Quality and Safety KPIs in Imaging

Ehsan Samei

DukeHealth

Overarching premise

Medicine: Discerning and intervening in the health state of the patient with sufficient accuracy, precision, and safety for definitive clinical outcom

Healthcare is about the patient, not the particularities of the techniques – techniques and quantities are valued to the extent they are relevant to the patient

Possible?

Reality check 1:
Clinical practice

Heterogeneous and Complex:
- Varying technologies
- Varying technical parameters
- Varying patients
- Varying human operators
- Competing interests

Variability in the quality of care

Reality check 2:
Expectations of modern healthcare

Evidence-based practice
Practice informed by science

Precision practice
Personalization of care in quantification terms

Comparative effectiveness - meaningful use practice
Enhanced focus on actual utility

Value-based practice
Scrutiny on safety, performance, consistency, stewardship, efficiency, ethics

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Reality check 3:
There is a cost!

- **Most people will experience at least one diagnostic error in their lifetime**
  - 10% of patient deaths
  - 6-17% hospital adverse events
  - Leading type of paid medical malpractice
  - Claims twice as likely to result in death
  - Highest proportion of total payments

Improving Diagnosis in Healthcare, NAM 2015

Drive towards high-quality, consistent, patient-centric, evidential, precise, safe healthcare

Why KPIs?

Measures of safety and quality to foster improvement and consistency in drive towards precision medicine

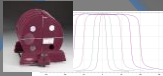## Key Performance Indicators (KPIs)

Measures that may be used to assess the health of an organization and define and quantitatively measure progress toward organizational goals.

Abujudeh et al, Radiographics 2010
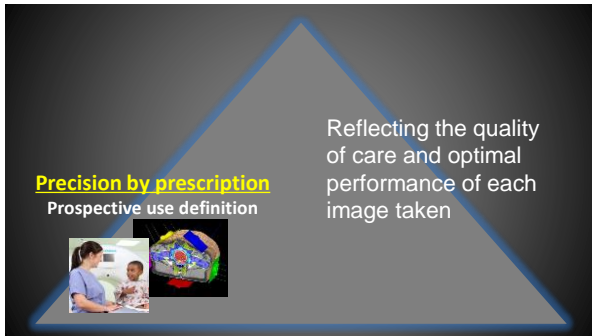
Quality and Safety KPIs

Precision by inference

Technology assessment

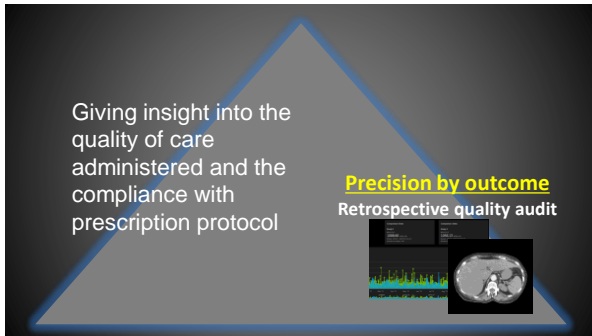Reflecting the safety of diagnostic imaging modalities and imaging modality performance

Reflecting the quality of care and optimal performance of each image taken

Precision by prescription
Prospective use definition

Giving insight into the quality of care administered and the compliance with prescription protocol
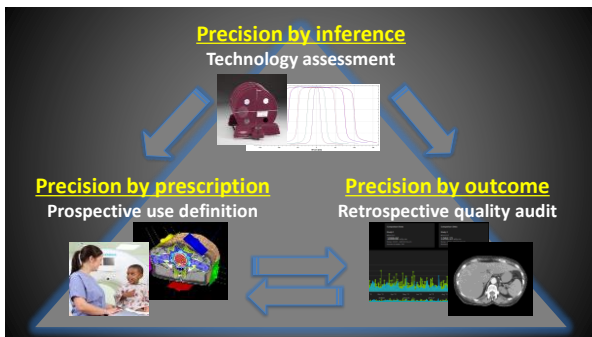
Precision by outcome
Retrospective quality audit

Precision by inference
Technology assessment

Precision by prescription
Prospective use definition

Precision by outcome
**Retrospective quality audit**

Key Performance Indicators for

1. Quality by Inference (Equipment Quality)
– Reflecting the safety of diagnostic imaging modalities and imaging modality performance

2. Quality by Prescription (Protocol Quality)
– Reflecting the quality of care and optimal performance of each image taken

3. Quality by Outcome (Actual Performance)
– Giving insight into the quality of care administered and the compliance with prescription protocol

4. Best Practices
– Reflecting the flow of knowledge and quantity of work being done in a patient-centered imaging environment

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KPIs pertaining equipment quality

1. The percentage of imaging equipment that underwent an **annual Q and S evaluation** within the last 14 months
2. Quantitative status of equipment in **meeting criteria for baseline performance** at annual inspection
3. Quantitative status of equipment in **meeting criteria for QC performance over time**
4. Number of times equipment is reported for a **repair**
5. Number of hours equipment is **out of clinical use** due to repair
6. The number of devices (or cases) that are connected (**tracked**) in the QS server/database
7. The **Percent deviation of inconsistency** of expected quality and safety amongst devices (eg, detectability)

Consistency in Detectability Indices Across Systems
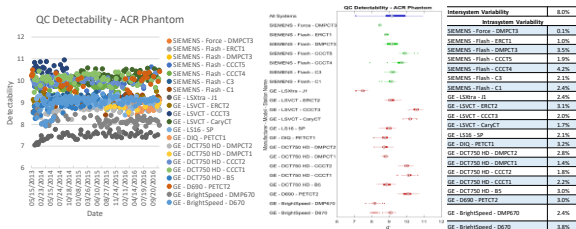
Intra-system variability: 1-4%   Inter-system variability: 8%

1. KPIs pertaining equipment quality
Example: Daily CT QC data

Daily Quality Control

CT Water Unit   Noise (Pixel STD)   Noise Texture

0.209 HU   4.795 HU   0.315 cyc/mm

2. KPIs pertaining protocols

1. Percent adherence to ACR appropriateness criteria in **exam prescription**
2. Percentage of protocols that has completed the definition or audit for optimality and consistency
3. Percentage of protocols undergone annual review with documented reasons/explanations for changes
4. The percentage of high dose cases for which staff follow the dose management procedure

Consistency in Protocols Across the US
ACR-RSNA-Duke Collaborative project

Detectability Indices

Adult Abdomen N=248   Adult Head N=252   Ped Abdomen N=149   Ped Head N=155
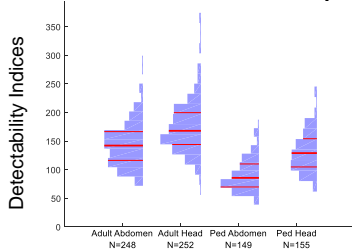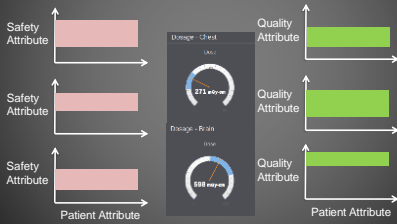
Zhang et al, RSNA, 2018

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3. KPIs pertaining actual performance
1. The percent of reported **cases that were resolvable**
2. The percentage of QC images registered for automated performance analysis
3. Percent consistency between prescribed and applied protocol
4. Number of examinations that fell within the **acceptable dose and quality ranges**
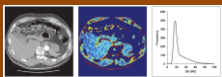

Multi-dimensional Precision
Indication-specific safety & quality constraints

Safety Attribute

Safety Attribute

Safety Attribute

Patient Attribute

Quality Attribute

Quality Attribute

Quality Attribute

Patient Attribute

Dosage - Chest

271 mGy·cm

Dosage - Brain

588 mGy·cm

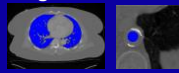
in vivo image quality

Noise
Christianson et al., AJR, 2014

Resolution
Sanders et al., Medical Physics, 2016

Organ-based HU
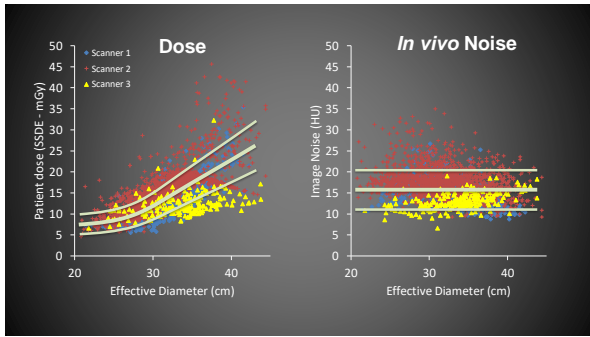Abadi et al., Medical Physics, 2017

Perceptual Quality
Samei et al., Medical Physics, 2014

Dose / In vivo Noise scatter plots

Example: Duke-Imalogix Trial

- Noise, resolution, dose across
  - 103,547 total scans
  - 95 facilities
  - 3 manufacturers
  - 30 models
- The largest study of its kind in breadth and depth

Smith et al, RSNA 2018

4. KPIs pertaining optimality of practice: adherence to expected practices

Physicists:
1. Months between annual exams
2. Percentages of equipment testing practices with defined SOPs
3. # of provided QS in-service for imaging technologists
4. # of provided QS in-service for physicians
5. # of completed QS CME
6. # of days critical repairs awaits physics endorsement

4. KPIs pertaining optimality of practice: adherence to expected practices
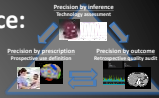
Physics integration:

1. # of clinical meetings physicist participated in
2. # of major clinical/facility decision informed by physicist
3. # of near misses caught
4. # of safety related issues addressed (program, patient)
5. # of variability reduction actions (eg, Protocol inconsistency)
6. # of changes in clinical activities based on physics input –things would have not been done if a physicist wasn't there
7. # of patient contacts
8. # of contacts with physician contacts in clinical setting
9. # of image quality issues physicist was asked to address

4. KPIs pertaining optimality of practice: adherence to expected practices
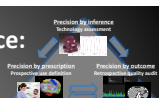
Technologists:

1. Percentage of exams that follow the prescribed protocol
2. The number of repeats
3. The turnaround time for resolving reported issues
4. The number of completed QS CME

Physicians:

1. The number of completed QS CME

4. KPIs pertaining optimality of practice: adherence to expected practices

Policies and administration:

1. Number and percentage of routinely reviewed/enforced QC policies
2. Number of incidence reports

Patient perception:

1. Average score of QS indicator from patient surveys

Quality and Safety KPIs

1. Directly related to the very purpose of imaging
2. Enables managing variability across clinical practice
3. Pragmatic surrogates to value-based care
4. Should encompass all aspects of patient care
   1. Technology (equipment quality)
   2. Technology use (protocol quality)
   3. Actual outcome (actual quality)
   4. The operational processes (our quality)