
Bonnie Testing Tool

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HIMSS 2016

<https://bonnie.healthit.gov>

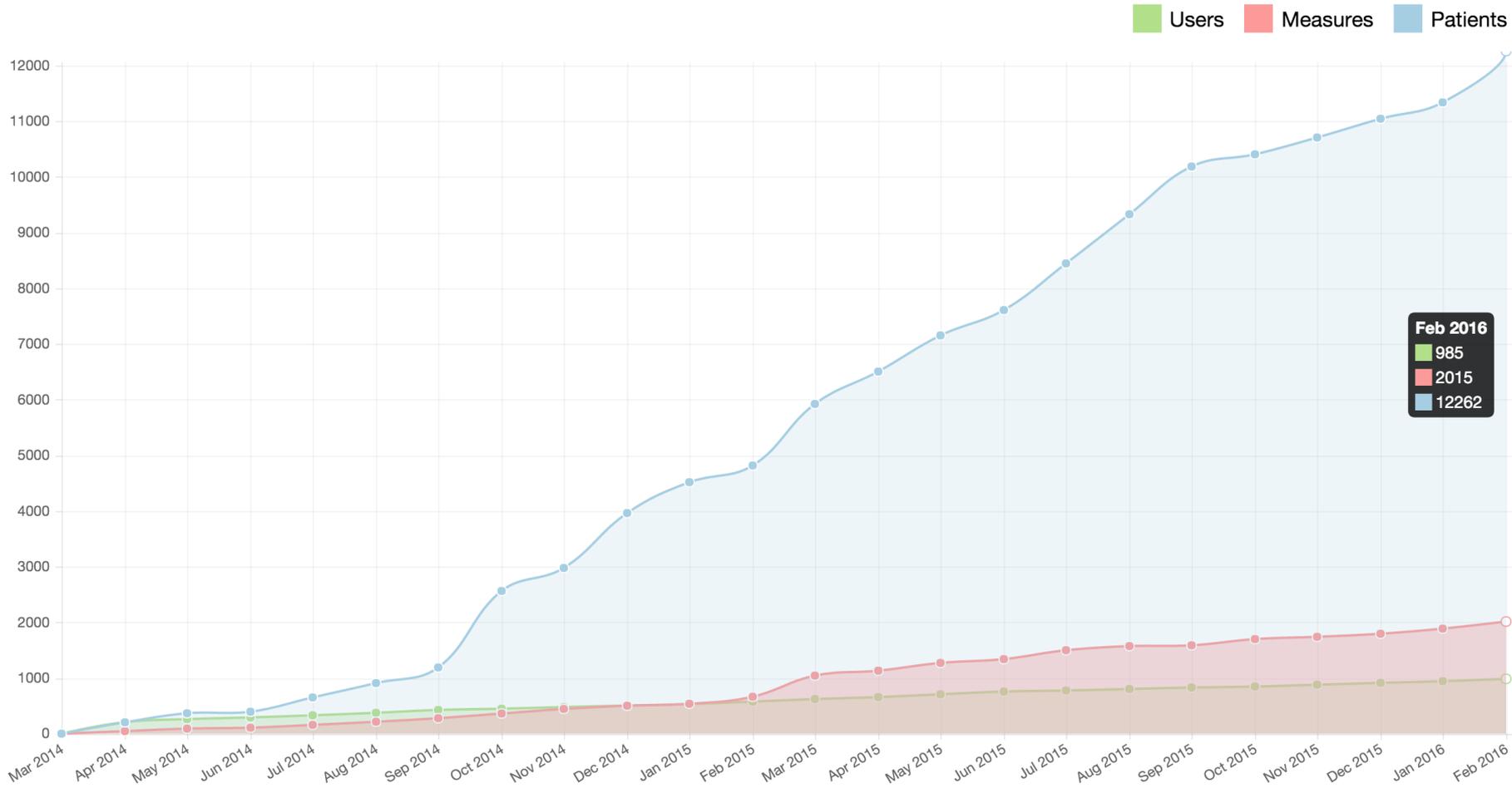
What is Bonnie?

- **Bonnie is a clinical quality measure testing tool that allows:**
 - Loading clinical quality measures from the HQMF format
 - Exploring the behavior and complexity characteristics of clinical quality measures
 - Rapidly building synthetic patients using data elements defined as part of the measure definition
 - Testing synthetic patients against existing and updated versions of a clinical quality measure
 - Creating synthetic patients for use in certification with Cypress
 - Sharing synthetic patient records with other Bonnie users using the patient bank

History

- **First released April 2014**
- **Used extensively for testing 2015 annual update measures**
 - 5,000 synthetic test patient records
 - Most measures have tests covering at least 80% of the logic
- **Currently being used for testing 2016 annual update measures**
 - Over 10,000 synthetic test patient records
 - Most measures have tests covering 100% of the logic

Bonnie Usage Over Time



Bonnie Screenshot

BONNIE

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Measure Period: 2012

MEASURES 		UPLOAD 	EXPECTED	STATUS	TEST PATIENTS
ADHD: Follow-Up Care for Children Prescribed Attention-Deficit/Hyperactivity Disorder (ADHD) Medication	CMS136v5	UPDATE 			32 
Population: Population 1 	100	PASS	32 /32		
Population: Population 2 	100	PASS	32 /32		
Bipolar Disorder and Major Depression: Appraisal for alcohol or chemical substance use	CMS169v4	UPDATE 	100	PASS	30 /30 

Bonnie Screenshot (continued)

BONNIE

🕒 Measure Period: 2012 📄 CMS117v3

☰ CMS117V3 ⚙

👤 TEST PATIENTS ⚙

CHILDHOOD IMMUNIZATION STATUS

Percentage of children 2 years of age who had four diphtheria, tetanus and acellular pertussis (DTaP); three polio (IPV), one measles, mumps and rubella (MMR); three H influenza type B (HiB); three hepatitis B (Hep B); one chicken pox (VZV); four pneumococcal conjugate (PCV); one hepatitis A (Hep A); two or three rotavirus (RV); and two influenza (flu) vaccines by their second birthday.

Complexity: ⚠️ ⚠️ ⚠️



Initial Population: ▾

AND : Patient Characteristic Birthdate: Birth >= 1 year starts before start of "Measurement Period"

AND : Patient Characteristic Birthdate: Birth = 2 years starts before end "Measurement Period"

AND :

UNION OF:

- Encounter, Performed: Office Visit
- Encounter, Performed: Face-to-Face Interaction
- Encounter, Performed: Home Healthcare Services
- Encounter, Performed: Preventive Care - Established Office Visit, 0 to 17

✓ 👤	Brown Charles	PASS >
✓ 👤	Brown Paul	PASS >
✓ 👤	Cash John	PASS >
✓ 👤	Cash June	PASS >
✓ 👤	Doe Jane	PASS >

Bonnie is under active development

- **Current development work includes**
 - Measure debugging tools
 - Test planning tools
 - Measure analysis tools
 - Application Programming Interface (API) support
 - Support for new standards

New Feature: Value set debugging

- **A large proportion of measure debugging challenges are due to issues with value sets**
- **New value set debugging features include**
 - Listing the value sets used by each measure
 - Listing value sets that have overlapping codes within a measure
 - Noting codes referenced by test patient records that are no longer contained in value sets used by the measure
- **This feature is currently in production**

Value set debugging (continued)

DATA CRITERIA

1.3.6.1.4.1.33895.1.3.0.45	Intervention, Order: Comfort Measures	Draft
1.3.6.1.4.1.33895.1.3.0.45	Intervention, Performed: Comfort Measures	Draft
2.16.840.1.113762.1.4.1021.7	Medication, Discharge not done: Statin ingredient specific	Draft
2.16.840.1.113762.1.4.1021.7	Medication, Discharge not done: Statin ingredient specific	Draft
2.16.840.1.113762.1.4.1021.7	Medication, Discharge: Statin ingredient specific	Draft
2.16.840.1.113883.3.117.1.7.1.212	Diagnosis, Active: Hemorrhagic Stroke	Grouping
2.16.840.1.113883.3.117.1.7.1.215	Laboratory Test, Performed: LDL-c	Draft
2.16.840.1.113883.3.117.1.7.1.215	Laboratory Test, Result: LDL-c	Draft
2.16.840.1.113883.3.117.1.7.1.215	Laboratory Test: LDL-c	Draft

Value set debugging (continued)

OVERLAPPING VALUE SETS

2.16.840.1.113762.1.4.1045.39 Low Dose Unfractionated Heparin For Vte Prophylaxis	2.16.840.1.113883.3.117.1.7.1.218 Unfractionated Heparin	1 overlapping code
2.16.840.1.113883.3.117.1.7.1.218 Unfractionated Heparin	2.16.840.1.113762.1.4.1045.39 Low Dose Unfractionated Heparin For Vte Prophylaxis	1 overlapping code
2.16.840.1.113883.3.117.1.7.1.255 General Surgery	2.16.840.1.113883.3.117.1.7.1.272 Urological Surgery	7 overlapping codes
2.16.840.1.113883.3.117.1.7.1.263 Obstetrics	2.16.840.1.113883.3.117.1.7.1.264 Obstetrics Vte	10 overlapping codes
2.16.840.1.113883.3.117.1.7.1.264 Obstetrics Vte	2.16.840.1.113883.3.117.1.7.1.263 Obstetrics	10 overlapping codes
2.16.840.1.113883.3.117.1.7.1.272 Urological Surgery	2.16.840.1.113883.3.117.1.7.1.255 General Surgery	7 overlapping codes

Value set debugging (continued)

2.16.840.1.113883.3.117.1.7.1.255
General Surgery

2.16.840.1.113883.3.117.1.7.1.272
Urological Surgery

7 overlapping codes

Code System	Code	Name
ICD-10-PCS	0WQFXZZ	Repair Abdominal Wall, External Approach
ICD-10-PCS	0WQF0ZZ	Repair Abdominal Wall, Open Approach
ICD-10-PCS	0WQFXZ2	Repair Abdominal Wall, Stoma, External Approach
ICD-10-PCS	0TRB07Z	Replacement of Bladder with Autologous Tissue Substitute, Open Approach
SNOMED-CT	68960009	Closure of enterovesical fistula with bowel and bladder resection (procedure)
SNOMED-CT	21482000	Closure of enterovesical fistula with bowel resection (procedure)
SNOMED-CT	56614001	Repair of fistula involving bladder and intestine (procedure)

New Feature: Excel patient record export

- **Excel is commonly used as a planning tool for test case development**
- **Generating Excel documents for planning is time consuming**
- **Bonnie synthetic patient records can be exported as Excel test case reports**
- **Reports include**
 - Patient record demographic data
 - Patient record expected calculation results vs actual calculation results
 - Calculation results for each measure logic clause
- **This feature is currently in production**

Excel patient record export

Expected				Actual															
IPP	DENOM NUMBER	DENEXCEP		IPP	DENOM NUMBER	DENEXCEP		notes	first	last	birthdate	expired	deathdate	ethnicity	race	gender	Patient Characteristic Birthdate: Birth Date >= 18 years starts before start of "Measurement Period"	Diagnosis: Primary Open- Angle Glaucoma overlaps Occurrence A: \$EyeCareEncounters	Occurrence A: \$EyeCareEncounters
0	0	0	0	0	0	0	0		Zelda	TESTArnold	12/31/1994			Not Hispanic c American Indi	F	F	FALSE	TRUE	TRUE
0	0	0	0	0	0	0	0		Xander	TESTClay	04/13/1986			Not Hispanic c American Indi	F	F	TRUE	FALSE	FALSE
0	0	0	0	0	0	0	0		Veronica	TESTEldridge	04/13/1976			Not Hispanic c American Indi	F	F	TRUE	FALSE	FALSE
0	0	0	0	0	0	0	0		Udi	TESTFranklin	05/14/1971			Not Hispanic c American Indi	M	M	TRUE	FALSE	TRUE
0	0	0	0	0	0	0	0		Trudie	TESTGermain	06/14/1966			Not Hispanic c American Indi	F	F	TRUE	FALSE	TRUE
1	1	0	0	1	1	0	0		Penelope	TESTKessingt	09/18/1946			Not Hispanic c American Indi	F	F	TRUE	TRUE	TRUE
1	1	0	0	1	1	0	0		Hilda	TESTSalinger	03/11/1981			Not Hispanic c American Indi	F	F	TRUE	TRUE	TRUE
1	1	0	0	1	1	0	0		George	TESTTrotsky	04/12/1976			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
0	0	0	0	0	0	0	0		Quin	TESTJackson	09/18/1951			Not Hispanic c American Indi	M	M	TRUE	FALSE	TRUE
1	1	0	0	1	1	0	0		Otis	TESTLightner	09/17/1941			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
1	1	1	0	1	1	1	0		Manny	TESTNolan	10/17/1937			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
1	1	0	1	1	1	0	1		Jane	TESTQuasay	01/10/1992			Not Hispanic c American Indi	F	F	TRUE	TRUE	TRUE
1	1	0	0	1	1	0	0		Fergie	TESTUnderhill	05/13/1971			Not Hispanic c American Indi	F	F	TRUE	TRUE	TRUE
1	1	0	1	1	1	0	1		Edward	TESTVance	06/14/1966			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
1	1	0	1	1	1	0	1		Denise	TESTWest	08/16/1956			Not Hispanic c American Indi	F	F	TRUE	TRUE	TRUE
1	1	0	1	1	1	0	1		Keith	TESTPaulson	11/18/1927			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
1	1	0	0	1	1	0	0		Ian	TESTRutenbe	04/13/1986			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE
1	1	1	0	1	1	1	0		Curtis	TESTXiao	08/16/1951			Not Hispanic c American Indi	M	M	TRUE	TRUE	TRUE

New Feature: Patient overview dashboard

- **Allow more measure planning to take place directly within Bonnie**
- **Measure developers will be able to**
 - View all synthetic patient records on one page
 - Examine detailed calculation results
 - Identify areas of missing test coverage
 - Edit patient records directly on dashboard
- **This feature is currently under development**

Patient overview dashboard

			Initial Patient Population	Denominator	Denominator Exclusion	Numerator
			Patient Characteristic Birthdate: Birth Date >= 18 years starts before start of Occurrence A: \$EncounterInpatient NonElective	Intersection of: Occurrence A: \$EncounterInpatientNonElective Encounter, Performed: Non-Elective Inpatient Encounter (Principal Diagnosis: Ischemic Stroke)	Intersection of: Occurrence A: \$EncounterInpatientNonElective Encounter, Performed: Non-Elective Inpatient Encounter SATISFIES ANY (Discharge Status: Discharge To Acute Care Facility) (Discharge Status: Left Against Medical Advice) (Discharge Status: Patient Expired) (Discharge Status: Discharged To Home For Hospice Care) (Discharge Status: Discharged To Health Care Facility For Hospice Care)	Medication, Discharge: Antithrombotic Therapy starts during Occurrence A: \$EncounterInpatient NonElective
Status	Name	Description	+16	+5	+27	+4
NO POPULATION						
PASS	1 IPFail	Patient is 17 with Non-Elective Inpatient Encounter (LOS 120 days) with principal diagnosis of ischemic stroke ends during MP.	✘	✔		
PASS	2 IPFail	Patient is 19 with no Encounter Inpatient	✘	✘		
PASS	3 IPFail	Patient is 18 with Non-Elective Inpatient Encounter (LOS 121 days) ends during MP with principal diagnosis of ischemic stroke	✘	✘		
INITIAL PATIENT POPULATION						
PASS	1 IPPass	Patient is 18 with Non-Elective Inpatient Encounter (LOS 120 days) with principal diagnosis of ischemic stroke ends during MP	✔	✔	✘	✘
PASS	2 turn 18 day of admission IPPass	Patient turns 18 day of admission with Non-Elective Inpatient Encounter ends during MP with principal diagnosis of stroke	✔	✔	✘	✘
PASS	3 turn 18 day before admission (1) IPPass	Patient turns 18 day before admission with Non-Elective Inpatient Encounter ends during MP with principal diagnosis of stroke	✔	✔	✘	✘
PASS	4 LOS 119 days (1) IPPass	Patient is 18 with Non-Elective Inpatient Encounter (LOS 119 days) with principal diagnosis of ischemic stroke ends during MP	✔	✔	✘	✘
DENOMINATOR						
PASS	1 DenexFail	Patient receives comfort measures performed before ED visit that ends <= 1 hour before IP Encounter	✔	✔	✘	✘
PASS	2 DenexFail	Patient receives comfort measures performed during ED visit that ends greater than 1 hour before IP Encounter	✔	✔	✘	✘
PASS	3 DenexFail	Patient receives comfort measures performed after IP encounter	✔	✔	✘	✘
PASS	4 DenexFail	Patient receives comfort measures performed before IP encounter	✔	✔	✘	✘
PASS	1 NumFail	Patient received anti thrombotic during encounter	✔	✔	✘	✘
PASS	1 NumFail	Patient is 18 with Non-Elective Inpatient Encounter (LOS 120 days) with principal diagnosis of ischemic stroke ends during MP received antithrombotic before IP encounter	✔	✔	✘	✘

New Feature: Measure history analysis

- **View detailed information on changes in a measure over time**
 - Store information on multiple versions of a measure
 - Display the differences between the different versions
 - Store information on test patient changes over time
 - Connect changes in test results to specific changes in measures or test patients
- **This feature is currently under development**

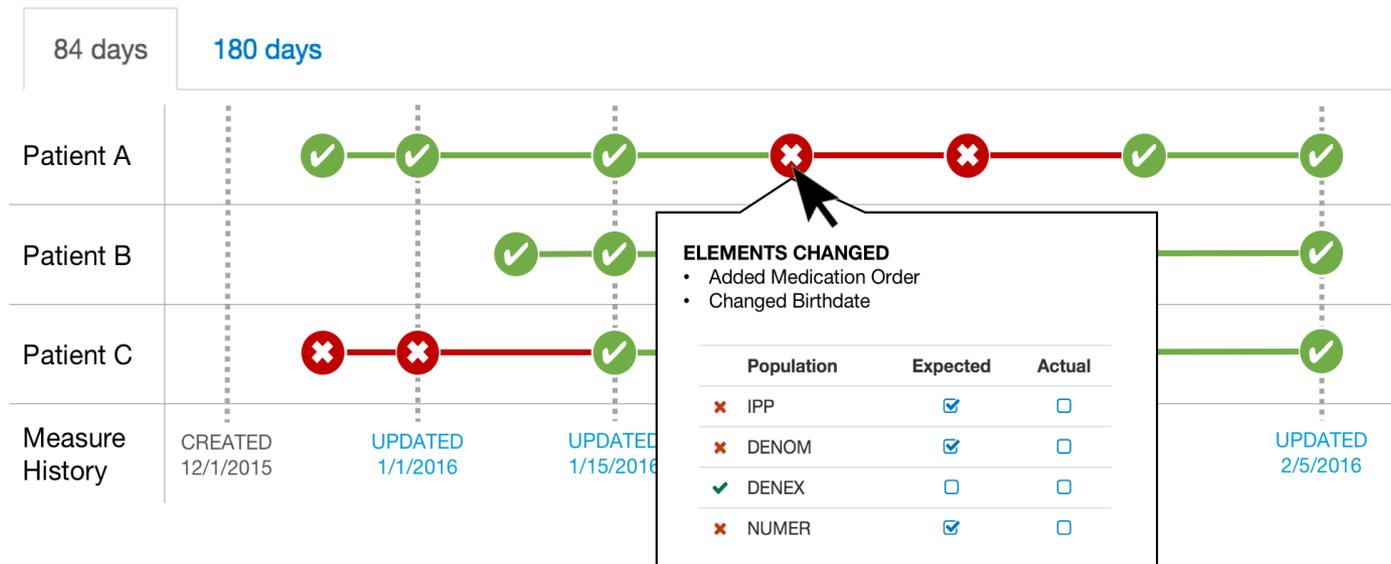
Measure history analysis

CMS00V1



SOME MEASURE

Measure description lorem ipsum dolor sit amet, nisl utamur no nec, odio utamur iudicabit mea ea, sea ad sale quidam fuisset. Ius viris salutatus sadipscing ne, omnes offendit ei eum. In mea hendrerit consetetur, nam inermis scriptorem ut. Per id stet esse, mei partem alienum ad.



New Feature: Application Programming Interface

- **Intended to allow Bonnie to integrate with other tools**
- **Will support functionality such as**
 - Uploading measures
 - Downloading test results
- **The initial driving goal is eventual closer integration with the Measure Authoring Tool (MAT)**
- **Other uses are certainly possible and welcome**
- **This feature is currently under development**

Support For Upcoming Standards

- **The Clinical Quality Language (CQL) is a new standard for describing Clinical Quality Measures**
- **CQL logic is expected to eventually replace existing QDM logic**
- **Regression testing during the transition will be vital to ensure that measures continue to convey the same clinical intent**
- **Bonnie will support testing of both CQL-based and QDM-based measures during the transition**
- **The functionality that Bonnie implements will leverage the extensive existing open source CQL implementation**
- **Initial support for testing and learning purposes will be available in Bonnie towards the end of 2016, well in advance of the transition**
- **Development is beginning now**

Support For Upcoming Standards

CQL Evaluation (Alpha)



SNIPPET 1 → SNIPPET 2 → SNIPPET 3 → SNIPPET 4 → SNIPPET 5

```
define OverEighteen: AgeInYearsAt(start of MeasurementPeriod) >= 18

// Inpatient encounters during the Measurement Period
define Encounters:
  ["Encounter, Performed": "Inpatient Encounter"] E where E."admission datetime" during MeasurementPeriod

define IschemicStroke: ["Diagnosis": "Ischemic Stroke"]

// Inpatient encounters where an ischemic stroke was diagnosed
define EncountersWithIschemicStroke:
  Encounters E with IschemicStroke D such that Interval[E."admission datetime", E."discharge datetime"] includes D."onset datetime"

define Denominator: OverEighteen and Count(EncountersWithIschemicStroke) > 0

// Discharged on antithrombotic therapy during an encounter with a stroke diagnosis
```

EVALUATE

Statement	Ischemic, No Meds	Ischemic, With Meds	Ischemic, Patient Left
OverEighteen	✓	✓	✓
Encounters	Encounter, Performed: Inpatient Encounter	Encounter, Performed: Inpatient Encounter	Encounter, Performed: Inpatient Encounter
IschemicStroke	Diagnosis: Ischemic Stroke	Diagnosis: Ischemic Stroke	Diagnosis: Ischemic Stroke
EncountersWithIschemicStroke	Encounter, Performed: Inpatient Encounter	Encounter, Performed: Inpatient Encounter	Encounter, Performed: Inpatient Encounter

Bonnie User Group

- **Interaction with our user community is vital as we**
 - Seek feedback for new features under development
 - Determine the future direction of the application
 - Share news about updates and changes
- **The users group uses an online forum**
 - <https://groups.google.com/forum/#!forum/bonnie>

Where To Look For Info

- **Main Bonnie site**
 - <https://bonnie.healthit.gov/>
- **JIRA for tracking issues**
 - <https://jira.oncprojecttracking.org/browse/BONNIE>
- **Contact development team**
 - bonnie-feedback-list@lists.mitre.org
- **Open Source on GitHub**
 - <https://github.com/projectacoma/bonnie>

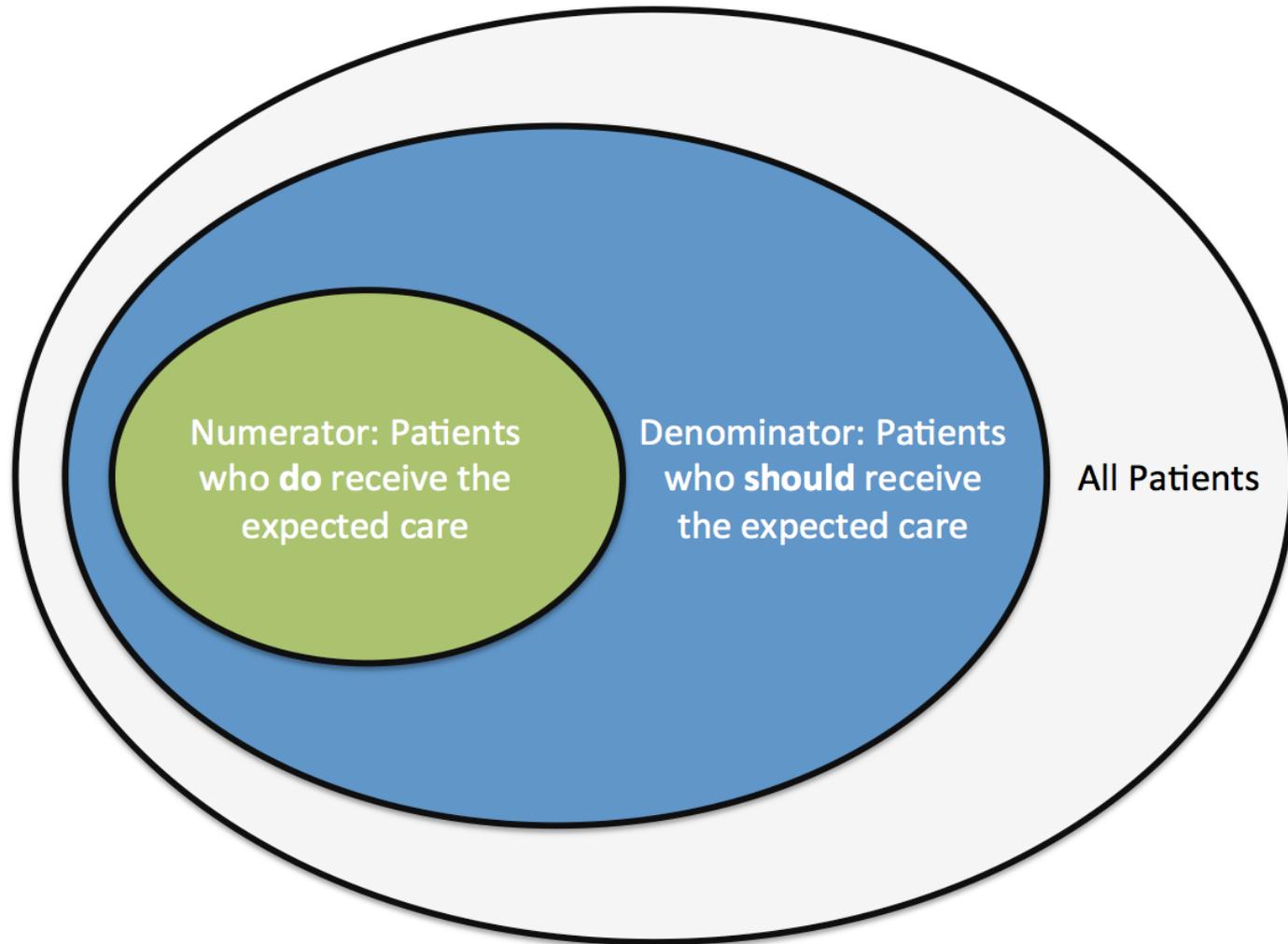
Questions?

Backup Slides

Clinical Quality Measures

- **Health Care Reports**
- **Measure provider delivery of standard of care to patients**
- **Electronic specification: eCQM**
- **Combine logical statements with clinical concepts**

Patient Populations



History

- **The process of Measure Development has been grueling:**
 - Does the measure logic capture clinical intent?
 - Lots of subtleties: timing, operator precedence, etc.
 - Hundreds or thousands of lines of logic
 - Every release is manually reviewed

Tooling

- **Better tooling is needed**
 - Understand what you're building
 - Don't test and review entirely by hand
- **Bonnie helps with both**

Delivery

- **Went live April 1st, 2014**
 - 778 users, about 210 actually testing measures
 - Over 1,500 measures loaded
 - Over 8,500 test patient records created
 - OFMQ, The Joint Commission, Mathematica, HHS, etc.

Final Notes

- **Open source**
- <http://bonnie.healthit.gov/>