Knowledge Management for the 21st Century Hospital System

The Quality Colloquium at Harvard
Patient Safety Officers' Workshop
August 23, 2003

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President & COO

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Patient Safety Quality Management Solutions

Presentation Outline

- A Systems Approach for Collection, Classification & Analysis of Close-calls and Medical Events
- A Process Based Quality Management System For Healthcare
- An Intelligent System for Patient Safety Quality Management

Requirements from Health and Human Services, AHRQ, CMS, NQF and the Leapfrog Group

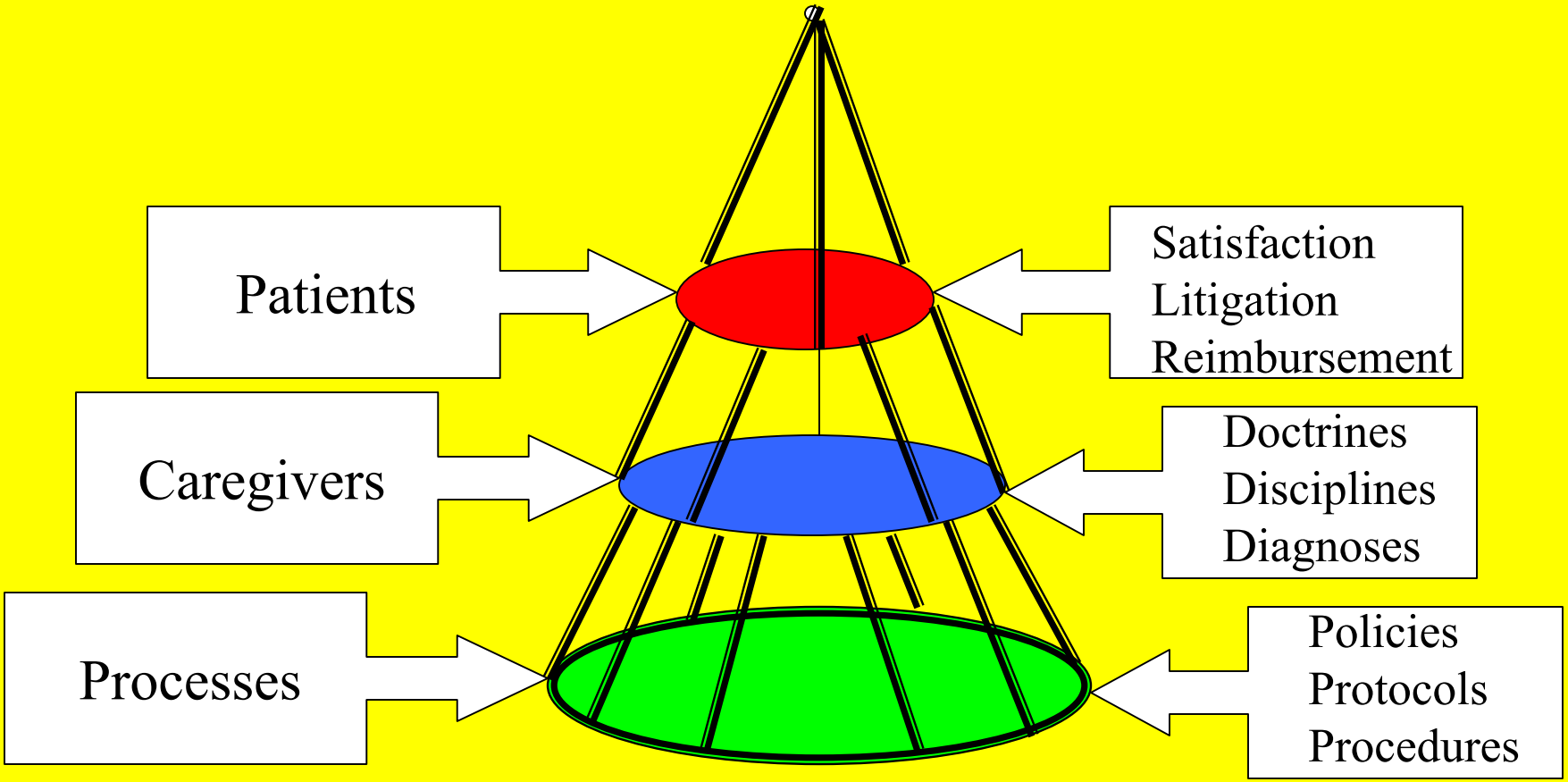
1. CMS requirement for a Health Care Quality Management System

2. Need for event reporting system

3. Need for e-Health IT, CPOE and EMR systems

A Systems Approach

- A systems approach is needed to integrate human resource solutions with organizational needs and priorities.
- Systems thinking recognizes that everything is interrelated and that an action or an event in one part of the whole affects all of the other parts.



Driving Forces, Restraining Forces and Equilibrium Behind Quality in the Health Care System

Examples

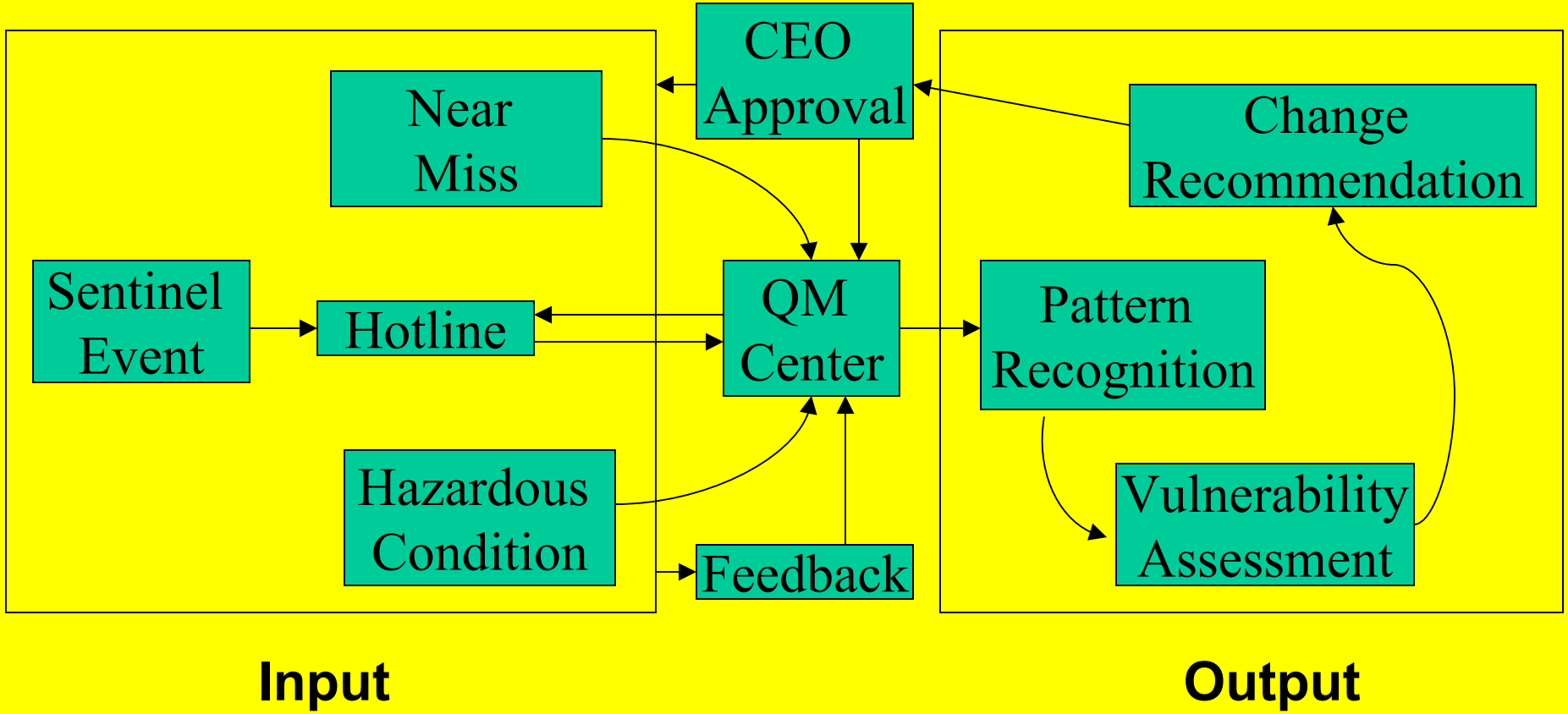
Driving Forces

- Direct behavior away from a steady state
- The need to get work done
- Being a good team leader

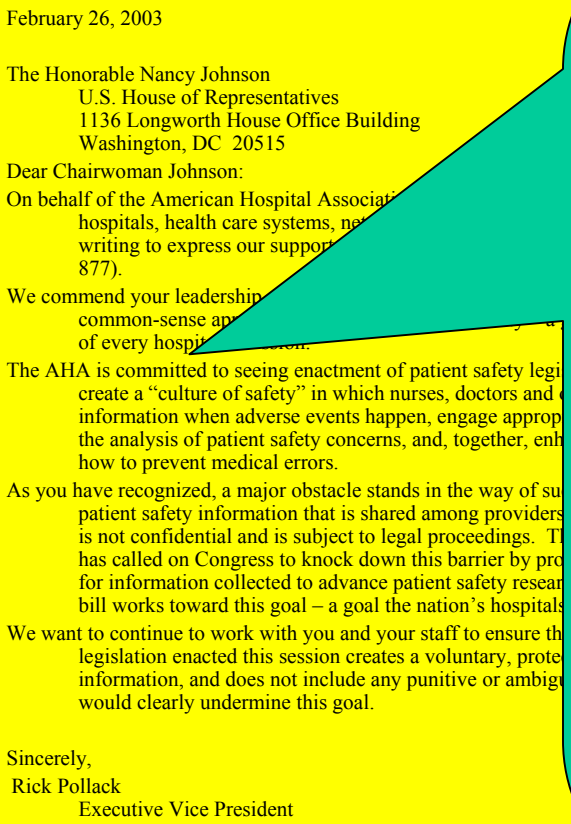
Restraining Forces

- Hinder movement toward a desired goal
- Prevent the job getting done properly
- Poor scheduling makes people late

Medical Event Management System



American Hospital Association



February 26, 2003

The Honorable Nancy Johnson
U.S. House of Representatives
1136 Longworth House Office Building
Washington, DC 20515

Dear Chairwoman Johnson:

On behalf of the American Hospital Associati
hospitals, health care systems, ne
writing to express our support
877).

We commend your leadership
common-sense ap
of every hospi

The AHA is committed to seeing enactment of patient safety legi
create a "culture of safety" in which nurses, doctors and
information when adverse events happen, engage approp
the analysis of patient safety concerns, and, together, enh
how to prevent medical errors.

As you have recognized, a major obstacle stands in the way of su
patient safety information that is shared among providers
is not confidential and is subject to legal proceedings. T
has called on Congress to knock down this barrier by pro
for information collected to advance patient safety resear
bill works toward this goal – a goal the nation's hospitals

We want to continue to work with you and your staff to ensure th
legislation enacted this session creates a voluntary, prote
information, and does not include any punitive or ambigu
would clearly undermine this goal.

Sincerely,
Rick Pollack
Executive Vice President

The AHA is committed to seeing enactment of patient safety legislation that will help create a "culture of safety" in which nurses, doctors and others can share information when adverse events happen, engage outside experts in the analysis of patient safety concerns, and, together, enhance our knowledge of how to prevent medical errors.

Chicago Hospital to Invest in EMRs

Chicago hospital to inves

March 27, 2003

Chicago's Advocate I
spend $5.5 million on
portion
hospital inte
and adopt electr

The 551-bed hospital a
budget on an electronic int
clinicians monitor patients using audio and video
technology. Physicians at a central
Brook, Ill., also will help the hos
patients. In a
women's imaging
surgical units (Japsen,

Advocate Health Care, which
provider in Illinois, announced
eight hospitals in Chicago usi
Visicu. The initial implementat
Advocate Lutheran General a
hospitals in Chicago

Chicago's Advocate Illinois Masonic Medical Center will spend $5.5 million on new information systems, the largest portion of the hospital's $30 million renovation project.

"We're moving closer to the electronic medical record, an important tool to reduce medical errors," said Karen Kansfield, Vice President, Business Development.

Taking Care of the Caregiver

Reducing vulnerability to the threat of medical errors, through a…

- Trust-based
- Non-punitive
- Proactive
- Confidential

Patient Safety Event Reporting System

What should a *Patient Safety Event Reporting System* be designed to do?

- Increase patient safety
- Analyze and reduce costs
- Mitigate the potential for harm caused by medical errors
- Increase caregiver and patient satisfaction
- Enhance process-based quality management & performance improvement

Our Situation Today

- Tens of thousands die, and hundreds of thousands are maimed or injured every year in the United States, as a result of preventable medical errors.
- *Variation* in care provided, and lack of dissemination of evidence-based best practices are factors leading to preventable medical errors.

Considerations

- Our process variations that contribute to these errors are being questioned
- Healthcare is being forced to give way to a newer model for providing better goods and services through changes and processes as were the medieval European guilds that were abolished in the 19th century

Case Review
A Communication Error

This is an example of a workplace culture that did NOT have a process imbedded into the system to identify potentially harmful events, and hazardous conditions that eventually led to an *undesirable outcome*.

An Error in Communication

- A patient in Open Heart Surgery dies
- Surgeon talks to the family, who accepts the death after explanation
- Surgeon dictates post operative report - *Reason for death: Pump Failure*

Error in Communication Cont..

- Surgeon gets certified letter –

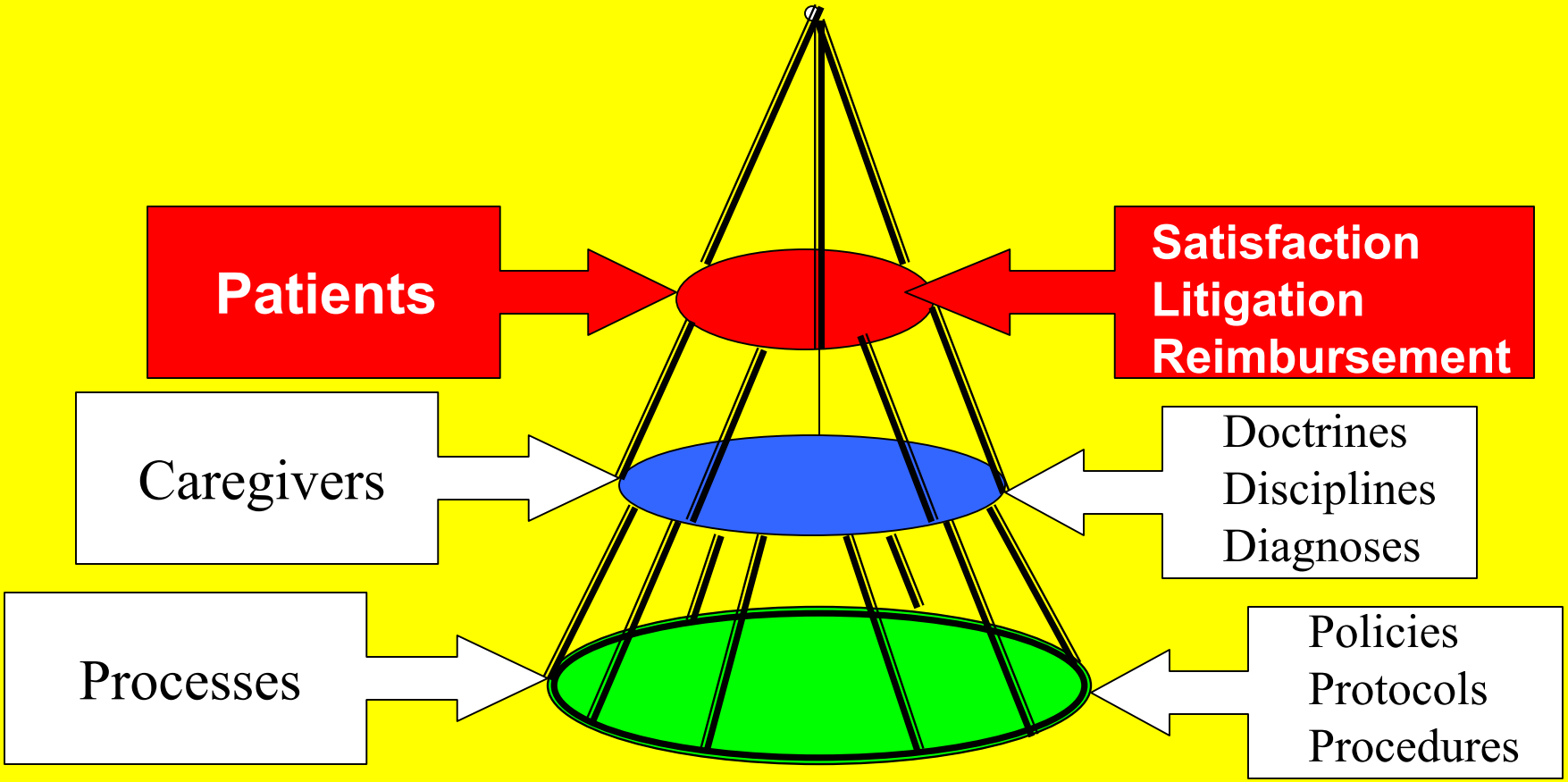
  1. Accusation of malpractice
  2. He lied to the patient's family

Error in Communication Cont..

- Surgeon wrote ‘pump failure’ meaning the “heart = pump” failed i.e. heart failure
- The family and attorney took it to mean the ***bypass pump*** failed and the perfusionist was at fault – plus – the surgeon “lied”

Litigation Outcome

- Outcome – 5 years + time + $$$ to resolve
- Case was finally dropped



Driving Forces, Restraining Forces and Equilibrium Behind Quality in the Health Care System

Case Analysis

If we had an event reporting and analysis system in place:

1. What should have we been able to find out?
2. What were there errors of omission and commission?
3. What recommendations could we have come up with to prevent reoccurrence?

Error in Process of Care (Case 1)

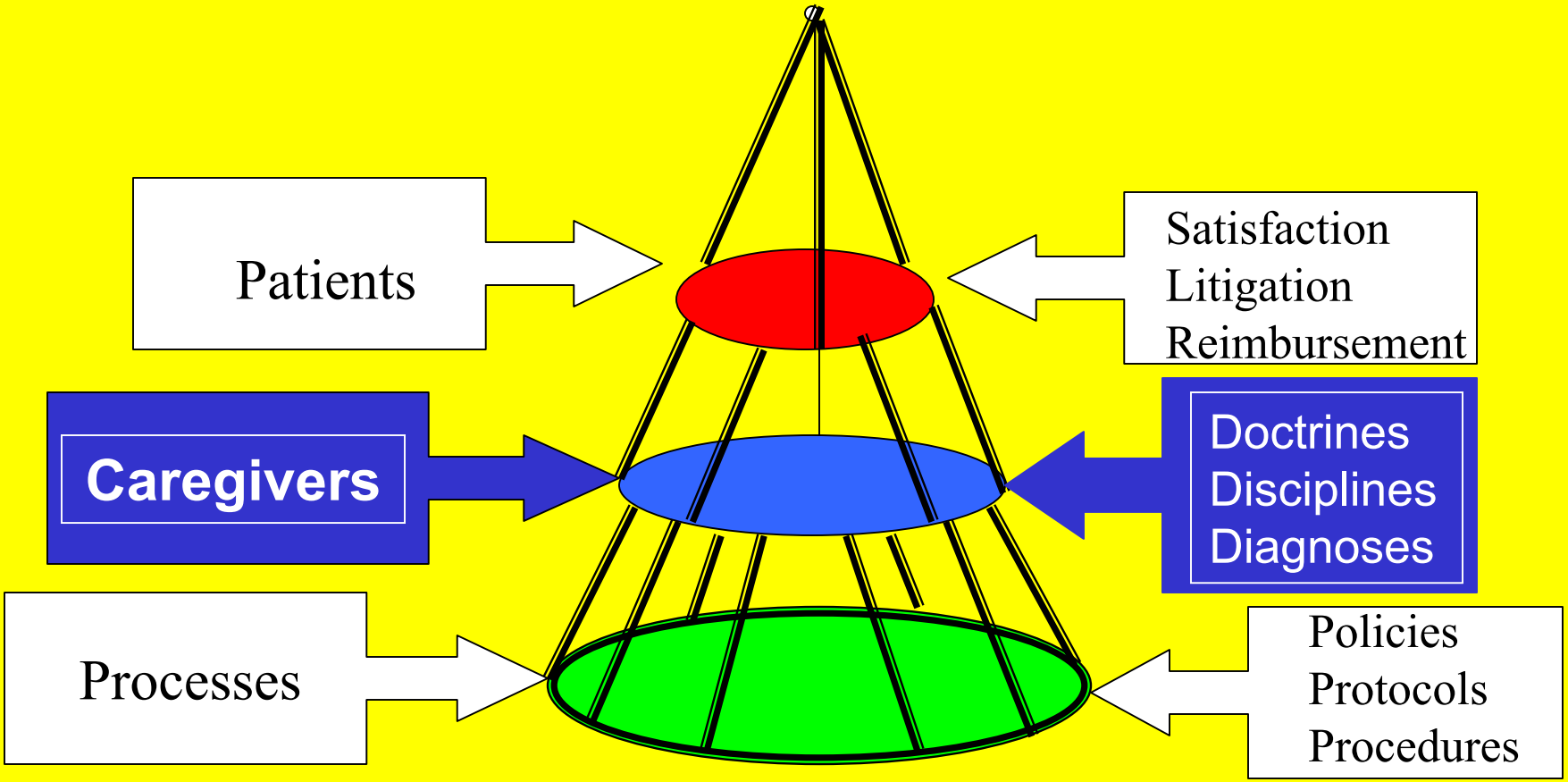
- After Open Heart Surgery the Anesthesiologist forgets to give Protomine to the patient
- Patient bleeds
- Surgeon diagnoses DIC and starts to treat DIC

- Perfusionist searches the records and cannot find notation that Protomine was given
- Perfusionist tells the Thoracic Surgeon
- Surgeon does not believe him and continues to treat DIC

- Perfusionist tracks down the Anesthesiologist who is now in another case
- Anesthesiologist does not recall giving the drug – he leaves the OR to talk to the Surgeon
- Protamine is given and the patient gets better
- NO BAD outcome to the patient

Discussion

- What would you have done to prevent recurrence of this event?
- If you were the Anesthesiologist?
- If you were the Perfusionist?
- If you were the Surgeon?
- If you were the CEO or CMO?



Driving Forces, Restraining Forces and Equilibrium Behind Quality in the Health Care System

Error in Process of Care (Case 2)

- One month later – same Thoracic Surgeon, same Anesthesiologist in an Open Heart surgery case
- Surgeon called to the Post Anesthesia Care Unit (PACU)
- Patient bleeding – looks like DIC

- Surgeon STAT pages the Anesthesiologist
- He was in the OR and could not respond
- Surgeon STAT pages Perfusionist who responds but does NOT know if Protamine was given

- Notation could not be found on the chart that Protamine was given
- Surgeon starts to RX but stops
- Perfusionist goes to OR and finds an EMPTY Protamine bottle and gives it to the Thoracic Surgeon

- Surgeon believes that Protamine was given and starts treatment for DIC
- Patient dies

  (Note: most DIC patients die)

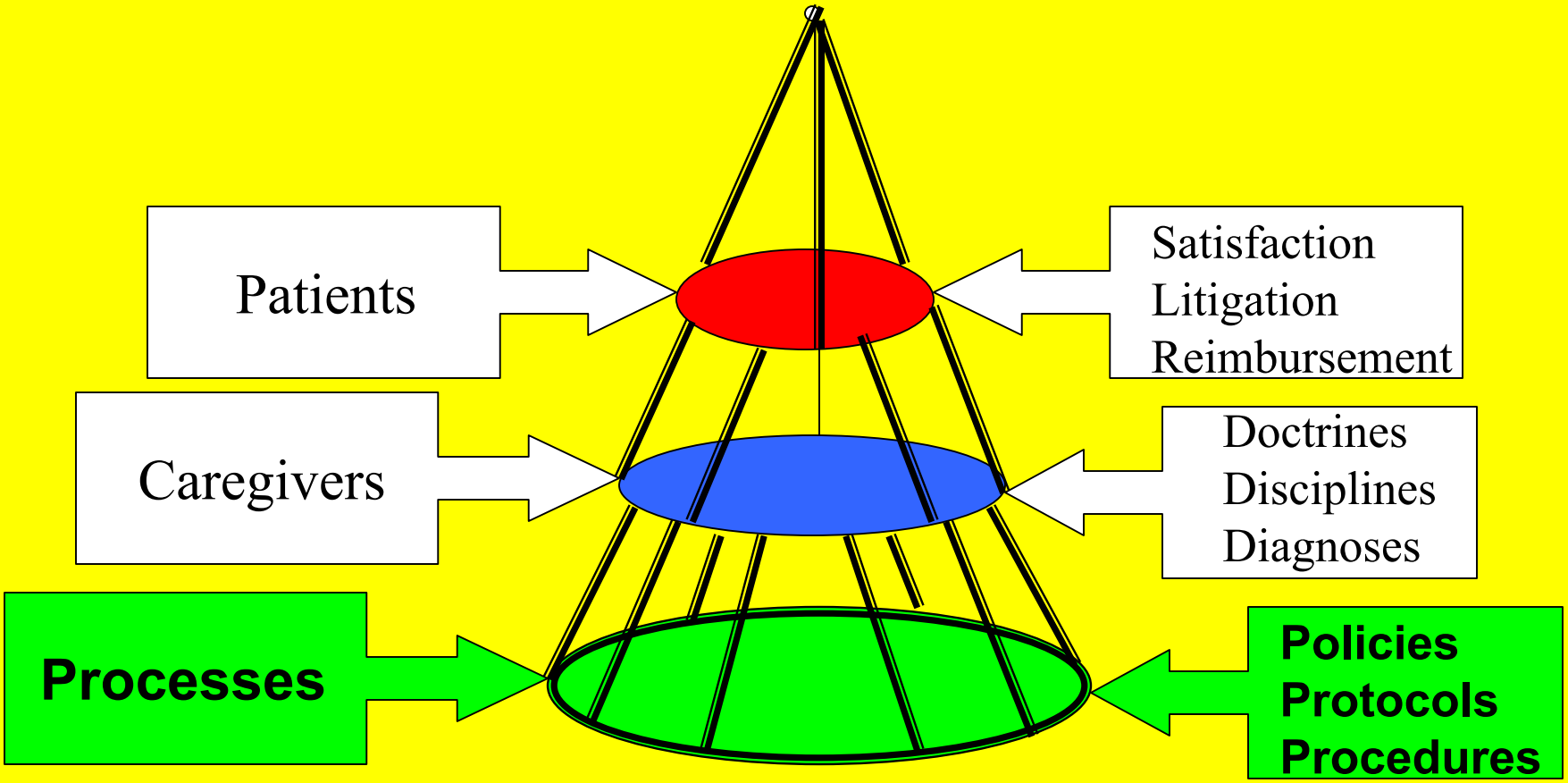
Winds of Change

- Today in healthcare we are being forced to reduce *variation* in our practices and provide evidence-based medicine

- By doing this we will reduce medical errors, provide better quality care and better service to our patients

Summary

- Impact on the *attitudes* of our future healthcare providers
- At institutions, students and post-graduate trainees in medicine, nursing, and pharmacy are increasingly taking a *systems approach* to healthcare
- Caregivers must be part of the solutions to patient safety problems



Driving Forces, Restraining Forces and Equilibrium Behind Quality in the Health Care System

A Process Based Quality Management System For Healthcare

Quality System Goals

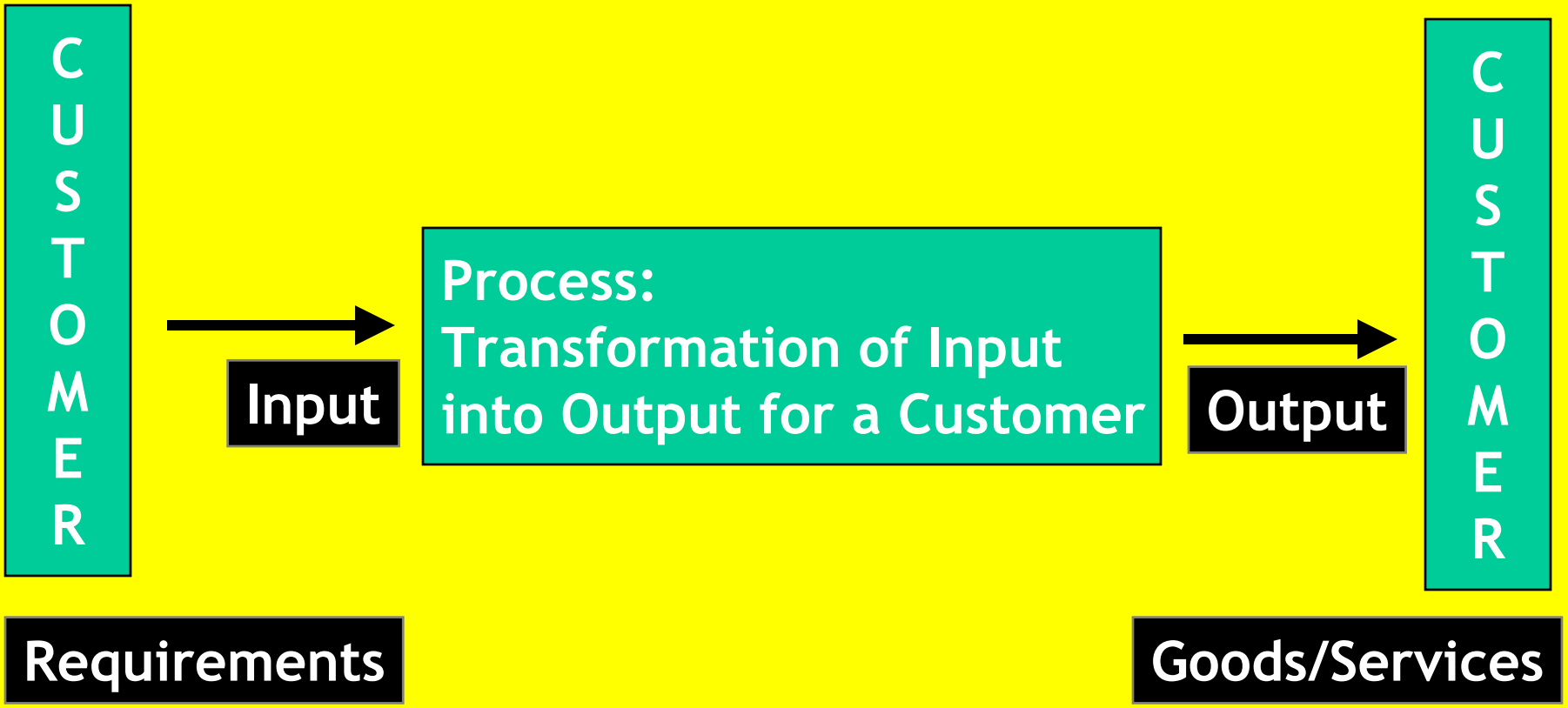
- Develop, implement, maintain & continually improve healthcare quality management system
- Enhance patient safety & error prevention
- Increase effectiveness and efficiency
- Conform to established health care industry requirements and standards
- Reduce variation and waste
- Increase patient satisfaction

Description

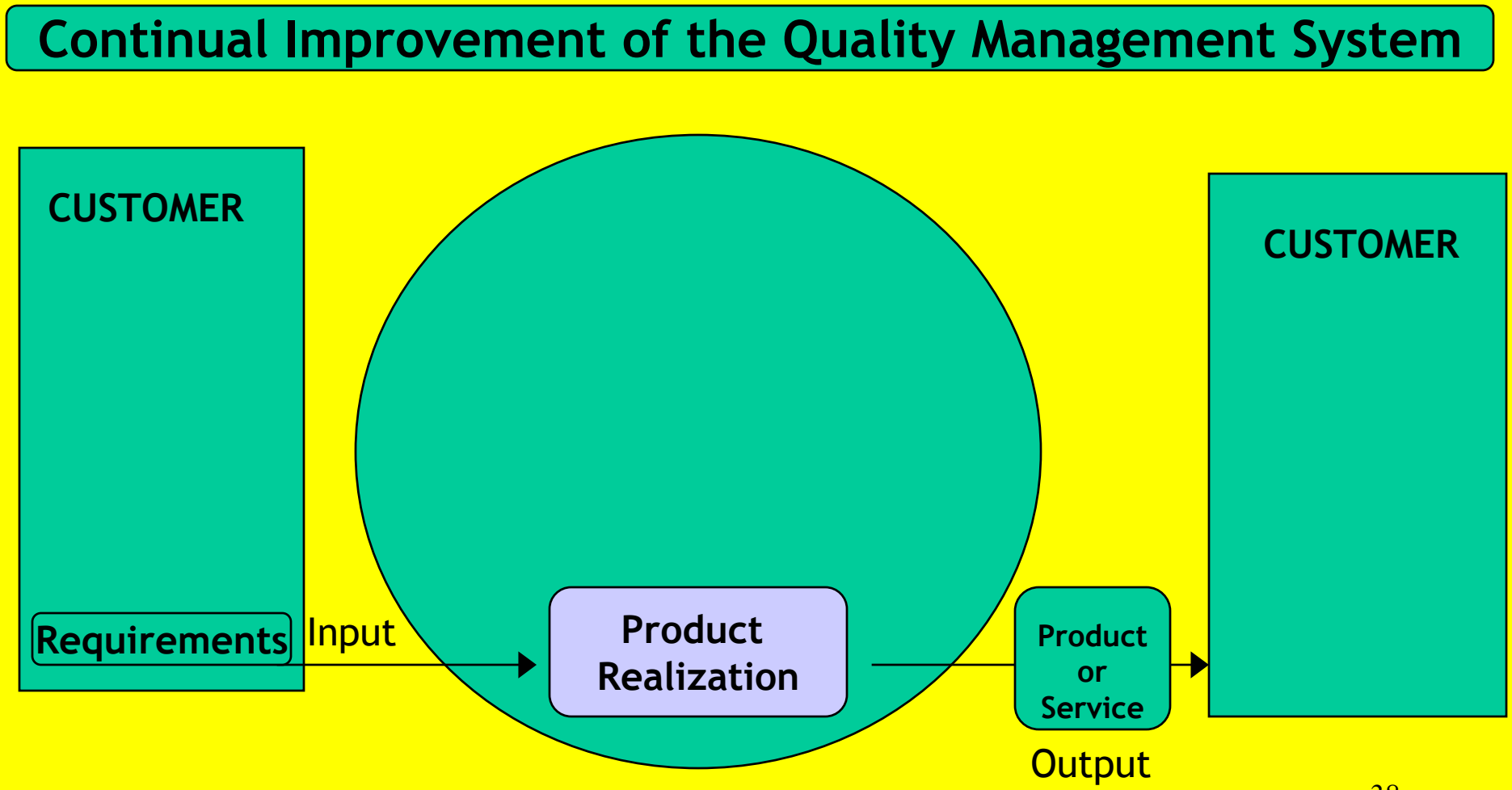
- Generic approach
- Applicable to all sectors and sizes of organizations
- Straightforward implementation using defined methodologies such as process management and improvement

The Process Approach

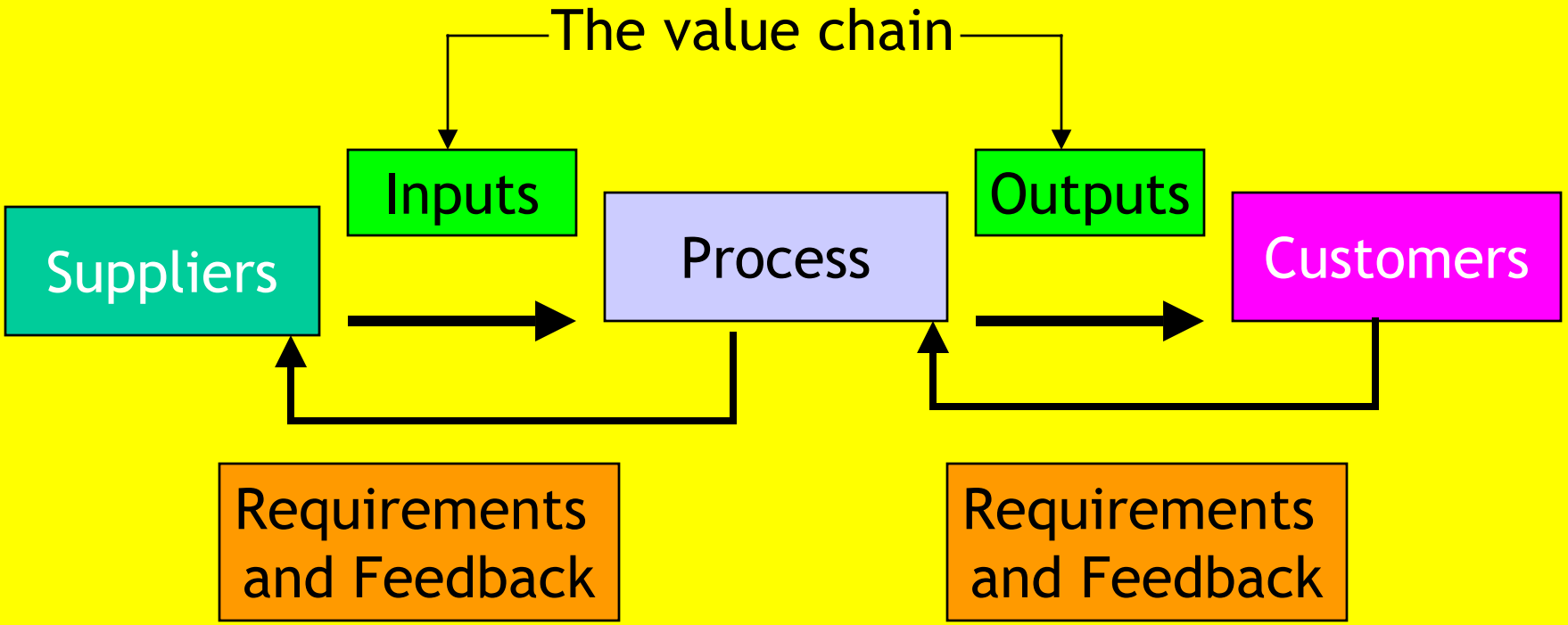
The Customer



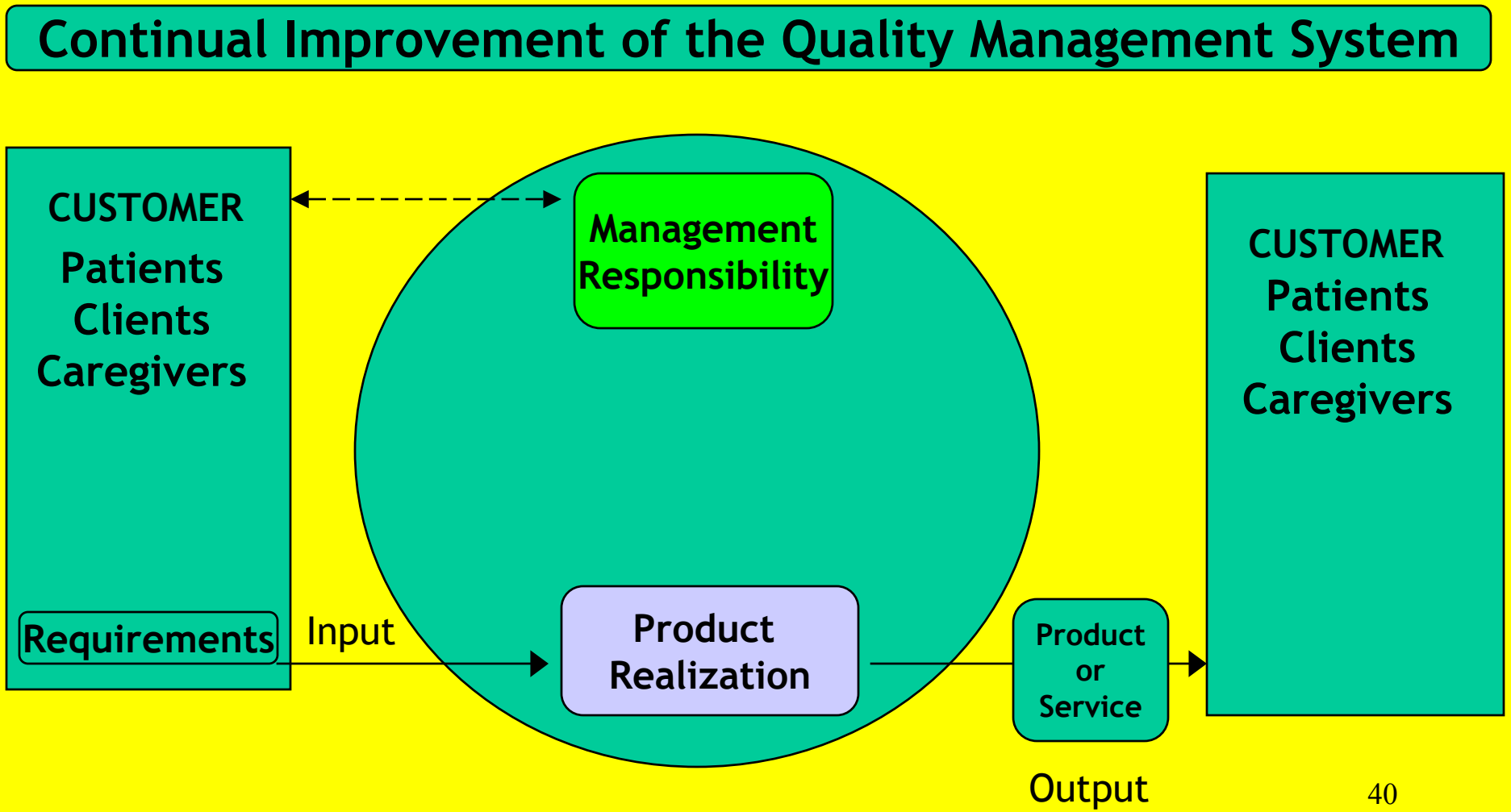
Product Realization



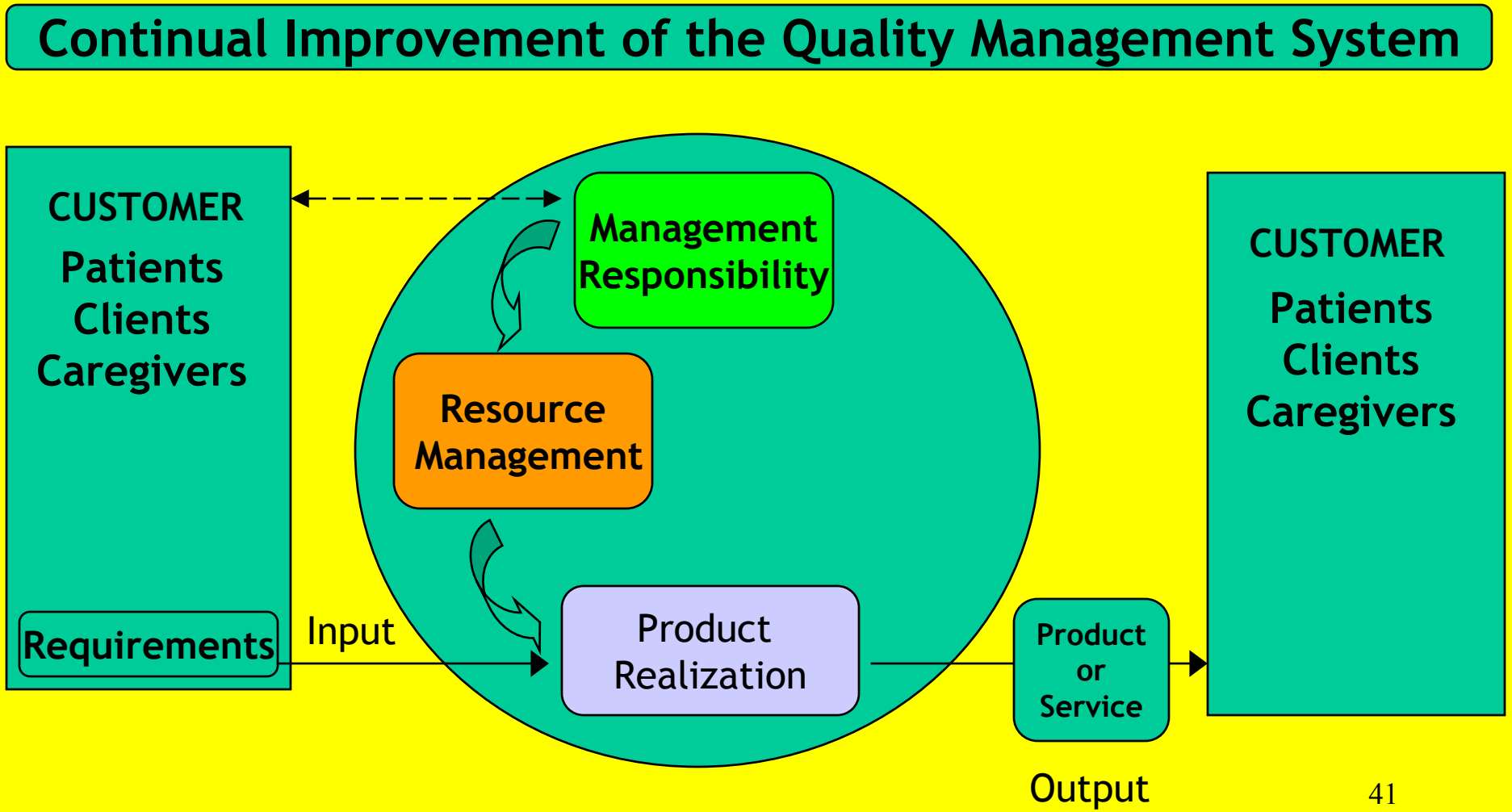
Relationships Between Suppliers and Customers of the Process



Management Responsibility

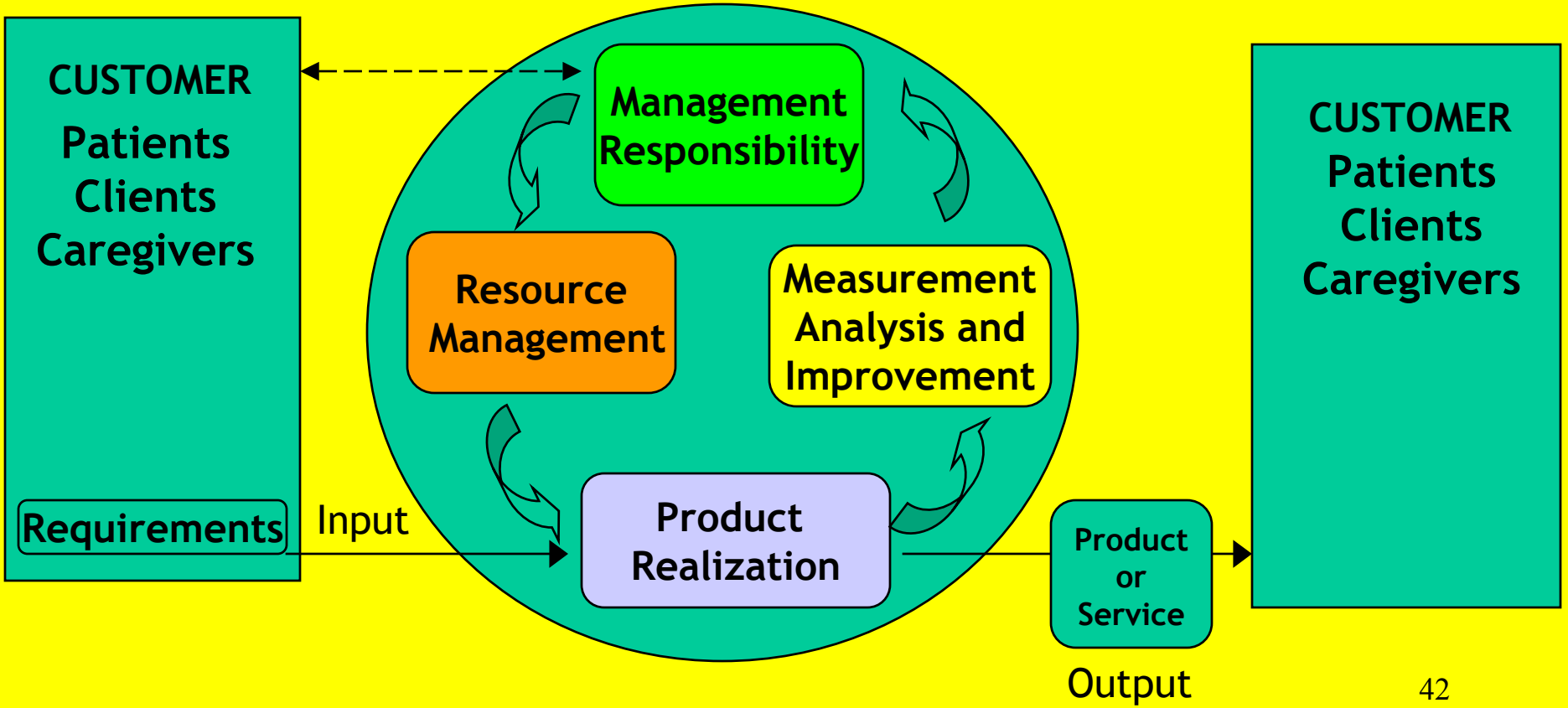


Resource Management

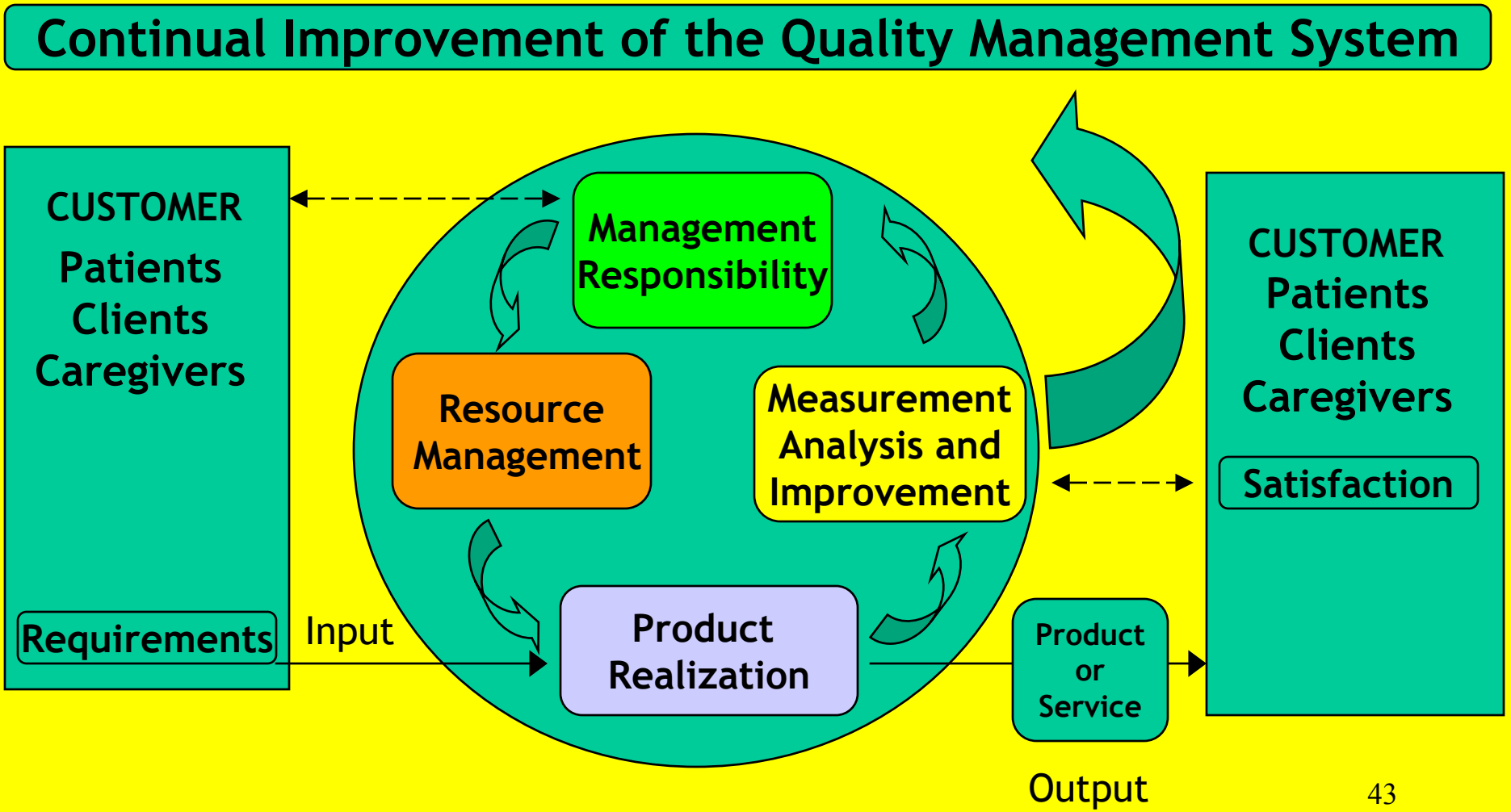


Measurement Analysis & Improvement

Continual Improvement of the Quality Management System



Model of a Process Based Quality Management System



Summary of the Process Approach

- All work should be viewed as a process and part of a system
- Directly manages the creation of value horizontally across functional departments
- Reduces quality problems that occur at department boundaries
- Directly ties process measures of performance to customers needs and suppliers performance

Summary cont…..

- Focuses process performance on what is important to customers
- Strong model for continual improvement
- Gaps between customer requirements and process performance provide an ideal starting place for improvement efforts
- Directly supports the systems approach to management
- Improvement involve everyone and every level of the organization

Regulation, Accreditation Standards And Certification

- Agencies and organizations:
  - JCAHO Joint Commission of Accreditation of Healthcare Organizations
  - Malcolm Baldrige National Award
  - NCQA The National Committee for Quality Assurance
  - URAC now American Accreditation Healthcare Commission
  - CMS Centers for Medicare/Medicaid Services

Team/Resources

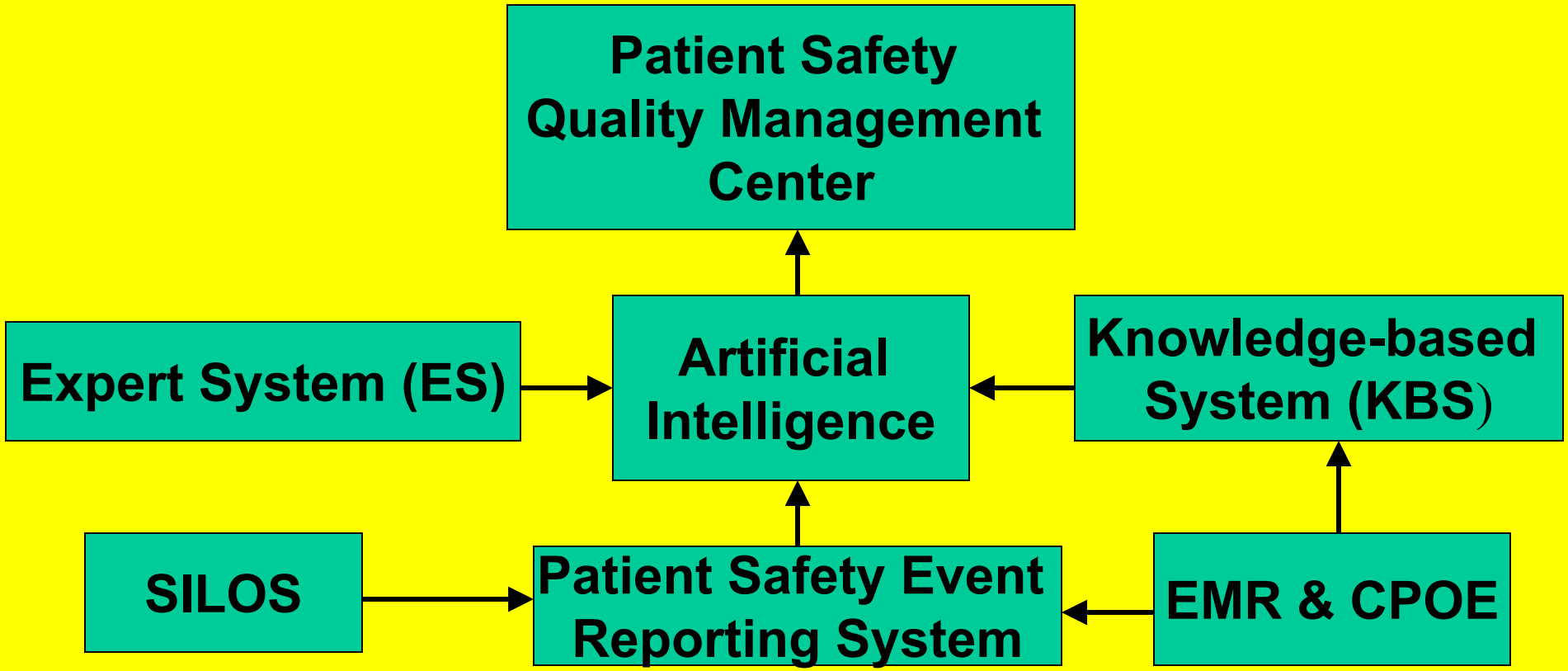
- Resources
  - Senior management supervision
  - Certified trainers
  - Qualified analysts
  - State-of-the-art technical support
  - Continued Quality Support
  - Browser-based IT systems

Procedures

- Policies, procedures, methods, and technologies currently in use should be included, to the maximum extent possible, to ensure system continuity and minimum disruption to daily activities.

An Intelligent System for Patient Safety Quality Management

Tools for Patient Safety Quality Management



Artificial Intelligence

- Artificial Intelligence (AI) is the integration of knowledge-based Systems (KBS) and Expert Systems (ES)
- KBS provide computer-based automation of *logical* reasoning
- KBS use AI techniques to perform *deductive* and *inductive* reasoning

Knowledge-based Systems (KBS) and Expert Systems (ES)

- KBS and ES utilize domain knowledge and reasoning strategies of one or several experts captured through knowledge elicitation and modeling (Knowledge Engineering)
- The KBS is automated to support either the systems experts themselves or other knowledge workers

Business Intelligence

- "**Business Intelligence**" means all methodologies and technical tools that:
  - **Produce knowledge** from a world of distributed, partial, confused and unstructured information;
  - **Exploit data**, turning it into information and extracting the value for business;
  - **Transfer** the right information to offer the right product or action into the hands of the right person at the right moment;
  - **Support** ongoing and future management decisions.

Value Added

Two classes of technological solutions

- Research and development carried out in statistics, mathematics, physics and, more generally, in the field of **cognitive sciences**, has brought about the realization of **two classes** of technological solutions able to:

  1. **Classify**, analyze, segment, correlate, and cluster the data and information
  2. **Forecast** trends and behaviors.

  Methodologies and tools used are the result of many years of experience carried out with partners in academic and industrial applications.

Why These Solutions Are Unique

- These methods and software are characterized by high precision in determining correlations and forecasts.
- This is made possible because this process has been conceived and implemented in a unique environment, at a crossroads between research and industrial development.
- Some of these tools were developed through the implementation of original theories.

Performance

- Some examples of performance obtained in order to classify and forecast:
  - The performance of correct classification reach more than 90% in credit scoring, fraud detection and market analysis;
  - The performance of forecasts for any time series are never less than 80%.

Choice of the Technique

- It is not possible to establish, a priori, which data mining technique is more proper for the problem.
- We need to select a choice depending on two factors:
  - the data mining objective to be reached
  - the available data for the analysis, because not all kinds of techniques are suitable for all data.
- It could be necessary to apply several simultaneous kinds of techniques to solve the single problem and to introduce in the models some kind of rules belonging to the knowledge of the single problem.

Detection Solutions

- The main data mining techniques used in Detection Solutions are:
  - neural networks
  - decision trees
  - decision tables
  - naive bayes
  - clustering methodologies

Methodology Used

- Building data representations that maximize the power of discrimination between good and bad events (pattern-related enhancement).
- Segmented forecasting classification model:
  - Mature or frequently done event model
  - New or sparsely done event model
- Use of rules derived from specific domain knowledge.

Complex Indicators

- Implementation of complex indicators in order to define potential incidents.
- Use of specific techniques in order to build clusters characterized by risk density (potential incidents).
- More specifically, implementation of:
  - Data representation through indicators with selected critical threshold indicators.
  - Non-supervised clustering classification model, based on estimation/maximization techniques.
  - Geographical data layering with corresponding clustering models.
  - Semantic representation of graphs and tables for the cluster's interpretation.

Analysis Requirement

- Two activities are key to the early recognition/detection of conditions, action, or lack of action that have the potential to cause medical errors:

  1. Classification: analysis, segmentation, correlation, and clustering of the data and information.

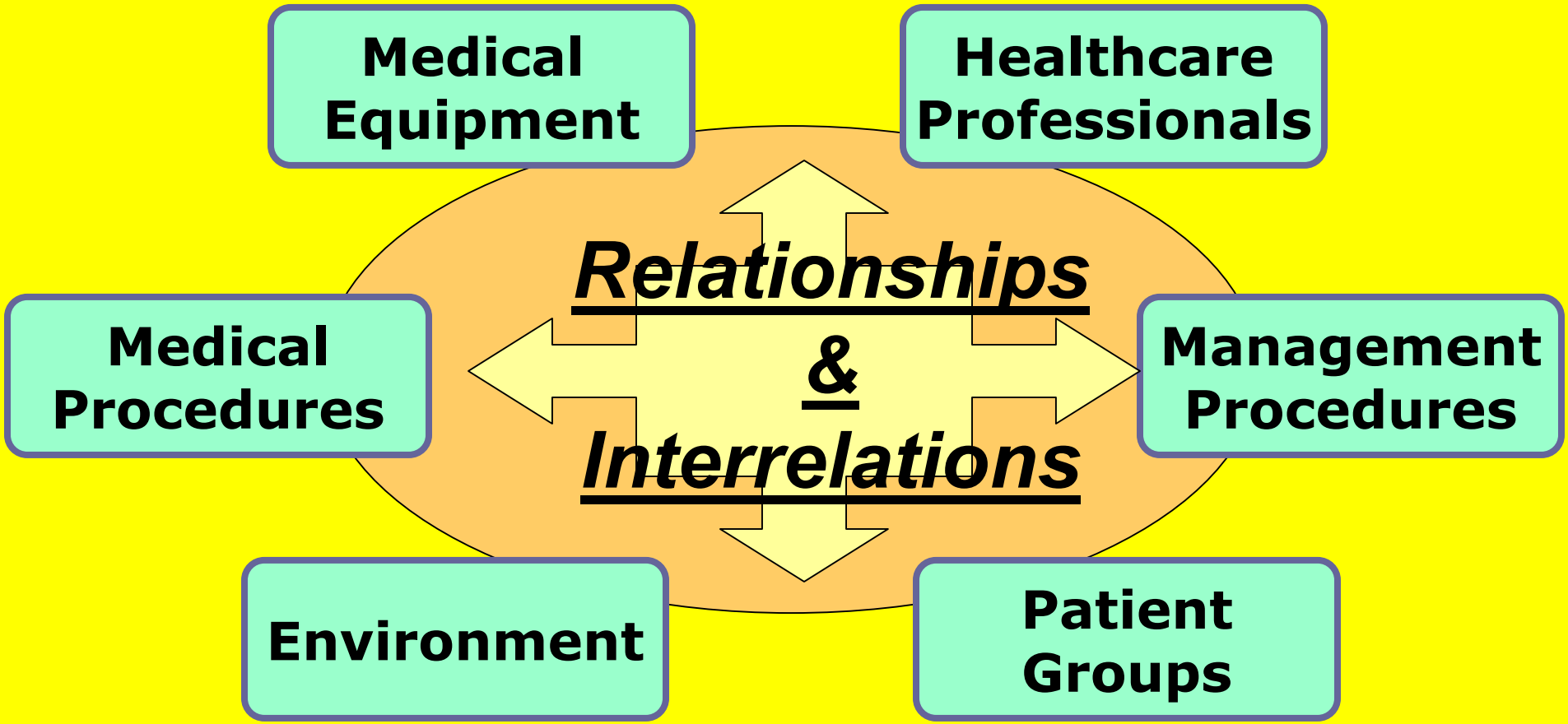
  2. Forecasting: discerning trends and behaviors from clustered data.

Analysis Methodology : Modeling

Healthcare Professionals	**Medical Equipment**	**Management Procedures**
Patient Groups	**Environment**	**Medical Procedures**

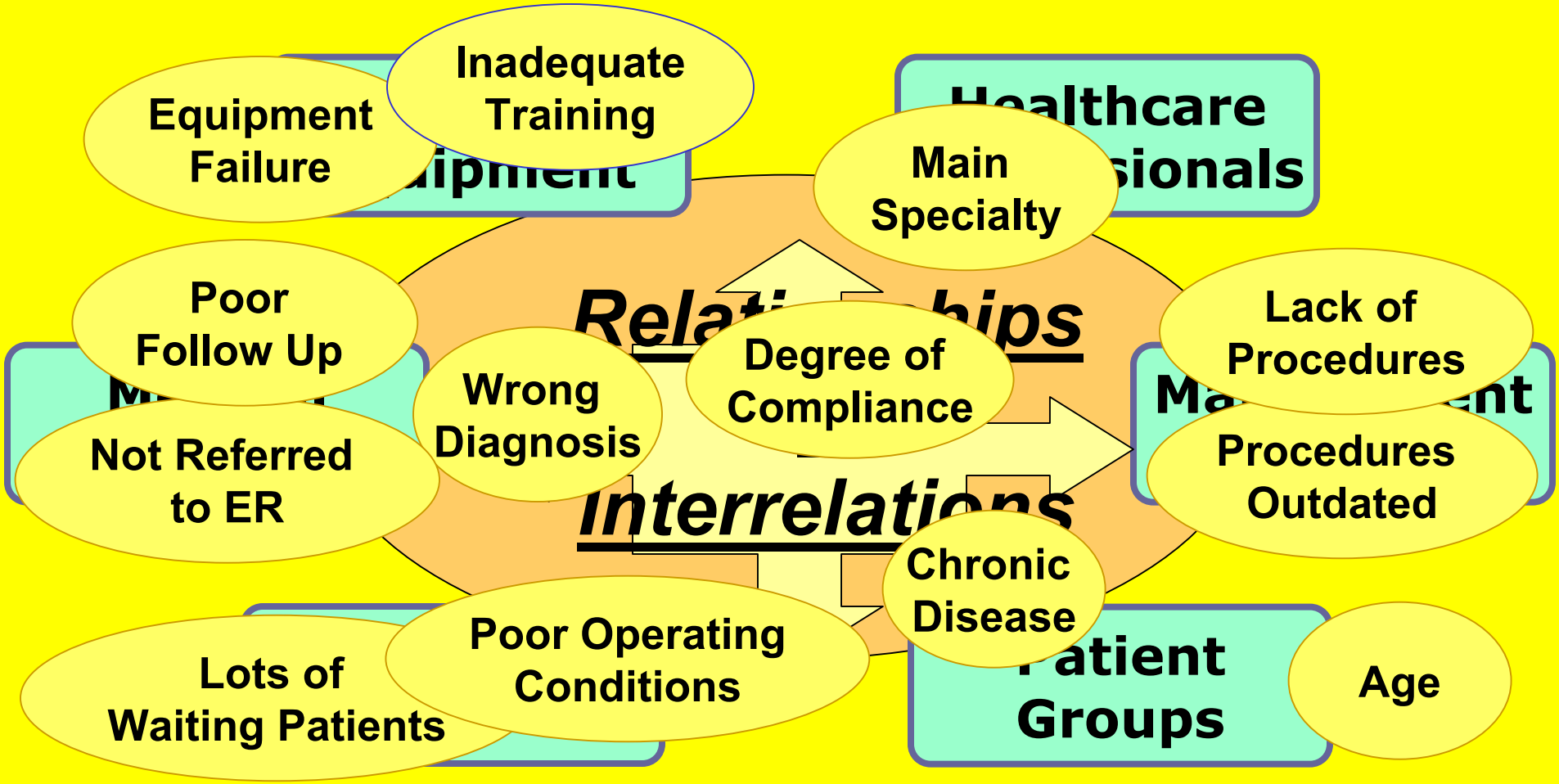
Fundamental components of hospital healthcare delivery are analyzed and modeled.

Analysis Methodology : Mapping



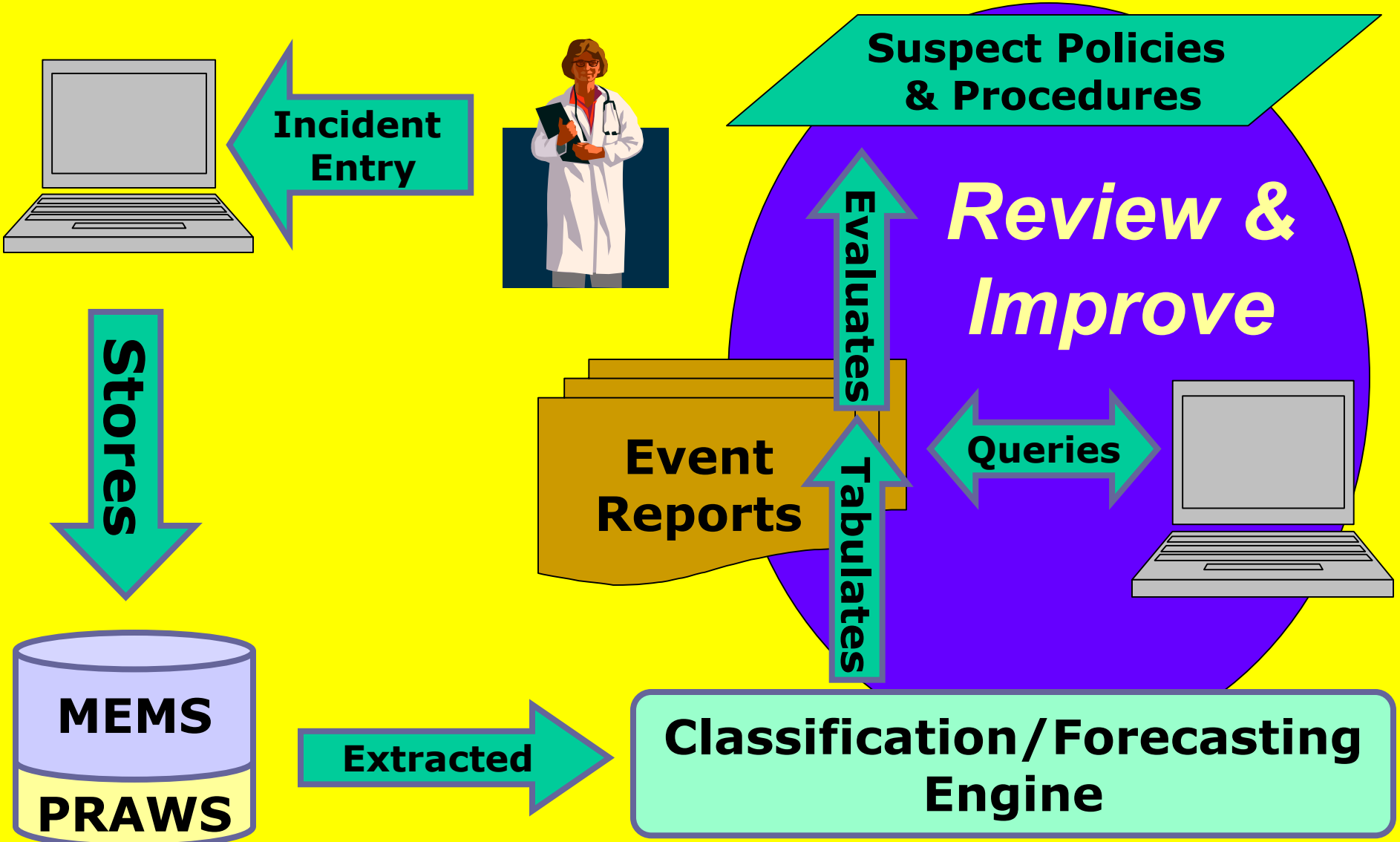
Relationships and interrelations between components are analyzed and classified.

Analysis Methodology: Clustering



As events are reported over time, patterns of similar characteristics emerge.

Unsupervised (passive) Processing



Results

- Increase of detection: identification of incident characteristics and identification of the subjects involved. This identification gives us the trigger for detection of potential improvements.
- Framework implementation in order to set up the available knowledge of the specific problem analyzed.
- Definition of more detailed criteria for the implementation of improved procedures with emphasis on departmental discrimination.

This last point is very important as the customer is enabled to plan for the legal rules in this field.

Unsupervised – Supervised (future)

- There doesn't exist a general purpose pragmatic approach to the problem of real-time detection using data mining techniques.
- According to the data and to the scope, we need to distinguish among:
  - Unsupervised (passive) analysis, where no targets are defined in an explicit way. The purpose of this analysis is to detect relationships in the data (using, for instance, clustering methods)
  - Supervised (real-time) analysis (goal oriented), where the target is known.

Supervised (real-time) Detection

- Short time delay during which it is impossible to suspend the actions.
- A very high number of transactions to be elaborated and analyzed.
- The action is a certain detectable event (objective), i.e. it is possible to single out the event, thus it is possible to apply supervised methodologies.

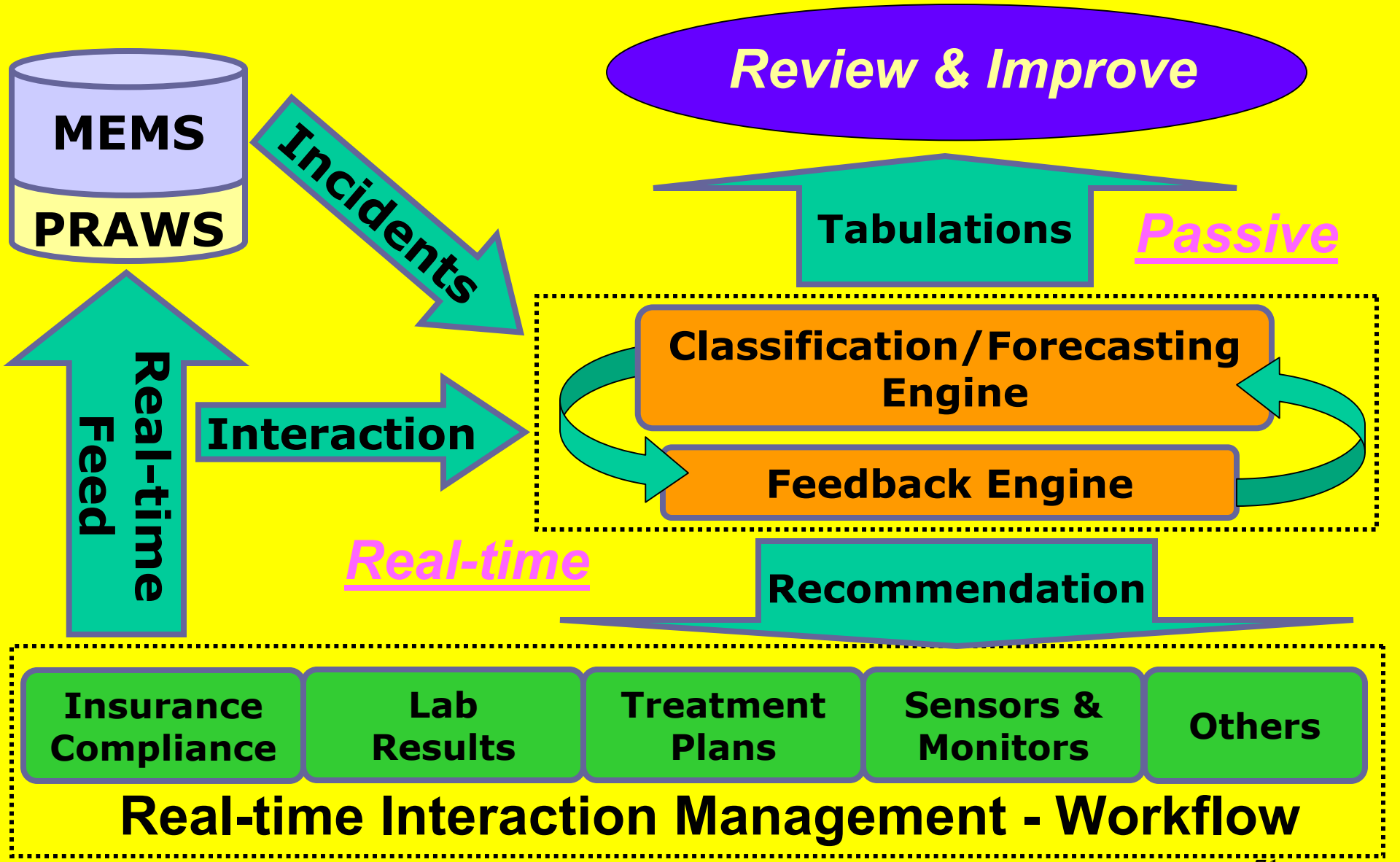
Real-time Detection

- Real-time detection is generally applicable for professionals where incidents are very costly and hard to detect.
- The goal is to recognize the largest number of events in the shortest time, where the rarity of events (0.04 – 0.08% out of the total transactions) is the most important limit.
- A large selectivity is needed in order to exclude false alarms, otherwise the suspected cases will be impossible to handle.

Types of Output

- The final model, realized by the "Detection Real-time Solution" provides the classification to distinguish three kinds of actions:
  - Good action
  - Uncertain action
  - Bad action

Real-time Event Processing (Future)



Result

- Qualitative results obtained with the methodology described are:
  - Shortest delays in detection, efficient use of the signals
  - Easy to change, adaptive, robustness in time;
  - Structural flexibility, merging between data learning and specific knowledge
  - Reasonable level of false positives, effective management of signals.

Practical Results for Similar Types

- Accurate identification increase – before the implementation of this methodology in one case, identification was approximately 70%, today, it is higher than 90%.
- Shortest detection time – before the implementation of the methodology in one case, the shortest time was 1 day, and the average was 3 days, today the shortest time is real-time, and the average is 1 hour.
- Easy possibility of extension of the methodology to other cases and solutions in short implementation time – months.

Thank You.

Questions?

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