

Kamira

An Open Source Clinical Quality Modeling Framework



Health in the 21st Century

MITRE

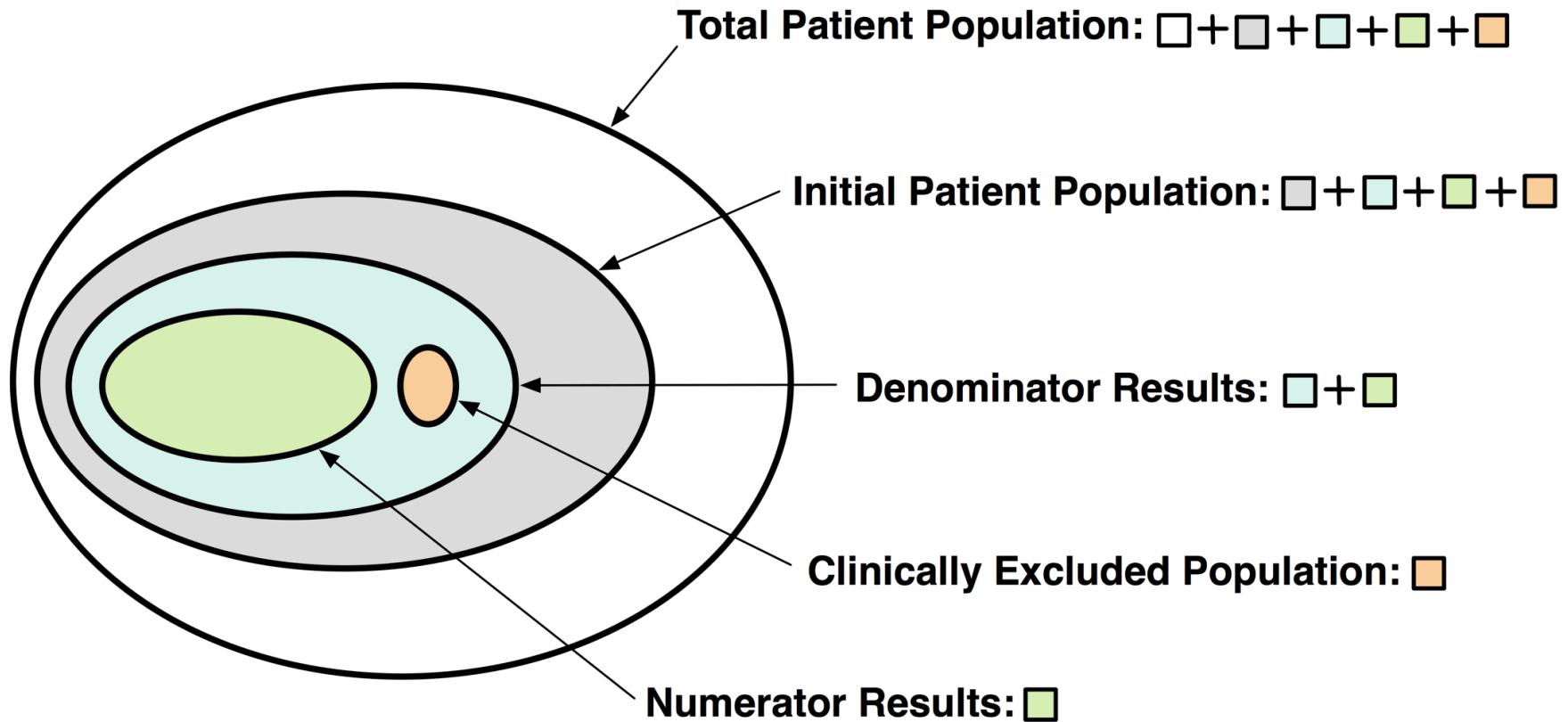
What is Kamira?

- The Kamira project aims to assess the “quality” of a Clinical Quality Measure, considering 3 dimensions:
 1. Complexity of a Clinical Quality Measure
 2. Short-term costs and long-term savings associated with an individual Clinical Quality Measure
 3. Availability of Clinical Patient Data required to drive Clinical Quality Measures
- The Kamira project is internally funded by the MITRE Corporation Innovation Program
 - MITRE is a 501(c)(3) non-profit corporation chartered to work in the public interest
 - In September 2012, MITRE was competitively awarded the role as the first operator of the Center for Medicare and Medicaid Services (CMS) Health Federally Funded Research and Development Center (FFRDC)

Background - Clinical Quality Measures

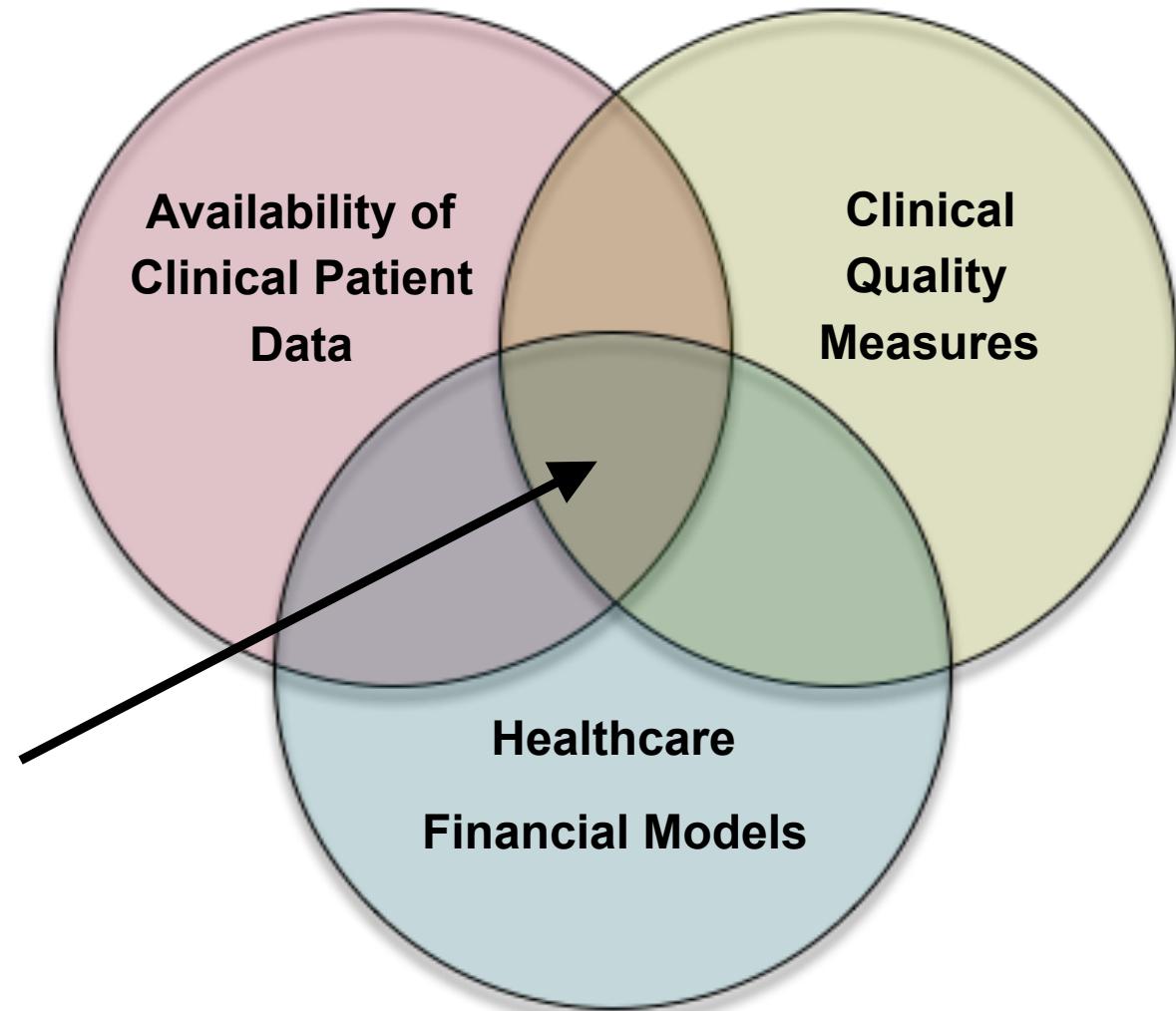
- **What are Clinical Quality Measures (CQM)?**
 - Tools that help us measure a segment of healthcare delivery
 - Each CQM has a different goal: effective, safe, efficient, patient-centered, equitable, and/or timely care
- **Clinical Quality Measures are key components of the Meaningful Use program as part of the HITECH Act**
- **It is assumed that over time, addressing CQMs will result in:**
 1. **Healthier outcomes for patients**
 2. **Lower overall cost of care for the Nation**

Clinical Quality Measures



Research Questions

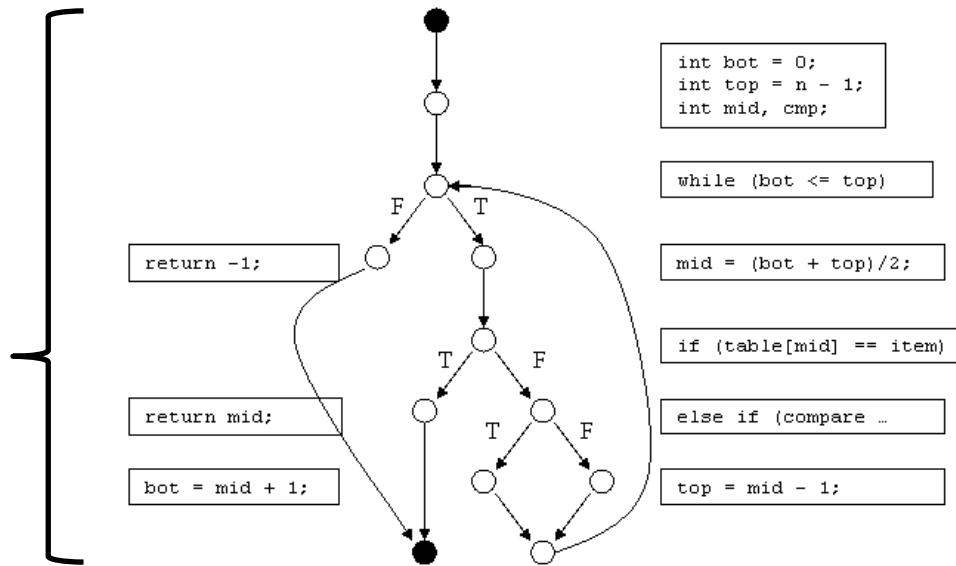
- **What are the best methods to assess the overall value of a Clinical Quality Measure?**
- **If the performance of a Clinical Quality Measure improves, how does it affect overall health outcomes? How does it affect total cost to the healthcare system?**
- **What are the best Clinical Quality Measures that improve the performance of other sibling Clinical Quality Measures?**



Cyclomatic Complexity Analysis

- **Cyclomatic Complexity (CC) is a software metric used to gauge the complexity of source code**
 - CC measures the number of linearly independent paths through the source code of a function

Simple example
function where
“CC” = 4



<http://www.whiteboxtest.com/cyclomatic-complexity.php>

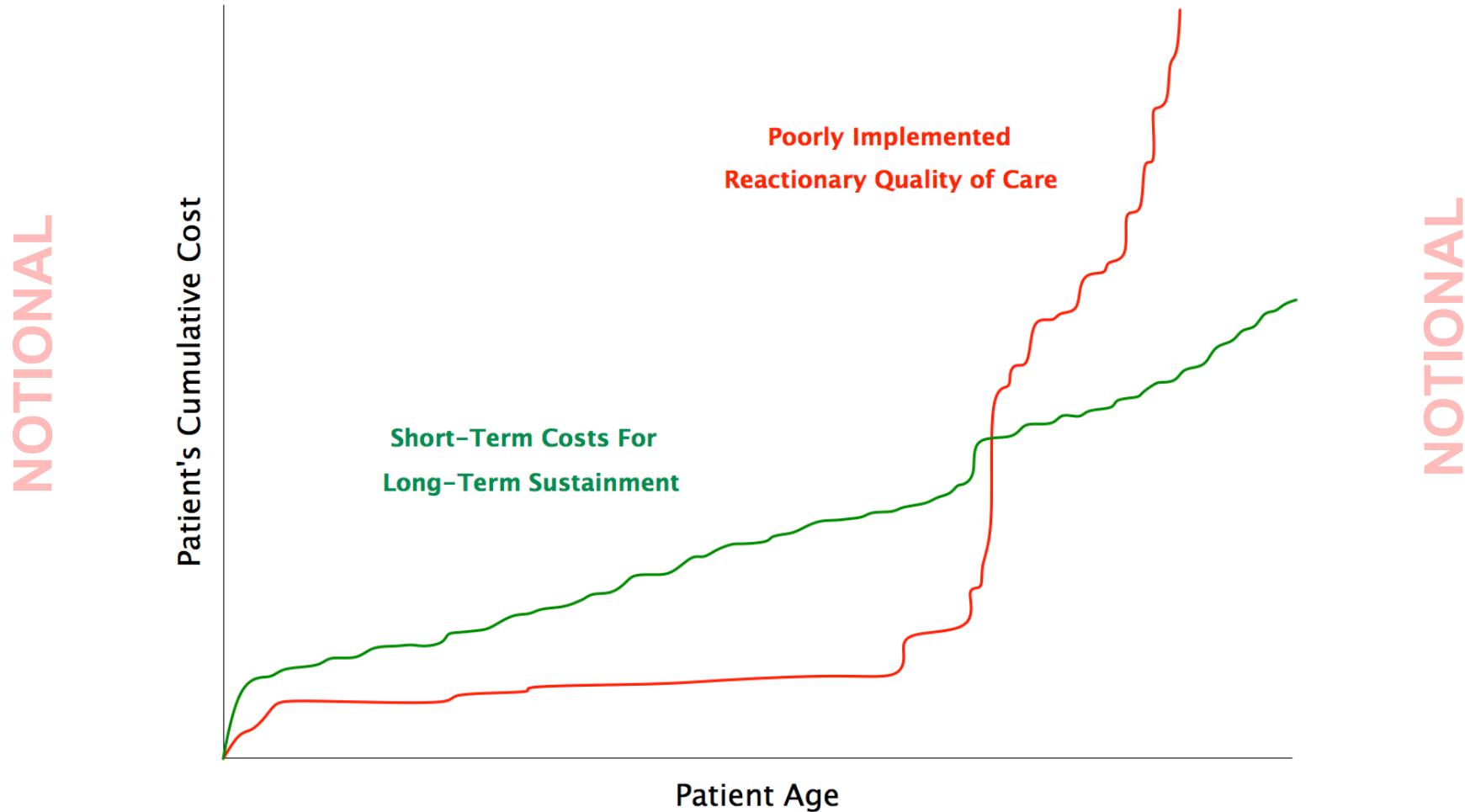
Cyclomatic Complexity Analysis

- Ideal metric to apply to assess the quality of software source code
 - Provides visibility into maintainability of software source code, agnostic of any particular programming language
- The ranges that constitute acceptable values on software Cyclomatic Complexity is a decades-long and ongoing topic with computer scientists
 - Carnegie Mellon University (CMU):

Cyclomatic Complexity	Risk Evaluation
1-10	Very simple; low risk
11-20	Nominal; moderate risk
21-50	Complex; high risk
>50	Untestable; extremely high risk

www.sei.cmu.edu/reports/97hb001.pdf (see page 147)

Using Clinical Quality Measures to Bend the Cost Curve



Model Financial Costs and Savings

- Predicting short-term cost increases associated with improvements in CQM performance
 - The majority of the CQMs provide opportunities for providers to take action
 - Laboratory Test
 - Procedures
 - Medications
 - Etc.
- CMS *claims-based* data contains upper bounds on provider compensation to address CQMs
- Kamira will identify a short-term cost associated with addressing gaps in care with the Clinical Quality Measures
- Future plans for Kamira: Forecasting cost savings by addressing improvements in the CQMs

Example: Influenza Vaccination

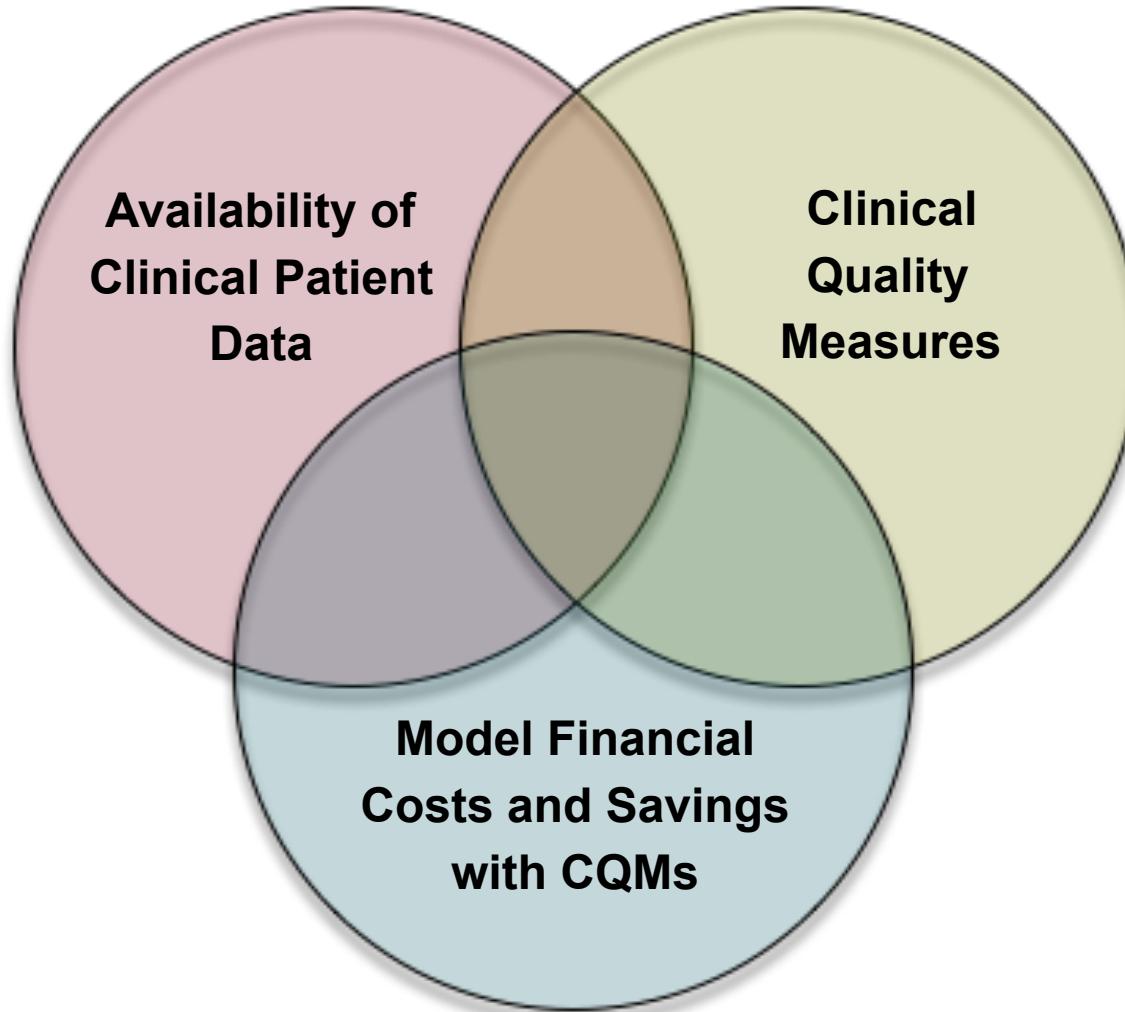
Measure	Description	Short Term Cost (Influenza Vaccination)	Cost per Hospitalized Case, ages 50-64	Cost per Hospitalized Case, ages ≥ 65
NQF 0041	Influenza Immunization for Patients > 50 Years Old	~\$15 per person	\$7,276 (\pm 25%)	\$8,278 (\pm 25%)
		Current	Future	

- In 2010, Influenza/Pneumonia ranked as the 9th cause of death (50,000 deaths)
- One third of all Americans 50–64 years of age have one or more chronic medical condition that puts them at increased risk for serious flu complications
- Among the elderly, influenza vaccines can prevent 50 percent–60 percent of hospitalizations and 68 percent of deaths from flu-related complications
- Achieving 90 percent vaccination coverage would reduce deaths by over 15,000 annually in a year with an average flu season (i.e., not a major epidemic)

Availability of Clinical Patient Data

- Current requirements for clinical attributes in continuity of care standards do not match required attributes for calculating CQMs
 - CQMs often contain a super-set of the clinical attributes provided in continuity of care XML standards
 - Examples include the C32, CCDA, and CCR XML formats
 - Current shortcomings of this clinical data problem are optional attributes which could be generated by EHR systems
 - Medications
 - Immunizations
 - Allergies
 - Tobacco Use
 - Etc.
- This activity will include the development of a model that will detail the availability of these clinical attributes through data collected from operational health IT sites

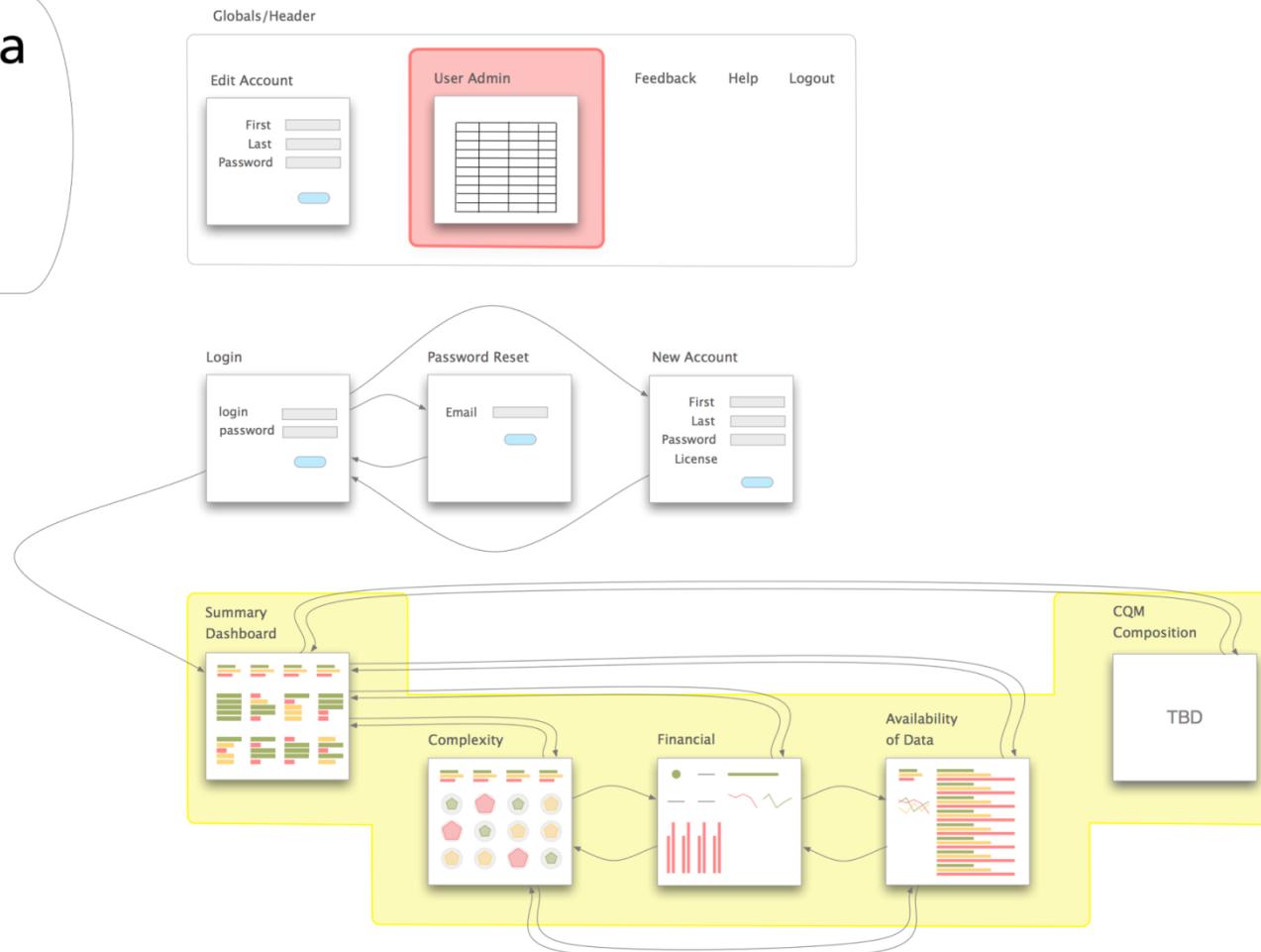
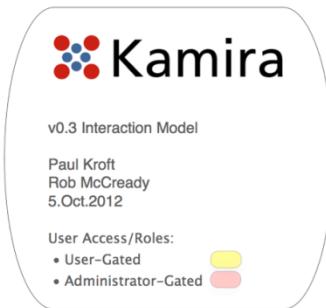
Idea



Open Source License

- The Kamira software is freely available via an Apache 2.0 Open Source distribution license
 - <http://www.apache.org/licenses/LICENSE-2.0.html>
- Apache 2.0 is very industry-friendly and permissive for integrators
 - Apache 2.0 provides numerous freedoms on the use of Kamira software source code
 - Use, integration, modification, and re-distribution of the Kamira software source code is allowed, as long as attribution is also provided
- MITRE is reviewing options to extend the Apache 2.0 license to include information on usage (to allow us to better align our research with community needs)

Interaction Model



Dashboard Visualization

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Overall Summary

Good	32	
Nominal	68	
Poor	18	

Data Availability

Good	47	
Nominal	79	
Poor	31	

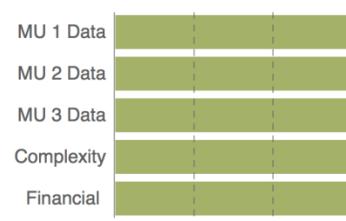
Complexity

Good	13	
Nominal	32	
Poor	68	

Financial

Good	57	
Nominal	58	
Poor	18	

Measure Status



Asthma Assessment

Appropriate Testing for Children with Pharyngitis

Hypertension: Blood Pressure Management

Prenatal Care: Anti-D Immune Globulin



CQM Complexity Analysis Visualization

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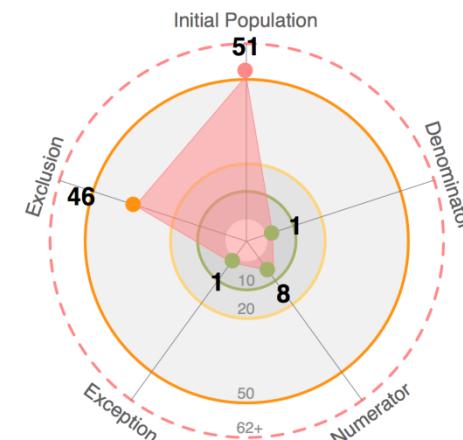
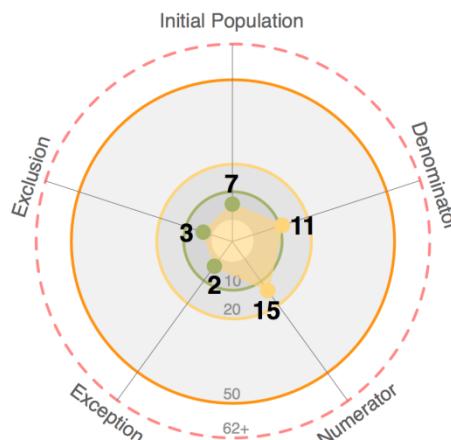
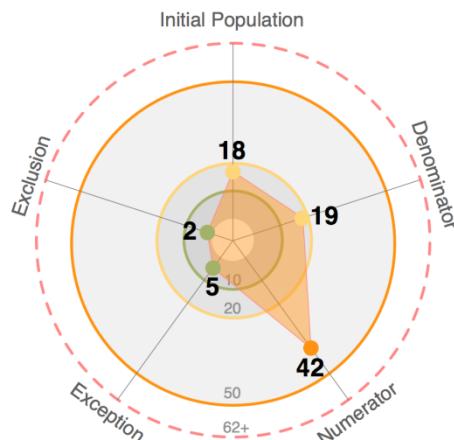


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Complexity Analysis

- 1-10 | Very Simple | Low Risk
- 11-20 | Nominal | Moderate Risk
- 21-50 | Complex | High Risk
- >50 | Untestable | Extreme Risk

Measure Complexity



Financial Analysis Visualization

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search for measures



Influenza Immunization for Patients > 50 Years Old

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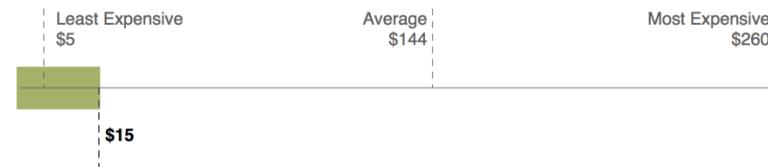
Financial Status



Est. Short Term Cost

\$15

Cost Comparison



Non-treatment Costs

**Ages 50-64
\$7276**
(+/- 25%)**Ages 65+
\$8278**
(+/- 25%)

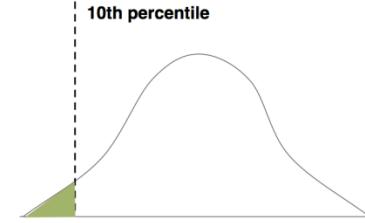
Based on estimated cost per hospitalized case.

Potential Cost Savings

**Ages 50-64
\$7261**
(+/- 25%)**Ages 65+
\$8263**
(+/- 25%)

Based on estimated cost per hospitalized case.

Cost Distribution



Cost Trends

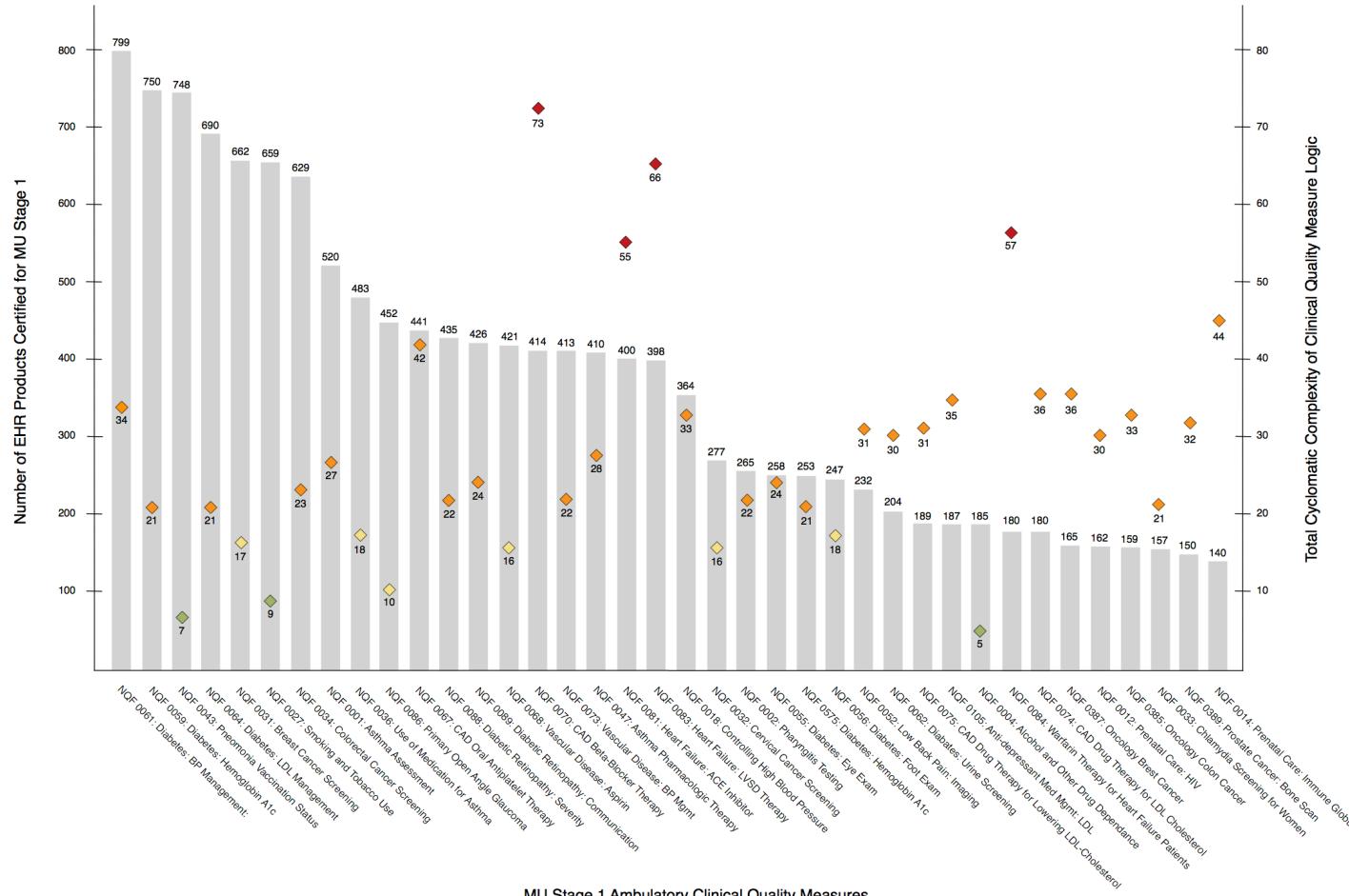




Backup

MU Stage 1 Ambulatory CQM Certification Analysis

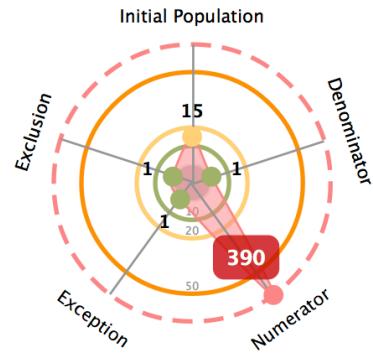
>50 Untestable/Extreme Risk ●
 21-50 Complex/High Risk ●
 11-20 Nominal/Moderate Risk ●
 1-10 Very Simple/Low Risk ●



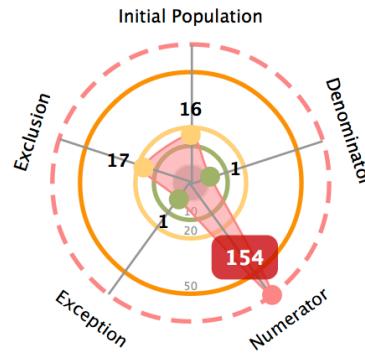


Meaningful Use Stage 2 Ambulatory CQM Complexity Analysis

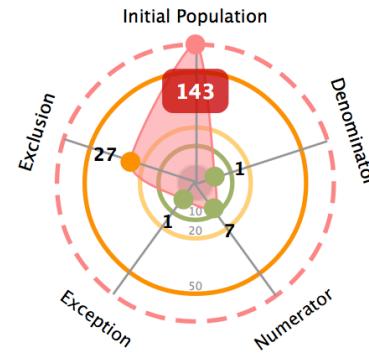
MU Stage 2 Cyclomatic Complexity Results



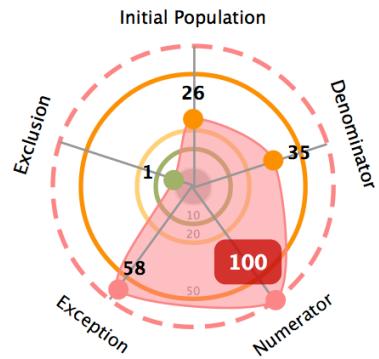
NQF 0038:
Childhood Immunization Status



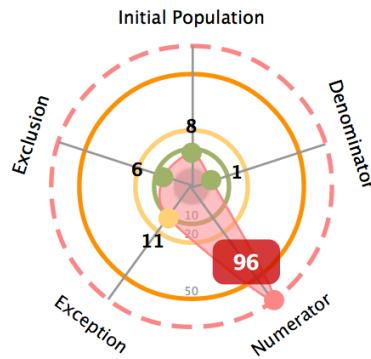
NQF 0108b:
**ADHD: Follow-Up Care for Children
Prescribed Attention
Deficit/Hyperactivity Disorder
(ADHD) Medication**



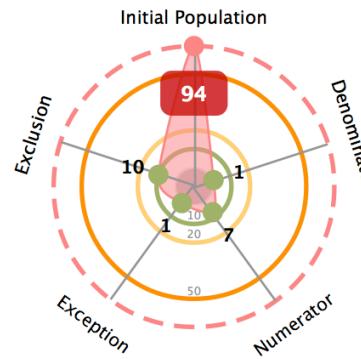
NQF 0710:
**Depression Remission at Twelve
Months**



NQF 0385:
**Colon Cancer: Chemotherapy for
AJCC Stage III Colon Cancer Patients**

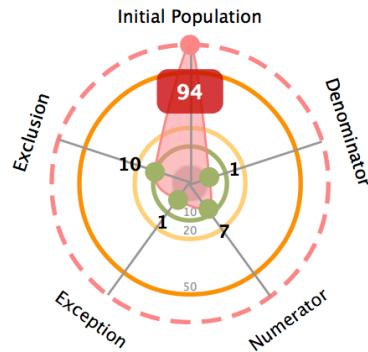


NQF BP Screening:
**Preventive Care and Screening:
Screening for High Blood Pressure
and Recommended Follow-Up
Documented**

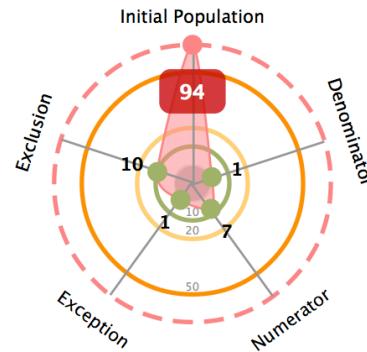


NQF 0033c:
Chlamydia Screening for Women

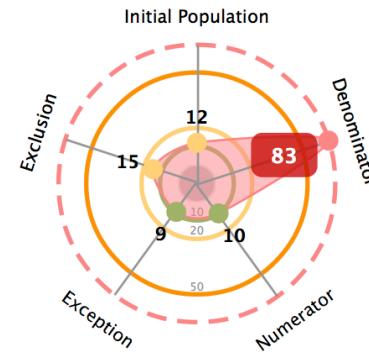
MU Stage 2 Cyclomatic Complexity Results



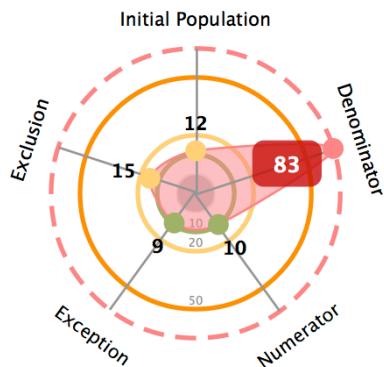
NQF 0033b:
Chlamydia Screening for Women



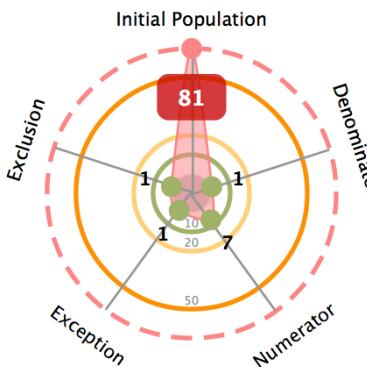
NQF 0033a:
Chlamydia Screening for Women



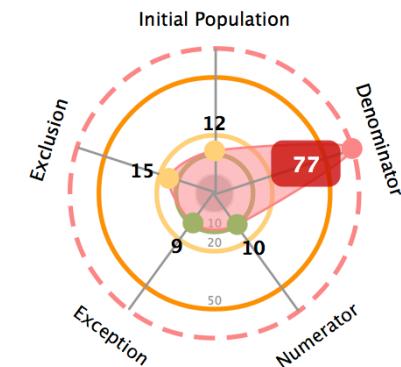
NQF CholesterolScreeningRisk:a:
Preventive Care and Screening: Risk-Stratified Cholesterol - Fasting Low Density Lipoprotein (LDL-C)



NQF CholesterolScreeningRisk:c:
Preventive Care and Screening: Risk-Stratified Cholesterol - Fasting Low Density Lipoprotein (LDL-C)

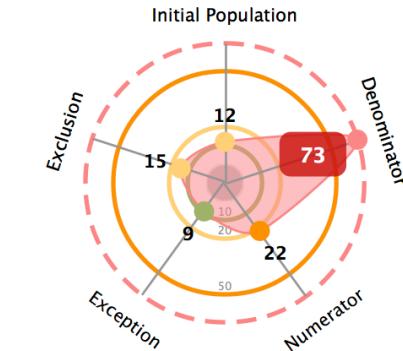


NQF 1365:
Child and Adolescent Major Depressive Disorder (MDD): Suicide Risk Assessment

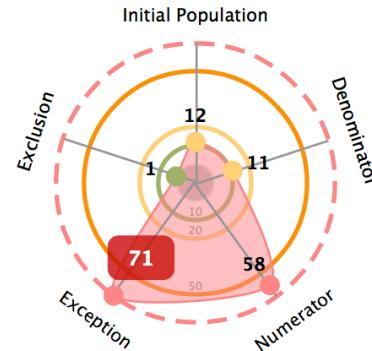


NQF CholesterolScreeningRisk:b:
Preventive Care and Screening: Risk-Stratified Cholesterol - Fasting Low Density Lipoprotein (LDL-C)

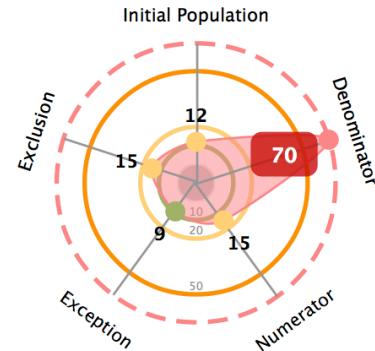
MU Stage 2 Cyclomatic Complexity Results



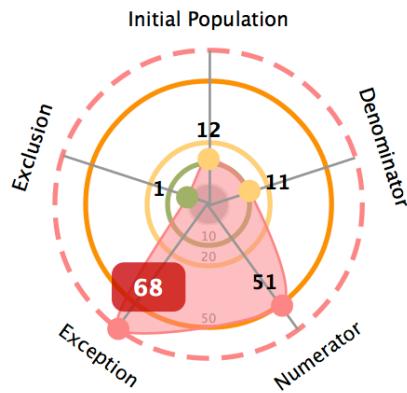
NQF Cholesterol Screening Test:
Preventive Care and Screening:
Cholesterol - Fasting Low Density
Lipoprotein (LDL-C) Test Performed



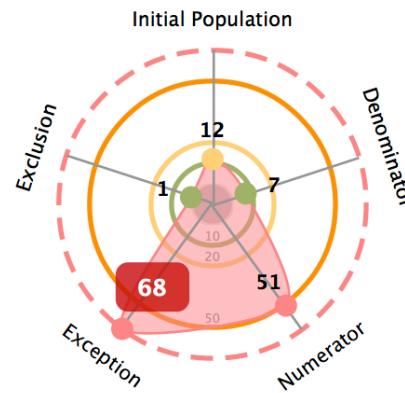
NQF 0083:
Heart Failure (HF): Beta-Blocker
Therapy for Left Ventricular Systolic
Dysfunction (LVSD)



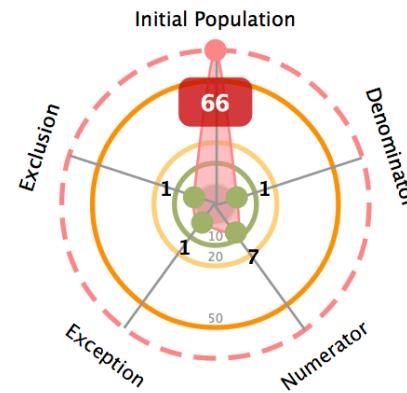
NQF Cholesterol Screening Testb:
Preventive Care and Screening:
Cholesterol - Fasting Low Density
Lipoprotein (LDL-C) Test Performed



NQF 0070a:
Coronary Artery Disease (CAD): Beta-
Blocker Therapy—Prior Myocardial
Infarction (MI) or Left Ventricular
Systolic Dysfunction (LVEF <40%)

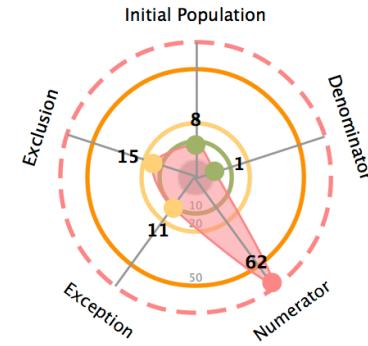


NQF 0070b:
Coronary Artery Disease (CAD): Beta-
Blocker Therapy—Prior Myocardial
Infarction (MI) or Left Ventricular
Systolic Dysfunction (LVEF <40%)

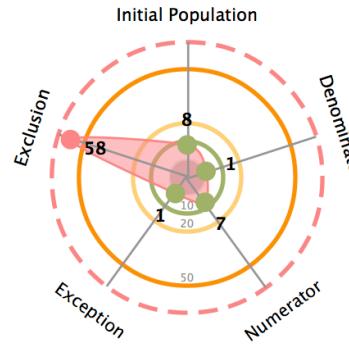


NQF 0104:
Major Depressive Disorder (MDD):
Suicide Risk Assessment

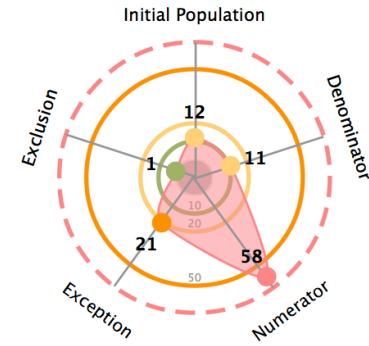
MU Stage 2 Cyclomatic Complexity Results



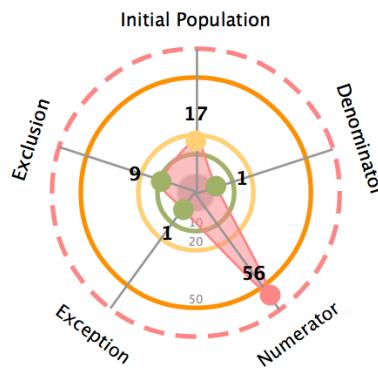
NQF 0418:
Preventive Care and Screening:
Screening for Clinical Depression and
Follow-Up Plan



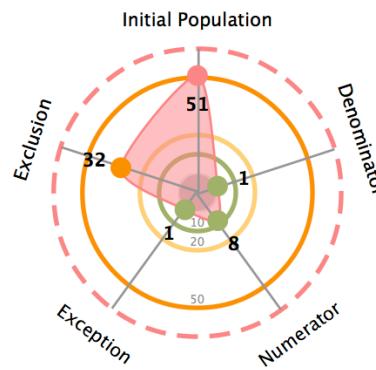
NQF 0565:
Cataracts: 20/40 or Better Visual
Acuity within 90 Days Following
Cataract Surgery



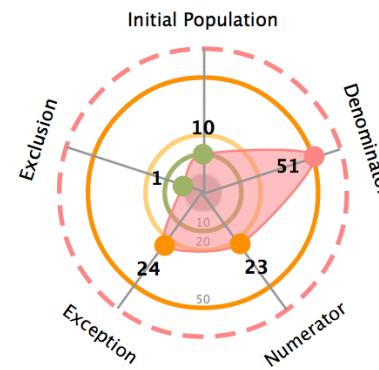
NQF 0081:
Heart Failure (HF): Angiotensin-
Converting Enzyme (ACE) Inhibitor or
Angiotensin Receptor Blocker (ARB)
Therapy for Left Ventricular Systolic
Dysfunction (LVSD)



NQF 0062:
Diabetes: Urine Protein Screening

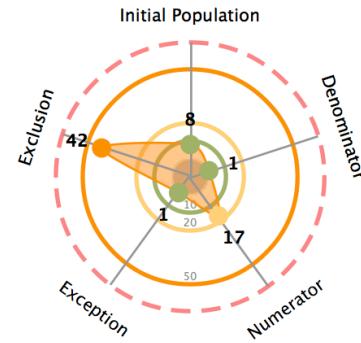


NQF 0712b:
Depression Utilization of the PHQ-9
Tool

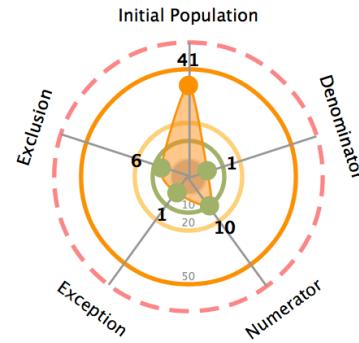


NQF 0387:
Breast Cancer: Hormonal Therapy for
Stage IC-IIIC Estrogen
Receptor/Progesterone Receptor
(ER/PR) Positive Breast Cancer

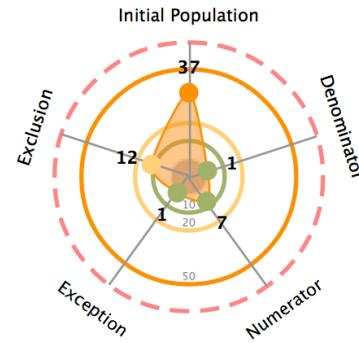
MU Stage 2 Cyclomatic Complexity Results



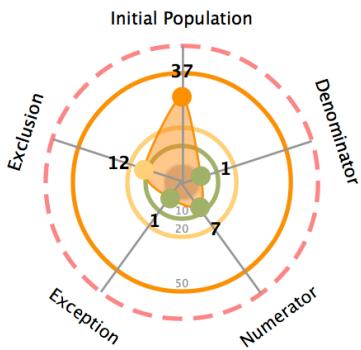
NQF 0564:
Cataracts: Complications within 30 Days Following Cataract Surgery Requiring Additional Surgical Procedures



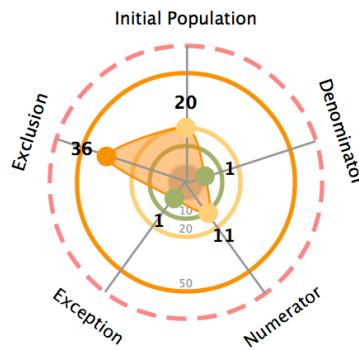
NQF 0002:
Appropriate Testing for Children with Pharyngitis



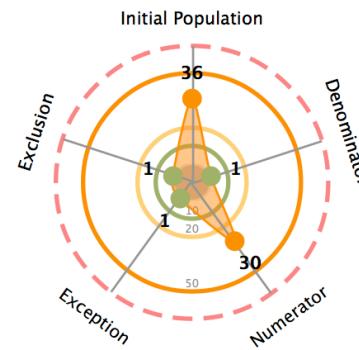
NQF 0712a:
Depression Utilization of the PHQ-9 Tool



NQF 0712c:
Depression Utilization of the PHQ-9 Tool

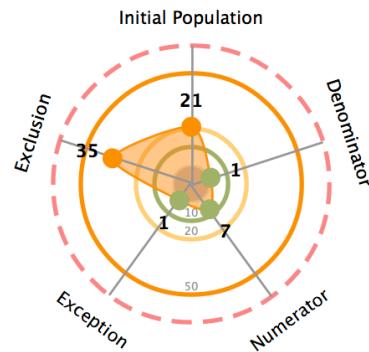


NQF 0018:
Controlling High Blood Pressure

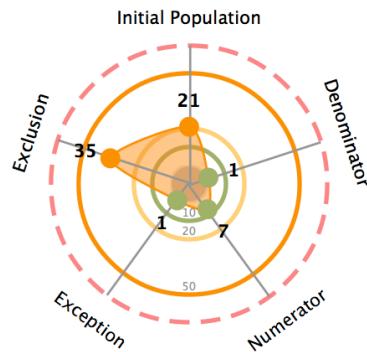


NQF ADE_TTR:
ADE Prevention and Monitoring: Warfarin Time in Therapeutic Range

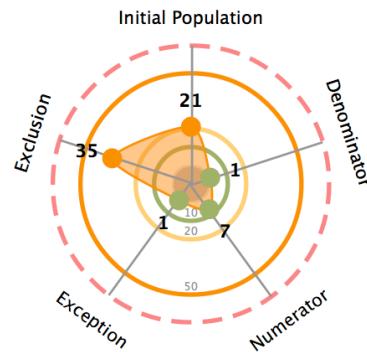
MU Stage 2 Cyclomatic Complexity Results



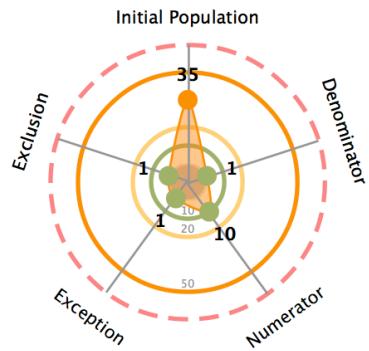
NQF 0036e:
Use of Appropriate Medications for
Asthma



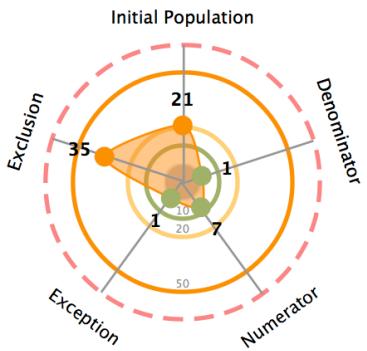
NQF 0036a:
Use of Appropriate Medications for
Asthma



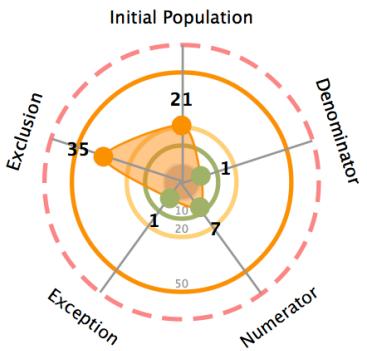
NQF 0036d:
Use of Appropriate Medications for
Asthma



NQF 0068:
Ischemic Vascular Disease (IVD): Use
of Aspirin or Another Antithrombotic

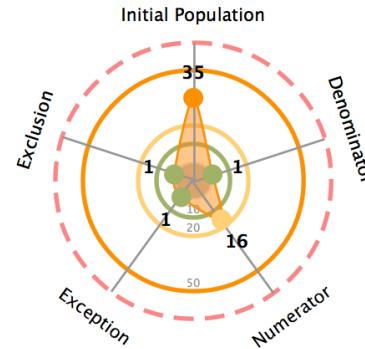


NQF 0036b:
Use of Appropriate Medications for
Asthma

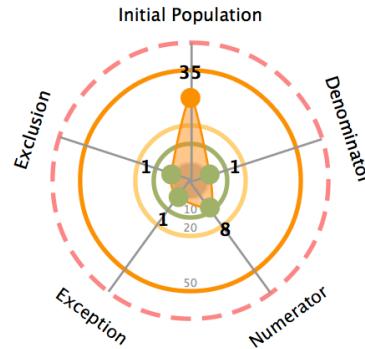


NQF 0036c:
Use of Appropriate Medications for
Asthma

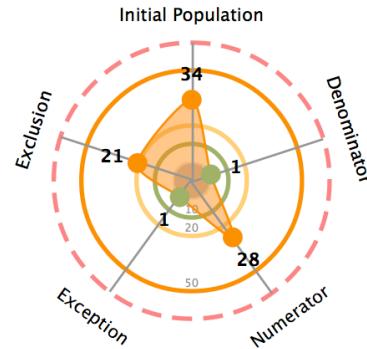
MU Stage 2 Cyclomatic Complexity Results



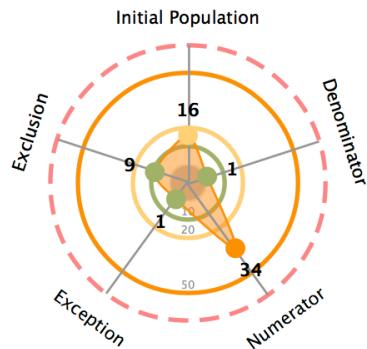
NQF 0075a:
Ischemic Vascular Disease (IVD):
Complete Lipid Panel and LDL Control



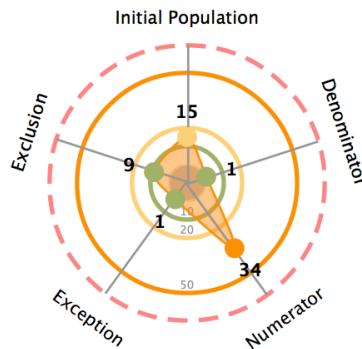
NQF 0075b:
Ischemic Vascular Disease (IVD):
Complete Lipid Panel and LDL Control



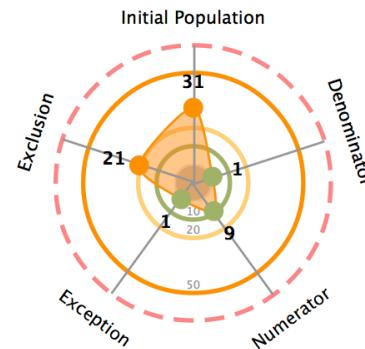
NQF FSACHF:
Functional Status Assessment for
Complex Chronic Conditions



NQF 0421b:
Preventive Care and Screening: Body
Mass Index (BMI) Screening and
Follow-Up

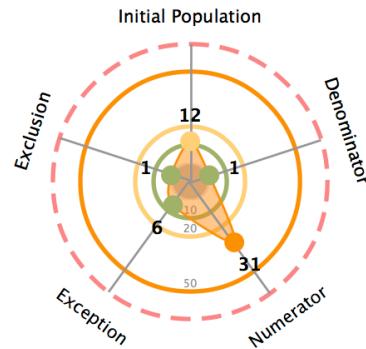


NQF 0421a:
Preventive Care and Screening: Body
Mass Index (BMI) Screening and
Follow-Up

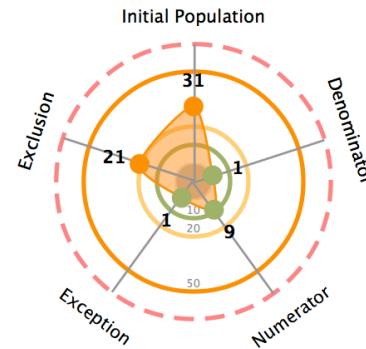


NQF FSAKnee:
Functional Status Assessment for
Knee Replacement

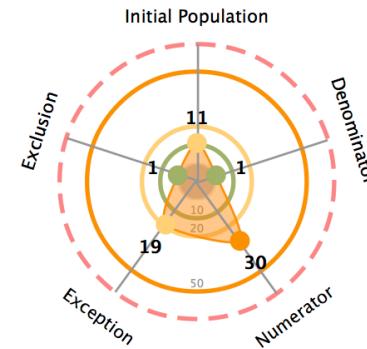
MU Stage 2 Cyclomatic Complexity Results



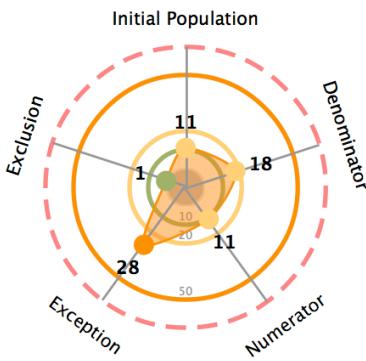
NQF 0405a:
HIV/AIDS: Pneumocystis jiroveci pneumonia (PCP) prophylaxis



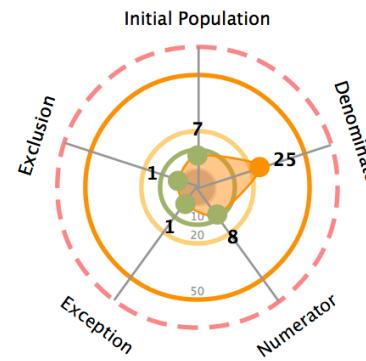
NQF FSAHip:
Functional Status Assessment for Hip Replacement



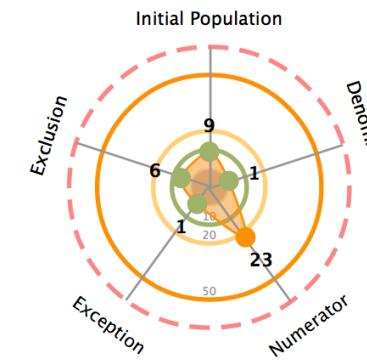
NQF 0028:
Preventive Care and Screening: Tobacco Use: Screening and Cessation Intervention



NQF 0041:
Preventive Care and Screening: Influenza Immunization

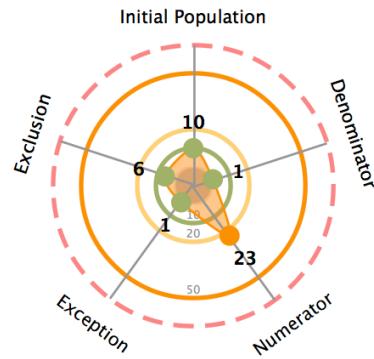


NQF 0110:
Bipolar Disorder and Major Depression: Appraisal for alcohol or chemical substance use

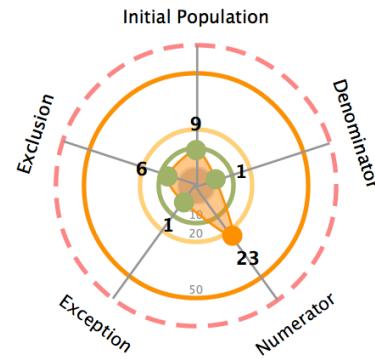


NQF 0004b:
Initiation and Engagement of Alcohol and Other Drug Dependence Treatment

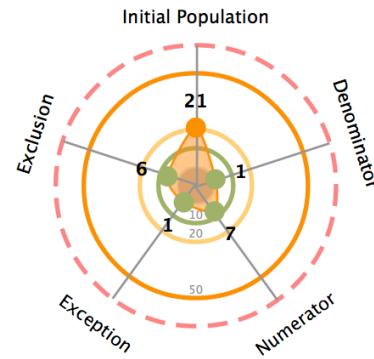
MU Stage 2 Cyclomatic Complexity Results



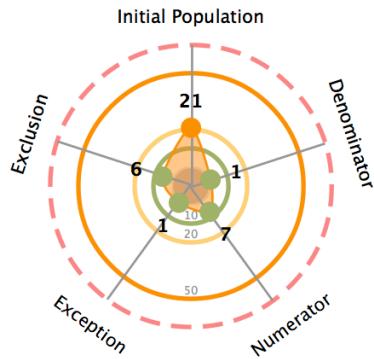
NQF 0004e:
**Initiation and Engagement of Alcohol
and Other Drug Dependence
Treatment**



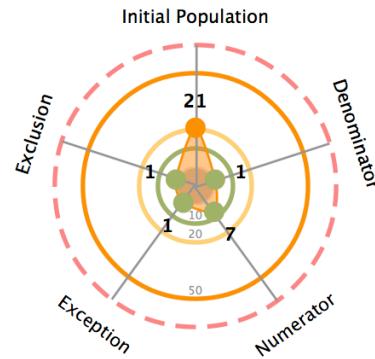
NQF 0004f:
**Initiation and Engagement of Alcohol
and Other Drug Dependence
Treatment**



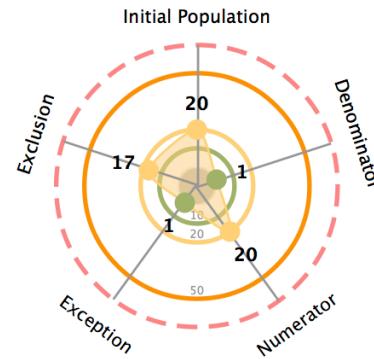
NQF 0105b:
**Antidepressant Medication
Management**



NQF 0105a:
**Antidepressant Medication
Management**

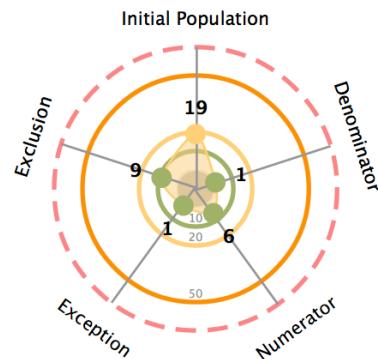


NQF 0384:
**Oncology: Medical and Radiation –
Pain Intensity Quantified**

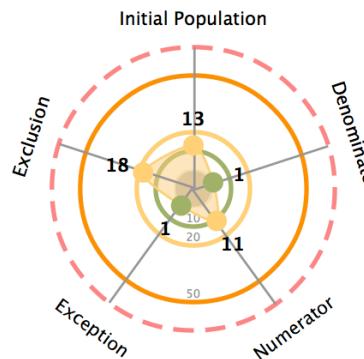


NQF 0108a:
**ADHD: Follow-Up Care for Children
Prescribed Attention
Deficit/Hyperactivity Disorder
(ADHD) Medication**

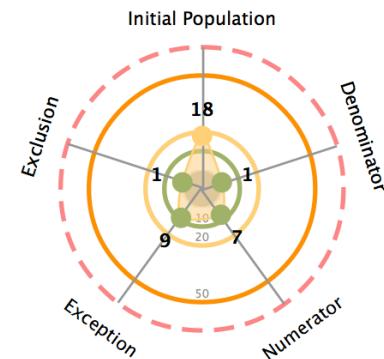
MU Stage 2 Cyclomatic Complexity Results



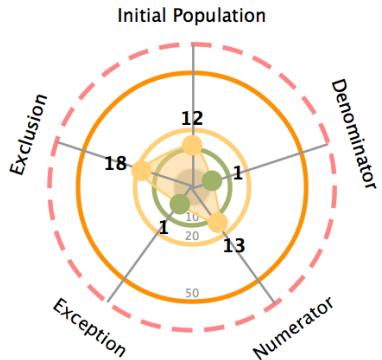
NQF 0069:
Appropriate Treatment for Children
with Upper Respiratory Infection
(URI)



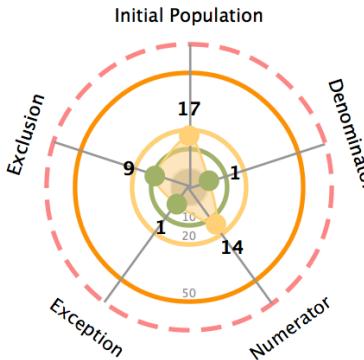
NQF 0052:
Use of Imaging Studies for Low Back
Pain



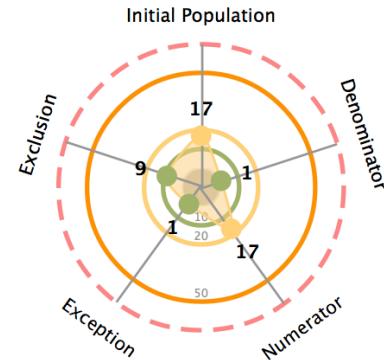
NQF 0101:
Falls: Screening for Future Fall Risk



NQF Hypertension Improvement:
Hypertension: Improvement in Blood
Pressure

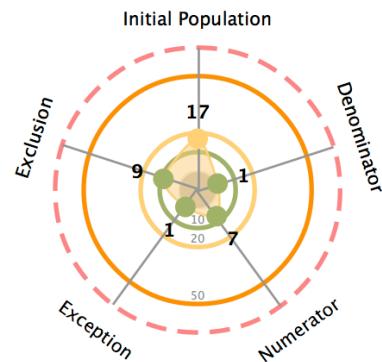


NQF 0056:
Diabetes: Foot Exam

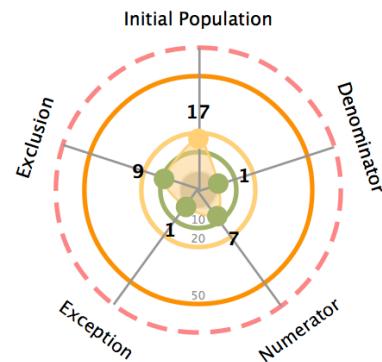


NQF 0059:
Diabetes: Hemoglobin A1c Poor
Control

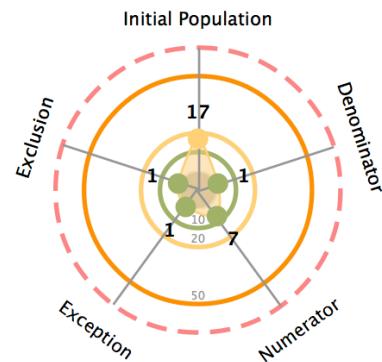
MU Stage 2 Cyclomatic Complexity Results



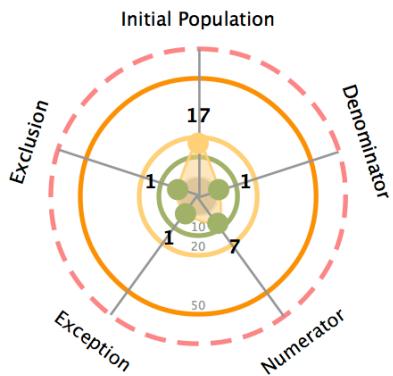
NQF 0024f:
**Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents**



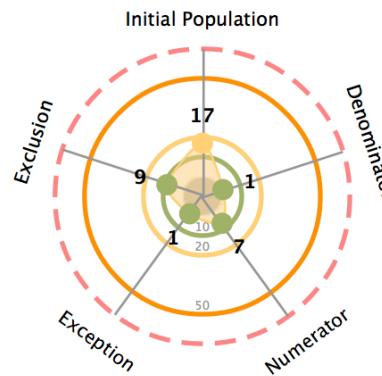
NQF 0031:
Breast Cancer Screening



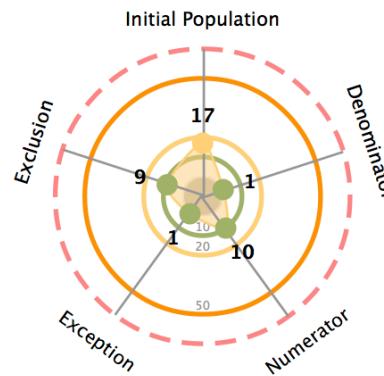
NQF ChildDentalDecay:
**Children Who Have Dental Decay or
Cavities**



NQF PrimaryCariesPrevention:
**Primary Caries Prevention
Intervention as Offered by Primary
Care Providers, including Dentists**

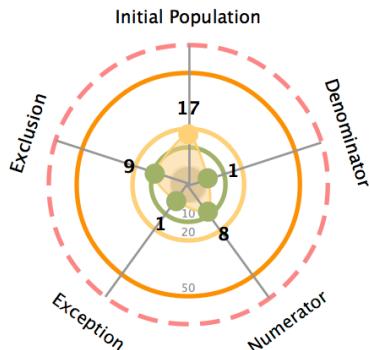


NQF 0024h:
**Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents**

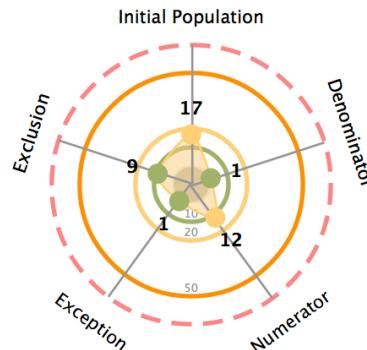


NQF 0055:
Diabetes: Eye Exam

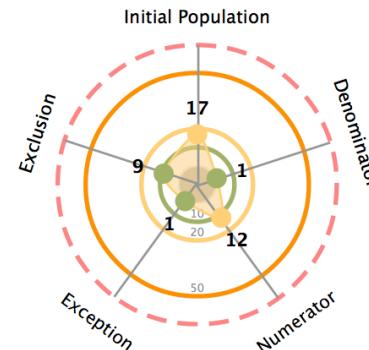
MU Stage 2 Cyclomatic Complexity Results



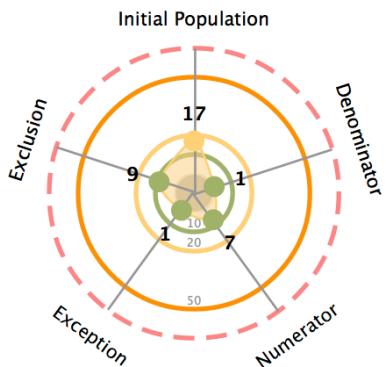
NQF 0064:
Diabetes: Low Density Lipoprotein
(LDL) Management



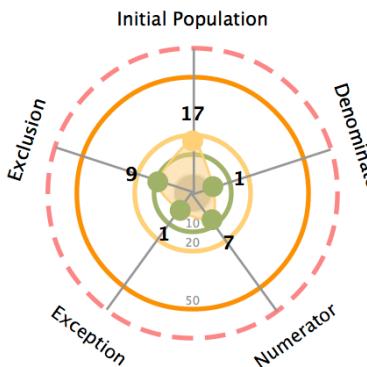
NQF 0024d:
Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents



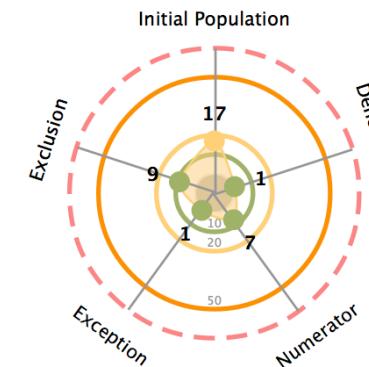
NQF 0024a:
Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents



NQF 0024i:
Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents

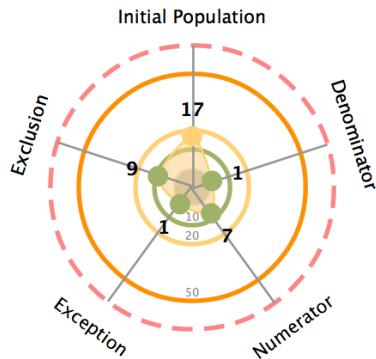


NQF 0024g:
Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents

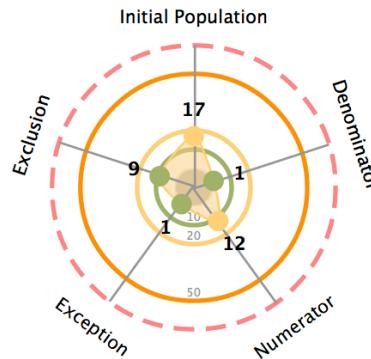


NQF 0024c:
Weight Assessment and Counseling
for Nutrition and Physical Activity for
Children and Adolescents

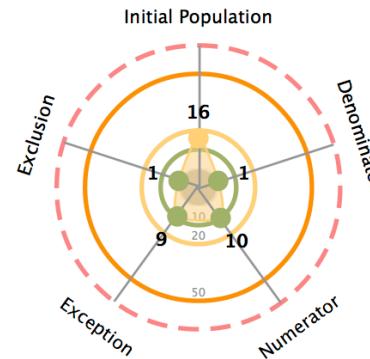
MU Stage 2 Cyclomatic Complexity Results



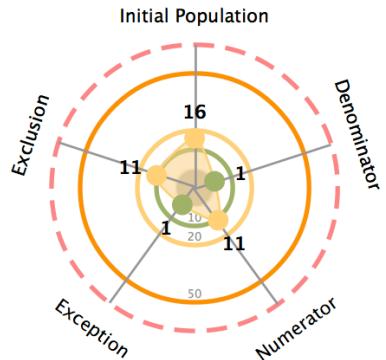
NQF 0024b:
Weight Assessment and Counseling for Nutrition and Physical Activity for Children and Adolescents



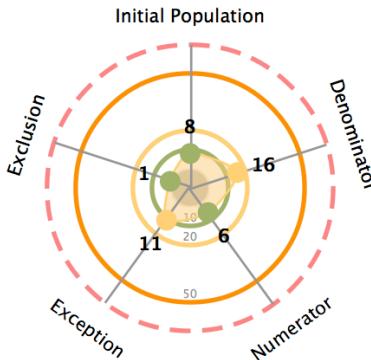
NQF 0024e:
Weight Assessment and Counseling for Nutrition and Physical Activity for Children and Adolescents



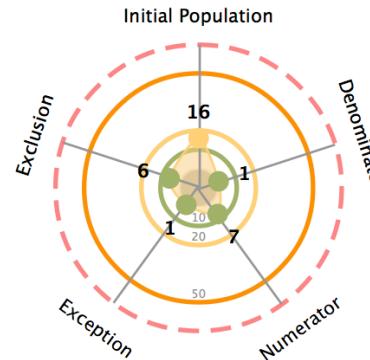
NQF 0405b:
HIV/AIDS: *Pneumocystis jiroveci* pneumonia (PCP) prophylaxis



NQF 0034:
Colorectal Cancer Screening

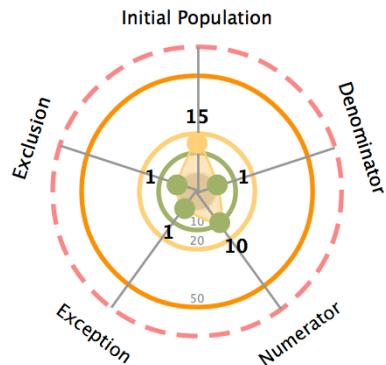


NQF 0389:
Prostate Cancer: Avoidance of Overuse of Bone Scan for Staging Low Risk Prostate Cancer Patients

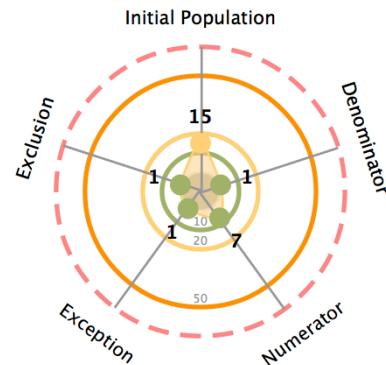


NQF 0032:
Cervical Cancer Screening

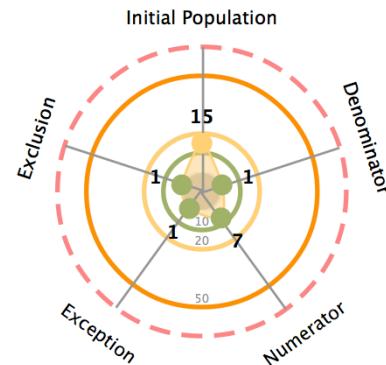
MU Stage 2 Cyclomatic Complexity Results



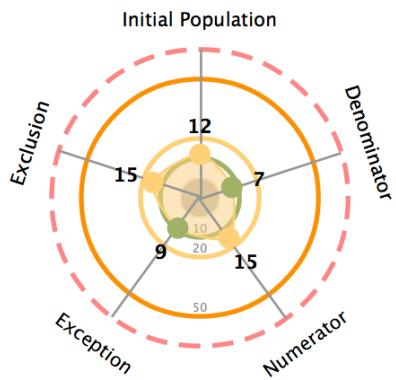
NQF 1401:
Maternal Depression Screening



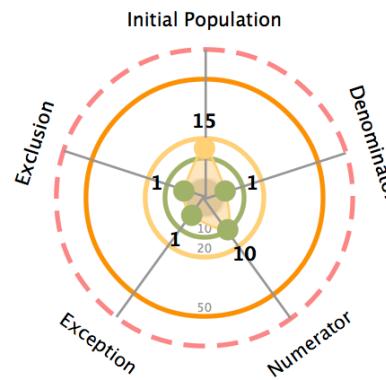
NQF 0022b:
Use of High-Risk Medications in the Elderly



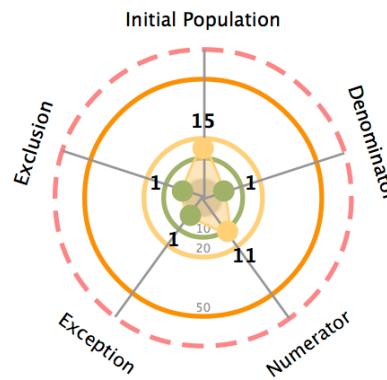
NQF ClosingReferralLoop:
Closing the referral loop: receipt of specialist report



NQF CholesterolScreeningTesta:
Preventive Care and Screening: Cholesterol - Fasting Low Density Lipoprotein (LDL-C) Test Performed

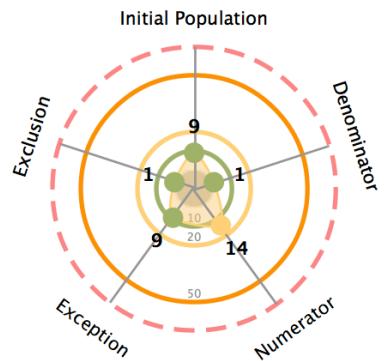


NQF 0022a:
Use of High-Risk Medications in the Elderly

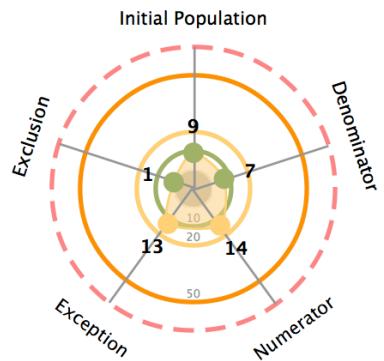


NQF 0043:
Pneumonia Vaccination Status for Older Adults

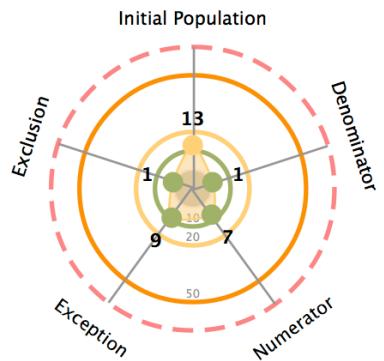
MU Stage 2 Cyclomatic Complexity Results



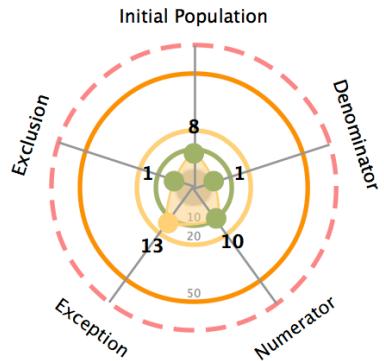
NQF 0088:
Diabetic Retinopathy: Documentation of Presence or Absence of Macular Edema and Level of Severity of Retinopathy



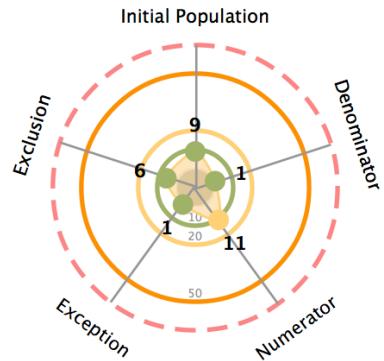
NQF 0089:
Diabetic Retinopathy: Communication with the Physician Managing Ongoing Diabetes Care



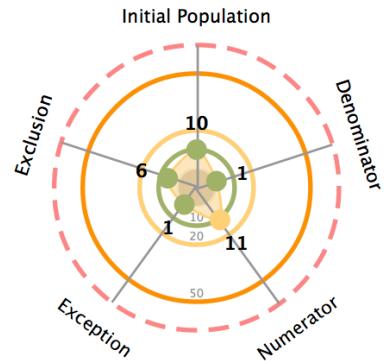
NQF 0608:
Pregnant women that had HBsAg testing



NQF DementiaCognitive:
Dementia: Cognitive Assessment

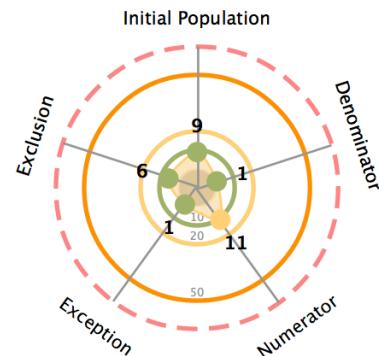


NQF 0004a:
Initiation and Engagement of Alcohol and Other Drug Dependence Treatment

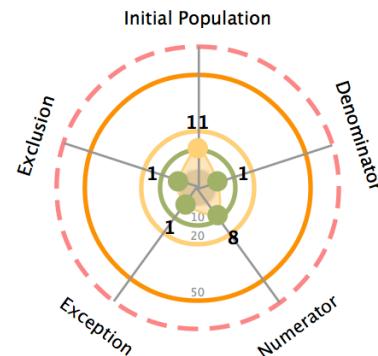


NQF 0004c:
Initiation and Engagement of Alcohol and Other Drug Dependence Treatment

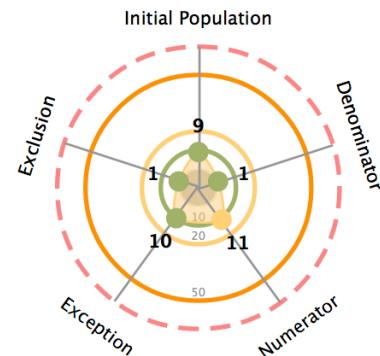
MU Stage 2 Cyclomatic Complexity Results



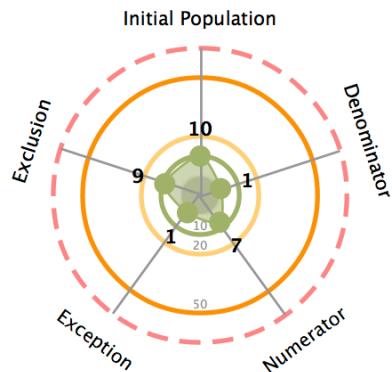
NQF 0004d:
**Initiation and Engagement of Alcohol
and Other Drug Dependence
Treatment**



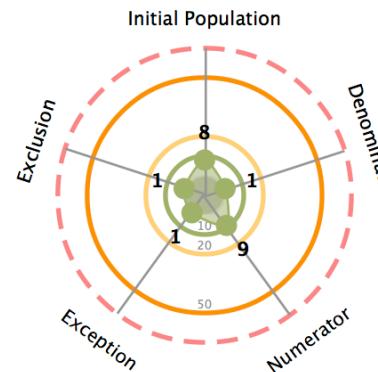
NQF 0407:
**HIV/AIDS: RNA Control for Patients
with HIV**



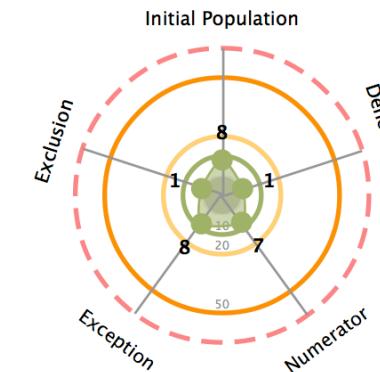
NQF 0086:
**Primary Open Angle Glaucoma
(POAG): Optic Nerve Evaluation**



NQF 0060:
**Hemoglobin A1c Test for Pediatric
Patients**



NQF 0403:
HIV/AIDS: Medical Visit



NQF 0419:
**Documentation of Current
Medications in the Medical Record**