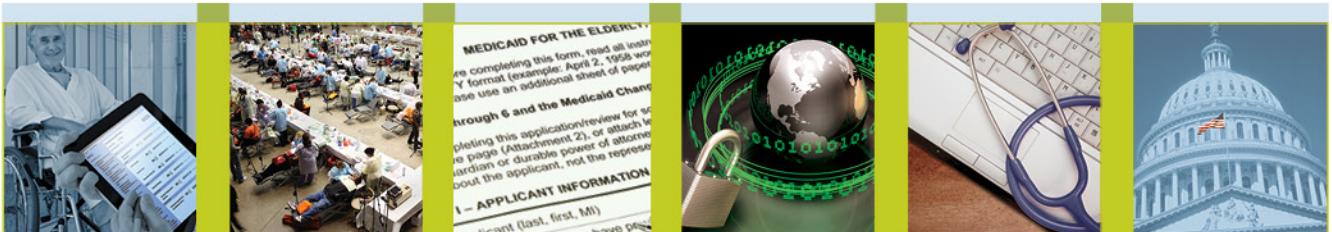


Kamira

An Open Source Clinical Quality Modeling Framework



Health in the 21st Century

MITRE

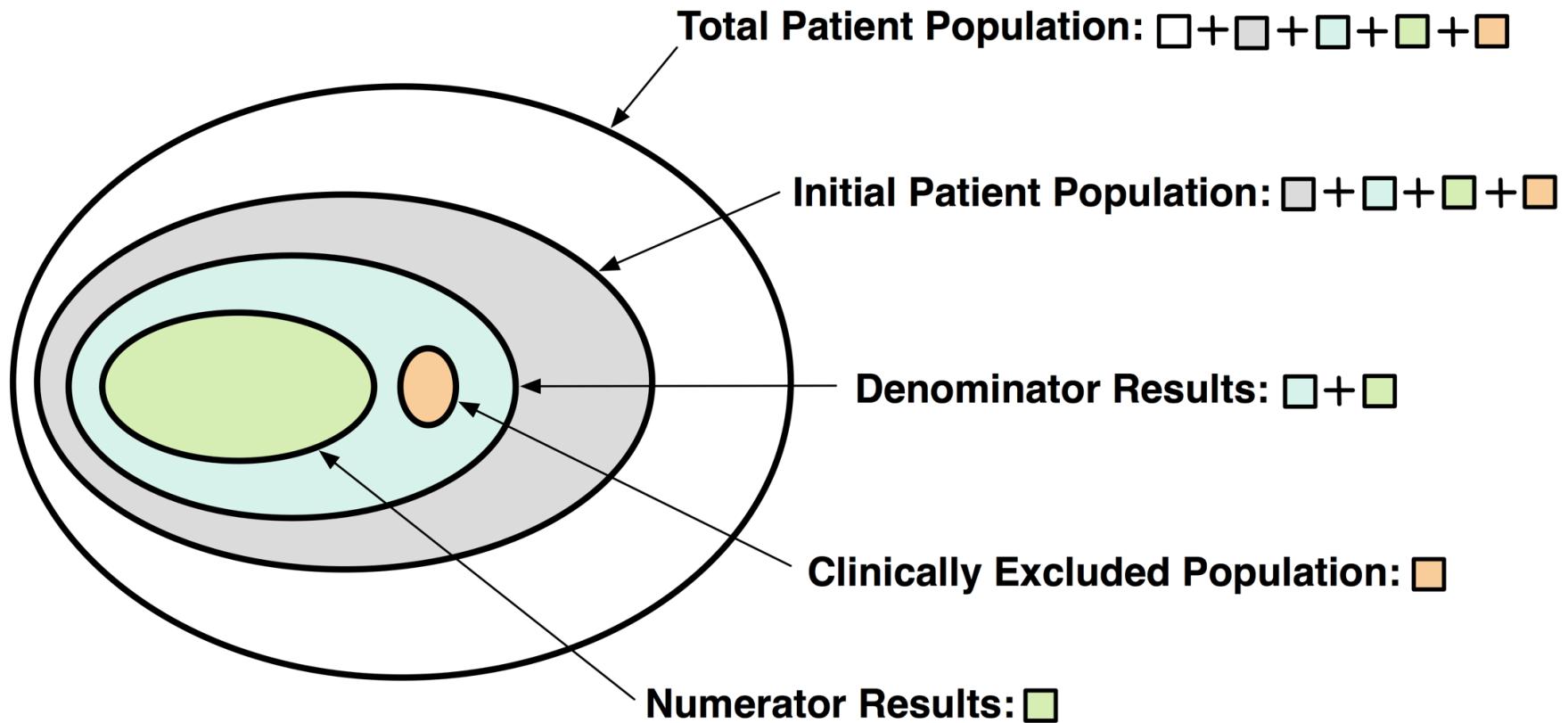
What is Kamira?

- 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

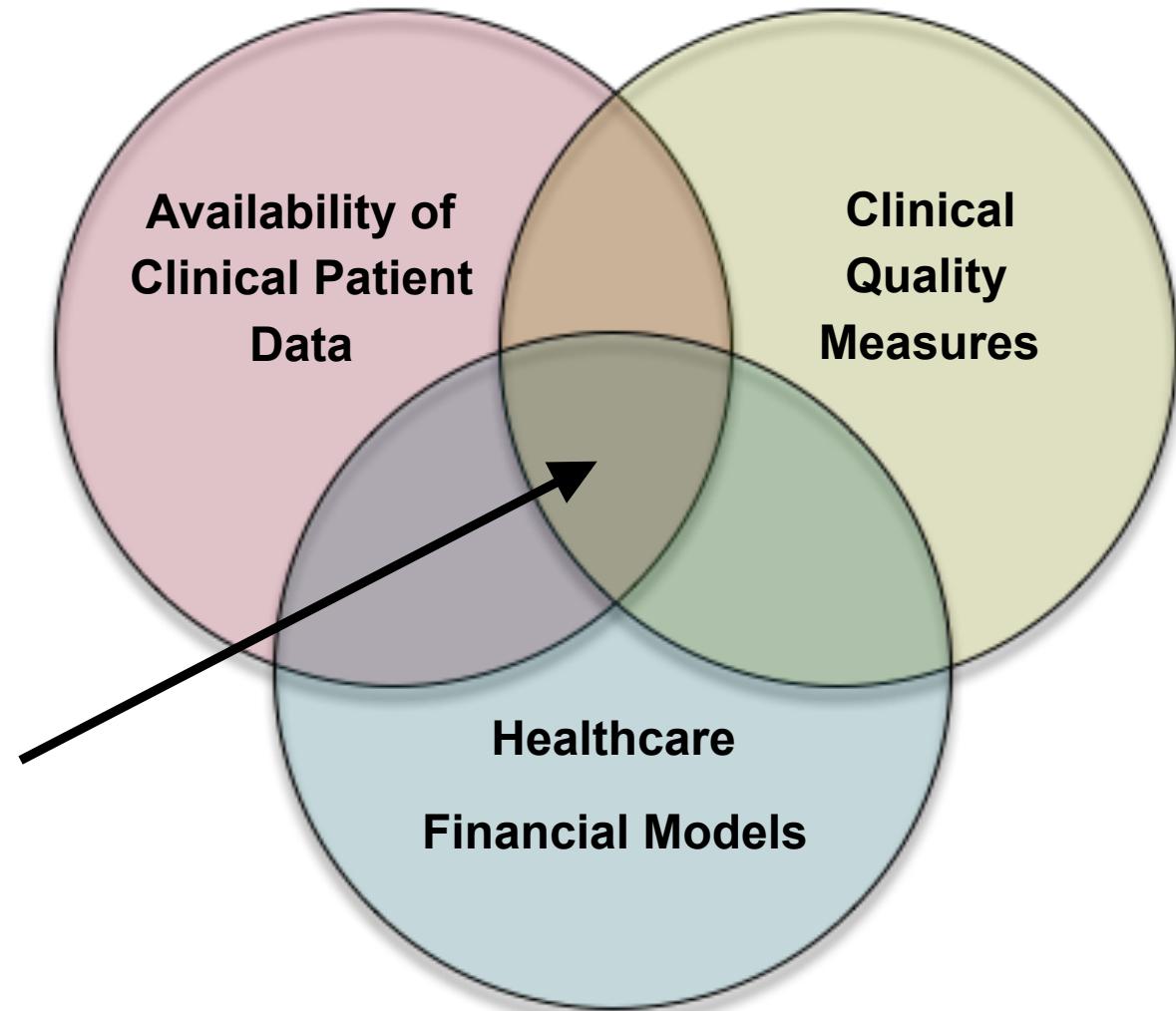
- **What are Clinical Quality Measures (CQM)?**
 - Tools that help us measure a segment of healthcare delivery
 - Each CQM has a different goal: effective, safe, efficient, patient-centered, equitable, and/or timely care
- **Clinical Quality Measures are key components of the Meaningful Use program as 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

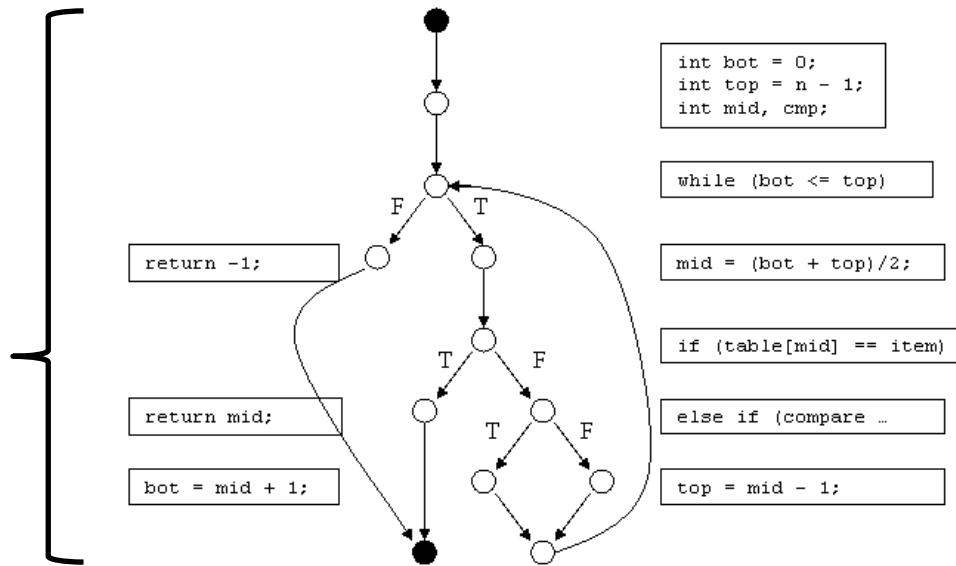
- **What are the best methods to assess the overall value of a Clinical Quality Measure?**
- **If the performance of a Clinical Quality Measure improves, how does it affect overall health outcomes? How does it affect total cost to the healthcare system?**
- **What are the best Clinical Quality Measures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

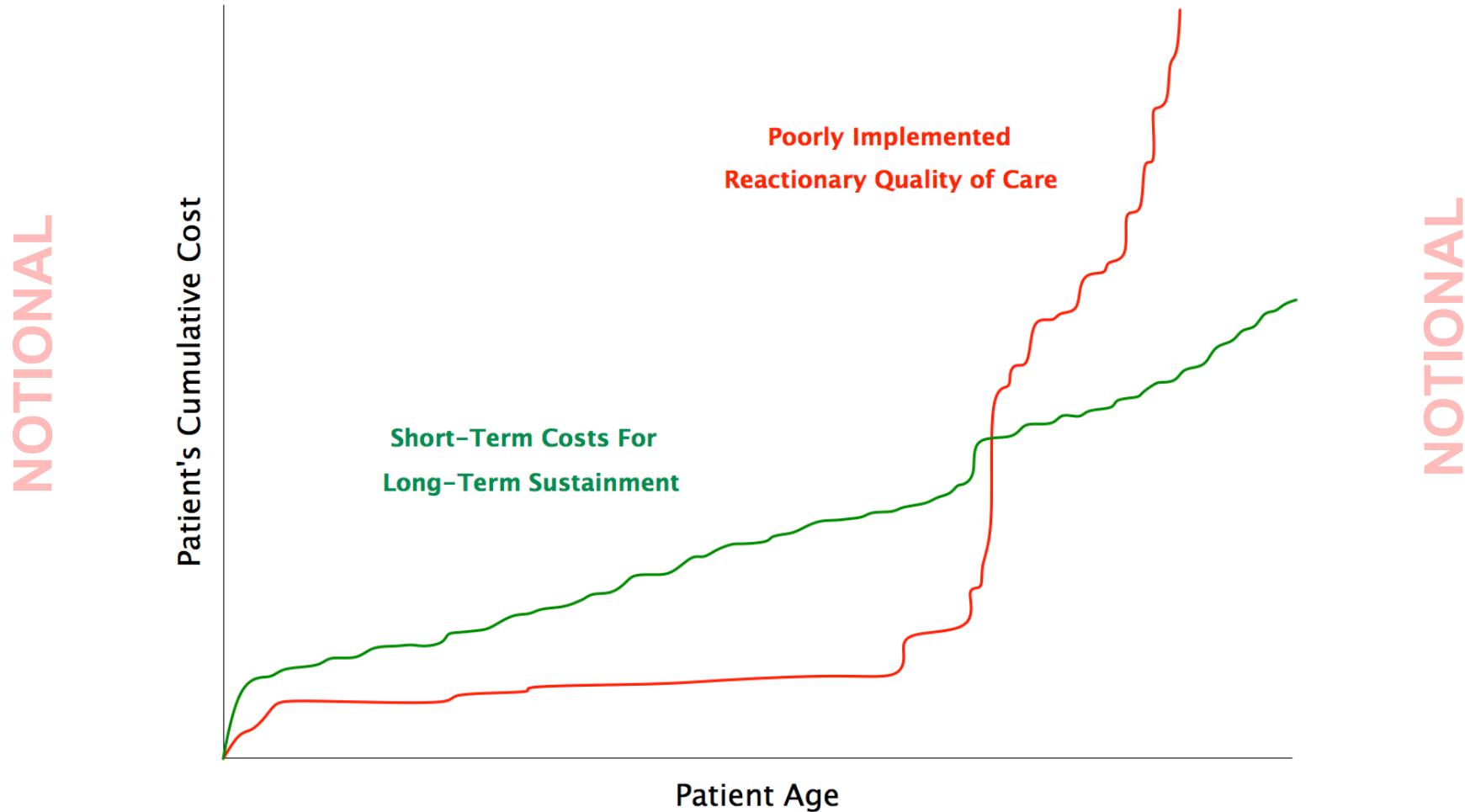
Cyclomatic Complexity Analysis

- 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

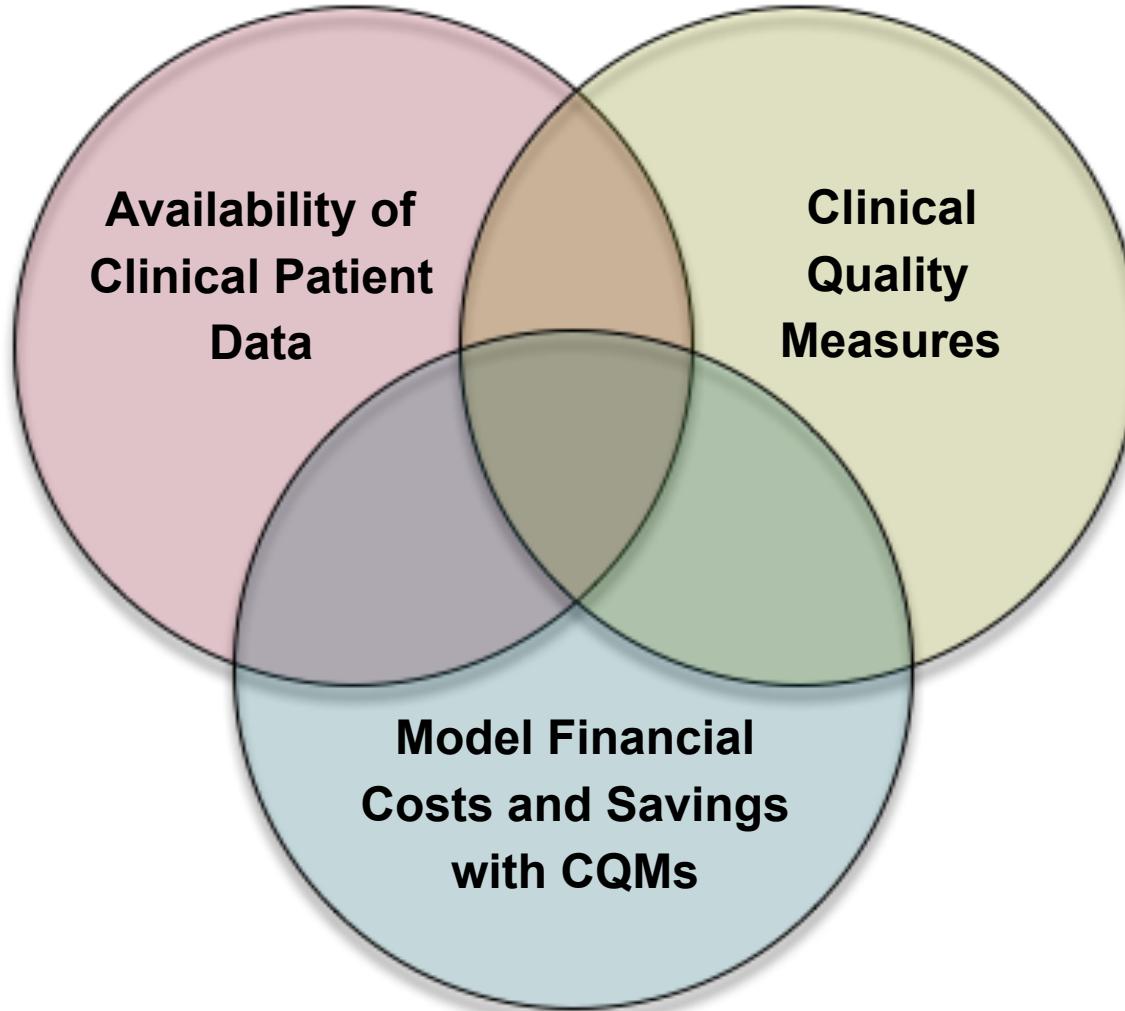
| Measure | Description | Short Term Cost (Influenza Vaccination) | Cost per Hospitalized Case, ages 50-64 | Cost per Hospitalized Case, ages ≥ 65 |
|----------|--|---|---|--|
| NQF 0041 | Influenza Immunization for Patients > 50 Years Old | ~\$15 per person | \$7,276 (\pm 25%) | \$8,278 (\pm 25%) |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

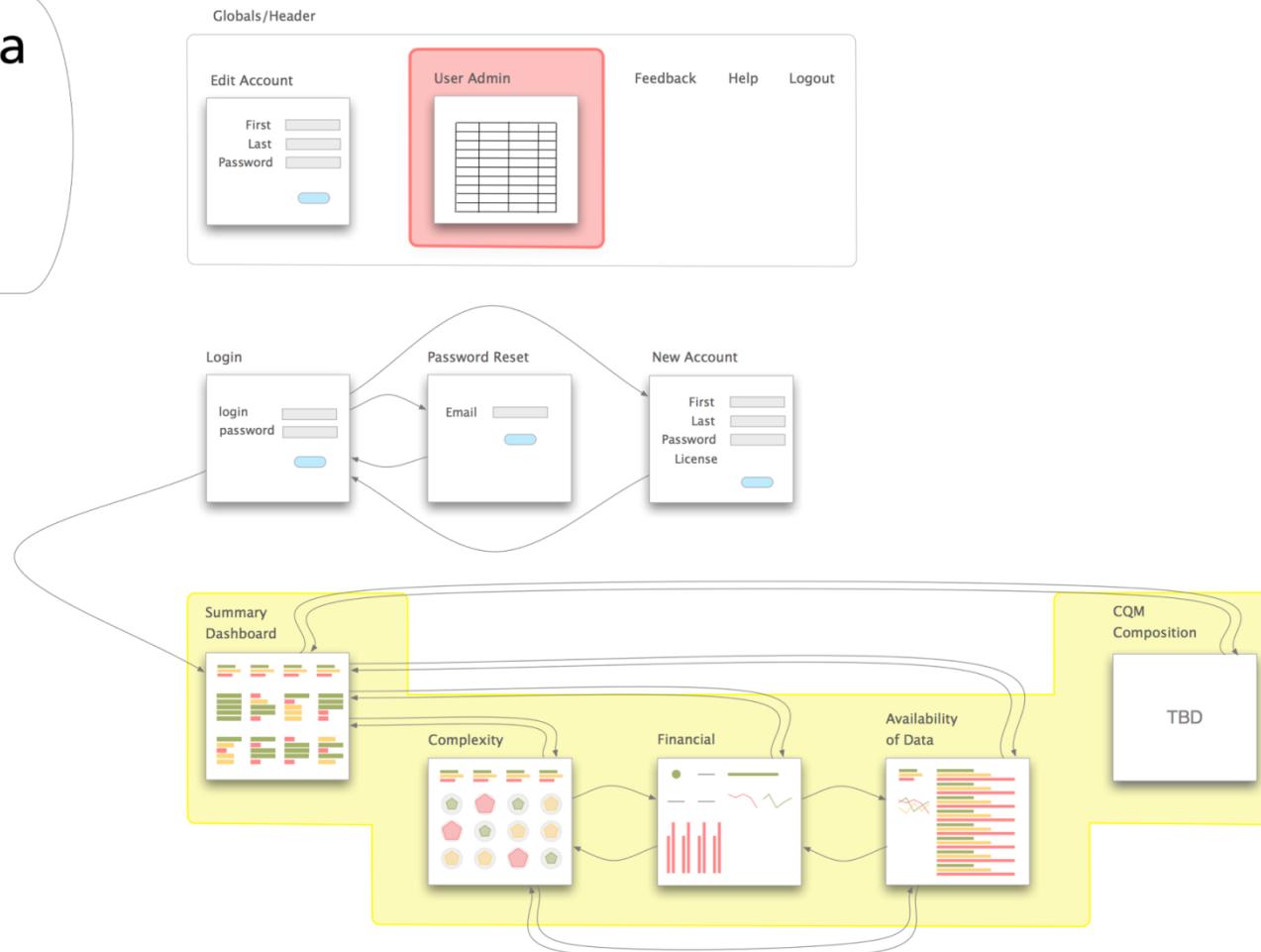
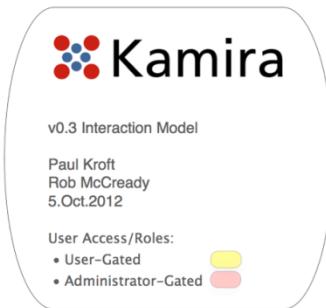
Idea



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 | |

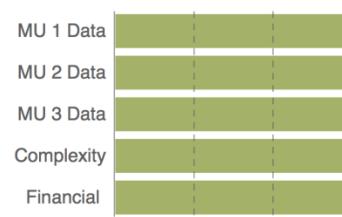
Complexity

| | | |
|---------|----|--|
| 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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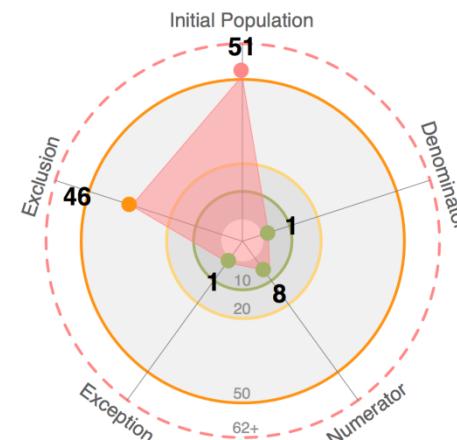
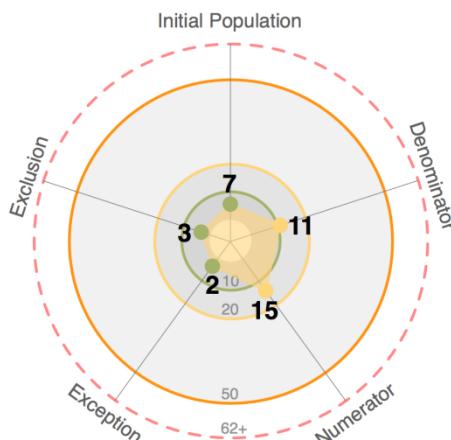
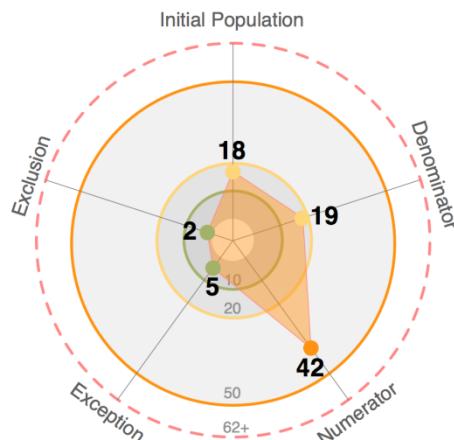


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Complexity Analysis

- 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

[Back to Dashboard](#)

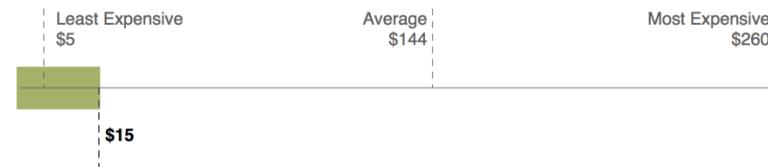
Financial Status



Est. Short Term Cost

\$15

Cost Comparison



Non-treatment Costs

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

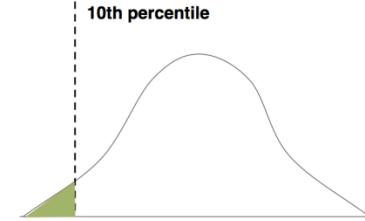
Based on estimated cost per hospitalized case.

Potential Cost Savings

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

Based on estimated cost per hospitalized case.

Cost Distribution



Cost Trends

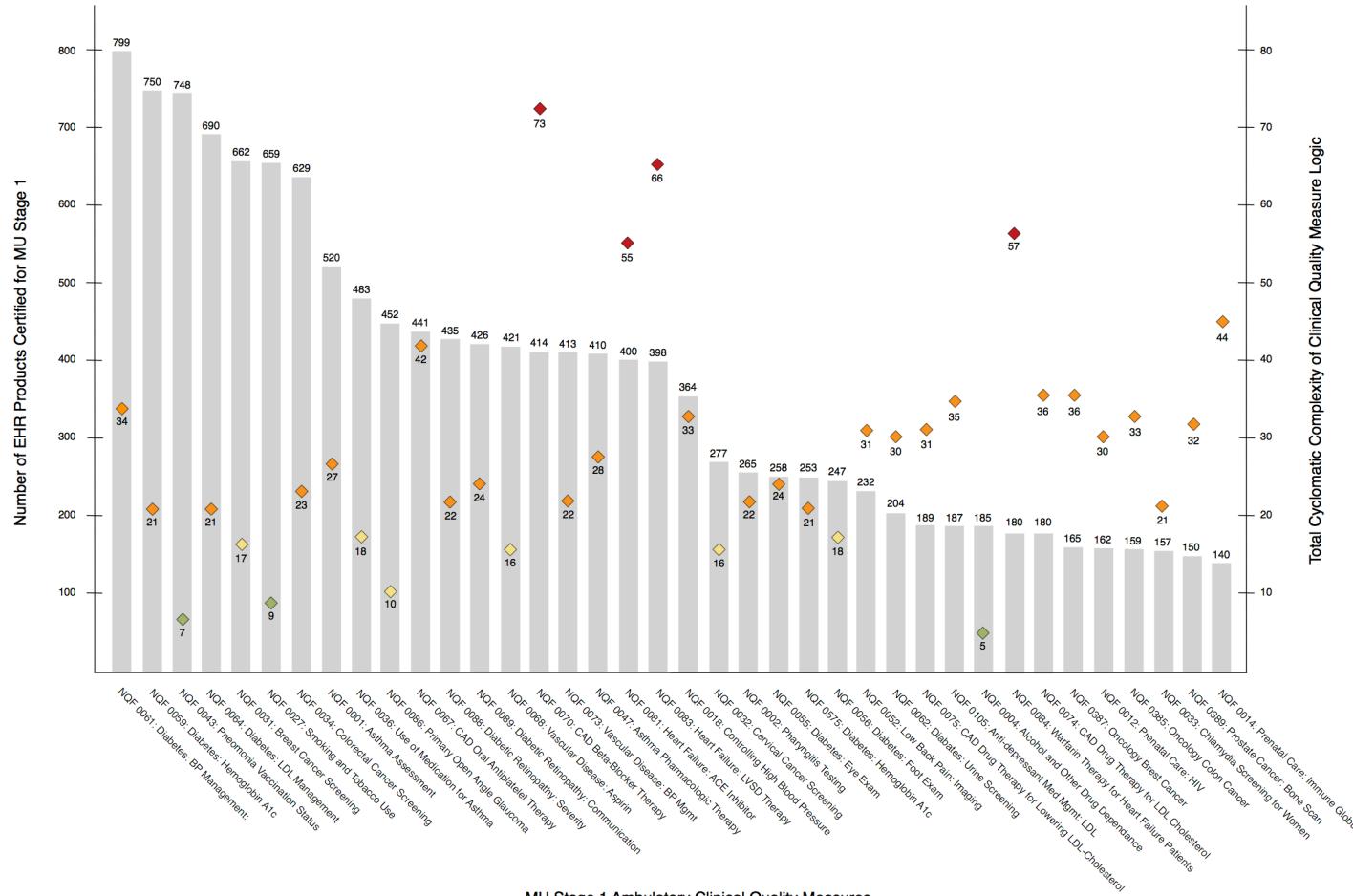




Backup

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

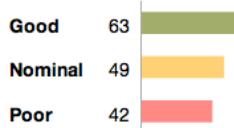




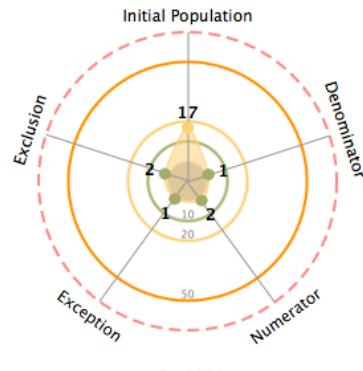
Meaningful Use Stage 2 CQM Complexity Analysis

Complexity Analysis

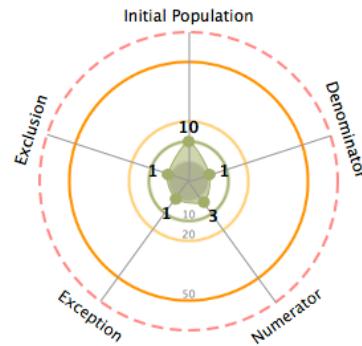
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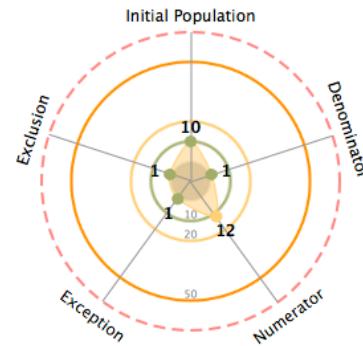
| | | | |
|---|-------|-------------|---------------|
| ● | 1-10 | Very Simple | Low Risk |
| ○ | 11-20 | Nominal | Moderate Risk |
| ● | 21-50 | Complex | High Risk |
| ● | 51+ | Untestable | Extreme Risk |



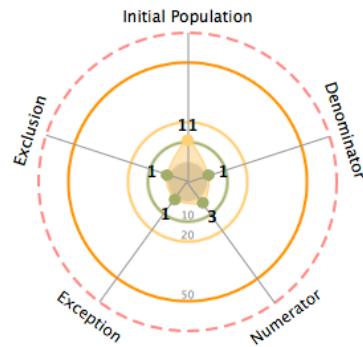
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Appropriate Testing for Children with
Pharyngitis**



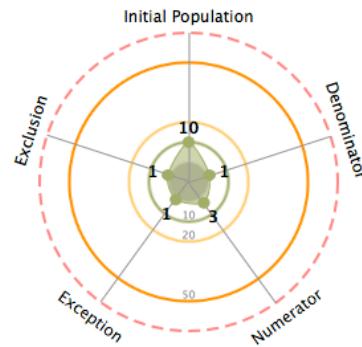
NQF 0004a:
**Initiation and Engagement of Alcohol and Other
Drug Dependence Treatment**



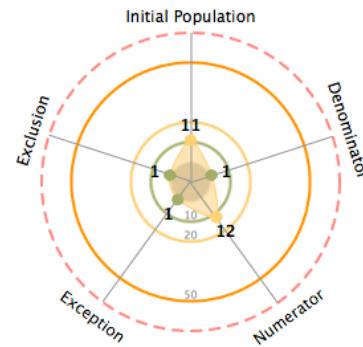
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**Initiation and Engagement of Alcohol and Other
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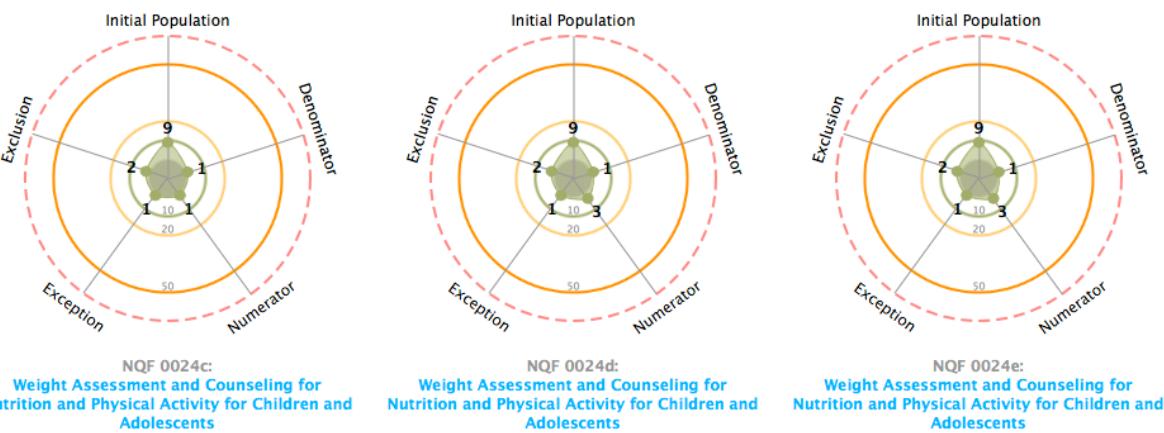
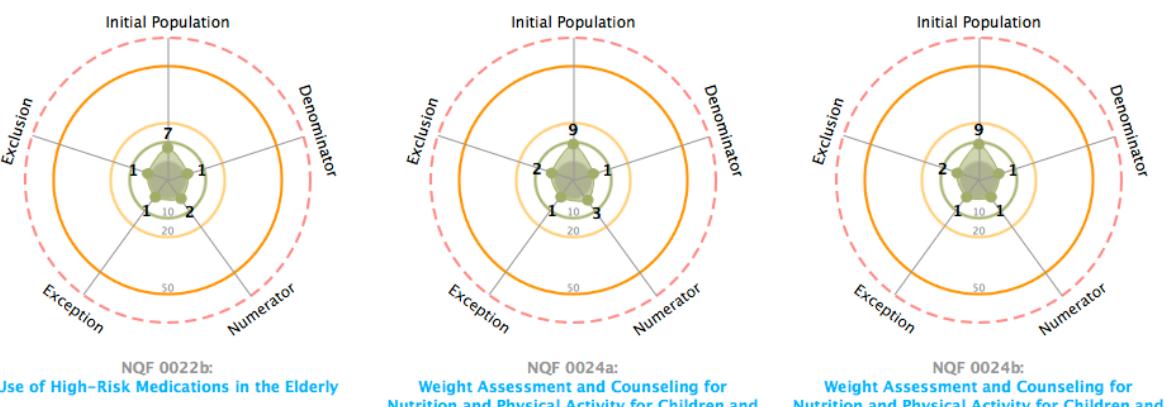
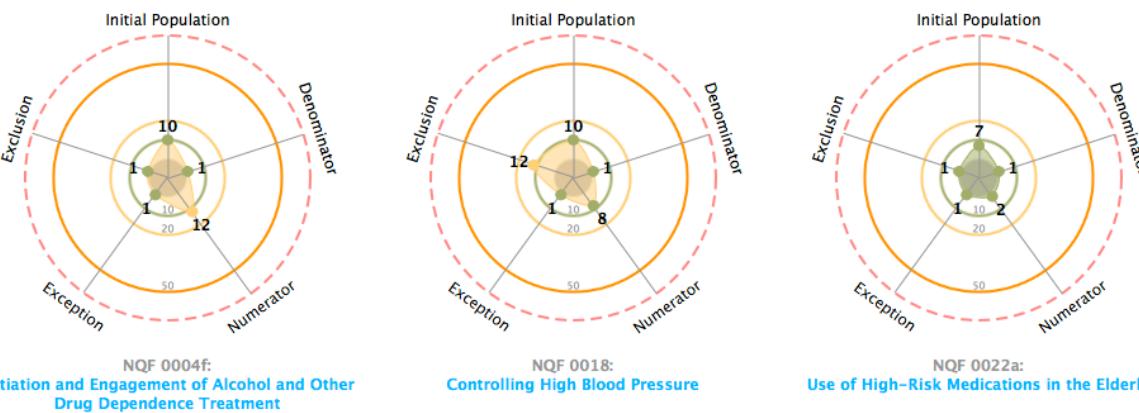
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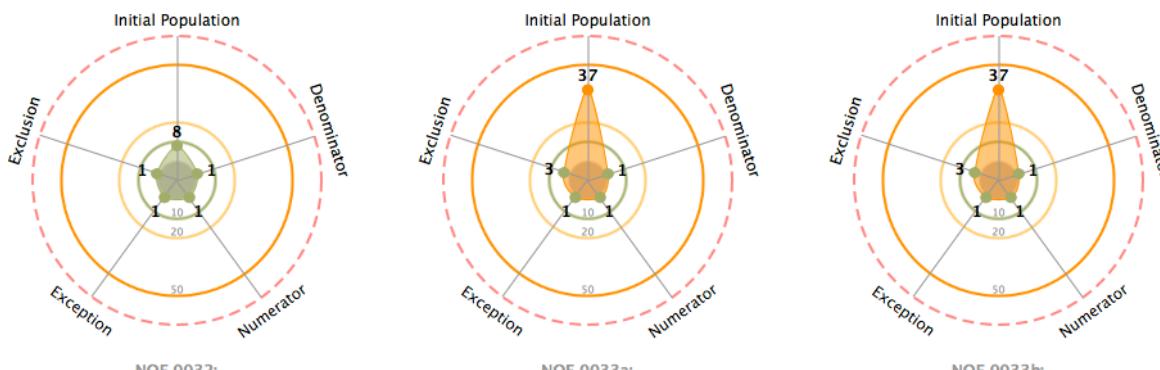
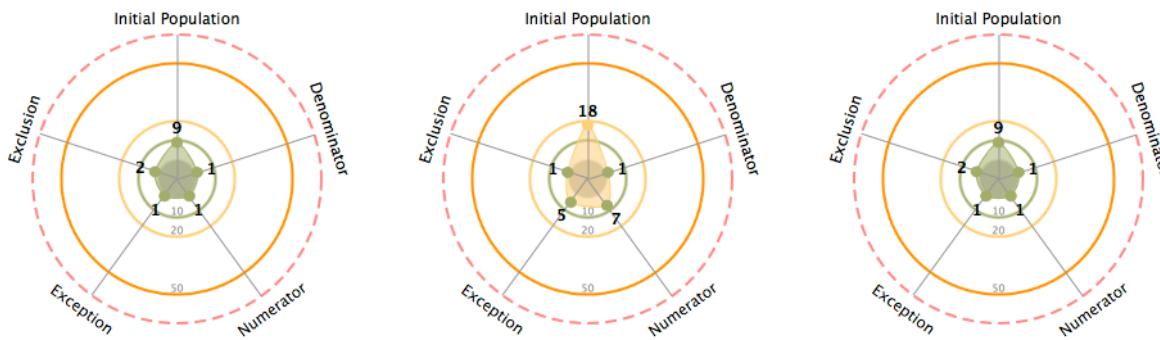
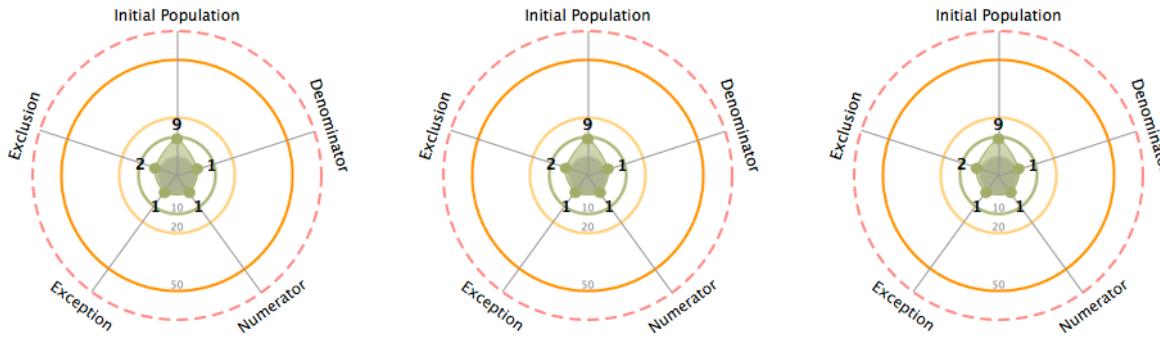


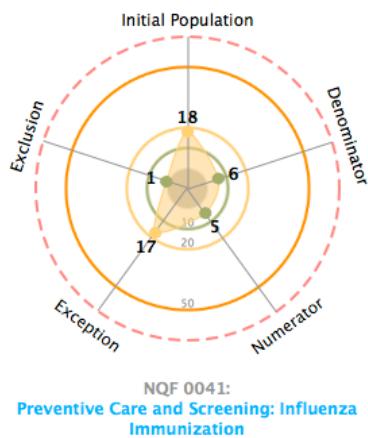
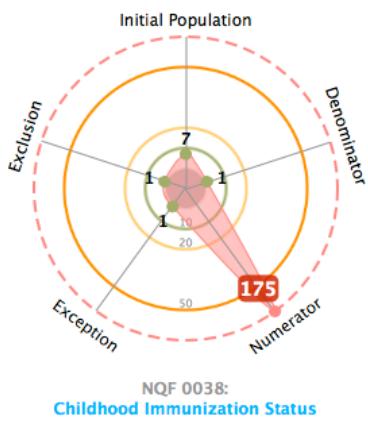
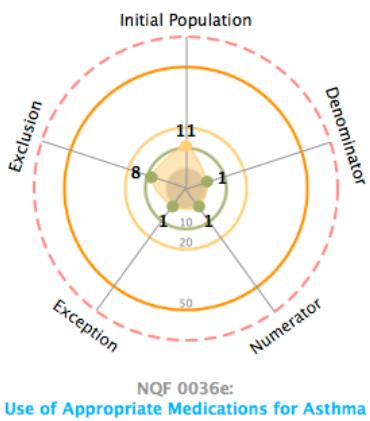
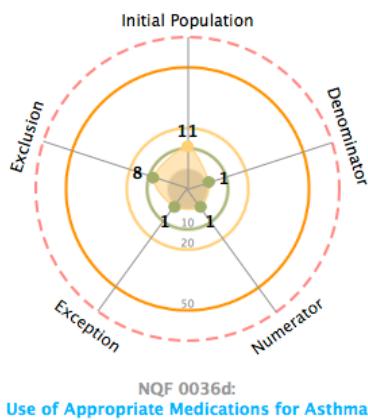
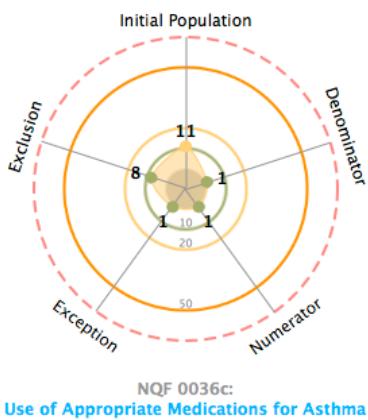
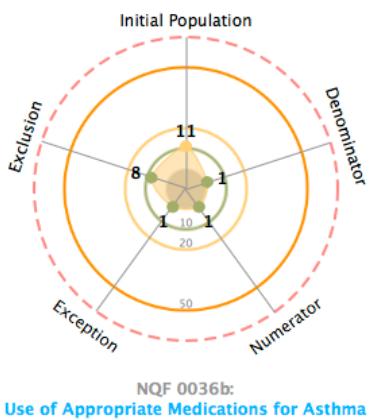
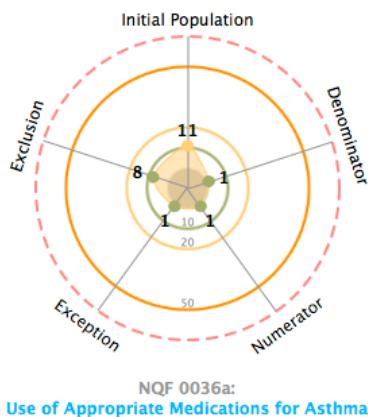
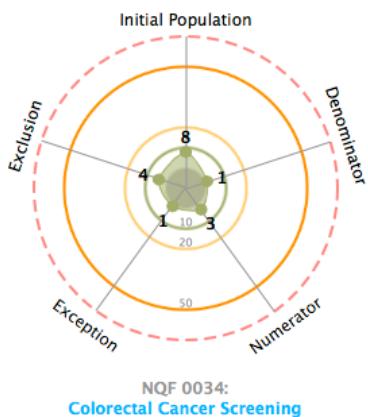
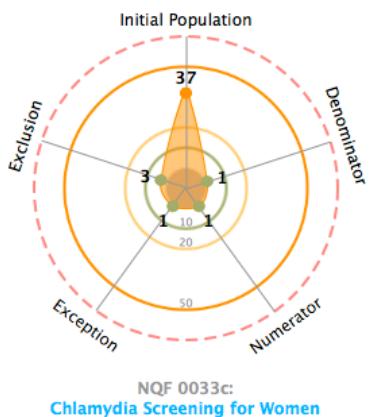
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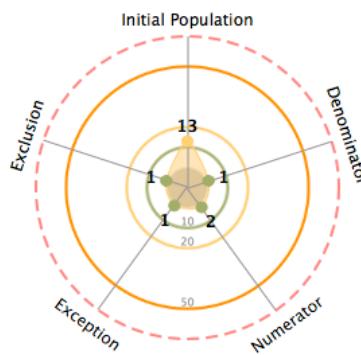
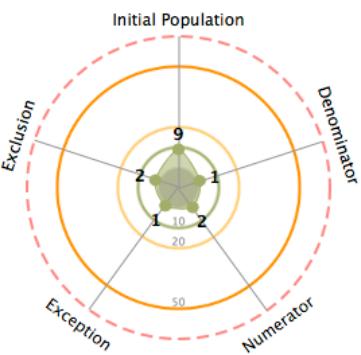
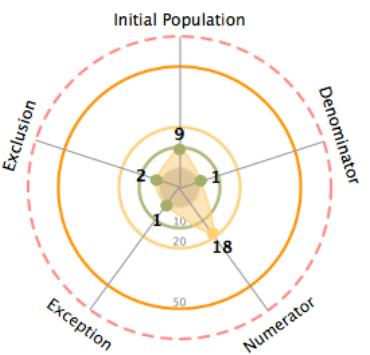
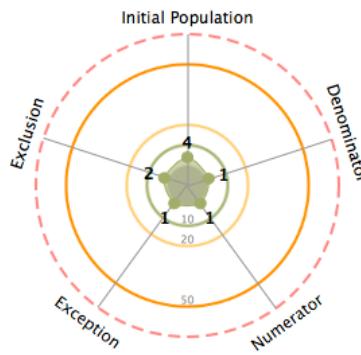
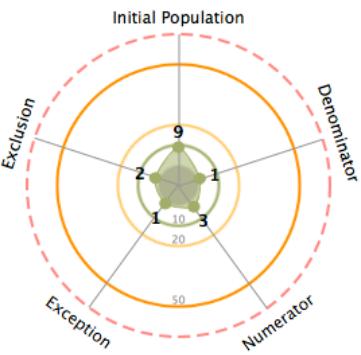
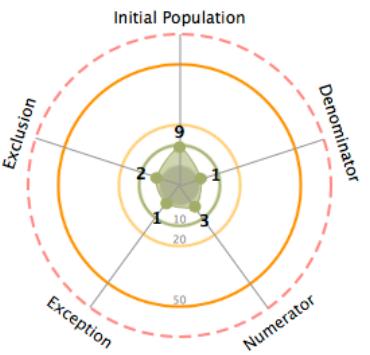
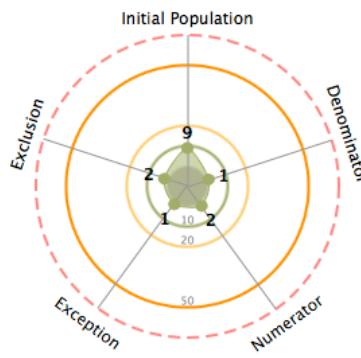
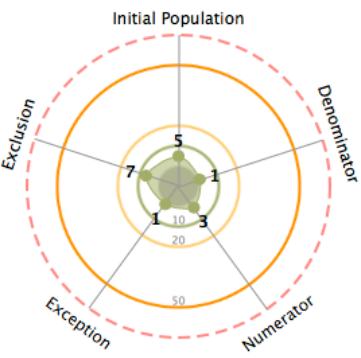
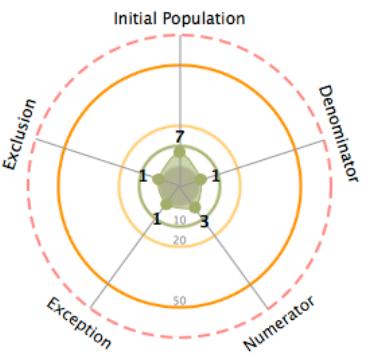


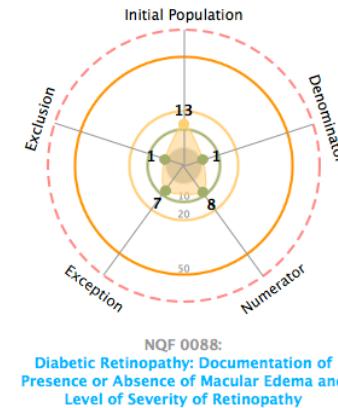
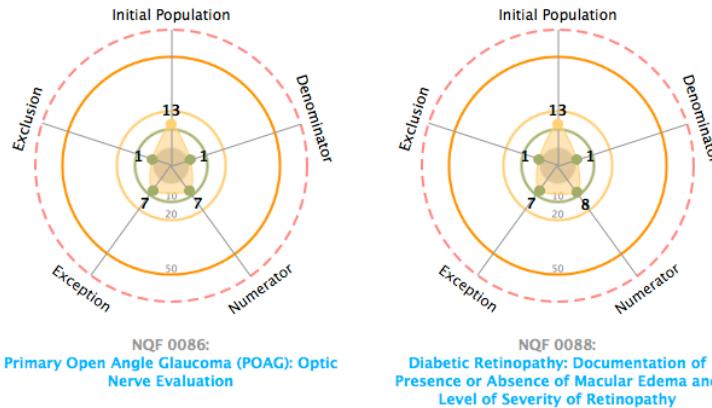
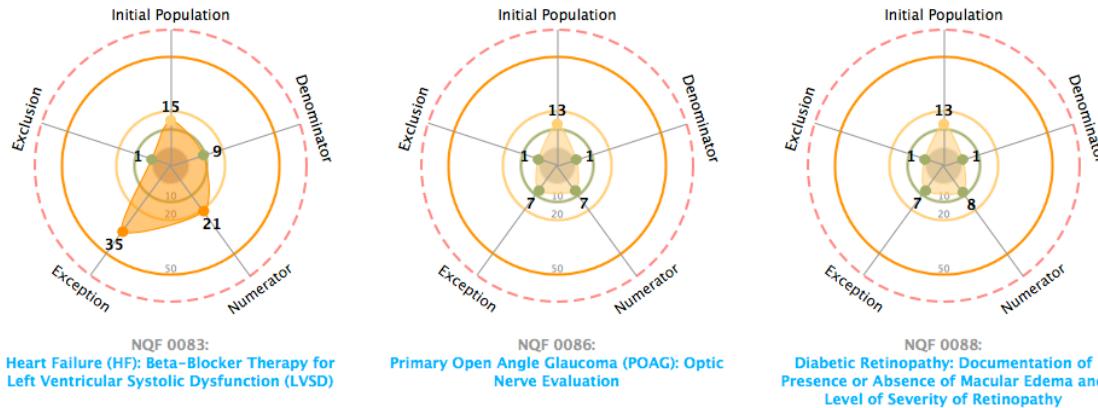
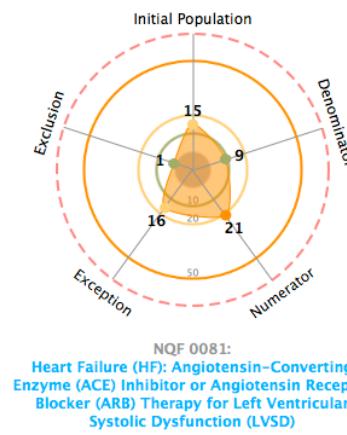
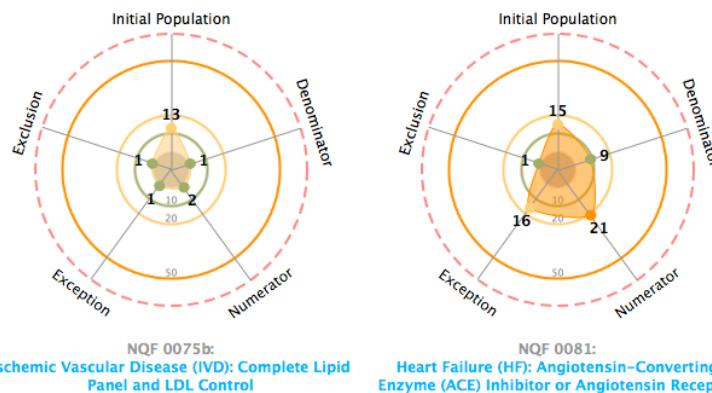
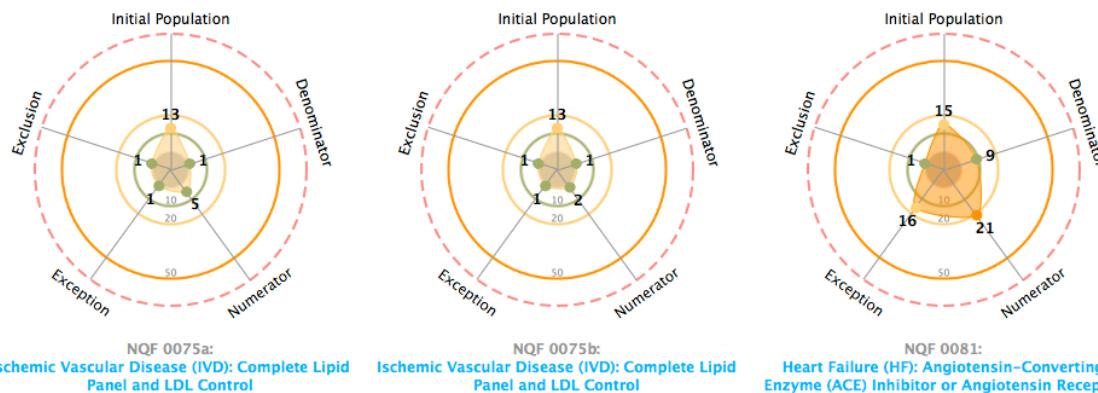
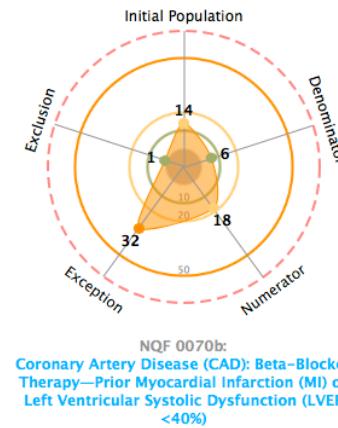
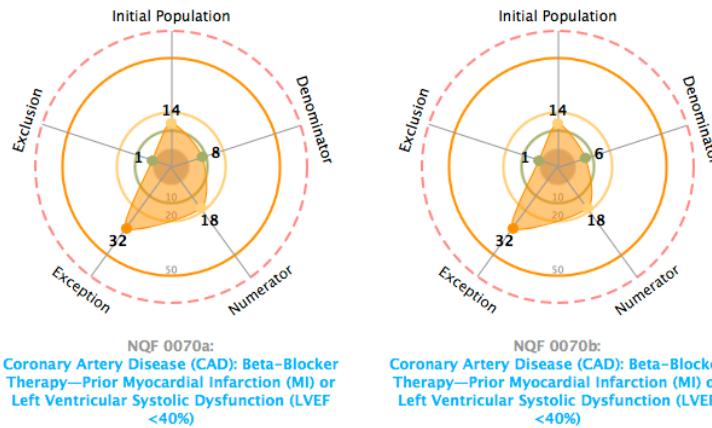
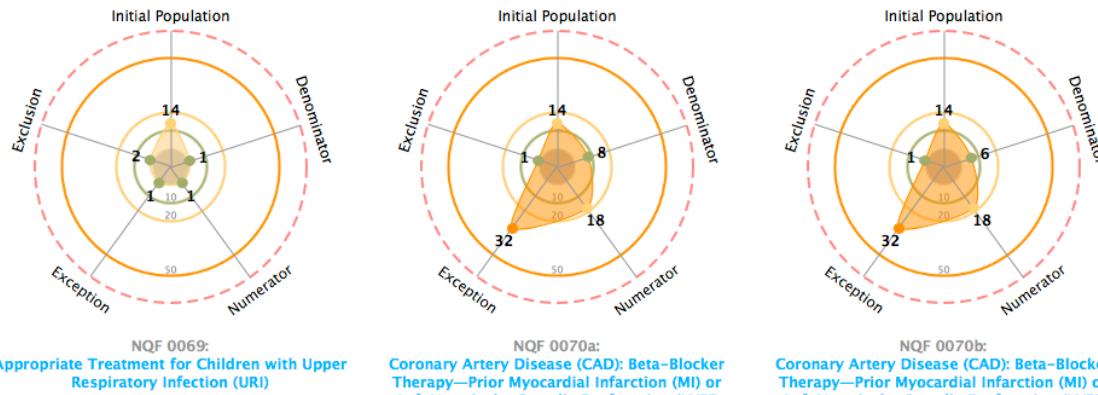
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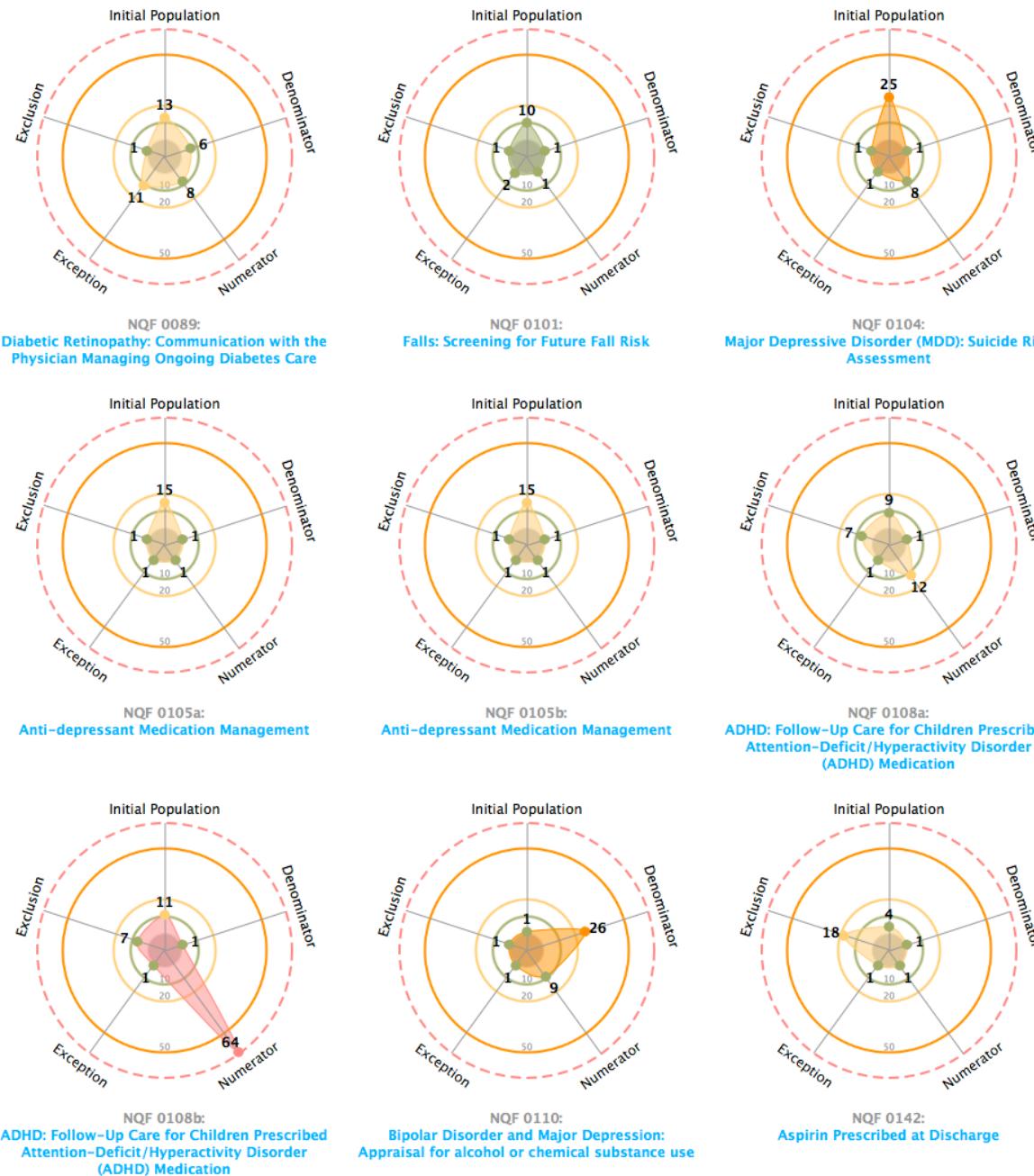


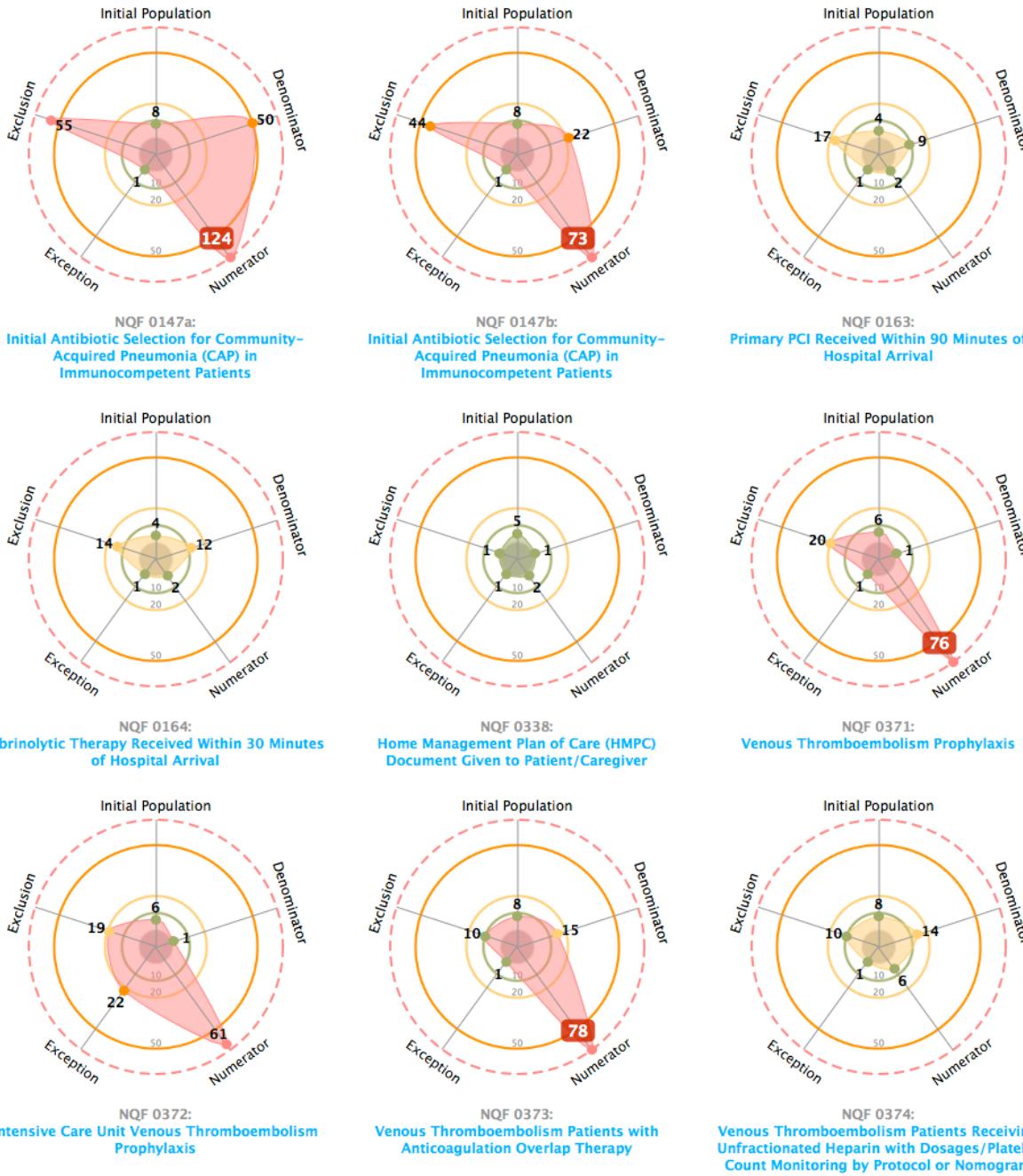


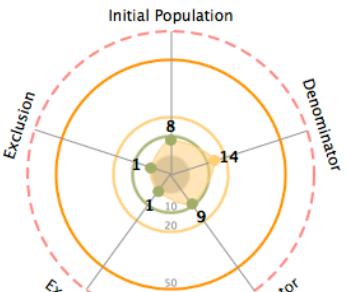




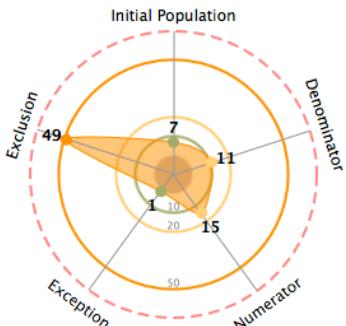




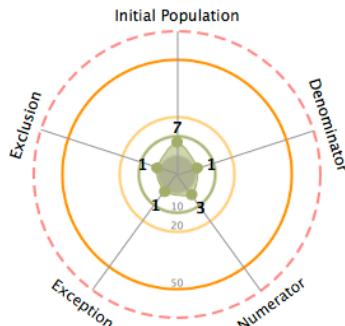




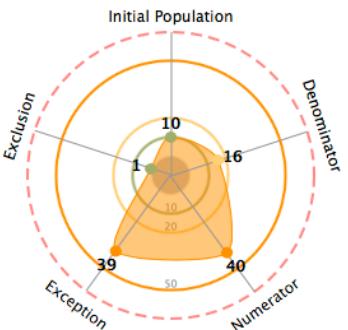
NQF 0375:
Venous Thromboembolism Discharge Instructions



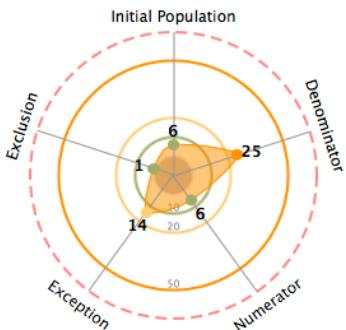
NQF 0375:
Incidence of Potentially-Preventable Venous Thromboembolism



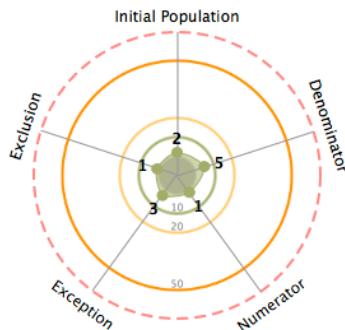
NQF 0384:
Oncology: Medical and Radiation - Pain Intensity Quantified



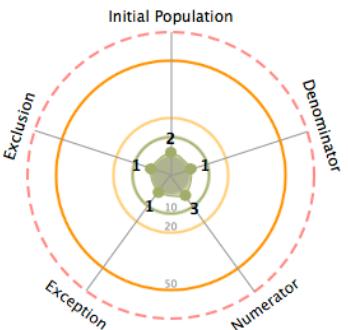
NQF 0385:
Colon Cancer: Chemotherapy for AJCC Stage III Colon Cancer Patients



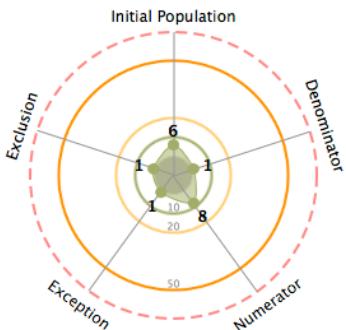
NQF 0387:
Breast Cancer: Hormonal Therapy for Stage IC-IIIC Estrogen Receptor/Progesterone Receptor (ER/PR) Positive Breast Cancer



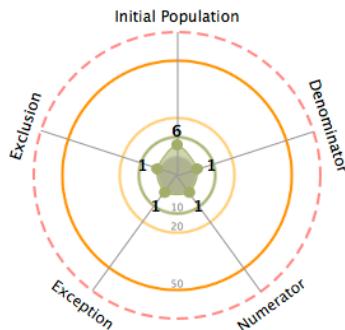
NQF 0389:
Prostate Cancer: Avoidance of Overuse of Bone Scan for Staging Low Risk Prostate Cancer Patients



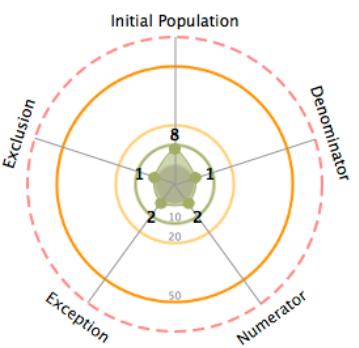
NQF 0403:
HIV/AIDS: Medical Visit



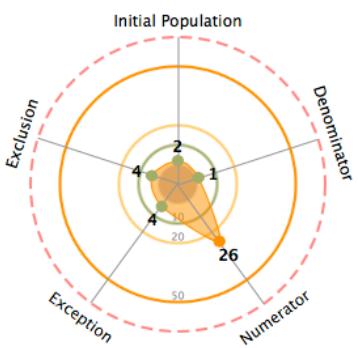
NQF 0405a:
HIV/AIDS: Pneumocystis jiroveci pneumonia (PCP) prophylaxis



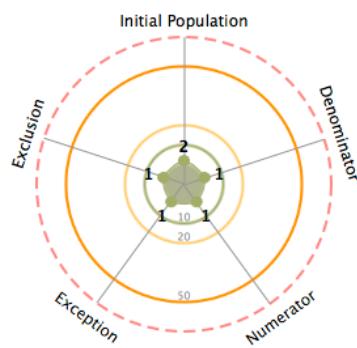
NQF 0405b:
HIV/AIDS: Pneumocystis jiroveci pneumonia (PCP) prophylaxis



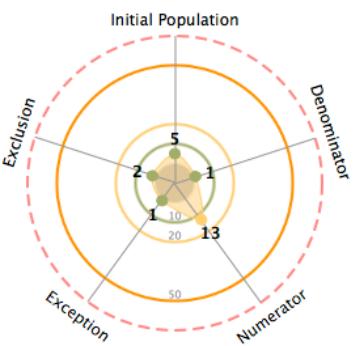
NQF 0405c:
HIV/AIDS: *Pneumocystis jiroveci pneumonia (PCP)* prophylaxis



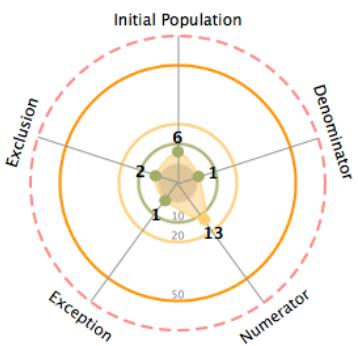
NQF 0418:
Preventive Care and Screening: Screening for Clinical Depression and Follow-Up Plan



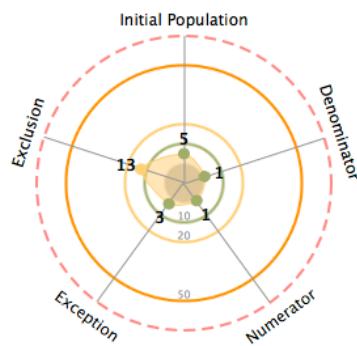
NQF 0419:
Documentation of Current Medications in the Medical Record



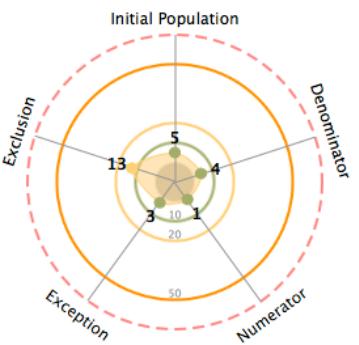
NQF 0421a:
Preventive Care and Screening: Body Mass Index (BMI) Screening and Follow-Up



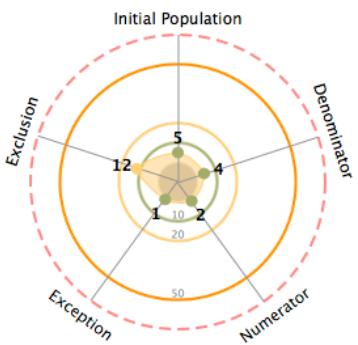
NQF 0421b:
Preventive Care and Screening: Body Mass Index (BMI) Screening and Follow-Up



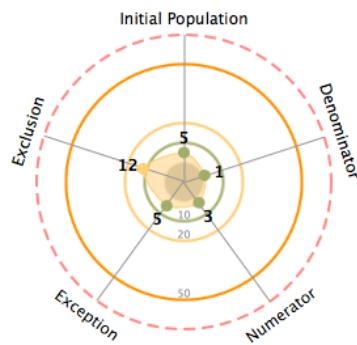
NQF 0435:
Discharged on Antithrombotic Therapy



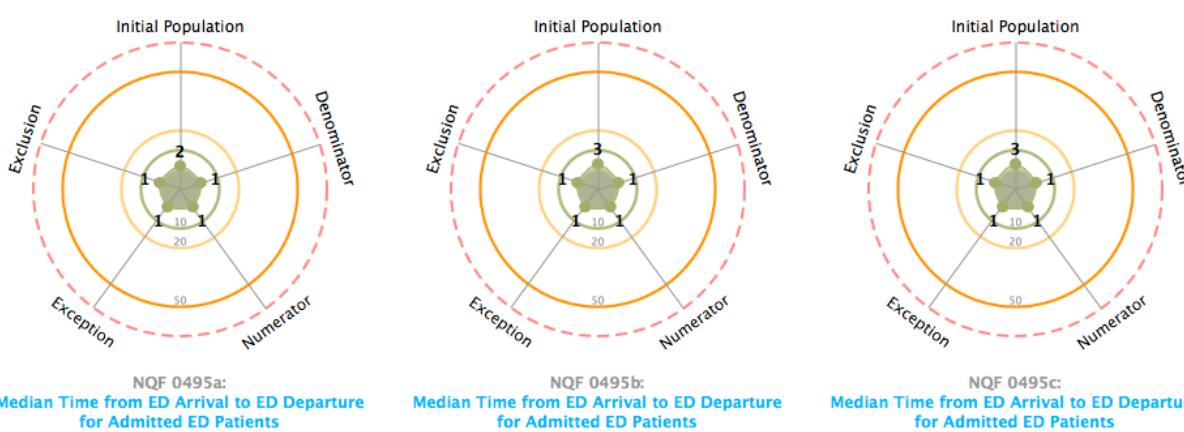
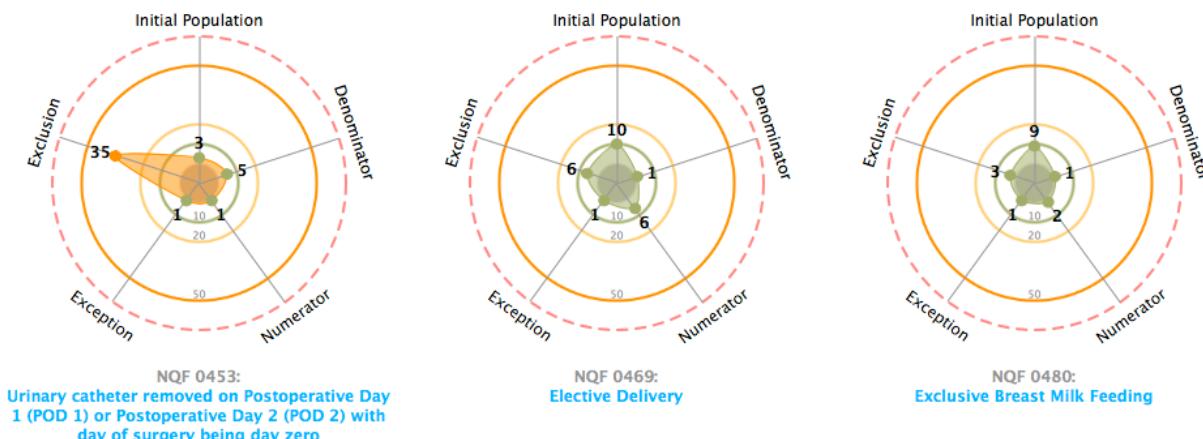
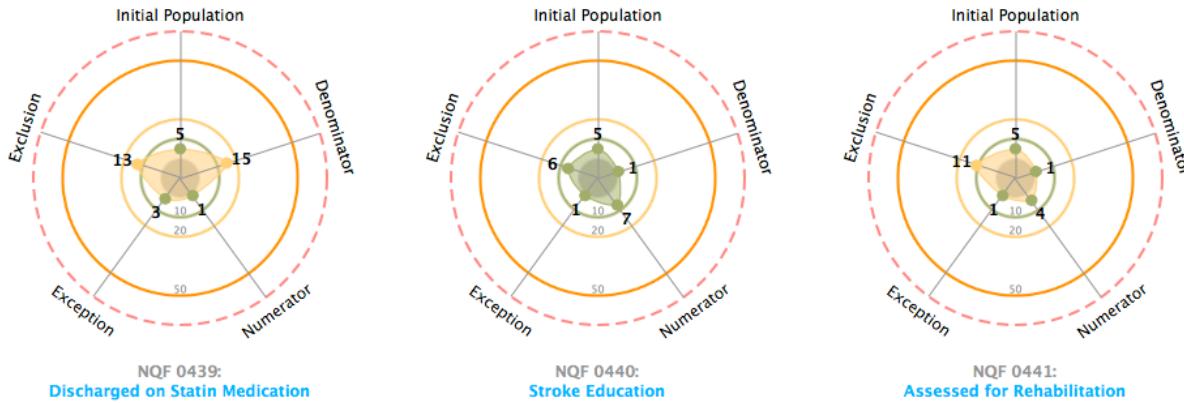
NQF 0436:
Anticoagulation Therapy for Atrial Fibrillation/Flutter

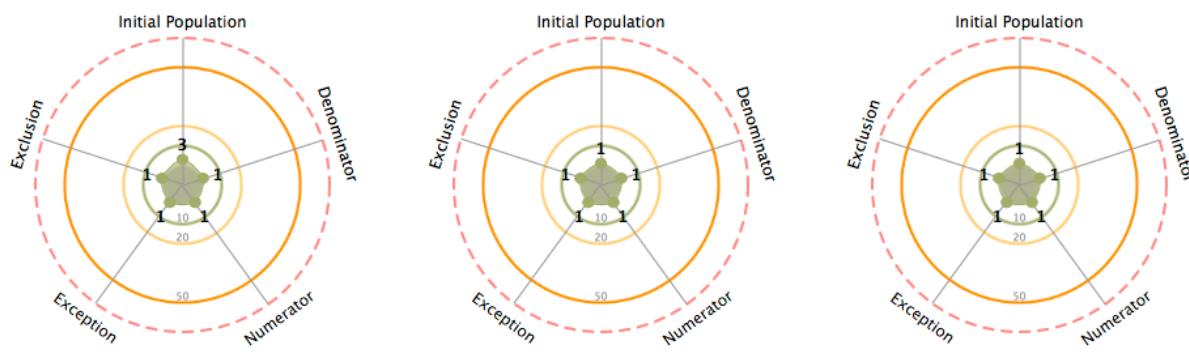


NQF 0437:
Thrombolytic Therapy



NQF 0438:
Antithrombotic Therapy By End of Hospital Day 2

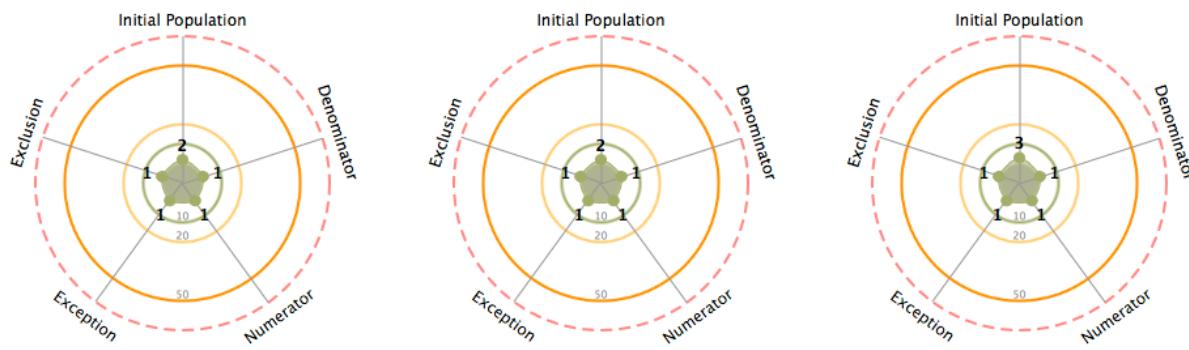




NQF 0495d:
Median Time from ED Arrival to ED Departure
for Admitted ED Patients

NQF 0496a:
Median Time from ED Arrival to ED Departure
for Discharged ED Patients

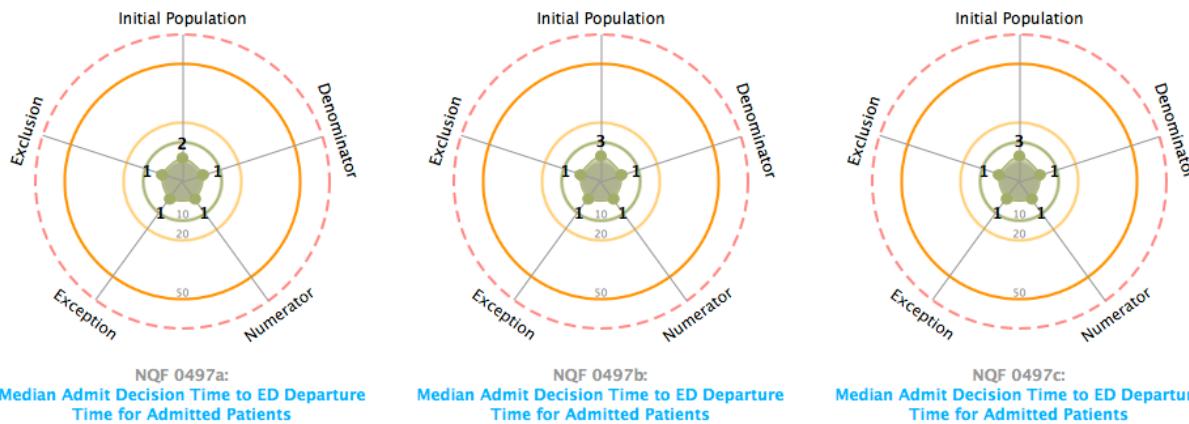
NQF 0496b:
Median Time from ED Arrival to ED Departure
for Discharged ED Patients



NQF 0496c:
Median Time from ED Arrival to ED Departure
for Discharged ED Patients

NQF 0496d:
Median Time from ED Arrival to ED Departure
for Discharged ED Patients

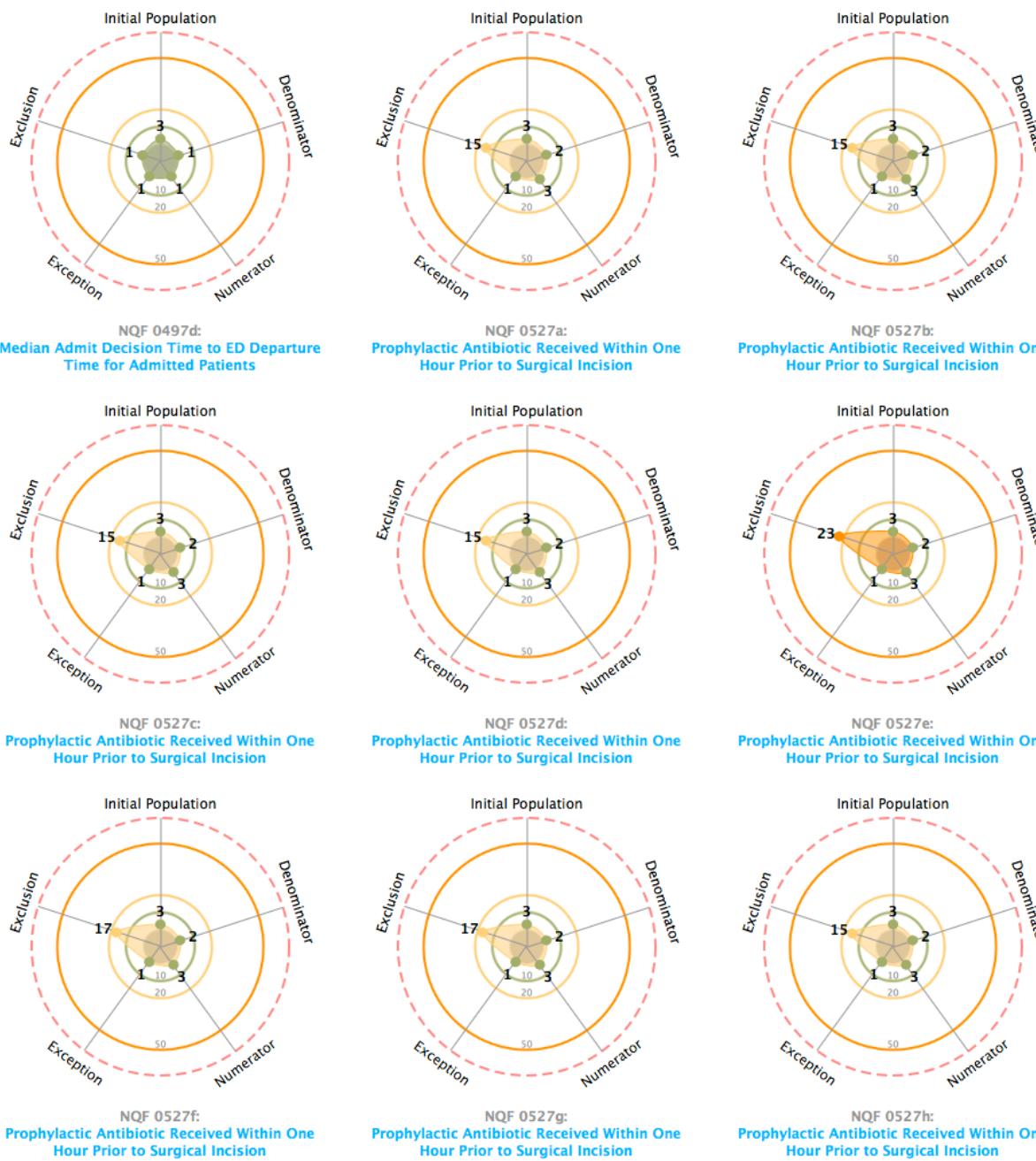
NQF 0496e:
Median Time from ED Arrival to ED Departure
for Discharged ED Patients

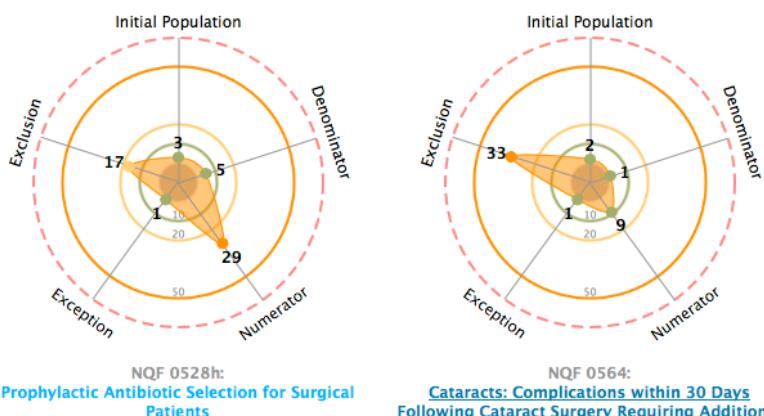
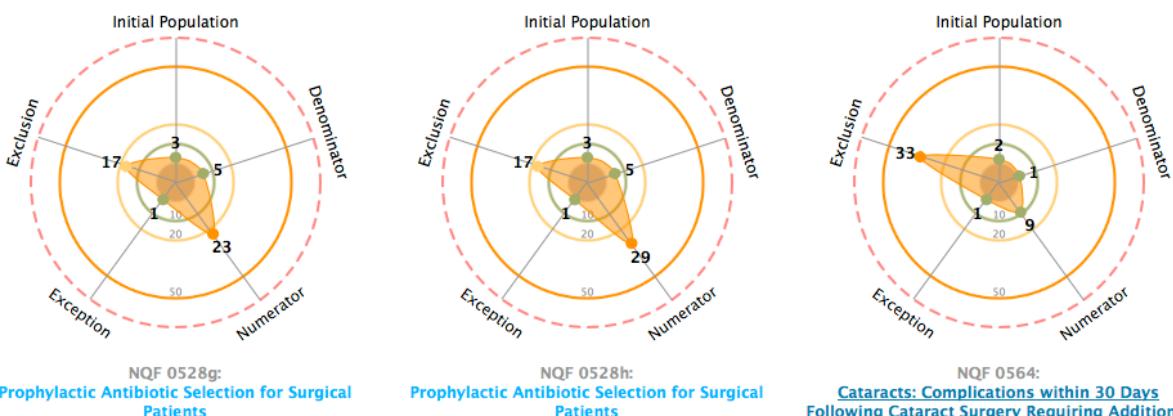
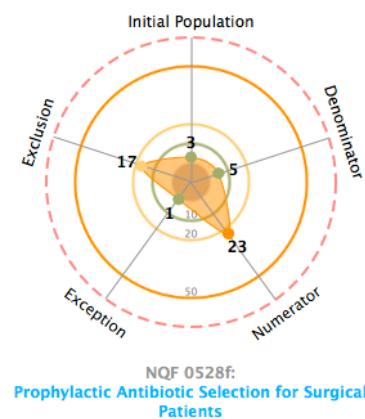
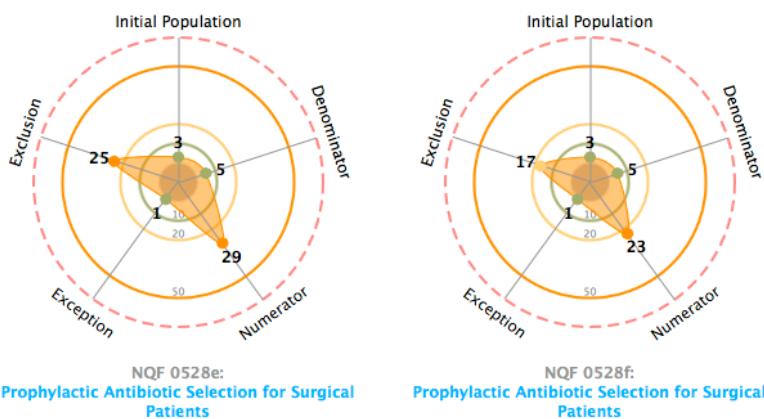
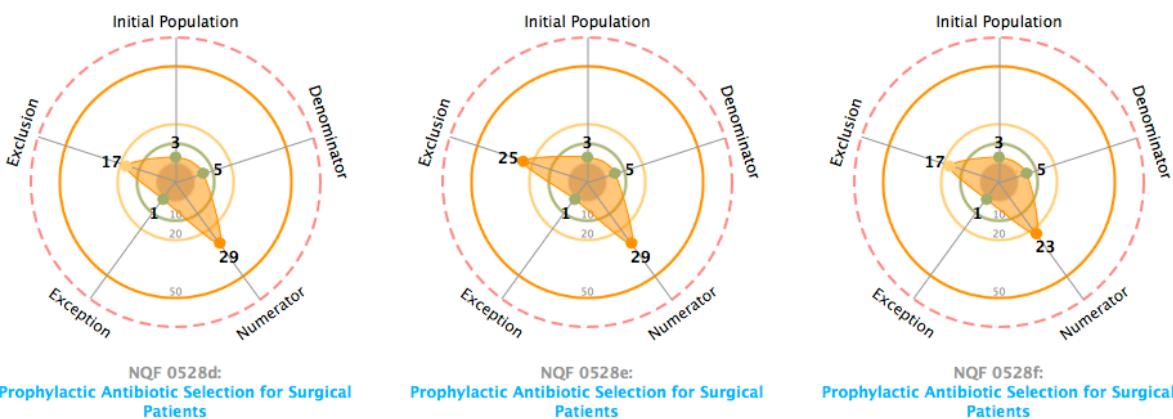
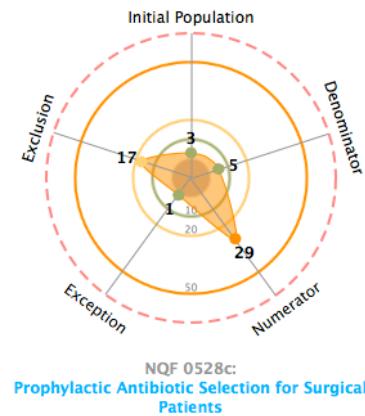
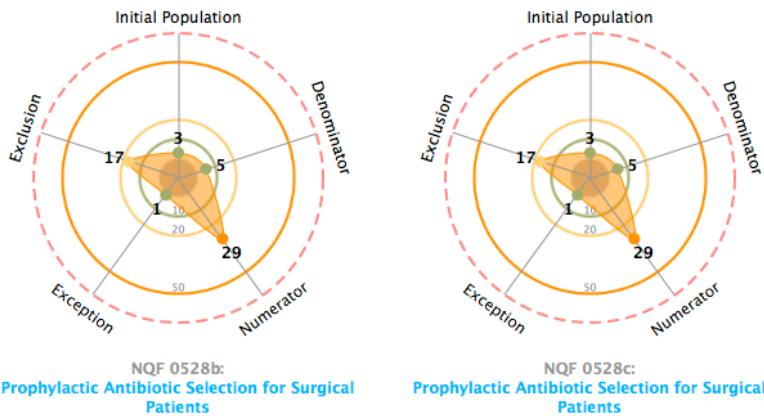
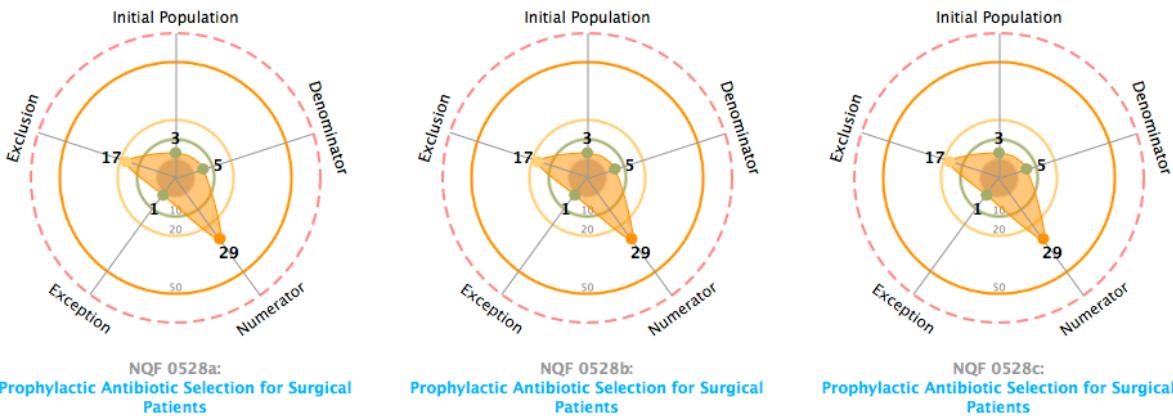


NQF 0497a:
Median Admit Decision Time to ED Departure
Time for Admitted Patients

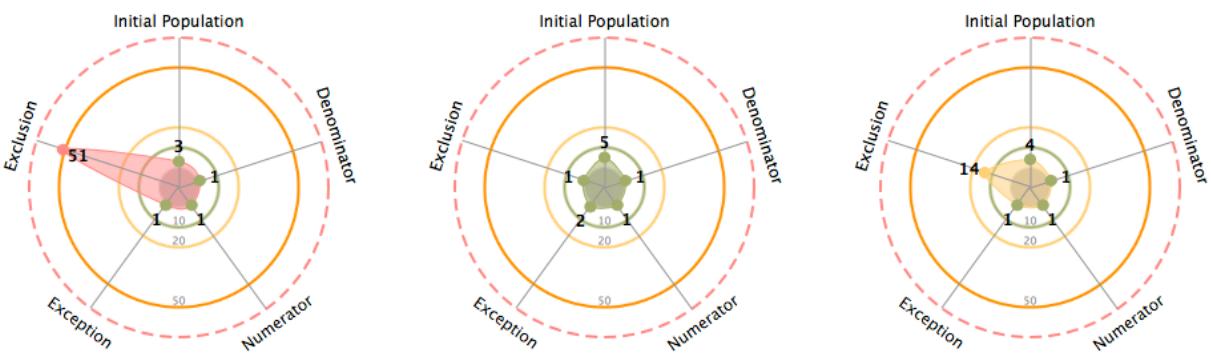
NQF 0497b:
Median Admit Decision Time to ED Departure
Time for Admitted Patients

NQF 0497c:
Median Admit Decision Time to ED Departure
Time for Admitted Patients

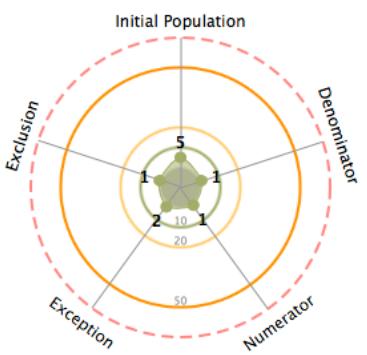




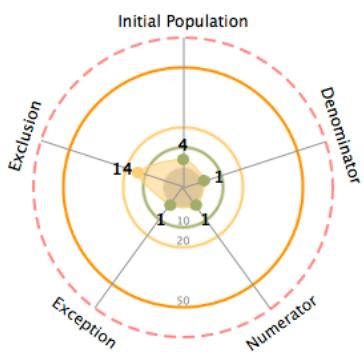
NQF 0564:
Cataracts: Complications within 30 Days
Following Cataract Surgery Requiring Additional
Surgical Procedures



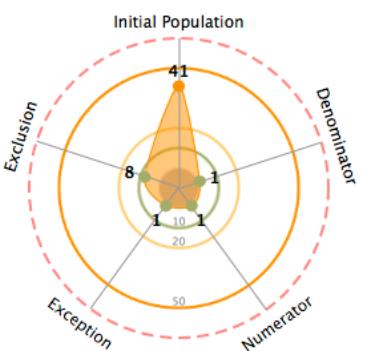
NQF 0565:
Cataracts: 20/40 or Better Visual Acuity within
90 Days Following Cataract Surgery



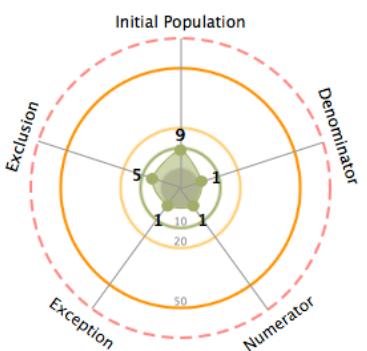
NQF 0608:
Pregnant women that had HBsAg testing



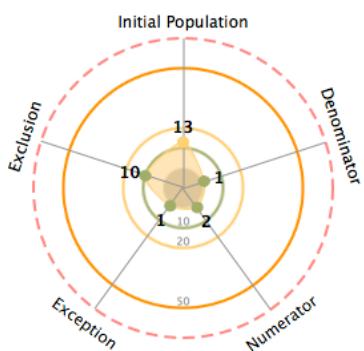
NQF 0639:
Statin Prescribed at Discharge



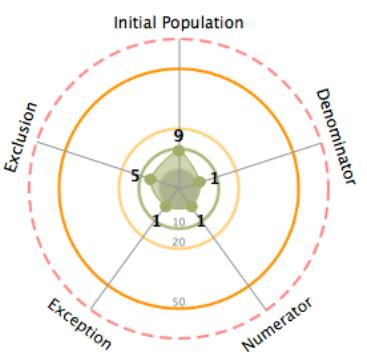
NQF 0710:
Depression Remission at Twelve Months



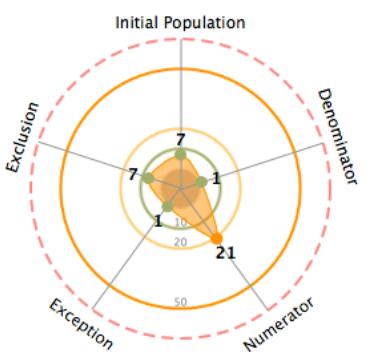
NQF 0712a:
Depression Utilization of the PHQ-9 Tool



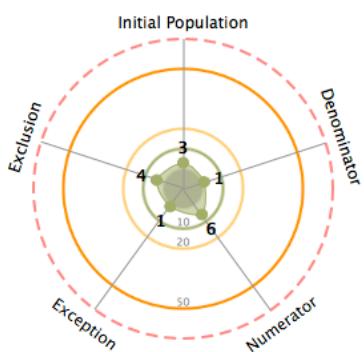
NQF 0712b:
Depression Utilization of the PHQ-9 Tool



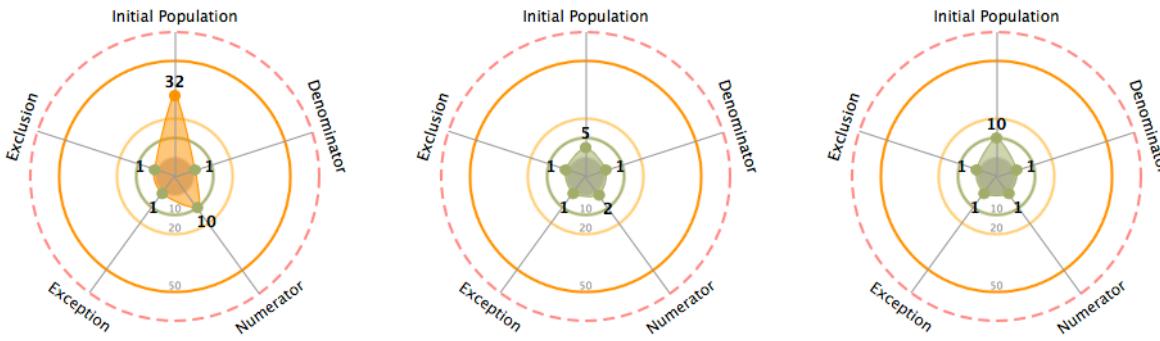
NQF 0712c:
Depression Utilization of the PHQ-9 Tool



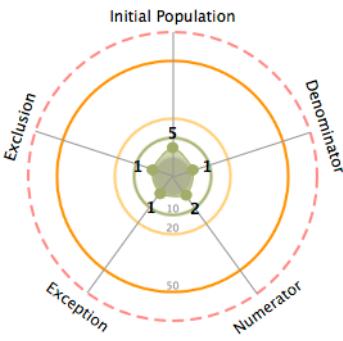
NQF 0716:
Healthy Term Newborn



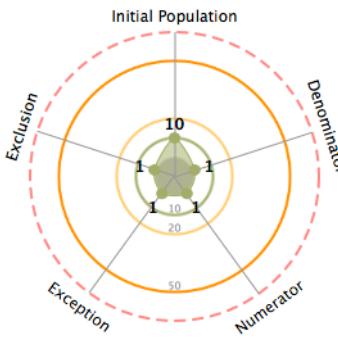
NQF 1354:
Hearing Screening Prior To Hospital Discharge
(EHDI-1a)



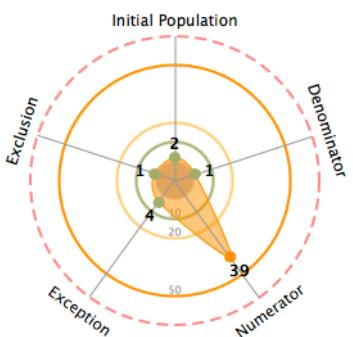
NQF 1365:
Child and Adolescent Major Depressive
Disorder (MDD): Suicide Risk Assessment



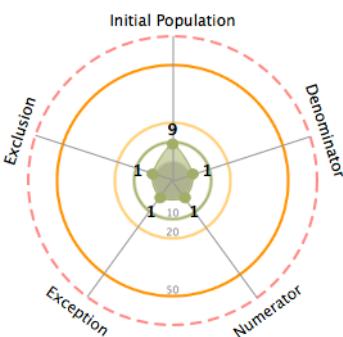
NQF 1401:
Maternal Depression Screening



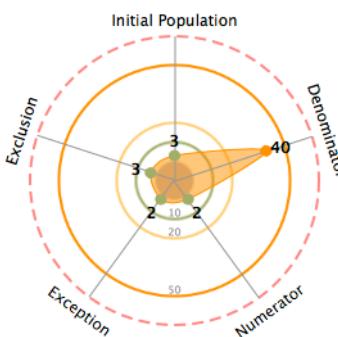
NQF ADE_TTR:
ADE Prevention and Monitoring: Warfarin Time
in Therapeutic Range



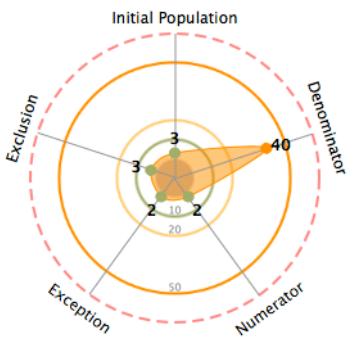
NQF BPScreen:
Preventive Care and Screening: Screening for
High Blood Pressure and Follow-Up
Documented



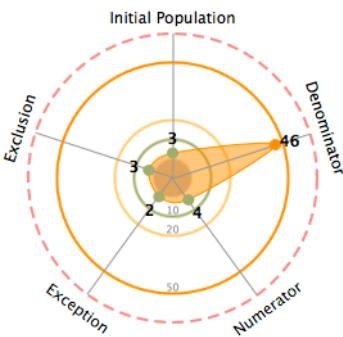
NQF ChildDentalDecay:
Children Who Have Dental Decay or Cavities



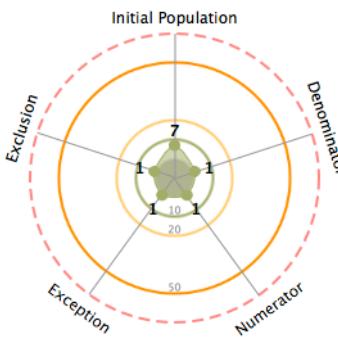
NQF CholesterolScreeningRiska:
Preventive Care and Screening: Risk-Stratified
Cholesterol - Fasting Low Density Lipoprotein
(LDL-C)



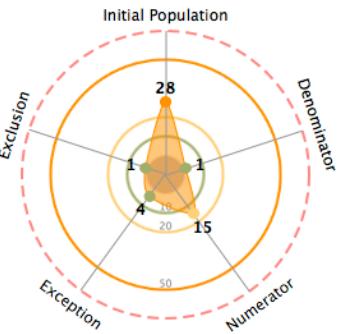
NQF CholesterolScreeningRiskb:
Preventive Care and Screening: Risk-Stratified
Cholesterol - Fasting Low Density Lipoprotein
(LDL-C)



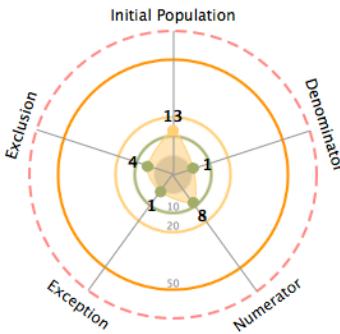
NQF CholesterolScreeningRiskc:
Preventive Care and Screening: Risk-Stratified
Cholesterol - Fasting Low Density Lipoprotein
(LDL-C)



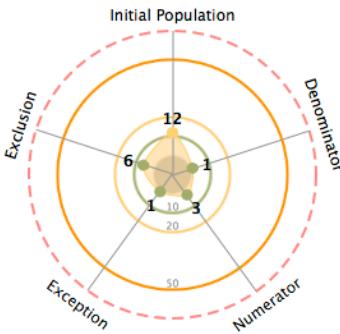
NQF ClosingReferralLoop:
Closing the referral loop: receipt of specialist
report



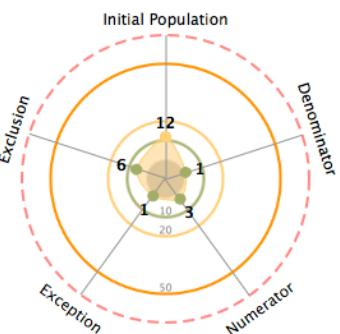
NQF DementiaCognitive:
Dementia: Cognitive Assessment



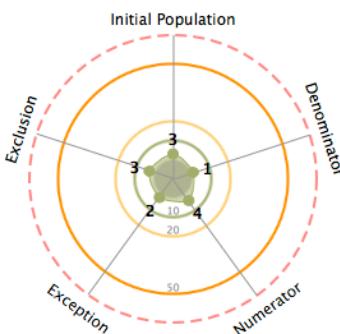
NQF FSACHF:
Functional Status Assessment for Complex
Chronic Conditions



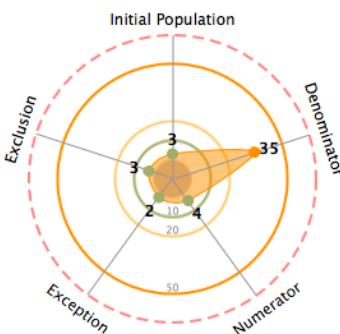
NQF FSAHip:
Functional Status Assessment for Hip
Replacement



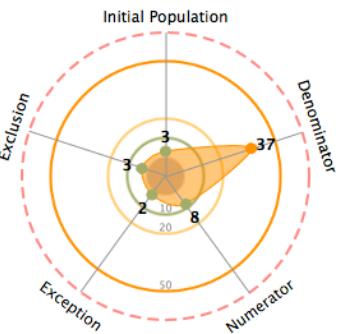
NQF FSAKnee:
Functional Status Assessment for Knee
Replacement



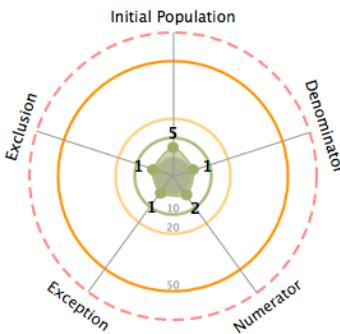
NQF FastingLDLTestb:
Preventive Care and Screening: Cholesterol –
Fasting Low Density Lipoprotein (LDL-C) Test
Performed



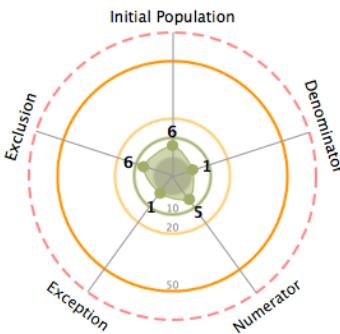
NQF FastingLDLTestb:
Preventive Care and Screening: Cholesterol –
Fasting Low Density Lipoprotein (LDL-C) Test
Performed



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



NQF HIVRNAControl:
HIV/AIDS: RNA Control for Patients with HIV



NQF HypertensionImprovement:
Hypertension: Improvement in Blood Pressure

