provider preferences determine access, compliance, modulation of risk factors and more. The area of counterfactual status of information has a huge virtual impact on networks. For example, health care pricing would have an effect on utilization and formation of referral networks were it not for health care facility consolidation. These issues create virtual incentives for network formation and ultimately affect the quality cost aim.

The pyramid as a graphical tool elaborating transactional and transcendental real and virtual information will include the prominent impact of counterfactual and causal virtual information.

Why Logic

In the journey to Value, with topology as a first step, Logic is the key to bridging the gap between population standards and information and the N of 1 moment. These include value in a general sense understood more broadly than value defined as a specific accountable metric. Combining the high dimensionality of the ecosystem of large and small entities with their different scales creates this general sense of value. High dimensionality of the N of 1 patient centered stratum is averaged out in higher scale localities and populations, leading to reduction of information. Logical relations guiding actions are the key to value at the inflection point, or the decision of the moment. These Inflection points are composites of many sources of information centered on moving from the past in predictive modelling to the future in prospective modelling. This high dimensional composite information is not necessarily limited to known facts, and can have an inductive logical form of facts arising from possible future actions not yet realized. Possible future actions that account for decisions in the moment are prospective as well as predictive . The logical relations make it possible to return to not just the effects or outcomes of actions, but to why certain outcome occurred from the range of possible outcomes of actions in the uncertain ecosystem of medical decisions. The range of potential actions may include patient, provider, local or ecosystem features that include

more than what may be known from the past. As a practical matter, logic guides scenario planning with the expectation that reinforcement learning will guide the trajectory of patient journeys to optimal outcomes. These optimal outcomes more often than not have not occurred before. Scenario planning therefore will include logical prospective features. These features may exist somewhere in the ecosystem, or nowhere before, but there can be an expectation for a new direction.

Deduction

Of the 3 basic categories of Logic, deduction, induction, and analogy, deduction reflects known information used for predictive modelling and decision support. All health care entities have structured information systems. For deductive analytics, the past is the only way to predict the future, causing potential bias (or a limited range), whether in statistics or machine learning. Accountable programs are deductive, drawing information from the ecosystem in a biased way that reflects the goals of the entity. Population entities communicate benchmarks with other entities of any scale using different semantics. Deductive logic is narrower than inductive logic. The topology of entities provides a framework for how semantics differ. Avoiding bias requires scalability among entities, and a topology gives the framework to move from a narrow logic to a broader one.

Induction

Induction is the logical frame for counterfactuals and causal paths. Transfacts mentioned above are the facts in the future created by imaginative inductive reasoning. Counterfactuals rise to awareness from the perspective of the ecosystem as a whole, where information exists as ranges as choices and actions, some selected, some not. These choices must be copied and communicated with interoperability by information media. The complexity of the collective of all entities within the ecosystem creates information that is not within the bounds of any particular entity, but this does not prevent counterfactuals as abstractions from affecting choices and actions. From the standpoint of using Logic to classify information, the single entity bounded information is intrinsic, and the multiple other entities beyond the bounds of the single entity collectively are extrinsic to the single entity. This information beyond this boundary will most likely be unstructured, but not always. It is possible to bridge the boundary making the unknown known, as long as interoperability exists among the entities. From known information, structure emerges from the unstructured by the logical process of induction. The ecosystem of today often prevents transparency for proprietary and competitive business reasons, a property of entities that are large and financial or both. The moment in its complexity must deal with information that usually exists in logical forms that do not fit in information systems of use in large and small entities. Inductive information that applies to wise clinical actions is often not in a medical format, meaning a claims database or an electronic medical record. For example, psychosocial and social determinants of health have great relevance in the moment of clinical decisions. The wisdom and scope of the clinician allows these unstructured information elements to inform decisions. However, making unstructured information accessible requires curation and transparency across scales. This is part of the role of Topology, which names entities and clarifies boundaries, which are targets of transparency, and focusses curation to bring

structured and/or unstructured into the view of entities. Being able to use unstructured information and analyze its effect on outcomes will come from being aware of the logical difference between deductive facts, and the inductive transfacts which are elements that have the potential to become facts and thus accessible to information systems creating a seamless transparent whole. Clinical decisions on this transparent platform guided by a logical format move to the value dimension.

Inductive reasoning allows a firm foundation for information that does not qualify as facts, or for that matter emergent fact such as transfacts.

Induction

Inductive reasoning opens the door to a business problem identified by a misquote of the business guru W. Edwards Deming. The incorrect quote is "If you cannot measure it, you cannot manage it". This loss in translation most probably originates from comfort in the familiarity from the certainties of deductive reasoning. The correct quote is "It is wrong to suppose that if you cannot measure it you cannot manage it – a costly myth". The hallmark of inductive reasoning is uncertainty, and in the management case, this comes from decisions that depend on intuition, imperfect information, insight into complexities of personal styles and strengths. None of these factors fit easily into a database much less a logical system. The grist for inductive logic is this uncertainty, and the impact this has on forecasting the future. The scheme of HCn3D builds and organizes abstract concepts designed to place inductive reasoning in the realm of awareness for ecosystem entities and information flows. These concepts build a framework from topology and logic that includes uncertain factors that affect the road to value. Value depends on choices at a fundamental level of the patient, and it is here that inductive reasoning captures the complexities inherent in the unique patient.

The road to value benefits from counterfactuals, a type of possible data known only with inductive reasoning. This allows the rise to awareness from the perspective of the ecosystem as a whole transfacts, which are potential real things that are options for wise decisions on path to value. These transfacts support ranges as choices and actions for many entities. With numerous networked information flows within the ecosystem at any scale, the scope of possibilities for transformation enlarges the real space for value, particularly when potential inductive data affects value.

Analogy

Clinical activities abound in storytelling as a way to set the stage for explanation. Not only patient centered activities, but also all entities in some way tell stories about the entity fits in the ecosystem. Analogy is about storytelling as a way to link the uncertainty of a single patient to a cohort of similar patients. Just as with deductive and inductive reasoning stories can be framed as scenarios that draw from patient and provider experience, information from networks and populations, evidence based medicine and anything else in the ecosystem. Scenarios at the most basic level attempt to reduce the degree of uncertainty inherent in any scenario using similarities discovered with the template

provided by topology and logic. Analogies are the best way to link patient and provider centered data to Value.

Reminded of the uniqueness of the patient centered moment, with its complexity and high dimensionality, it is clear this information cannot be structured in accordance with the standards of evidence-based medicine. Clinical decisions cannot be exact given the ubiquity of variables in the moment, nor even relevant to some value objectives. For example, cost efficiency standards cannot be limited to deductive reasoning that base best practices. Clinical decisions when framed by the high dimensionality of the moment are better decisions if the full scope of relevant dimensionality is in play. This full scope entails the full range of logic which will offer more complete solutions for value. For scenario planning the ultimate goal of a local entity frames optimization for cost effectiveness in the context the impact of a larger ecosystem on the local entity. For many outcomes the sources and causes of outcomes from anywhere in the unstructured and structured space of the journeys as they progress through the ecosystem's provider networks benefits from analogy being an important of the analytical toolkit. Design of reinforcement learning programs can include assessment of decisions in the moment. Analyzing the chain of these decisions will force provider collaboration and patient coordination. Collaboration can become a deductive metric after it evolves through a high-level process based on transparency, inductive where the uniqueness of the patient is shared knowledge, and analogy where the stories providers tell each other about the patient impact the outcome.

Determines Flow of Information

Perceiving counterfactuals in the healthcare ecosystem requires interoperability. When information exists not as simply facts but as options, this leads to choices that must be communicated to quality as counterfactuals. For the details of health care operations with impacts on outcomes to change, information must flow freely.

Why Stratification?

Topology Includes Pyramids and Strata

As stated above, topology gives a graphic representation of entities. The ecosystem unwieldy in its full scope narrows using explanatory graphics that represent entities of the ecosystem and their relation to each other. These relations are hierarchical, meaning as the scale of an entity changes, becoming either larger or smaller, these relations show as strata ordered in a pyramidal format. Because a pyramid containing the strata has an apex and a base, the width connoting the scale of strata, the orientation of the pyramid has additional information. This orientation, base and apex up or down, for example may convey direction of information flow. The usefulness of information flow represented graphically conveys the dynamic relation among entities in a hierarchical format.

The explanation of topology is arcane, but its usefulness will be apparent with HC3nD framework of dimensionality in scenario planning.

Framing the ecosystem as structures, whether it be insurance plans, pharmaceutical companies, provider networks, standards and so forth, makes the ecosystem a basic level of information. When scaled down to a local place in the ecosystem structure, process and outcomes becomes small and manageable. Moreover, scaling down to the smallest unit, the moment, allows the fundamental property of counterfactuals, flip and copy (selection of choices, and interoperability) to drive information flow. The ecosystem as a whole is a set of small entities. The importance of defining the unit of measurement out of many possible units of the large or local ecosystem will become clear when guiding scenario planning. Stating scenarios therefore is a starting point for managing information, and visualizing the local ecosystem graphically can begin the work of value creation amidst an ecosystem hierarchically arranged.

Of course, raw information is tricky and demands curation to limit the information. For potentially vast amounts of information from the ecosystem with some entities such as populations represented by insurance plans, and others scaled down to provider networks information remains prodigious. For potentially vast amounts of information, executing queries on behalf of scenarios highlights the relevance of information for the scenario at hand.

The process of using logic will naturally scale information to the ecosystem entity working with the data. The scale of an entity is linked to the scale of other entities, and when stratified by scale, the links across scales is what information flow follows. This is an essential prerequisite of value and is the basis of transparency that supports value.

Importantly the ability to specify the future as different from the past requires inductive Logic, not simply deductive, transactional logic. Logic as an essential tool permits execution of queries that are not limited to concrete information, but can handle what the future may hold.

Stratification of a pyramidal structure creates a hierarchy that is context for entities. In other words, as entities have relationships and links to other entities, information is assembled and transmitted among entities manipulated as the various scales of entities use this information. The place in the hierarchy of information is itself a data point participating in the flow. For example, a patient journey is complex within provider networks. The moments of the journey reflect the basis of a dynamic network of a changing set of providers placed in the flow. The flow reflects the information of the patient summarized in the provider networks, scaled up to the population level. At no point in the flow is information lost, but aggregated and summarized to meet the needs of entities in a hierarchical way. The metaphor of the pyramid holding the strata, which is the basic component of information of a larger scale than the entities, networks and even value, and can be considered the place for information to show facts, transfacts, flow and hierarchy. This use of the strata abstractions is a data reduction step that assembles diverse types of entities such as insurance plans or provider networks that resemble each other by information scale but not function. Another abstraction is the shape of the pyramid. The point at the apex of the pyramid at its narrowest denote priority of information flow from the smallest entity, such as the patient, to the largest entity such as the insurance plan. An inverted pyramid denotes information flow from the larger insurance plan to the smallest, the provider.

Using these abstractions of pyramids, strata, hierarchy, shape of pyramids, and information flow has a profound impact on allowing robust scenario statements. For example, real world health care reform uses terms such as accountability, coordination, collaboration, post-acute care, chronic to acute care, value, bias, evidence-based medicine; all these are in themselves scenario statements that beg execution logically.

Why Dimensions?

Contain Categories

The starting point for defining the dimensionality of the ecosystem is the 3 Dimensions of HCn3D. The first is patient centered, the second is the network as an abstraction, and the third is Value. Placing dimensions that are more granular in one or more of these 3 Dimensions achieves the first step in managing the broad scope of ecosystem information.

Dimensions describe general entity categories that differ by scale. What does this mean? Because the health care ecosystem is stratified and complex, a well-designed, formal approach is needed to understand entities and their contexts. As discussed above, the value of Health Care in 3 Dimensions© is to facilitate analysis of structure, process and outcomes at the entity level. This reflects current practice of using internal information of entities for predictive modelling and forecasting. In reality each entity exists in an ecosystem with a wide scope of entities impacting success of each ecosystem member. HCn3D facilitates optimization from information internal to organizations and well as information external lying within the ecosystem. Although organizations are adept at casting out a wide net for external information, this poses the risk of ignoring or not knowing a vast array of important business critical knowledge.

Patient Centered Dimension

A Moment as a collection of information with its intrinsic and extrinsic components fixed at one place in time is the most familiar dimension. All transactions in the ecosystem start with the patient and from there are produced for the other 2nd Dimension. Products of the patient encounter can be for the patient, other encounters in the patient centered journey, other providers, networks of providers in the second Dimension, and for accountability in the third Value Dimension. The uniqueness and in some ways the strangeness of this Dimension is its N of 1 scale.

Network Dimension | Bridge to Value

The ecosystem and entities of the ecosystem acquire specificity when named as a part or structure of a network. Networks are ubiquitous everywhere in the ecosystem. From self-organized provider groups, groups established by insurance plans, vertically integrated hospital-based networks, and loosely affiliated groups such as PPOs, all have characteristics described in network theory as nodes and links. The network character of entities exists with a focus at the mesoscale between patient

level and value determined from patient centered metrics at the population scale. This focus organizes metadata, that is data descriptive of fundamental patient centered data collected in the network, and this mesoscale is described and quantified in HCn3D as the 2nd Dimension.

To be fully described to follow, Value in the 3rd Dimension depends on how fundamental data at the patient level is linked to data from the Network, whatever the Network is. The 2nd Dimension has a virtually infinite number of Networks from a global ecosystem perspective, but from a patient centered vantage point in the 1st Dimension, networks are limited by information such as geography, regional features such as provider to provider influence, type of provider control, range and scope of accountability metrics in the population. The list of network features is limitless. The purported objective of any network is to serve the patient. Doing this makes the existence and functionality of the network patient centered, which is to say the metrics descriptive of the patient encounter are fundamental. All Dimensions and categories of information will stand as a derivative of the fundamental patient metric, the encounter. From an information standpoint, the network is the bridge between the 1st Dimension, patient centered, and the 3rd Dimension, Value. As a bridge of information, the network construct in the 2nd Dimension can be quite fluid. There is no limitation by scale of the entity in the ecosystem, transparency or lack thereof. Importantly networks can be virtual, created by organizing information differently. As will be discussed below, virtual network identification can be the most useful feature of HCn3D, which will allow an intermediate step of metadata in the link between patient centered information and population level Value. Thus, it is clear networks when created virtually are obviously fluid, and can be effective in creating context for patient centered encounters.

Networks are the destination for medical evidence. From the discussion of Logic, high quality evidence, established with randomized controlled trials, depends on creation of the appropriate base population as a comparator of treatment effects, and clinical characteristics for risk assessment and outcomes. The Logic of the population derived from the network of similar patient features, is deductive. This is to say known information that supports medical evidence, created from prior information, can support decisions and actions in the moment of the patient encounter. This encounter however may result in actions not covered by high quality medical evidence, but from information that arises from common patient processes in clinical scenarios. The virtual network with information of the mesoscale can include patient centered population level information that holds and presents information from any source, evidence based or not. Clinicians commonly but unknowingly use inductive Logic. Clinicians assemble many facets of information in an encounter, psychosocial, social determinants of health, in addition to medical when combined, shape decisions. Context of the N of 1 encounter because information is deductive for data that exists, and inductive which is data that could exist, spans a broader logical context. The value of capturing this granularity as information sharable with the network is enormous. The known ecosystem can become plastic, and amenable to change in the future. This is the essential objective of value-based care.

Population Dimension of Value

Value is the mantra for health care reform. Programs that facilitate production of value rely on payment reform to promote clinical care reform. Payment follows cost and quality by comparison of accountable care organizations to each other for global costs for attributed groups. Accountability for BPCI programs for specific procedures or disease groups, results from comparators of providers based on the index procedures. Thus, Value through accountability is therefore a relative measure with providers, groups and accountable organizations compared to each other rather than an absolute standard of value. The comparators can be population based as Medicare does for ACOs, and the debate about assigning comparators to regions rather than the entire Medicare population exists as population level policy. Issues about Value center on who measures and how it is measured. This reduces to policy, which fashions populations and groups within populations to create comparators.

As a Dimension, Value can be more than policy. With populations, there are many ways to describe what Value is. Policy takes the scope of very large numbers for creation of policy as Medicare will do, and private plans essentially model government policy in their Value-based programs. To execute policy, with care redesign an objective, large numbers allow metrics to apply across the board of a large population scale. This essentially applies a financial, transactional measure to the provider ecosystem. The policy of payment reform is dependent on creating interventions that make sense for a population, but populations have more complexity than transactional measures will show. For payment reform to have successful interventions in lowering health care costs in the population, policy can be adapted to smaller scales in ways that are more effective than transactional compliance tools. There is much debate on how accountability policies fall short in making a significant impact on provider behavior. At the same time, the targets of compliance, the provider ecosystem at many scales, wonder how to provide Value, if only they knew what to do. Clearly, something is missing in what providers see as compliance measures that leave out information that is important for what providers see as Value. For example, the complete picture of a patient includes life stories, family support, social determinants of health, psychosocial factors, all of which have non-measurable variables. These are often relevant for Value in that cost and quality can be affected by these variables.

The proper unit of measurement to create the value may originate from any scale. Value measures may come from all 3 Dimensions, not just the 3rd large population scale which is translated to the 1st Dimension as compliance. Compliance with value measures at the point of care, N of 1, is actually 3rd Dimension forcing of action or decision. What would be the proper unit of measurement? First, it must originate in the 1st Dimension. These actions and decisions are transmitted not as statistics, but as influence by behavior. More on influence and what it means in the section on reinforcement learning.

For example, value created by collaboration is a function of virtual provider networks. Applying Dimensions to Value allows the many scales of the ecosystem to promote executing policy at all scales, to support the flow of information from the largest to the smallest. For example, Medicare policy designed from millions of beneficiaries flows through the Dimensions of Networks, categories

within networks, to patient level information such as journeys and encounters. How does this differ from simply expecting policy to promote compliance measures and accountability? To answer this question from the smallest scale up to the largest population, consider how ACOs are currently designed to participate in the flow of information. First, a case can be made that the patient level is the most complex. Information originating from the highest dimensionality (small d) is unique as N of 1 and supports clinical decisions that reflect this dimensionality. In the ACO environment, the unit of measurement for accountability is a benchmark derived from a larger population than the attributed population. However, benchmarks as sets of transactional retrospective measures use far less dimensionality than the clinician uses for patient care. This is to say metrics are of a lower dimension than N of 1 and do not reflect the uniqueness of the patient in the moment. For the objective of care redesign as policy, this level of dimensionality transmitted from the patient through the networks to Value as a population objective is needed to inform policy. To recognize the importance of the clinician managing the complexity of patient care for care redesign, the flow of information from the patient level to the network level then to the population Value level needs a formal process of information transition and reduction, which will be described below.

Why Categories?

Using topology and logic for understanding a process, which consists of information of high-level abstractions as well as low level granular data opens the door to a novel way of finding Value in the broad ecosystem. For a process, organizing time supports making topological, logical and categorical information of the 3 Dimensions dynamic. Within each dimension multiple categories of entities in the ecosystem exist that have a hierarchical relation to each other. Reality is stratified, and no entity of the health care ecosystem, exists or succeeds apart from relations to other entities. These entities are similar or different in scale and for purposes of value measurement and influence as is done with value-based purchasing, attention to these differences can make the difference.

This scheme of graphically showing many features as categories including place in the ecosystem, logic of relations of ecosystems, with scale of entities within strata, and time give a method to structure undifferentiated information for a novel way to show value.

Certainty | Prediction by Statistics

Certainty is deductive, ambiguous albeit well-reasoned inductive facts or transfacts are not captured by the scope of known facts. Therefore, prediction deductively is incomplete.

Uncertainty | Logic Potential

Uncertainty in outcomes or proper selection of cost-effective actions always exists when counterfactuals play a role in decisions. These counterfactuals, or what is possible on the path to cost control, are a key to changing what exists as normal to a new regime of care redesign when considering counterfactuals.

Transitions | Journey of N of 1 to Many for Analysis of Value

From a counterfactual standpoint guiding information flow scaling up to a larger N though with a lower dimension (small d), transmits not only actions as facts, but potential actions not chosen. In the Brief section showing the comparison of aggregation of flip yes for actions, to flip no for the same action will become apparent at the network scale.

From a deductive transactional standpoint, scaling the N of 1 moment to the Dimension of Networks is an aggregation step. Aggregation of information at this step supports predictive modelling, benchmarks and other quantitative tools that characterize retrospective analysis. Extending the past to the future comes from inductive logic that adds other possibilities to transactional analysis. These possibilities are counterfactuals. What is possible applies at the N of 1 as well as the N of many at the network scale. Carrying the high dimensions of the moment where the holistic approach exists at the patient level, to the higher scale of the network adds the much larger universe of counterfactuals to the usual past oriented information.

The transition to a higher scale, or strata in the topology scheme used here, with the logic of inductive reasoning, allows the transition to face the future not just the past.

Reductions | Link Operations to Analysis of Value

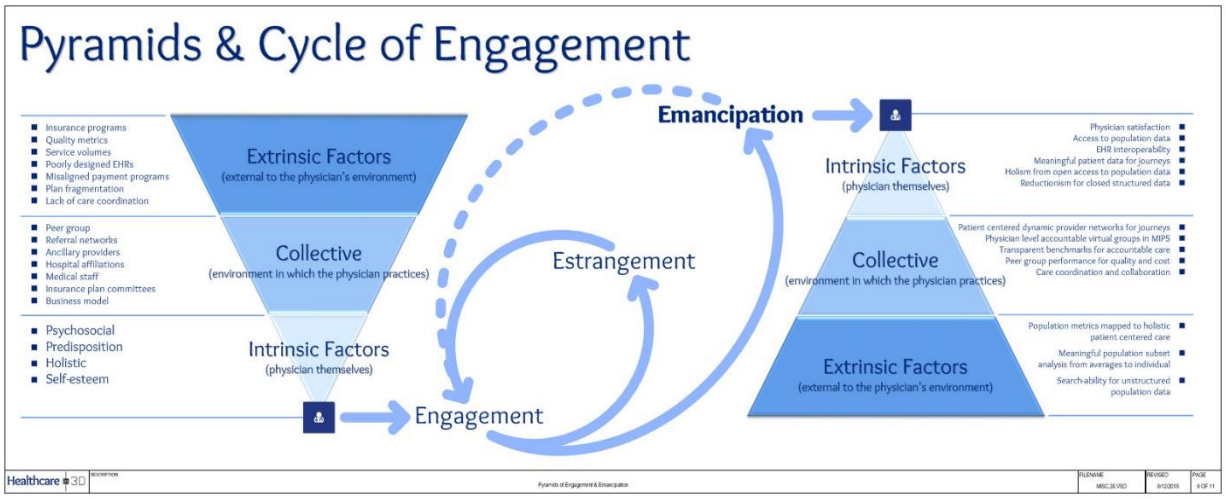
From the large N of network scale, to the larger population scale, these large numbers create metrics for compliance. The action of compliance falls on the moment of individual provider decisions and actions. Compliance is a reductive step from the point of view of the entity creating the metrics. The moment in the maze of many compliance metrics originating from many organizations, and best practice originating from another set of organizations, adds up to a burdensome job in the moment to sort through all this. The moment itself has an opportunity to be counterfactual dealing with abstractions freed of details of operations. Selection of options points the way to specific, simpler targeted operations communicated to the complex networks at large. The Brief on network complexity will show how a business process to control costs can change to one where the burdensome preapproval process becomes irrelevant. If tests and procedures when treated as possible counterfactuals that exist at a network level become reduced to possibilities at the patient level one can move from an unproductive compliance tool, to one where clinical decisions benefit from the interplay of inductive to deductive reasoning. Promulgating these decisions to the network as a whole then becomes a tool for care redesign.

How this communication occurs is a topic for another discussion, but highlights as essential feature of counterfactuals, which is communication of possibilities before actions are taken.

What is complexity?

For the ecosystem of health care with all the entities, relationships of entities, links between pyramids and counter pyramids with strata and categories in each pyramid, evolution by time, scale of entities, there is a clear massive high dimensional world collectively termed an ecosystem. The

ecosystem term implies this scale, and furthermore means the scope of this ecosystem available as knowns to individual entities is small compared to the breadth of this world. Even though each entity would perceive a complex world when relevant to their operations, the unknown world is in fact much larger and unimaginably high dimensional. It is the task of HCn3D to describe and model the complexity before adding data to the mix. These models are on tap to assist in designing scenarios. The Network second dimension scale described below is the place for the complexity to order categories shaped into network formats that show relations, or links, among entities of the network.



Moment in the Maze, Reduced for Mesoscale or Expanded for Ecosystem

The cycle of engagement is a good illustration of how an entity, in this case a patient centered moment, fits in the complex ecosystem. As explained in prior section, the ecosystem at a high level is broken down into one more pyramids with strata. This topology has an orientation, up or down, that reflects logic whereby the entities contained in the hierarchically arranged strata reflect deductive, transactional information, or inductive information. For the perspective of the moment, the complexity, scale and scope of the maze reduces to a local scale or expands when the maze accounts for the ecosystem.

Holistic vs. Reductive Process | as Characterization of Moment

For the agent or provider in the moment, actions and decisions develop from reading information extrinsic to the moment linked to intrinsic information that determines actions. The scope of actions can be narrow when the extrinsic information is highly reduced or broad when the moment is holistic. The potential options in the moment therefore are fluid and context dependent. The cycle of engagement varies as well, with estrangement or engagement potential contrasting results following the impact of a reduced or holistically oriented maze on the moment.

Predictive vs. Potential Outcomes | as Characterization of Value

Simply put, reductions allow statistical predictions; the holistic scope in the moment allows potential outcomes of the future, which transcend past information as the basis of predictions. A direct bearing on provider engagement follows recognition of the holistic approach by arbiters of value based purchasing.

Linkages Within and Among Hierarchical Dimensions

As is clear in many contexts, the moment of the provider or agent's actions are not isolated actions. Functioning in the ecosystem, many entities influence the behavior in the moment. Arranging these entities hierarchically centered on a single agent of the moment, shows linkages stratified by the local topology of the ecosystem. For example, providers have groups, are members of networks, communicate with plans, and respond to quality metrics promulgated from the population level. Engagement means linking providers to other agents in the network or ecosystem. Applying a metric from a population to a provider, attempts to create the objective of engagement. Often the unintended consequence is estrangement. The cycle of engagement graphically shows the double edge sword that is a hazard of metrics that are reduced and do not account for individual variation which is always a feature of a holistic moment. The point here is that using a hierarchical framework of the local ecosystem lends status and attention to the complexity of the moment. This will tip the scales from estrangement to engagement, particularly when the hierarchy transcends transactional information alone.

Why Scenarios?

The inherent complexity of the ecosystem poses an overwhelming problem for any entity optimizing its potential for success. A scenario is a blueprint for achieving a desired objective. The scenario takes account of the external factors in the ecosystem that impacts the entities success.

Scenario planning began as an economic forecasting method for corporations to predict future commodity prices. Many realized that looking to the past to predict the future was limited by failing to include rare, unanticipated events such as wars and natural calamities. Shell Oil Company developed these methods and its popularity waxed and waned over the decades. Only recently has this method entered medicine, (ref. NEJM, 2017), but only as a method to group known medical outcomes to show which are relevant and important to patients. Patients expect an outcome even if unlikely statistically because certain outcomes are preferable. It is the job of the wise clinician to guide a hopeful patient to a reasonable expectation.

The language of healthcare has become quantitative which is at odds with the expectation that the unusual is always a possibility. For the scale of populations, patient specificity is averaged out and the unusual is averaged out as well. This forces decisions to rely heavily on information from the past even though this information purports to predict the future. From the perspective of the global ecosystem, potential decisions are infinitely many because the entities of the ecosystem are vast. The

ability of an individual entity to thrive in a vast ecosystem depends on the wisdom of the entity. Why wisdom? Why not quantitative skills alone? The latter works for organizations and large populations. The former, wisdom, is essential at the patient level. It can be imagined that organizations from small to large practice forecasting, using resources and skills of vastly different scope. One would think that the ability to forecast rises with the scale of the organization and the market power in the ecosystem. Forecasting falls short for the N of 1, the patient, who will unpredictably consider options quite varied and idiosyncratic and not predicted with quantitative methods. Witness individual choice for covid vaccination.

Scenario planning is well suited for the interplay of the predictable and the idiosyncratic, for the large and small scale that collectively comprise the ecosystem, and most importantly for planning the effect of factors external to the organization for optimizing outcomes.

Some examples of optimizing forecasting by diverse entities in the ecosystem will help here. First, optimization means a result of population level outcomes. This includes cost saving for health plans, access for disadvantaged populations, and disparities in disease prevalence and other factors such as value-based purchasing. Within the ecosystem optimization at scales smaller than populations, means success of individual provider organizations in terms of profitability, market share, technology and control of physician providers. Further down the scale, to physician groups, provider networks, optimization means practice base, profitability, care coordination and collaboration, and compliance with accountable programs. The problem here is that the ecosystem becomes a random collection of uncoordinated parts hopelessly massive beyond the comprehension of individual entities in the ecosystem. This quick screen does not even include the pharmaceutical industry.

Second, no entity is an island, they cannot optimize on their own. Consider the effect of one group of entities optimizing to the detriment of another entity. This is true of maximizing profitability of integrated provider networks causing insurance premiums to rise with costs passed on to consumers. The force today effecting health care costs is monopolistic practices of hospital networks which prevents optimization for the public good at the population level.

Third, optimization as a hierarchical concept can place priorities on the collection of entities.

Framing scenarios as an expression of a plan for optimization, requires information about the organization, about the external relations to entities large and small in the ecosystem, and objectives of the organization. Value-based purchasing framed at the population level for success, will benefit from an aligned value program involving all entities important for success of the program.

In the Brief section, examples of aligning value across entities will be developed. To look ahead to the Brief on 3rd Dimension transactions at the population level, raises the issue of how Medicare Advantage programs cause harm to cost reduction efforts by incentivizing upcoding. This is an example of not having aligned incentives.

Establish Sources of Information

From transactional standpoint sources of information, exist as information platforms of entities, and for multiple entities, technical interoperability extends the scope of these sources. This

interoperability is emerging from information exchanges. From a transcendental standpoint, interoperability includes potential options coming from information defined as counterfactuals and causal paths originating in the broader ecosystem. (Judea Pearl, Causality, 2012). The power of using these different meanings of information allows prospective guidance towards the future, which is more robust and realistic than retrospective predictive modelling using information only from the past.

Relevance of Topology and Logic

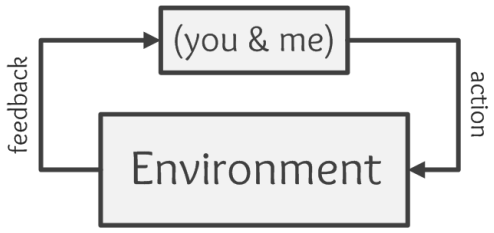
Using time and place in Topology, and relations among abstractions of Logic sets up the platform for information flow. Information created at new levels adds to understanding day-to-day transactions and operations of entities in the ecosystem.

Targets of information to Achieve Objectives

Integrated providers, networks, health plans, and the public interest for cost containment are context for entities directly linked to transformation in health care. These responsible entities tend to be small scale, the individual providers indexed by NPI numbers. The context framed as a maze described above, or direct influencers such as employers in integrated provider networks. Clearly, context is vast, and too often contextual variables serve as objectives of change. However, the targets that can affect change are limited. For value objectives to be realized, it is critical to find causal entities, in this case providers that have the potential to do the job. Reduction of information guided by scenario planning aims to find the best agents of transformation.

Reinforcement Learning to Achieve Scenario Objectives

Links of the above to flow information to the targets to monitor and influence practices on the path to cost effective behaviors. This will be described more fully below in the section on Reinforcement Learning



Why Production of Information?

Production for entities must be in terms that are relevant for each entity, namely transactions. For this relevance to transcend individual entities, the information must be abstract to include counterfactuals and causal paths. Targets of production as above achieve more useful information when expanded from the transactional to the inductive transcendental.

Brief As a Pragmatic Use of HCn3D Centered On Organizations

HCn3D guides information for pragmatic use. Entities need to know what to do in their terms. The Briefs classified by a combination of Topology and Logic, use this classification to place each entity in their own intrinsic world within the context of the ecosystem. Pragmatically, actions and choices account for context, though for purposes of influencing actions and behaviors, context contains counterfactuals, in other words paths not taken to avoid less cost-effective options. This can only be known from context of actions, choices, options that exist as extrinsic information of the ecosystem at large.

Brief | Moment, Mesoscale (Network), and Population

Pragmatic use of topology and logic applied to an ecosystem at large, reduced to the locality of the network scale.

Objective

Public good for HCn3D in full mode for cost effective optimization, to rise above suboptimization for single entities.

The objective of production of information is to allow inclusion of all relevant information originating in the ecosystem clarified by topology and logic, reduced in the path to value for the goal of interoperability. Decision support in the scheme of HCn3D includes counterfactuals that become meaningful with the interoperable flow of information. In the sense used here interoperability means much more than technical access of data across entities in the ecosystem.

Sources of information

Once categorized by topology and logic, using the place metaphors of pyramids and strata with the overlay of logic, frames sources of information dynamically as a flow.

Brief at All Scales and Dimensions

The information flow originates from entities, categorized by topology and logic, and when treated dynamically, interoperability makes the information usable by entities. The convention of Briefs enumerates the practical information specific for entities, and most importantly because of interoperability, these entities can function cooperatively as collaborative networks

Transactional and Transcendental as Logic

Logic frames the categories of the ecosystem. The transactional exists as structured information, and the transcendental as unstructured, though this difference does not always hold. Not necessarily evident in operations of the entities, the categories of logic can be extremely important in assigning value to decision support functions retrospectively, which will set the stage for reinforcement learning prospectively.

Scenario Planning

Scenarios support day-to-day operations of any entity at any scale within a framework. The first step in planning is to clearly state the objective of the plan, usually a value based transformation. Next identifying the entities affected by the execution of the plan builds a network and their important links based on a topology. The network links narrow the scope of the ecosystem in which the entity operates. For the full power of the information centered on the entities' objectives, how it originates, where the destination is, and how this information flow results in transformation of the entity by influencing operations. Actuating the scenario plan with a reinforcement plan completes the initial planning process.

Scenario Plan

HCn3D provides the details to lay down an actionable plan on behalf of an entity.

Contain the Entities of the Ecosystem with Hierarchies and Dimensions

As discussed above the generic topology including the hierarchical relation for each level of the ecosystem, frames the scales of other entities. This is the function of the scenario plan, which is local in terms of the topology, which includes the 3 levels of logic.

For example, a scenario for the N of 1, the single patient/physician moment has the potential as a holistic moment. Here the high dimensionality of the moment centers the relationship of the moment to all other scales. The scenario plan can express future looking outcomes because of the uniqueness of the patient centered moment. Possibilities for care redesign places the moment as the target of reinforcement. In line with the discussion of logic, particularly induction, counterfactuals and causal paths exist only at this level of the moment. Transparency brings the scope of logic to the full hierarchical relation of entities at any scale. This is the essence of interoperability, with the transparency among all relevant entities in a hierarchical relationship allowing the full power of counterfactual inclusion for purposes of value.

Likewise centering on networks in a hierarchical relationship of the local ecosystem provides information to the moment about summed provider performance, clinical outcomes, and public and private plan requirements. For the reverse flow of information from the moment to the network, a form of data reduction average many complex features of the moment distills into general metrics. These summations are meaningful, and support current value based programs such as ACOs, BPCI, and episodes of care. These are the basis of shared savings. For moments that capture counterfactuals, and transmit these throughout the network, prospective analytics become possible.

Specify Visualization

In the spirit of geometric visualization of Value we have a powerful way of reducing information that contributes to Value. An excellent visualization of the high dimensionality of the moment and the large scale of the population follows in the Scenario Planning section below.

Staging Ecosystem Complexities for Analytics

From the point of view of any entity, whether high dimensional with many categories of information, and large N, or both high dimensional and large scale, the ecosystem is vast. To deploy analytics to fit the needs of an individual entity, reduction of complexity curates information tailored to the entity. This raises the question of how the vast scale of the ecosystem presents itself to the entity. In fact the entity determines what slice of the ecosystem is relevant. As operations of the entity rely on information for standardized processes and capabilities, technical interoperability determine what information is available, or even known to the entity. Analytics provide tools to improve operations, define relations of stakeholder, and even forecast growth. With these analytic tools, surprises usually occur, predictions are not met, and the ecosystem, framed as a market, stubbornly proves resistant. It is not surprising that the ecosystem contains complexities unknown. A common response is to bring the ecosystem down to size, and assert market power. This happens with all types of organizations, from provider groups, integrated provider networks and insurance plans. The public good struggles with accountability, at least in terms of cost. The benefit of regarding an ecosystem that transcends market power accrues to populations, not just national, but regional as well.

For value to be effective in health care transformation, its definition must originate with the public good. This means populations as policy makers and beneficiaries of value.

Semantics, Technology, Transparency, Beast

To place populations as the purveyors and beneficiaries of Value, work must follow in many areas. To use novel techniques of counterfactual analytics, a starting point is the complexities of the ecosystem, as it exists.

Topology of Dimensions and Strata

(Text Place Holder)

Brief

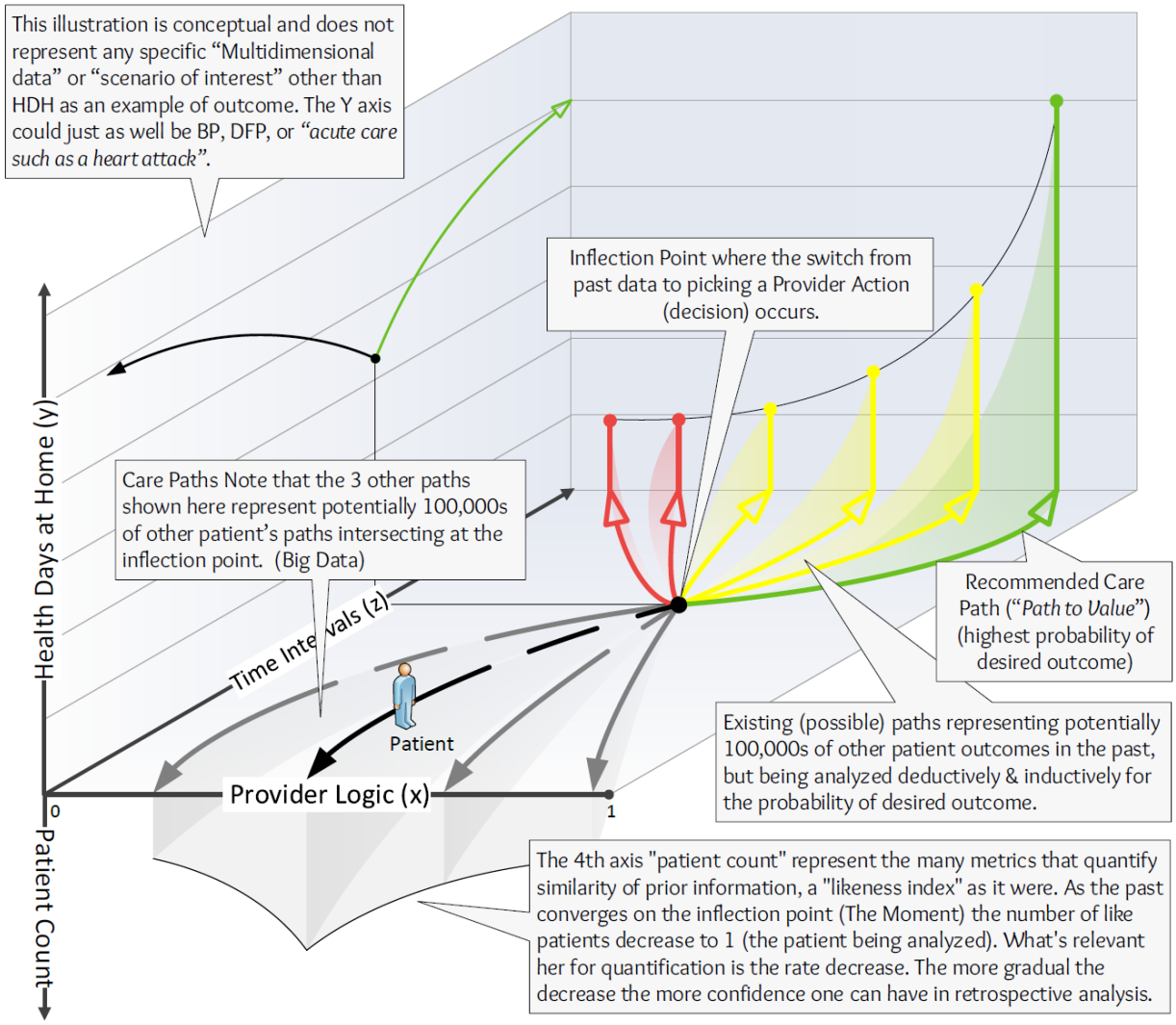
Topology determines the many Brief headings. The Brief sections will take topology to the next level where entities presented as relations to other entities show as networks. These networks center on the particular entity, in other words each entity as part of one or more networks defines the network

for the purposes of a Brief developed at the single entity level. This is the most important scenario planning step where networks show the impact of the Beast as described above.

Why Quantitative Methods?

Clearly, the quantitative methods that do well at the population and network level do not do a good job at the patient level. The production from the higher levels serves to standardize actions at the patient level, but does not address the uniqueness of the single patient.

This graphic encapsulates the single patient in the moment. The large N of populations and the smaller local N of networks drive information to the moment. The small dot in the center highlights a destination at the decision point for informatiion of the patient centered past, the population centered future of counterfactual possibilities as well as expectations from statisical predictions, and



desirable outcomes subject to influence by incentives.

The high-level view of the healthcare ecosystem afforded by HCn3D offers novel methods of data analysis. Topology and Logic frame this analysis. Each pyramid and strata identifying the time of events and the place of entities, naming of facts and the possibilities of counterfactuals by the structure of logic, begins the process by identifying information flow. Within this flow, there is marked variation of scale and dimensionality. The challenge is that quantitative methods familiar and meaningful to some entities of the ecosystem may not be so to all.

Present models of Value, well known as value-based purchasing, use quantitative methods originating from, and selected by entities that represent large populations. For example, CMS promotes accountability via accountable care organizations and BPCI. The program starts with Medicare scale populations, and is implemented through small-scale provider networks, and very limited scale assigned populations. The tool of shared savings penalties and incentives designed to meet requirements such as total financial risk to Medicare makes the program large scale. The quantitative method implements this program through variation of performance measured by provider cost and quality at the local provider level as averages compared to large regions of populations.

Predictive modelling with standard regression, P values, confidence intervals work for large populations. AI finds patterns in huge datasets by training followed by application to similar data from similar populations. Evidence based medicine is most robust at this population scale using randomized trials. Value as a metric originates at this scale.

Narrowing the scale of entities offers other tools. This is the scale of local regions of populations and provider networks. A whole range of tools is appropriate at this scale. For standard programs of accountability, the shared savings programs create data of defined provider groups matched to benchmarks. These quantitative methods do not often show statistical significance although they may. As mentioned above the program originates at a large population scale, where statistical significance works, and is applied to a smaller scale where statistical significance is uncertain. For this scale, network analysis of performance links to programs for example post-acute care and readmission rates. Less frequently used tools such as principal component analysis (PC), K means clustering, weighted network co-expression analysis (WNCA) are useful to recapitulate provider network performance, and risk adjust for patient groups.

Clearly, the quantitative methods that do well at the population and network level do not do a good job at the patient level. The production from the higher levels serves to standardize actions at the patient level, but does not address the uniqueness of the single patient.

At the smallest scale, the single provider and patient, topology and logic opens up use of completely new quantitative methods. As mentioned, many times in this white paper, the smallest scale, the patient, is in fact the highest dimensional. To explain what this means, starting with a view of all scales from population to networks and lastly to the patient, consider information production at each scale. After data acquisition and analysis, production moves information out of the intrinsic, entity-centered realm to the extrinsic realm of other entities. This creates links among entities with influence as a result. Low dimensional information flow comes from large datasets of population because the information is averaged as metrics for compliance. Networks consume population

production as extrinsic information linked to intrinsic information of the network entities. When the flow arrives at the single provider all dimensions of the population and networks impact the N of 1 as extrinsic information. These extrinsic inputs are additive and contribute to the dimensionality of the moment. The moment's dimensionality enlarges with the intrinsic information.

To focus on the dimensionality of the moment when the dimensions of entities of larger scales are included, shows that the many dimensions throughout the ecosystem are also additive. Paradoxically the small dimensions of summary information from large scale, designed as information production, enlarges as well when the detailed non-summary information has relevance at the single patient level. For example, social determinants of health are policy level elements with features highly relevant and numerous at the patient level. As another example, psychosocial descriptors are of great policy importance, which has unique effects at the personal level. From here it is clear that the moment is quite complex and must include the dimensions of all entities.

Methods from fields outside of value-based purchasing can inform approaches to the single patient. These include single cell technologies for genomics, proteomics, and are in line with personalized medicine for cancer therapy and genetic risk. These include methods mentioned above for network level tools.

A very novel approach to drill down to the single patient comes from transcendental logic with induction and analogy framed as counterfactual possibilities. Discussion detailed above, and thrashed out in the Scenario Planning and Reinforcement learning sections of the white paper, clears the way to show how to manage the high dimensions of the patient. The full scope of the physician's task caring for the patient, and managing the metrics for compliance from many sources for each patient goes back to first principles, which are the personal attention to detail of the patient, the intrinsic moment separated though not isolated from the extrinsic network and population. This is the essence of holism, which will rise to awareness in the ecosystem as a whole with counterfactual quantitative method.

Section 2

Brief | As a Prelude to Value

The full scope of the ecosystem is unworkable as a platform for Value. As conceived in HCn3D, Value is high dimensional. Constructing the group of topics as Briefs with this view of Value reflects the universal unit of measurement, the Moment which itself is high dimensional. Linking Value currently used in value-based purchasing, to cost and quality from claims data, gives a limited view that misses the potential to do more if the high dimensional character of health care is not recognized. For an entity, operating in the maze of the ecosystem, reducing the range of the maze by using topology and logic of HCn3D is the tool to do this.

A Brief is a tool that centers the part of the ecosystem on the entity that frames its own scenario.

The Brief begins with finding the unique feature of an entity that defines it, the unit of measurement. For a patient this is the moment; for a network, it is a group of entities; for a population it is the

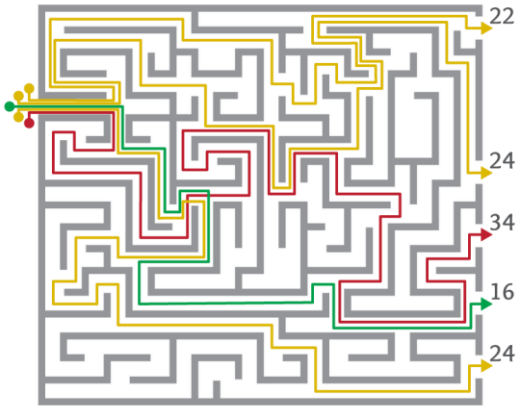
financial risk. Each of these measurable units has its unique scale, and topology and logic positioned by scale, makes this information relatable to other entities of the ecosystem. Transitions and reductions are the mechanisms of information management that enable the links of entities for the purpose of Value.

A Brief will show how a transition changes information as an entity links to another set of entities in the topology. Reflecting this change is the scale of the entity within the scale of the maze in the portion of the ecosystem relevant for the entity. For example, in the first Dimension the moment is large within the maze because the unit of measurement is N of 1, with maze reduced to what is relevant for N of 1. Transitioning to the network, as the moment becomes small within the maze of a larger N of group level entities as the unit of measurement shifts to group level Dimension 2. The maze reflects the scale of the network. Transition to the population scale is tantamount to transition to Value. Because value has a financial dimension as the source of metrics for value-based purchasing, which requires a link back to the moment, there is a clear need for a reduction step. It may seem paradoxical that in a transition to the largest population scale means reducing information. The point here is a transition to value does not mean the scale Is reduced, but the dimensionality is. It cannot be forgotten that the lowest scale, the single patient in the moment, may have the largest dimensionality. From the discussion above about stratification, for promoting value to be possible, there must be coordination among the hierarchy of scales. The high dimensionality of the moment stays with the moment. In transition to the larger scale of the network many moments, episodes, events or whatever carry a lesser scope of a single moment's possibilities to segments of the network. The diversity of moments means the breadth of the moment's dimensionality will assign segments of the dimensionality that are clinically relevant to corresponding segments of the network. From the topological point of view, this packaging of clinical dimensions exists within the scale intermediate between the moment and the population. This relation of the N of 1 to a larger scale is the link important for clinical care and the Value financial dimension. By its nature, cost is a summary population measure and is complete in that there is no loss of information by averaging. Current value programs use cost as a unit of measurement of the population and is where cost containment targets are set. BPCI programs and ACOs segment network level costs, but the overriding targets are the level above at the population. The opportunity to enhance value lies with the link among strata, or scales, where cost information from both the population and the network can be produced as inputs to the moment. This is tantamount to bridging the units of measurement across strata. The possibilities of these links raises the potential for cost saving because the dimensionality of the moment translates to the population. This is the benefit of framing information flow by Logic, and is the basis of a feedback loop among entities of different scales. This may amount to inputs designed to work in the moment that originate at another level in the maze. Or to put it another way, the maze becomes context for the moment as extrinsic information. For example, the moment in the reduced maze may benefit from a reduction in administrative complexity, or in fact elimination of the administrative maze if other features replace the need for administrative controls of utilization.

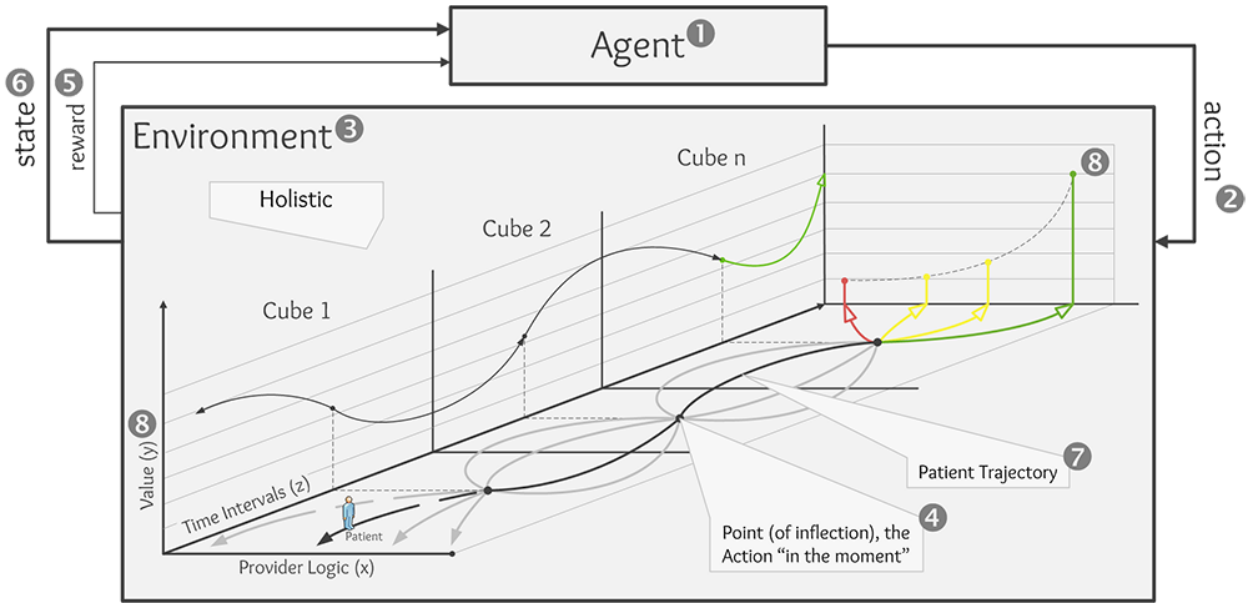
Brief | In the Moment Dimension 1

These are general comments on the fundamental unit of measurement of the ecosystem, the Moment.

Moment in the Maze (reduced)



The maze is a metaphor for a large and complex healthcare ecosystem that is always context for the moment. This moment is the smallest scale in the ecosystem as the N of 1. Nevertheless, the significance of the moment is vital for an ecosystem needing new directions and processes. However, as a concrete entity that includes standard episodes in a single place and time; visits; cognitive and procedural codes; pharmaceutical monitoring and selections; compliance with best practices; and summaries of prior episodes (all collected within complex boundaries containing high dimensional information) needs simplification. Of course, the provider, or agent of action in this single point in time, must limit the complexity of the moment to function moving the patient forward in the journey for health and disease management. Complicating the agent's purpose in this dynamic is the breadth and scope of information of the ecosystem, which leads to the perception of the agent operating within a maze. A limitation or a reduction of this information clarifies this moment. Otherwise, the action will be paralyzed at best or inappropriate at worst. A reduction step, effecting the scope of the ecosystem apparent in the moment, will achieve this clarification.



Healthcare in 3D

The reduction step provides broad based prior information to the Moment as inputs. This reduction step simplifies the maze of the ecosystem. At this point, the moment is ready for inclusion in the varied and complex ecosystem. This dynamic of prior information, action and production of information for other scales of the ecosystem creates a feedback loop between entities of the maze and the complexity of the Moment. Thus, N of 1 is ready for transition to the N of many of the network.

Sequence of Moments as Journeys

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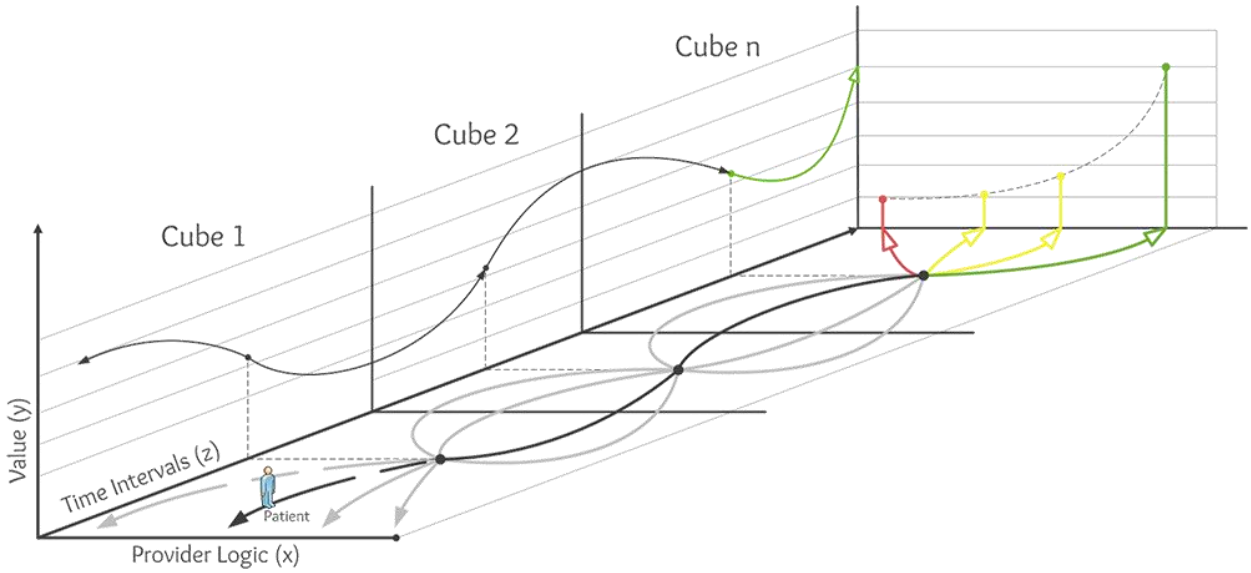


Action as a Bridge from the Moment to the Journey

The maze as a metaphor for the ecosystem, as experienced in the Moment, allows some actions rather than others to be relevant for a Moment. This is the essence of a reduction step in the third Value dimension produced for the Moment as an input. As the dynamic element in the Moment, well-considered actions need the input from the entire complex ecosystem, framed by topology and logic. Similar to the moment, value is a composite of many dimensions. With the Value dimension spanning the full scope of the ecosystem statistical, predictive information from populations matches potential information from dimensions of smaller scale. The potential actions as companions to the possible actions from the statistical production from prior actions enhance the range of actions of the moment. From a graphical standpoint, the inflection point where possible meets potential links the transactional pyramid to the counter pyramid of the transcendental. This linkage makes sense only with reduced contextual information from the ecosystem targeted to the moment of decisions. The pyramid and counter pyramid topology highlight the distinction between predictive modelling and potential possibilities. This is the essence of the difference between retrospective and prospective analysis, targeted to the moment gleaned from the context provided by the reduced ecosystem. Here the reduction results from the full use of the topology and logic, guided by scenario, with the goal of

optimizing value. Logic comes into play because it links actual information to what could be information if it were known. Analogy and induction create the space for potential possibilities because these logical forms allow the uniqueness of the patient, and the uniqueness of provider experience, to inform potential decisions that may be obvious to the wise clinician though not necessarily registered as medical evidence in the formal sense. This is another way of saying statistical significance does not always guide the patient's journey. This method of reduction when matched to holism can be clear when imbedded in a topology of the healthcare ecosystem.

These comments highlight the complexity of the moment where actions occur, and as will be discussed below, make the moment a better target for value-based interventions.

Topology of Dimensions Linked by Transitions and Reductions

(Text Place Holder)

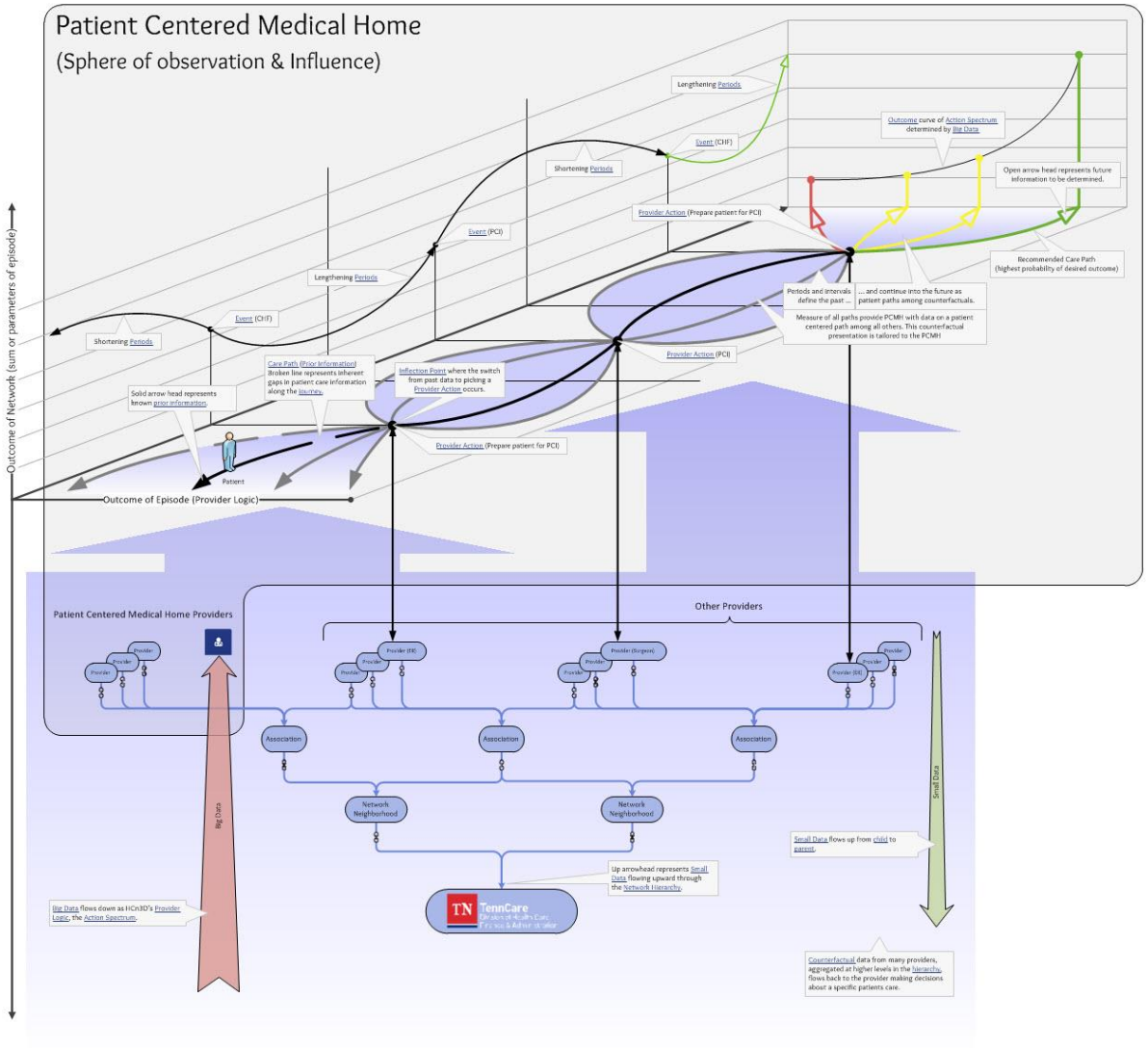
Strata Pyramid Transactional Dimension 1

Of Value Population scale

Accountable programs from a topology standpoint are low dimensional. Measurement of cost and quality at this population transactional scale with information limited to claims databases determine metrics. Comparisons of provider performance are for averages of cost given diagnoses with risk stratification. The population information averages limit the dimensionality of the patient centered level. The information flow from the population to the provider is of necessity low dimensional, and from a logic standpoint is deductive only. The influence on actions by these low dimensional metrics is not patient centered and is a limitation of interventions that are transactional only.

Of the Network Mesoscale

The Network when the unit of measurement is the patient of the Moment. Here a good graphic would be a network diagram highlighting numerous moments as nodes with the links from the patient groups to other groups making the network. This is affecting a patient network.

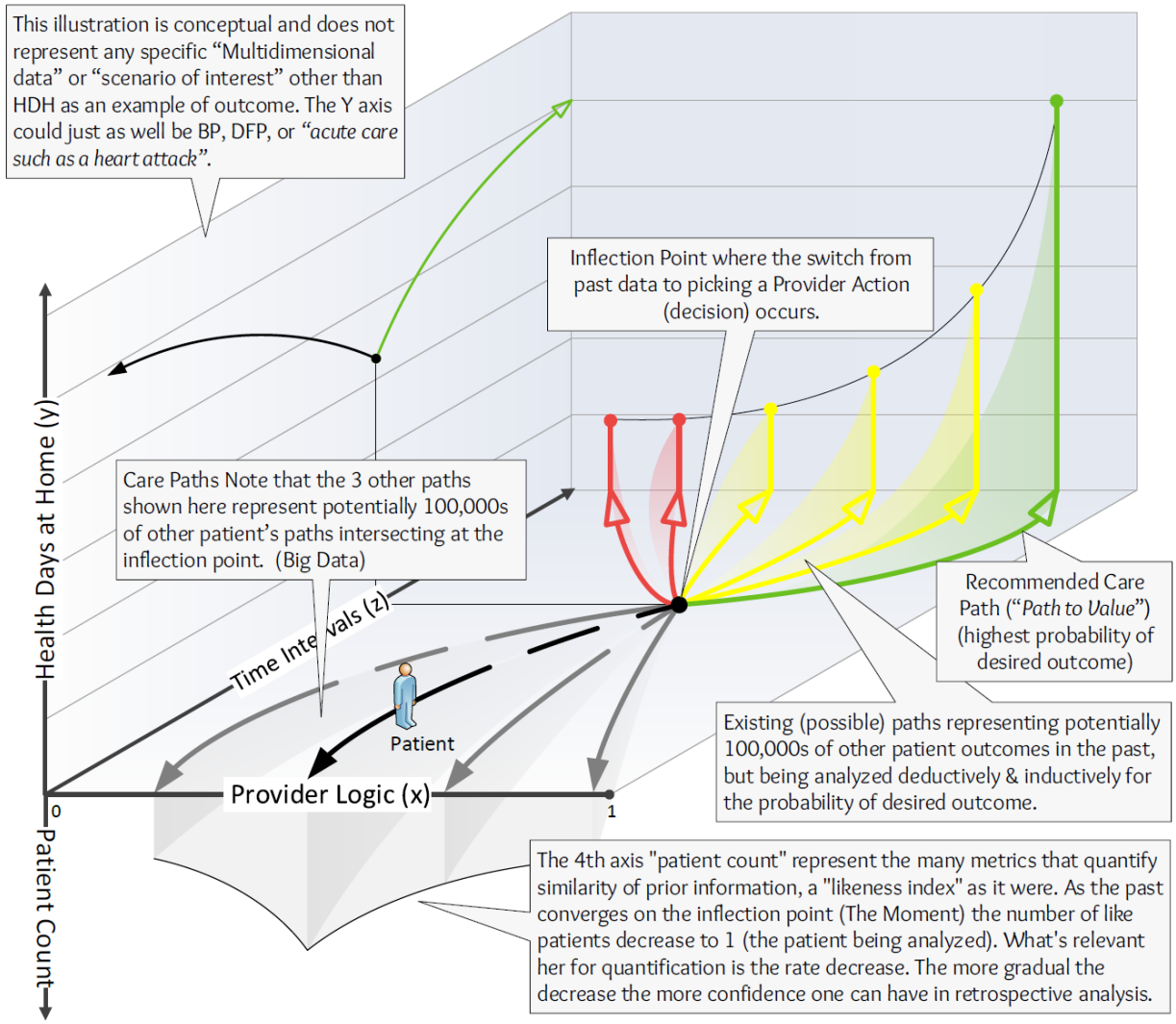


Variable unique to this network scale include SDOH, local factors such access,

Behaviors for cost and quality framed as group variable rather than patient centered, which the unit of measurement of the network in Dimension 2. The network strata in Dimension 1 is framed as inputs to the moment. These inputs can be graphic positioning a patient or provider within the network group as in a scattergram, Heatmap, scale free network graphic that identifies individuals.

Results of Reinforcement Learning

In the Moment Patient Scale



In this scale for a transactional inverted pyramid, the information flows from the broad population at the top to the N of 1 high dimensional cube or the holistic moment. Metrics from above determine and control the actions at the patient level. The effect of this direction of flow of information is to create and enforce interventions that are ineffective, if for no other reason than the information reduction step occurs by averaging at the population level. The lowest rung on the pyramid where this transactional moment resides reacts to averages rather than patient centered uniqueness. See below for the effect of positioning the information reduction step at the moment itself which avoids the loss of relevant information.

Strata Pyramid Transcendental Dimension 1

What makes it Transcendental?

To follow the discussion above about the Moment as the fundamental unit of measurement of the ecosystem, the topology presented above reflects the transactional pyramid of the topology. To follow is a switch to a transcendental pyramid with the same hierarchy of strata with the orientation reversed. Here the flow of information starts at the narrow apex representing the transcendental holistic moment. Logic differentiates these 2 orientations, with the transactional deductive graphically at the top as a wide population centered strata, and the transcendental inductive graphically at the top of the opposite orientation where information begins its flow from an inductive patient centered stratum. As above the Briefs follow a topology framework of 3 Dimensions that differ by scale with each Dimension having Logic categories of deduction, induction and analogy.

In the Holistic Moment

Within the framework of the ecosystem, the holistic moment is the most complex of all. The full scope of logic and relations of logical entities resides here. As mentioned above, the challenge of the ecosystem is its vast space. Not just the topology of entities in space, but the structures, processes, and outcomes linking healthcare entities with the patient all have a place in the holistic moment. The glue that holds this all together is information. If the trajectory to Value is to be useful as a metric, cost and quality must account for all existing and potential factors that affect the patient.

Logic works here, inductive and analogic in addition to deductive. The scope of logic in the transcendental realm warrants a separate structure in the topology of the ecosystem. The topology of the transcendental pyramid shows an upright pyramidal shape. Here the peak of the pyramid is the holistic moment; from this peak, information is generated in a high dimensional form, which is a realistic representation in that a holistic moment is not bounded by limited information. The inductive logic may include information from many sources, compiled by what the provider or patient deems important in the moment. This topology contrasts with the transactional pyramid where the widest strata representing the population is at the top. Thus, the contrast when representing information flow from top to bottom, from N of many to N of 1, demonstrates the limitation of what transactional data can show. Using this topology in conjunction with Logic places this contrast in the forefront whereby the limitation of transactional analysis is evident.

The high dimensional holistic moment as N of 1 using the full range of logic allows prospective analysis. Predictive modelling is retrospective only. This will not account for possibilities of action steps to achieve outcomes that are not already in the databases. The power of this topology representation is to show how high dimensional information impacts decision making, that is not limited to transactional low dimensional information only.

Of the Network Mesoscale

The network in Dimension 1, middle strata between the holistic Moment and the Value-based population scale when patient centered with a transcendental color has the potential to provide context for the complex moment. To be discussed in more detail in the Value Dimension section, context is the key complement to this moment. In scaling up from the patient centered moment to the N of many, network, groups of patients and providers are realized that reflect the dimensionality of the moment. For the general categories can be mechanisms that effect entities, as well as features of the entities themselves. Abstract terms common in the health care reform space, often show up in contracts of managed care organizations with providers. Examples include provisions promoting relations such as coordination and collaboration. These terms imply many sort of links such as provider-provider links, plan-provider links, and vertically integrated provider internal links. Links are varied, and the point is the source of links of many kinds originates in networks. If networks have the breadth and capacity to see and observe these links, a foundational basis of Value will emerge.

The mesoscale indicates the scale of the network. The mesoscale is local. This scale is appropriate for provider networks, informal and formal referral networks, and relationships for referrals and influence. Accountable organizations fall in this level, as models for benchmarking cost and quality. The importance of the mesoscale for information management is to have a destination for information about local provider networks, and local best practices. Cost and quality may be a function of groups of providers and is a network metric, not only an individual provider metric. The topology of networks highlights the role and importance of mesoscale metrics as a component of value.

Of Value Population Large N Applied to N of 1

Value in the transcendental realm opens the door for the high dimensional place of the moment to contribute to value. Value as a transactional metric is low dimensional, limited to cost and quality. Questions providers may have about how other providers manage clinical issues need data about these providers. This data is not available from community sources, and usually not from integrated provider groups. Another barrier to sharing of information is logical. The provider in the moment brings a range of approaches to his or her patient, which relates to other providers based on information that is more expansive than medical evidence alone, namely psychosocial, social determinants of health, all soft data that creates a composite of patient information that is unique for the patient. Value in the transcendental realm can account for this high dimensional information if unstructured formats are used for data. This is the point of inductive logic; providers and their patients and peers can use uniqueness of the patient as legitimate inputs for patient decisions.

How does logic fit in the population space? It is clear logic brings more types of unstructured information to the table. This is not to say structured deductive information is not useful, but the approaches to analysis are different for deductive and inductive data. Not to forget the deductive realm, which is where evidence based medicine and randomized trials reside for definite answers to clinical options. The chloroquine studies are a case in point where structured data create definitive

answers for clinical guidance. A scientific bias is needed for consumers of population data to buy in to the result that chloroquine is of no benefit. It is clear a scientific bias is not shared by everyone with a stake in medical decisions at the population level. For this important subset of consumers of scientific information, whether they are amenable to persuasion or not, a transcendental approach can name results and patterns of belief that can focus attention to why a person has these beliefs. Of more relevance is how a group has these beliefs. Finding these beliefs or resistances in the cultural realm is the only way to shift behaviors. A purely scientific debate will leave out the inductive, transcendental dimension. If with the transcendental approach, analysis of beliefs reveals clusters of belief systems, targeted persuasion works for a subset of the population.

A topology with logic offers new approaches to population value, and there is a technology to support analysis of unstructured as well as structured data. The logic form would state this as inductive logic as a complement to deductive, deterministic science. Most of us believe the science guides acceptance of vaccines, conditioned as we are by a science background. For most of the population, trust is a more important determinant of acceptance of science, particularly when the details of science lose people. Here the N of 1 Moment is the place and time to embrace the inductive and analogic logic most people use, particularly the non-specialists. A topology that includes the transcendental dimension has a place to note trust as a cultural reflection of how the public views medical recommendations.

Transitions

Transition from the First Dimension to the Network (Dimension 2)

The moment is the time and place for the agent to assess a patient's information, whether it be acute or chronic care, relevant best practice, and specifics of the patient. The key objective is to assign relevance to this broad scope of information important for patient decisions in the moment. Decisions that are patient centered exist and are guided by the larger context of the network. Moreover, to manage what can be an impenetrable maze the reduction step must have the needs of the provider in the moment paramount. For example, a need is transparency, knowledge of the scope of patient's medical information community wide, resulting from proper care coordination and provider collaboration. Another need is medical best practice as guidelines from a population that includes the patient's characteristics. Local knowledge of health care resources must be included, including outcomes of similar patients. Local knowledge includes payor requirements for quality documentation, standards of care, and network provider membership. Social determinants of health and psychosocial factors influence the moment. The immediate source of frustration operating in a maze comes from the local complexity felt at the provider level from numerous requirements of payors. In fact, this is the best opportunity to reduce the maze if it is possible to coordinate payors. From the moment, there is opportunity to make some requirements patient centered, which is the basis of information reduction.

As stated above, Information production from the moment is an issue of collecting inputs, from the patient and the local and population ecosystem and presenting this information as the support for

actions. The trajectory to value (described below) comes from selecting actions from a set of choices. Thus, information production from the moment includes potential actions given the options. Moreover, what the agent or provider chooses in comparison with his or her peers is how prior information is applied to choices of the providers and can be included in the analysis of the key information output of the moment. The patient centered objective of choosing the best choice is informed by a local centering of a local provider group to determine the range of options. In this light of the Moment in the maze as a composite of many features of the ecosystem in addition to patient centered features, the moment is more than a billable event. It is a compilation of features centered on the locality of the mesoscale, and the larger populations. The diversity and high dimensionality of the moment offers many points of contact, which influence actions in the moment to serve larger entities such as populations with a broad scope for cost containment and efficiency.

Brief | Network Complexity Dimension 2

Moment in the Maze (expanded) After Transition

Transition from the moment to the larger scale of the Network changes the relation of the moment to the ecosystem. The network scale, or as often termed in this white paper the mesoscale (from an information standpoint) places N of 1 high dimensional patient centered information in the context of N of many, in groups of various sizes and categories. As the N scales from 1 to many in the network, the maze of the ecosystem scales as well. As mentioned above, the road to value is really a process of keeping track of the complex context of the network and moment as the clinical process evolves on journeys.

Strata Counter Pyramid Transactional Dimension 2

Population

The stratification of populations starts with a data repository, then aggregates patients in different ways depending on the purpose for collecting data. Insurance companies pay claims, determine quality, and define provider networks. For policy issues such as pay for performance, shared savings, cost saving and many more transactional data supported functions, output is to support financial transfers and justification for services. These repositories and functions are not designed nor intended to support clinical activities.

The counter pyramid shape shows information flow from the large scale of the population to the mesoscale then to the single provider. The message relates to the flow, where the transactional information starts at the top and in Dimension 2 creates network level benchmarks.

Mesoscale (Change to Network)

The mesoscale is shorthand for describing a middle ground between provider & patient at the N of 1 scale, and larger local networks of providers. Payors design provider networks at the local scale. Transactional information creates benchmarks for cost and quality to establish value-based

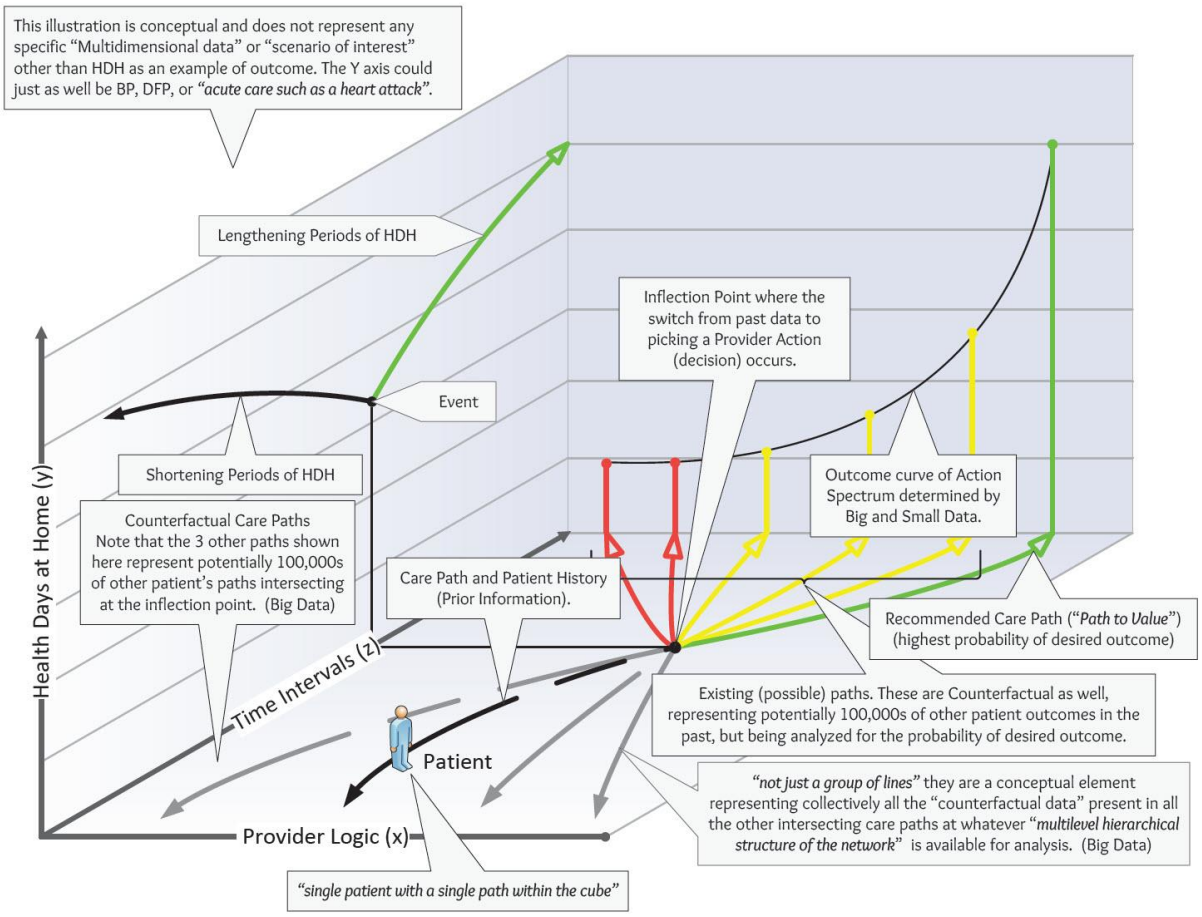
purchasing. Local groups configured as ACOs or as risk bearing BPCI programs assume financial risk at the provider group level, not the individual level.

A great deal of informal information exchanges among providers at the local scale that creates local custom and local uniqueness of provider behaviors. This will be discussed further in the transcendental topology where the network receives information from the smallest provider scale, unlike top-down flow from the population. The point here is that claims data as transactions only, is incomplete.

The practical application of the difference in flows, from large to small, or from small to large scales will become evident in scenarios.

Cube

Pay for performance assigned to providers exists as an incentive or penalty applied to providers singly in episode payment models, or as groups in ACO models. The pay for performance methodology uses network level benchmarks derived from claims data, and applies them retrospectively to providers. The cube concept as used in HCn3D relates to the moment, but is devoid of elements other than transactional information.



Strata Pyramid Transcendental Dimension 2

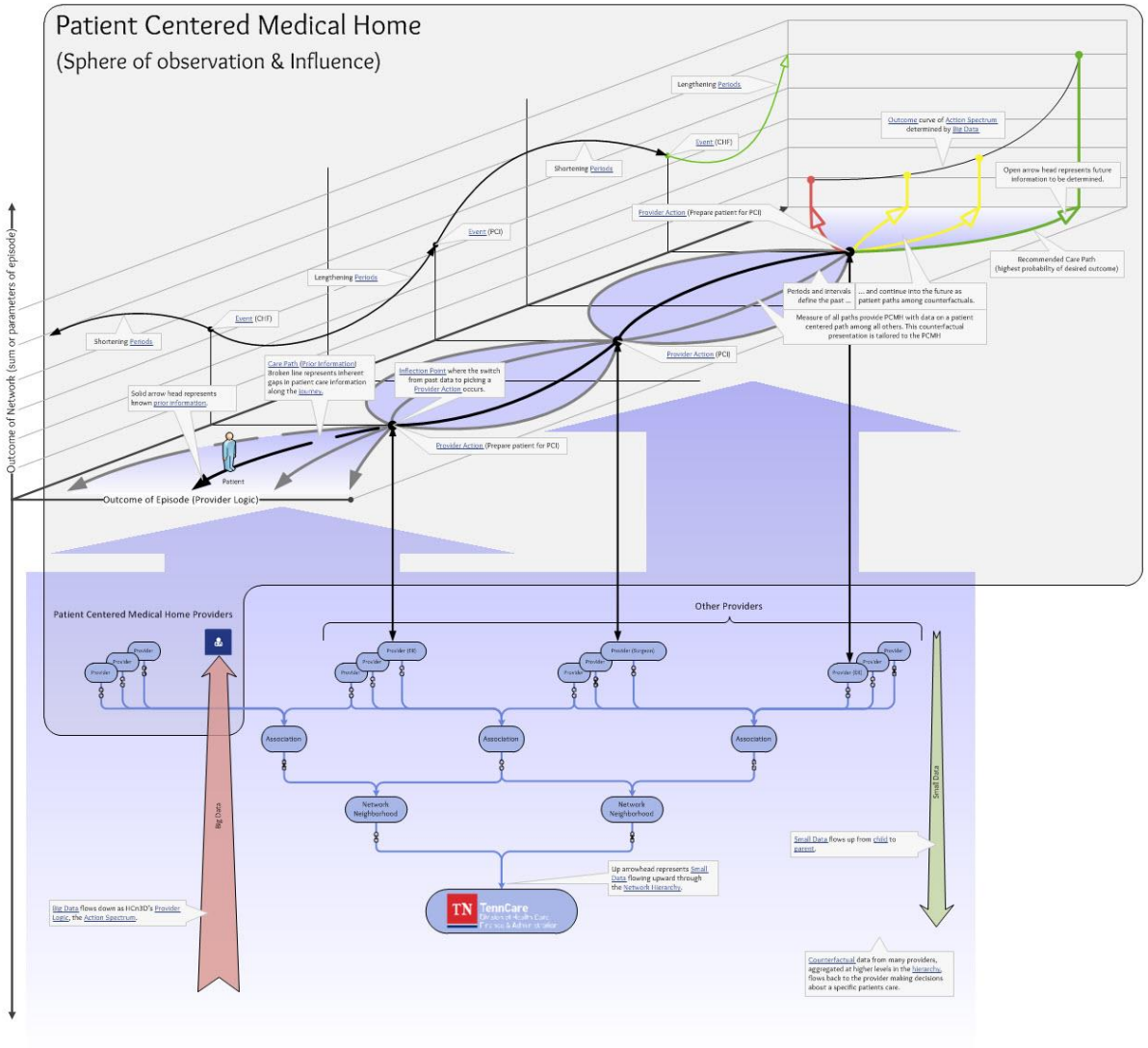
Holistic Moment

The moment as a patient centered entity contains the most complex and high dimensional information. As the moments as single events or as journeys aggregate in Dimension 2, the network level, the single patient aggregates to many at a scale appropriate for local provider groups, networks of groups, and payors that craft provider networks at a larger scale, but still smaller than networks of regional scale. The challenge is to transform the complex patient centered data from N of 1 to N of many. Like the transactional moment, context of the ecosystem captures and controls the actions in the moment. The moment graphically is centered as an entity at one place and time with context captured as information from the entire ecosystem. The transcendental moment however captures information that is not only transactional. Information that is difficult to get or unique to a patient, but highly important in completing the required knowledge to make informed choices about a potential action. This moment carries the inflection point where the past becomes a potential future. In the transcendental moment the action can be based on information that does not exist in the past. It includes metrics of ubiquitous context such as SDOH and psychosocial factors that are usually not included in the medical record or claims databases. The completeness of the decision in the moment when it includes forward looking potential outcomes is more than predictive modelling, which depends on structured and known past information. Having a transcendental holistic moment allows the agent of change, the clinician, to do more than attempt to predict the future based solely on the past.

The combination of the transactional and transcendental holistic moment that informs a small-scale population centered production for the network of providers and payors sets the stage for value to migrate from transactional only to a more robust analysis of the patient interacting with the context of the ecosystem. The production and migration of this information to a higher level of value will carry information to support a future value that has not necessarily occurred in the past.

Network Complexity of semantics and links

The transcendental moment will carry the burden of needing semantics that challenge current information support for clinicians.



Population | of N of 1

The transcendental moment drives the population information, in this transcendental conception of information flow. Although the population is of large scale, the information is still patient centered. This is possible when inductive reasoning determines the scope of information of the moment, which is always N of 1 patient centered. This is true as well for analogical reasoning, stories being the paradigm for N of 1. What would aggregation of inductive data points look like? This is counterfactual data production and causal paths. The context is the population, as standard population level information, but the actions and decisions are patient centered. The Topology of the transcendental allows the counterfactual production of information.

Reductions

On the pathway to Value, the topology with Logic leads through the patient centered 1st Dimension in both transactional and transcendental shapes, through the complex network of the 2nd Dimension, again transactional and transcendental, before arriving at the topology of Value. When the starting point is the high dimensional moment, here dimension means the intrinsic variables of each grand Dimension; clearly, it is obvious a large amount of information follows the topology. The moment, the initial patient/provider centered fundamental unit of measurement that is the foundation of the logical form of the topology, drives the potential information content of the flow.

The next step from the Moment in the 1st Dimension is the transition to the Network as the 2nd Dimension. Here the n of 1 patient moves into the world of the N of many, limited only by the space of the local network. The content of the moment is scaled up to this space, but from n of 1 to N of more, information will be simplified. How this is accomplished depends on the logic of the topology, whether the information when deductive, arrives from the moment to the network as structured, or whether the information from the 1st dimension is inductive and partly unstructured. Deductive aggregates present averages to the network with loss of individual characteristics; inductive is not averaged and therefore retains the N of 1 quality even though the N scales to the network group. Statistical tools, such as propensity scores, regression coefficients, etc. will work with deductive information. On the other hand inductive aggregates hold on to individual characteristics as visible data points, within K means clusters used for example in assessing similarities and/or differences in local subsets of networks. With both logical forms, there is reduction of information, occurring with inputs to the moment, and production from the moment.

For the network to collect large numbers of moments for the flow to value, aggregates can extend to provider, disease groups, and prevention. Here the objective is not inputs into the moment as decision support, which requires the granularity of the moment, but performance of the set of the small ecosystem of a network. The set of the ecosystem can assess general behaviors of providers; propensity to use diagnostic tests, use of pharma, efficiency and more. These performance measures however are one step short of value. Quantitative methods when statistical significance is not possible or needed focus on degree of uncertainty as an objective. This is in the realm of counterfactual analysis, which is a measure of what does not happen if value follows absence of potential events or spend reduction in the network.

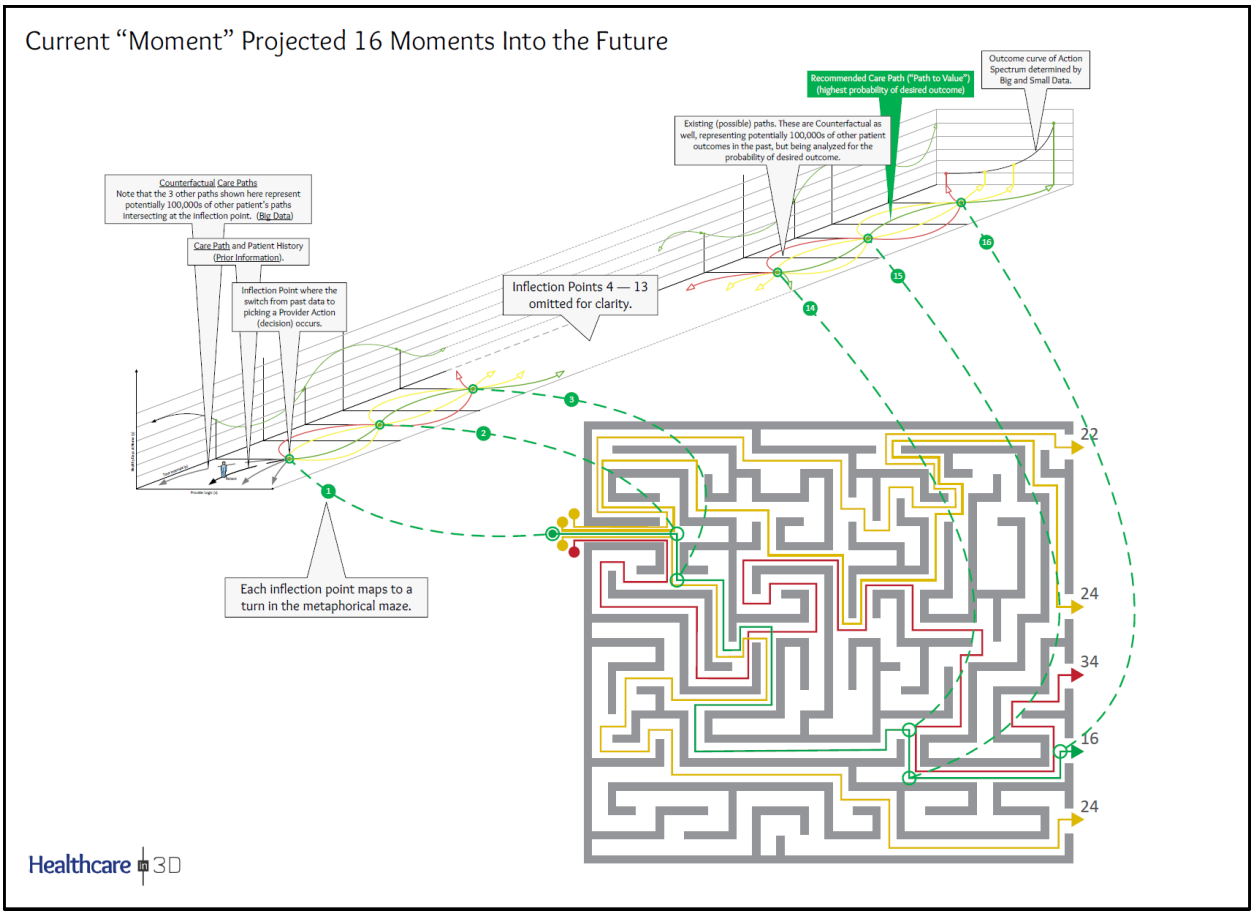
Brief | Future Value (Dimension 3)

Moment in the Maze

As discussed above, the Maze is an important metaphor for the complexity of the ecosystem as it affects the moment. A prime objective of value is to reduce this complexity to foster efficiencies in care delivery. The ecosystem impacts the moment as a set of transactions required to do the business of medicine. It is well known to all that many business processes add nothing to patient

benefits, but create the largest amount of wasted costs. This is the first and most critical impact of the maze, waste and inefficiency.

The topology with logic will find its greatest use in designing alternatives to waste.



Strata Counter Pyramid Transactional

Population

Value framed as a transaction, derives from aggregated information of populations. Medicare's value-based purchasing programs use claims data to establish cost and quality. Accountable programs benchmark provider performance for attributed populations, or benchmark episodes in BPCI programs. The force for change is comparative provider performance, which is a relative benchmark rather than an absolute measure.

As the primary, largest payor in America, Medicare has the most to gain from value-based purchasing and at the same time the most to lose. The loss from using value-based purchasing, designed from transactional information only, is from the narrowness of analysis due to lack of context for benchmarks. This is an issue for deductive analysis that causes reduction in potential value. With total reliance on transactional codes, the larger space of the ecosystem, which contains context for transactions, causes incomplete and limited value. Providers and groups in networks in the family of

patient care generate information that has an inductive source. This means before transactional information is brought into existence for care procedures, there is a robust process of considering information of potential importance. Each moment is an opportunity for innovation to reduce uncertainty. As long as this moment is real for the providers and the patients, scaling up to the deductive transactional population level will create value. This is a secondary effect for Medicare and a primary effect of Value for the patient. The hazard for Medicare is to ignore or be unaware of the logical inductive moment. The value for Medicare is to use the moment as a foundation for transactional value, which is cost saving. Looking at health care performance at the level of the ecosystem, managing the maze, selecting efficiency tools, doing what providers long to do which is profiling other providers, cannot be done with transactional information alone. Clearly paying providers without formal justification poses a risk. However, value can function at a broader high dimensional base, amenable to information search in a variety of formats, particularly using unstructured data formats. This high dimensional scope for value is very familiar to providers, but extends into the transcendental, complementing the transactional payment systems. Value is about cost and quality, but can be more than what Medicare uses in value-based purchasing metrics.

Accountable care organizations can be a bridge between the deductive and inductive logical forms of information. Medicare's approach to ACOs is to set up relative benchmarks to profile the accountable organizations. The source of the variation of profiles is unknown. In other words, it is up the ACOs internally to act on benchmarking, but how they do so is unstructured. Types of organizations perform differently in cost reduction. Hospital based ACOs, do not succeed whereas physician based ACOs do. There is no mechanism to look deeply into the functionality of the organizations to show why this is. Clearly, providers are able to do intuitively what they do in care processes, which to use inductive reasoning at the individual patient level. Inductive reasoning is not available in bureaucratic organizations. For Medicare, programmatically, the solution to enhancing ACO functionality is to provide a wide range of transactional data not limited to the ACO organization itself, but the wider population. This information can be transactional context for the interplay of deductive and inductive reasoning at the ACO level. The ACO can do its own unique benchmarking at the patient level, and not depend on area wide regional benchmarking at the mesoscale level that is available from Medicare. The potential for Value with population scale information from Medicare will cause an explosion in Value.

Mesoscale

Presentation to ACOs communicates performance differences for quality and cost. As for Medicare, the data presented as variation from benchmarks is transactional. The ACO and BPCI programs have mixed success, primarily with CJR, joint replacement. The CJR program succeeds, in a narrow realm, whereby the provider can identify post-surgical rehab as the cost driver, which is amenable to intervention. For other realms such as non-surgical medical conditions, for example chronic heart failure, the information available for providers is complex and high dimensional. The transactional descriptors of heart failure do not pose a single potential target for cost saving. The cause of differing success in these contrasting realms highlight the limitation of using only transactional information. CJR shows rehab as a discrete and well- defined entity that is the target of cost saving intervention, which by the way has been successful. The solution is conceptually simple. The heart

failure realm is not so conceptually simple. The process in this condition that stands out as a well-defined program for intervention is the 30 day readmission rate. However, heart failure is a high dimensional process that offers no simple focus for intervention. The readmission rate as a target for intervention and as a comparator of provider performance, as a descriptor of an event, is a collage of many factors. No one factor is the target of intervention. More than the simple readmission rate, heart failure is complex and brings in a need for coordination and collaboration, interactions of medical and social factors, and complex medical evidence that spans many domains, devices, pharmaceuticals, and a broad group of providers. Simply counting each of these things as transactions will not combine them in a way that presents opportunities for intervention.

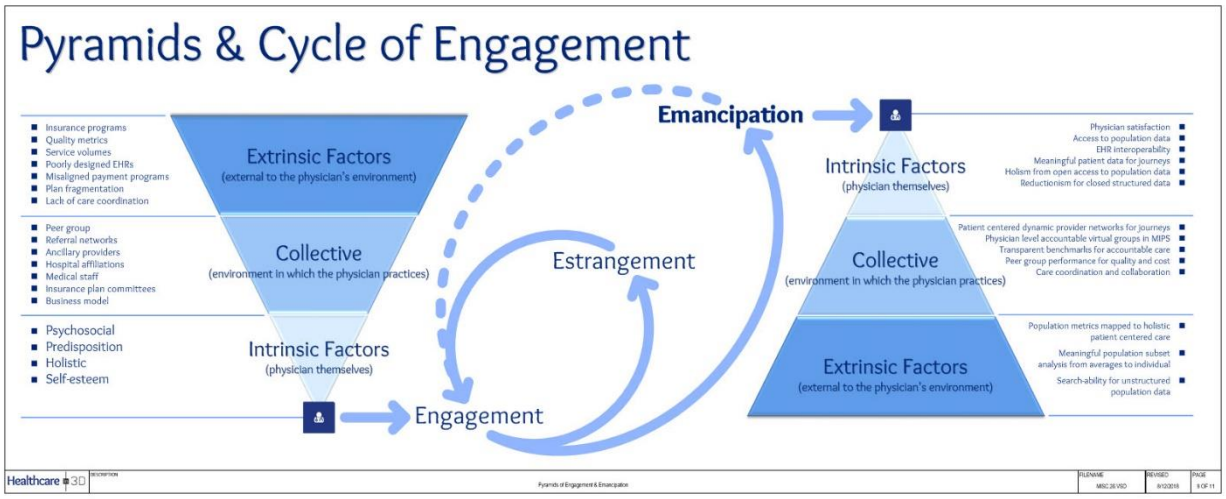
The mesoscale, the scale of local groups and networks, is unique as the source of context for coordination and collaboration. The ecosystem with a local reduction brings transactional information to a definition of functioning interactive networks. These networks of payors and providers source profiles of performance. As context, performance moves patient level information, either transactional or transfactual, to actionable profiles. These include behaviors, administrative costs, imaging indications, and pharmaceuticals. Mentioning these features in policy level literature, for examples in numerous articles by Ezekial Emmanuel and Robert Califf, brings up the notion of how best to measure these features. Though there is no direct way to benchmark collaboration, as an example, there is an indirect way when collaboration is contextual for detailed performance at the patient level. The advantage of the mesoscale as a concept gives a level of measurement of profiling that adds meaning to patient level data.

The mesoscale as an actionable framework has other benefits when analyzed transactions, simply aggregated deductively, offer no insight into the transfactual world. These are facts that could be, but are not yet known or defined. Fitting in with the provider's desire to know when he or she does something, something else is avoided, questions about transfactual information arises. It cannot be said strongly enough that this desire to know now, when something is avoided later, though counterintuitive, is the motivation for most medical services. Reaching beyond the patient level of outcomes to a context of a larger level of the mesoscale gives the ability to measure counterfactuals. These counterfactuals may exist as facts in the context of a large population at the mesoscale and its variety of networks, but not in the care paths of the moment or the patient centered journey. From a value perspective, nothing can be more important than knowing differences in care paths, avoidance of unnecessary tests and procedures, and other forms of waste. The interplay of context and actions in moments is an output for coordination and collaboration where the profiles of provider performance presented as graphics of counterfactuals. This is a profound basis of Value, most effective at the mesoscale.

Cube

The moment as a transaction aggregates information as a cube. This database term denotes transactional information. The metrics from populations and the local group, mesoscale frames requirements, and compliance from providers. Information at this patient centered level, because of the design of medical records, flows back to populations as quality measures and insurance plan codes.

Here is the opportunity for efficiency, considering the position of this clinical moment, in the Maze of the ecosystem. Relations with: payors; other providers; authorization and precertification; and quality measure reporting requirements all exist here. The time and administrative costs fall here for input from the ecosystem. There is no avoiding these requirements, compounded by design of medical records workflow, issues at this level of the moment contribute to physician burnout more than any other factor.



Strata Pyramid Transcendental

The topology of the ecosystem visualizes information, and flows among the entities of the ecosystem. The pyramid represents logic as well. Both metaphors allow a productive separation of transactional and transcendental information to show how the narrow scope of transactions can expand to a broader transcendental viewpoint. The power of this will become clear when scenarios are created that work toward cost effective solutions.

Holistic Moment

Logic in the moment is holistic. The deductive form of logic corresponds to the transactional, and as information, deductive logic is structured. Because the moment is high dimensional, inclusion of many factors exists. These include the medical, the content of the transactional cube, the psychosocial, social determinants of health, and other unique patient centered factors. Assembling all this into an accessible whole is a challenge that cannot be done with a medical record, information provided from populations, guidelines from medical evidence, and more. The value from the moment is that this high dimensional point in space and time is the most complete site of information that is patient centered. The N of 1 flavor requires the provider arbitrate the many potential variables that assemble uniquely in the moment. For the complexity of the moment to drive value, the information is transmitted to the population after the provider moves information forward in the topology scheme used here is from the apex of the pyramid to the base, meaning the moment drives the population. The logic of doing this works, when the information (from an inductive source as it originates from the provider as decision maker) is patient centered, in effect moving from N of 1 to N

of many. Then the transactional technology with data aggregation and statistics supports value and does not lose the transcendental character of N of 1. The difference in the holistic flow of information from population generated flow is that unstructured data applies. This is more realistic in the complex world of the ecosystem where information needs discovery as much as analysis.

Mesoscale

The discussion of the transactional mesoscale above, draws heavily on the interaction of the transcendental and transactional. The above discussion uses this interaction as the enabler of output as a transactional metric, in other words cost saving. The mesoscale in its role as context for patient centered moments, and provider profiles at the network level, aggregates transactions and alludes to transfactuals. The mesoscale as with any level in the ecosystem is a byway for information flow. The flavor of the mesoscale is as a conduit for information that originates from populations. The flow is therefore transactional and flows from the population to the moment of the patient. The mesoscale is therefore a conduit for population Medicare type programs with compliance needs and utilization controls. Because Medicare competes with other public and private plans, with numerous other programs, the mesoscale becomes the level of the most intense maze. Here is the source of the largest waste, administrative costs. Therefore, the mesoscale is the level of the best and the worst of patient centered care; quality services with local support, and unconstrained waste.

In a transcendental sense, the mesoscale can also be the conduit of information originating at the patient level. For the holistic moment, the complexity exceeds the ecosystem in dimensionality. The topology information flow as characterized in the pyramid is from the moment down to the mesoscale and population. In other words, the moment drives information. When the information source is transcendental, meaning inductive logic exists, the moment exists as an N of 1 before it is aggregated to an N of many in the population, which makes it deductive. This leaves room for counterfactual analysis, and furthermore causal paths, which need the uniqueness of the patient centered moment.

With a view to reducing waste, counterfactual analysis opens the door to reducing administrative costs. The first and most obvious burden on providers and insurance plans alike are preauthorization requirements. The time and money complying with these programs is wasteful for all involved. Nothing is added to patient care, and there is no clear effect of the programs on reducing unnecessary services. Counterfactual analysis offers an alternative. If there is no pretest constraint, in other words elimination of precertification, posttest analysis of the N of 1 decision to do the services can be a substitute that in fact is more effective. The constraint can be shifted to peer pressure, and useful knowledge by information production about the utility of the test given certain conditions. The output of the posttest analysis includes features of the high dimensional moment when available for the condition being tested, as compared to the context from the larger group of the mesoscale. Tests therefore pose an opportunity to be a counterfactual data point before the fact, as well as a useful fact of a needed service again before the fact. This is an interplay of deductive and inductive logic before the fact and therefore is an alternative to precertification. The insurance plan can be left out of it, the decision of the provider depends only on what his or her peer group is doing in a certain context for a certain indication.

Population | Aggregated Metric of N of Many Applied to N of 1

Concepts below to be integrated into dimensions, strata and the classifiers of the ecosystem as transactional, equivalent to financial, and transcendental, equivalent to information.

The model needs links, functions, paths, trajectories of outcomes and actions to value. RPE builds on the total ecosystem reduced by scenario planning, with error shown as the difference between the point of action real time, and the future desired outcome.

Value

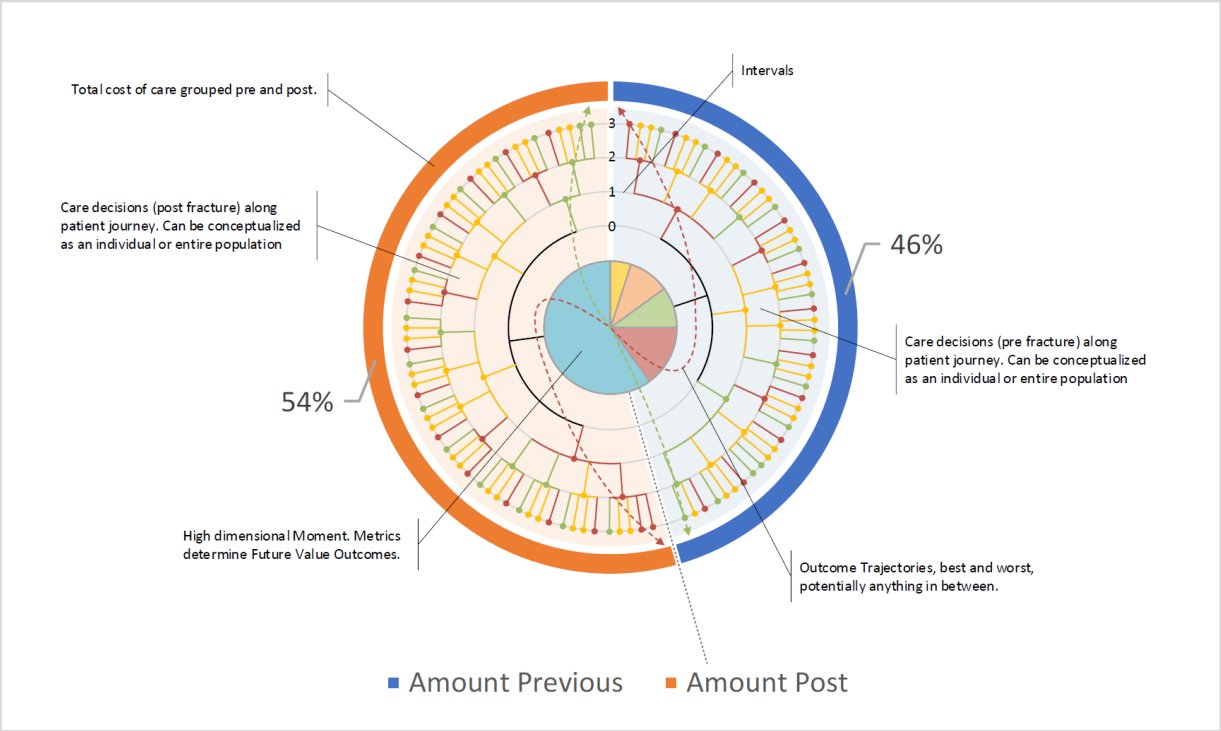
(Text Place Holder)

Value Context for Ecosystem in Angular Radial format

As will be discussed in the Brief section, value will do more from Scenario design standpoint if the ecosystem has a visual presence that shows the relation of all scales of the ecosystem. These scales as discussed above include the patient centered moment, the network, and the population. The angular scale shown below has the moment at the center, the trajectory from the moment, the journey, leads to the outer circle as a representation of Value. This put together the ecosystem reduced to the moment as the center. The details of the trajectory from the moment transition to a series of multiple decision points that sum over time to this trajectory. The direction, or in this format, the angle of the trajectory provides information that is determined by actual quantity of value, in this example value is simply cost categorized before or after an event. Each subsequent branch point on the journey is a data point selected from the moment at the center. These branch points are derived from data arranged as triangles; therefore, a component of the triangle, a cosign or a tangent gives a geometric signal to a point on the trajectory leading to an endpoint of value reflecting a geometric quantity.

This seemingly complex arrangement is actually a simplification with a visual impact that reduces information from the large scale of populations to the workable patient centered moment. This impact serves the twofold counterfactual purpose of showing possibilities for the decisions of the moment, and the transparency, or interoperability of these decisions for any entity invested in value. The details of how this looks with schemas containing data will follow in the Brief sections.

Cost of care for the year before hip fracture diagnosis vs. cost of care after (outpatient services only).



Section 3 Scenario Planning

Scenarios are stories about the future. These stories reflect a point of view of entities of the health care ecosystem. Stories incorporate wisdom, facts, and features of the ecosystem that are context for a particular entity and forecasting process. As a tool to focus input for a problem that may be critical for the organization, or to adapt to pressure from the ecosystem, scenario function is to trigger a discussion. This conversation may be broad base or narrowly focused. Drawing upon expectations of an organization that are not limited by the boundaries of topology, logic or any particular quantitative method, stories may be told that are inclusive. Scenarios give free rein. The purpose of scenarios is to lead organizations to recognize potential outcomes in the future, even those that have not occurred before and are impossible to quantify. Cost saving in health care has many cost saving programs transactional in nature that have not had a significant impact. Bending the curve towards value as a policy goal realizes some effect as transactional interventions, but could be more if potential outcomes were married to predictive outcomes as solutions for cost saving. The broadest possible scenarios can be the start of the process of change to achieve new and novel outcomes.

Because healthcare is stratified and complex, most if not all scenario statements will touch on a wide breadth of health care entities. These scale from the very small such as patient centered events to the very large such as government plans. An objective at one level, say a government plan for cost saving through accountable organizations, must be actuated at the smallest scale, the patient centered event. How does this work? A plan cannot directly affect an action at the patient level, but must do so by adjusting incentives originating from the plan and applied to the moment of the patient level.

This is tantamount to action at a distance, or transcending disparate scales. The complexity of health care exists at the population and the patient levels, but the complexity is different and it is difficult to translate across scales. The translation device currently in use is a very simple, non-complex compliance measure. It can be said that medical coding is anything but simple, but the real issue is does coding designed for compliance capture the complexity of the patient level high dimensional features used by providers for events at hand, treatment, prevention, assessment of the past, record maintenance, etc.

Many population level scenarios fall on the rocks of lack of transparency, lack of effective collaboration, imperfect coordination, but most of all failure to escape from too much reliance on transactional data that is limited by deductive only logic for analytic purposes. The reason the objective of a cost saving program is simple from the perspective of the task is that these programs do not account for or capture the fundamental process of patient level decision making. Captured by broad scenarios that do not shy away from transfactual, counterfactual logic that is inductive give a leg up as the start of translation devices.

The power of a scenario is from its creation using all forms of logic, starting from analogy, which is simply storytelling, moving to inductive reasoning which includes the yet to be determined but plausible transfacts originating in the storytelling, finally matching to the deductive realm of hard data. This is a level of rich complexity not possible with population data, but essential to incorporate into cost saving objectives.

Scenarios to be complete will reference crosstalk among the levels in the immediate ecosystem. The topology used in Health Care in 3 Dimensions shows relations among the entities. These noted in network terminology as nodes with links reflect both the complexity of each relation of the link and how the relations are built. For example, a code from a provider to a plan is a link. A compliance requirement from a plan to a provider is a link. Referrals among providers are links. These links are crosstalk. Other types of crosstalk include medical evidence, with well-defined entities that create the evidence and consume the evidence. The function and purpose of the infinitely large and complex links among providers, payors, vendors and others of the ecosystem is well understood. The problem, however, which point to the reason for formalizing scenarios, is that the networks and links become dysfunctional with a focus on internal optimization and resistance to change. New cost saving measures are therefore difficult to promote.

A well thought out, and carefully planned scenario will account for barriers to Value. The translation device to execute a scenario must include a topology of the ecosystem of relevance to an entity, and the logic that exists in information interchange among the entities. Because health care is complex and stratified, a method must insert into the crosstalk, or links, accounting for difference in scale. A topology to visualize relations creating the crosstalk; willingness to embrace fact and transfacts to highlight counterfactuals; transitions among events as information flow not simply additional codes that originate from a disparate entity; and a process of data reduction to present information that can be understood by entities of differing scale.

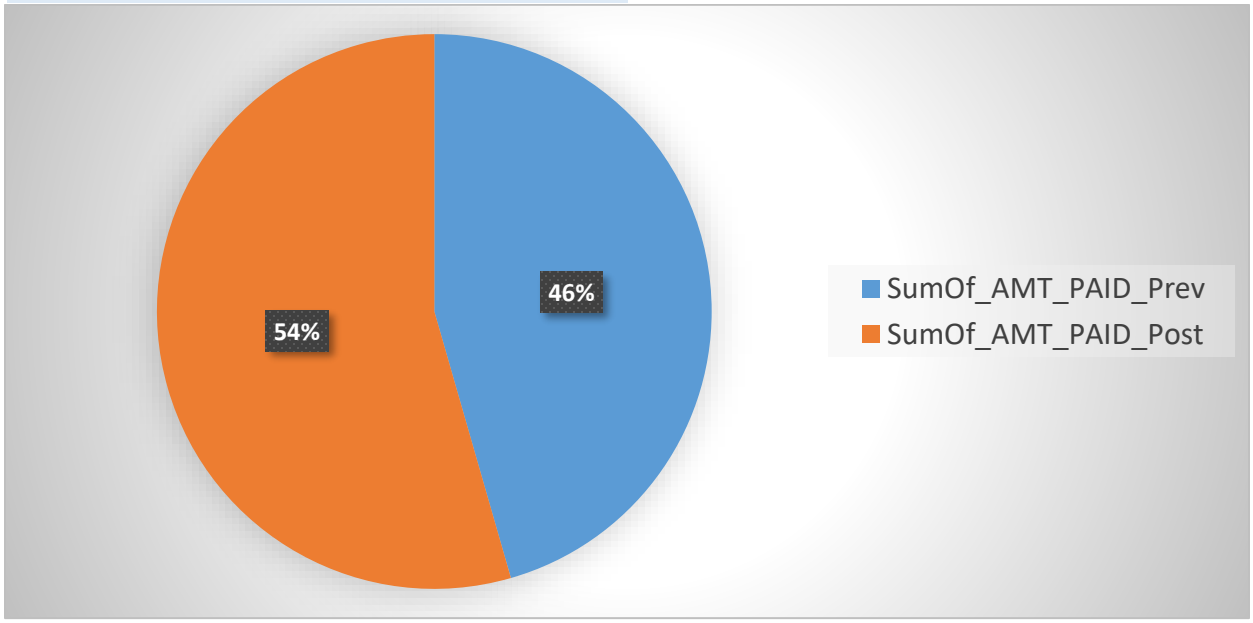
Retrospective analysis can serve as primer for future planning. What follows are two examples of how TennCare data was used to analyze costs and practitioner involvement prior and post hip fracture.

TennCare Example #1

Question: What was the cost of care for the year before a hip fracture compared to the cost of care after, outpatient services only.

Answer: Across the entirety of the transactions (T_CA_ICN) provided by TennCare the totals, year previous and year post (based on the date of the first Hip Fracture diagnosis) are as follows:

SumOf_AMT_PAID_Prev	SumOf_AMT_PAID_Post
$15,963,906.96	$19,085,725.39



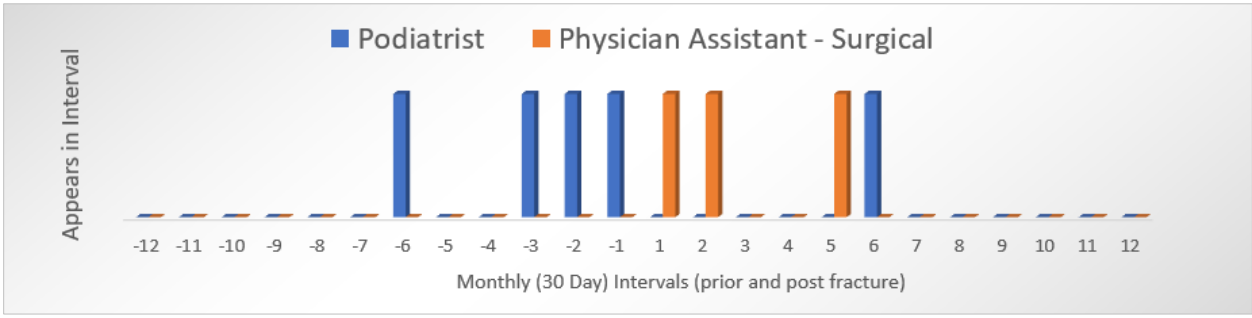
Note: Amounts paid on day of first diagnosis are included in the previous "bucket". Transactions that could not be associated with a specific recipient are excluded along with transactions where service dates (first/last) are not known. Also note amounts may not reflect adjustments depending on when and how they were applied. Additional analysis would be required to verify consistency of transactional amounts.

TennCare Example #2

Question: What providers, specifically practitioners, providing services in an outpatient role, "carry over" from interval-to-interval, in this case month-to-month.

Answer: To illustrate how this can provide insight it's best to look at one recipient (patient). We did not have to look far. The very first recipient (#605) showed a correlation in their patient journey that suggests at definitive causal relationship. In the 6 months prior to the fracture, the recipient had received services from a podiatrist (#2433) at least 4 times, at least 3 of those times in the last 3 months preceding fracture diagnoses. Another practitioner, a surgical physician's assistant (#347318), only appears after the fracture. This suggests the possibility that foot problems

contributed to a fall that resulted in the fracture. Obviously, further detailed analysis would be required to corroborate. HCn3D could analyze thousands of similar patient journeys, including those without a "hip fracture" to determine counterfactually why some patients had fractures and others did not. What was different about them as a patient and their journey?

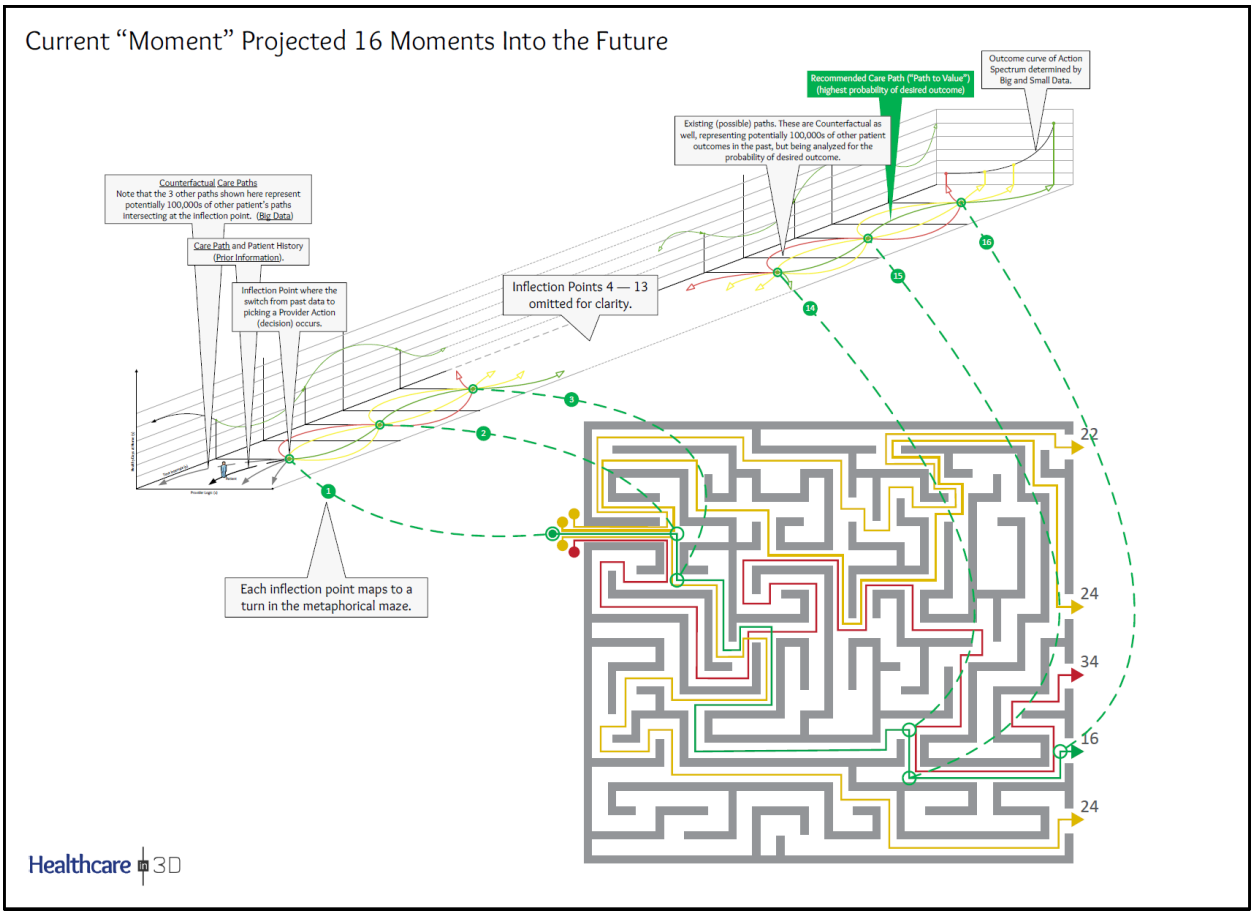


Note: Transactions on the first day of diagnosis are included in the previous interval.

SAK_RECIP	PROV_KEY	IntervalName	IntervalBegin	IntervalEnd	Appears	DSC_TAXONOMY
605	2433	Hip Fracture Interval Days Prior	-360	-331	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-360	-331	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-330	-301	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-330	-301	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-300	-271	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-300	-271	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-270	-241	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-270	-241	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-240	-211	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-240	-211	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-210	-181	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-210	-181	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-180	-151	1	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-180	-151	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-150	-121	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-150	-121	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-120	-91	0	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-120	-91	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-90	-61	1	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-90	-61	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-60	-31	1	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-60	-31	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Prior	-30	0	1	Podiatrist
605	347318	Hip Fracture Interval Days Prior	-30	0	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	1	30	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	1	30	1	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	31	60	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	31	60	1	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	61	90	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	61	90	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	91	120	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	91	120	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	121	150	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	121	150	1	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	151	180	1	Podiatrist
605	347318	Hip Fracture Interval Days Post	151	180	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	181	210	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	181	210	0	Physician Assistant - Surgical
605	2433	Hip Fracture Interval Days Post	211	240	0	Podiatrist
605	347318	Hip Fracture Interval Days Post	211	240	0	Physician Assistant - Surgical

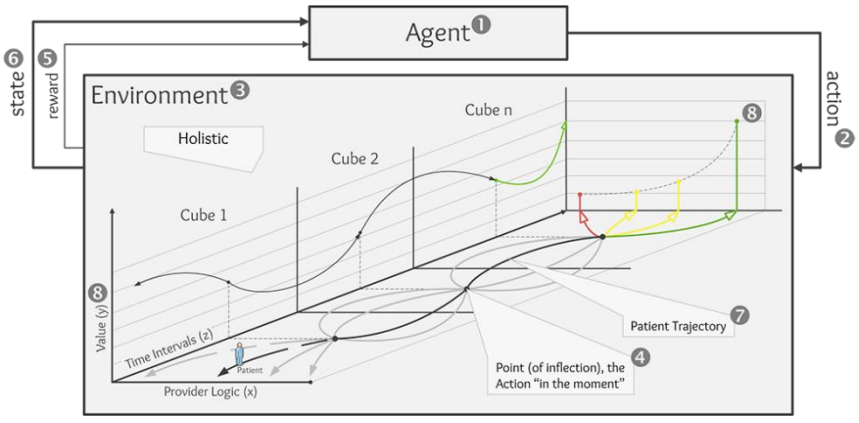
Month	Podiatrist	Appears (1=yes)	Phy. Assistant	Appears (1=yes)
-12	2433	0	347318	0
-11	2433	0	347318	0
-10	2433	0	347318	0
-9	2433	0	347318	0
-8	2433	0	347318	0
-7	2433	0	347318	0
-6	2433	1	347318	0
-5	2433	0	347318	0
-4	2433	0	347318	0
-3	2433	1	347318	0
-2	2433	1	347318	0
-1	2433	1	347318	0
1	2433	0	347318	1
2	2433	0	347318	1
3	2433	0	347318	0
4	2433	0	347318	0
5	2433	0	347318	1
6	2433	1	347318	0
7	2433	0	347318	0
8	2433	0	347318	0
9	2433	0	347318	0
10	2433	0	347318	0
11	2433	0	347318	0
12	2433	0	347318	0

Section 4 Reinforcement Learning



Reinforcement learning targets opportunities for cost saving intervention by scenario planning. Framing the ecosystem by scale facilitates links among entities and across scales. This allows reinforcement learning to have effects in the broad complex and stratified ecosystem including not just individual entities, but networks of many dimensions.

Framing these opportune targets by information production specified by scenario planning allows the ability to measure effects of interventions in multiple dimensions.



Many tools provide feedback from knowledge gained at all levels of the ecosystem to effect change. The result of tools is information about the quality and cost of actions, with the result intended to reinforce optimal actions using rewards or penalties.

Reinforcement learning differs from other analytic and interventional tools in that rewards from

actions occur at the time of the action, and not later. The challenge of reinforcement learning exists because the reward follows outcomes from the future unknown to the agent making a decision in real time. Retrospective information is the foundation of predictive modelling used to inform actions. These actions have a deterministic relation to the future meaning that knowing prior information from the ecosystem and the patient, and the preferences or behavior of the agent making the action result have a predetermined outcome. A less strong statement reflects a statistical distribution of possible outcomes. For medical evidence this range of outcomes possible based on the past does not reflect the full range of potential outcomes. The familiar programs for accountable care are entirely retrospective, and do not account for the uncertainty posed by outcomes not reflected in information from the past. The past because entities of the ecosystem and the patient are complex and stratified has information of many levels.

The key difference in retrospective predictive modelling from interventions by reinforcement learning resides in the difference between actions and decisions. In the medical context of cost containment codes denote actions, and reflect medical actions as transactions. However, in the real world of actions in the context of an ecosystem, patient specificity of information in the past, and choices in the moment, decisions precede actions. Decisions reflect more of an open-ended source of patient level information that is not deterministic nor statistical. Decisions because they are real time must exist with uncertainty about potential outcomes. Therefore, the real time creation of rewards follows actions that synthesize the known and uncertain potential outcomes. The reward frames the decision as the best choice of action in the moment. The question pushes optimization in the moment to real time. Optimizing the decision pushes the question back to the past with predictive modelling called upon to give a range of action choice from which the agent in the moment real time makes a decision.

Distributional potential outcomes, DPE, is the technical term for matching predictive modelling statistically to decisions in the moment of uncertainty. (Nature| Vol 577| 30 Jan 2020 page 671). There must exist a mediator between the past and the future to justify a reward given real time before the future exists. An interesting addition to reinforcement tools comes from psychiatry, specifically in the area of major depression. (Annu. Rev. Neuro. 2015. 38:1-23). The link between past and future in the mind of the patient is a schema. This model exists before the agent, in this case a patient, makes a decision. One can imagine parallels between value-based purchasing and decisions in a psychiatric context. Both compare an objective state of the world with many future outcomes, and a subjective knowledge of this state to select decisions with the greatest potential to optimize the outcome. The model used for the objective state of the world is a schema.

To reiterate, crafting cost saving objectives is a challenge when the scope of potential cost saving can be as large as an ecosystem. Reinforcement learning places the ecosystem level objectives in the context of the individual actor in the moment. Because the method described in this white paper crosses boundaries of organizations within the ecosystem or a subset of the ecosystem, there can be barriers to Value when the cause of inappropriate costs exists outside of normal organizational boundaries structured as knowledge and operations. The premise of the most important characteristics of the ecosystem is that it is complex and stratified, as explained in the sections on topology and logic. For any organization, no matter how large, knowing the segments and structure

of the ecosystem relevant to the operations and success of the organization, is mostly not possible. The ecosystem is layered, stratified, unmeasurable and known in a limited way by the boundaries that apply to entities.

To take a scenario, and decide how to apply a learning environment to a transactional ecosystem, is the start of a process to work through the layers and complexity of the ecosystem. Although entities have business processes in place, the need to adapt well-worn paths to pressure for change requires an organization to look outside itself. Although organizations can look within itself, this will at most result in more efficiency in operations and possibly marketing. For the change needed for cost saving, the search for inputs for learning must be broad.

The progress from identifying a need, to creating a scenario, to building a plan can occur within the boundaries of an entity within its known place in the ecosystem. However, reaching further, in fact to know where and how to reach, needs direction from the learning process. The learning step if done well and thoughtfully moves past the boundaries of the entity into a larger space of the ecosystem. To do this the ecosystem cannot be amorphous. The framework of HealthCare in 3 Dimensions offers a start in applying structure to the ecosystem. The dimension of the patient, the networks, and ultimately Value set the stage for the first cut at working through a scenario. Next, the scenario statement sets the boundaries posed by an entity and specifies the complexity of each entity that has a relation to the organization stating the scenario. Generating a scenario, which can be a free form story about the needs and direction of an entity, the information intrinsic to the entity matches information extrinsic to the entity from the surrounding relevant world of a subset of the ecosystem. This process of naming the intrinsic/extrinsic difference based on the boundary of the entity allows a deeper structure to emerge that describes a larger complex scope of operations of the entity.

The progress of designing the scenario, moving beyond the transactional bounds of all cost containment programs, moves to the transcendental, or transfactual dimensions. This strange notion in fact describes the common practice of agents deciding actions, appropriately using potential outcomes of the actions, using the combinations of known and unknown data, potentially relevant factors affecting outcomes as inputs to decisions. Thus, the success of scenario planning depends on following not only the trail outlined by the scenario itself, but complex extrinsic factors that complement the intrinsic entity centric data. This process describes clinicians as agents, operating in a maze imposed by the extrinsic factors, doing the best they can to move the moment of the action in a more cost-effective direction. Example scenarios will describe the details of this kind of scenario planning in the real world.

Reinforcement learning brings together all facets of a method for cost reduction. Beginning with a scenario, developed by a health care organization, logic defines the elements of the scenario as facts supporting deductive analysis, transfacts supporting inductive reasoning in the maze of the ecosystem, and analogy to translate the stories of the scenario to a form that can produce a plan. The plan builds schemas, from data reduction steps, that allow agents of cost reduction to interact with agendas of entities at many levels. This step of creating schemas, at the direction of organizations initiating the scenario, is how reinforcement learning links rewards of the moment to future outcomes.