

# Bonnie User Guide

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## Introduction

Bonnie is a software tool that allows Meaningful Use (MU) Clinical Quality Measure (CQM) developers to test and verify the behavior of their CQM logic. The main goal of the Bonnie application is to reduce the number of defects in CQMs by providing a robust and automated testing framework. The Bonnie application allows measure developers to independently load measures that they have constructed using the Measure Authoring Tool (MAT). Loading the measures into Bonnie converts the measures from their XML eSpecifications into executable artifacts and measure metadata. The measure metadata is then used to allow developers to rapidly build a synthetic patient testdeck for the measure using the clinical elements defined during the measure construction process. Using the measure metadata as a basis for building synthetic patients allows a test deck to be created rapidly and efficiently for a measure. Finally the Bonnie application allows measure developers to execute the measure logic against the patient test deck they have built to evaluate whether the logic aligns with the intent of the measure.

Bonnie has been designed to integrate with the nationally recognized data standards used by the Meaningful Use program for expressing CQM logic for machine-to-machine interoperability. This provides enormous value to the Meaningful Use program, since it also provides federal policy leaders and stakeholders with software that verifies the new and evolving standards for the Meaningful Use CQM program are tractable and can be implemented in software.

Bonnie was also designed to have an intuitive and easy to use interface that was based on feedback from the broader measure developer community. A key goal of the Bonnie application is to provide a user experience that provides an efficient and intuitive method for constructing synthetic patient records for the testing and validation of Clinical Quality Measures.

Finally, the Bonnie software is freely available via an Apache 2.0 open source license. The Meaningful Use program makes all or parts of the Bonnie software available for inspection, verification, and even reuse for other government programs or other federal contractors.

## Purpose

Bonnie is a web application which allows measure developers to test and verify the behavior of their CQM logic. The Bonnie application provides the capability to import measures defined in Health Quality Measure Format (HQMF) XML. The HQMF specification provides the metadata and logic that describes the specifics of calculating a CQM. The Bonnie application is able to load the HQMF describing a measure and programmatically convert the HQMF specification into an executable format that allows calculating the measure directly from the specification.

The CMS Measure Authoring Tool (MAT) is the primary source for HQMF documents used by the Bonnie application. The MAT allows measure developers to build CQMs and export those measures as measure bundles containing both the HQMF and value sets used as part of calculation. These measure bundles can be downloaded from the MAT and loaded into the Bonnie user interface allowing those measures to be tested by Bonnie.

Once a clinical quality measure has been loaded into the Bonnie Application, a user can inspect the measure logic and then build synthetic test records and set expectations on how those test records will calculate against a measure. This ability to build synthetic test patient records, set expectations against those records, and calculate the measures using those patients provides an automated and efficient testing framework for clinical quality measures. The clinical quality measure testing framework provided by Bonnie allows measure developers to more clearly understand the behavior of the measure logic, validate that the measure logic

encodes their intent, and allows for multiple iterations of measure updates to be validated against a test deck. Additionally, the development of a test deck as part of measure development provides benefits after the measures have been finalized. The test deck build as part of measure development can be used to demonstrate the intent of the measure through the use of patient examples included in the test deck. Furthermore, the test deck could provide systems that implement the measures a base set of synthetic patient records with known expectations against the measures to validate the development of their systems. Finally, the test deck could be used as a basis for the test deck used as part of the meaningful use certification program.

The purpose of this document is to provide a description of the functionality of the Bonnie application, and to provide Bonnie users with step by step instructions for testing clinical quality measures by building synthetic patient records.

## User Account Creation

### Login Page

In order for a user to access the Bonnie Application a valid account is required. All measures loaded into the Bonnie application and all synthetic test patients are isolated by account. Therefore, a user can only view, access, and modify data that they have loaded under their own account. 5 1 shows the login screen for the Bonnie application. In order to log in a user must provide the email address and password for a valid account.

BONNIE

email@example.com

password

LOGIN

forgot password?

register

Figure 1: Login Page

## Creating a New User

A user can create a new account by clicking on the “register” link on the login page. The register link brings the user to the account creation page (Figure 2). A user can create a new account by filling out the fields in the registration form and clicking the “register” button. Once an account has been created, the user can log in to the Bonnie application using the email address and password specified as part of account creation.

REGISTER

first name

last name

email@example.com

(000) 000-0000

password\*

confirm password\*

Must be at least 8 characters long and contain characters from at least two of: lowercase letters, uppercase letters, numbers, and special characters.

Terms and conditions for use of Bonnie.

Performance measures and related data specifications (the "Measures") are copyrighted by the noted quality measure providers as indicated in the applicable Measure. Coding vocabularies are owned by their copyright owners. By using the Measures, a user ("User") agrees to these Terms of Use. Measures are not clinical guidelines and do not establish a standard of medical care and quality measure providers are not responsible for any use of or reliance on the Measures.

THE MEASURES AND SPECIFICATIONS ARE PROVIDED "AS IS" WITHOUT ANY WARRANTY OF ANY KIND, AND ANY AND ALL IMPLIED WARRANTIES ARE HEREBY DISCLAIMED, INCLUDING ANY WARRANTY OF NON-INFRINGEMENT, ACCURACY, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NO QUALITY MEASURE PROVIDER, NOR ANY OF THEIR TRUSTEES, DIRECTORS, MEMBERS, AFFILIATES, OFFICERS, EMPLOYEES, SUCCESSORS AND/OR ASSIGNS WILL BE LIABLE TO YOU FOR ANY DIRECT, INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL, PUNITIVE, AND/OR CONSEQUENTIAL DAMAGE OF ANY KIND, IN CONTRACT, TORT OR OTHERWISE, IN CONNECTION WITH THE USE OF THE BONNIE TOOL OR THE MEASURES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH LOSS OR DAMAGE.

☐ I agree to the above Terms and Conditions of use\*

forgot password?

sign in

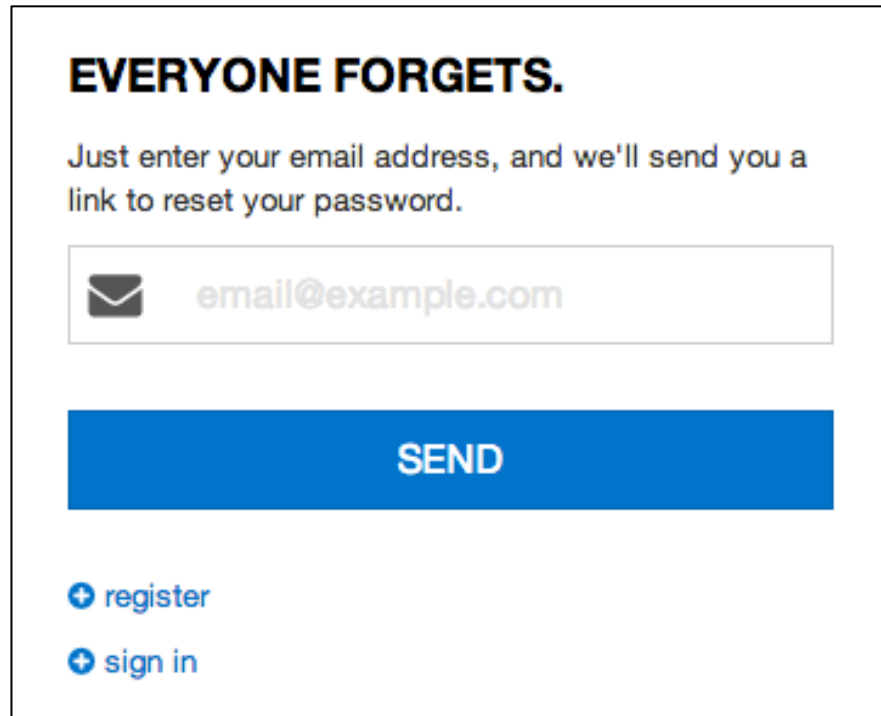
CANCEL

REGISTER

Figure 2: Account Registration Page


## Resetting your password

In the event that a password is forgotten or an account is locked, the user can reset the password using the password reset page. This page is accessed from the “Forgot Password?” link on the login page (Figure 1). On this page the user can provide the email address associated with the account and then press the “send” button. This will send an email to the registered email address for the account allowing the user to reset the password for the account.



**EVERYONE FORGETS.**

Just enter your email address, and we'll send you a link to reset your password.

 email@example.com

**SEND**

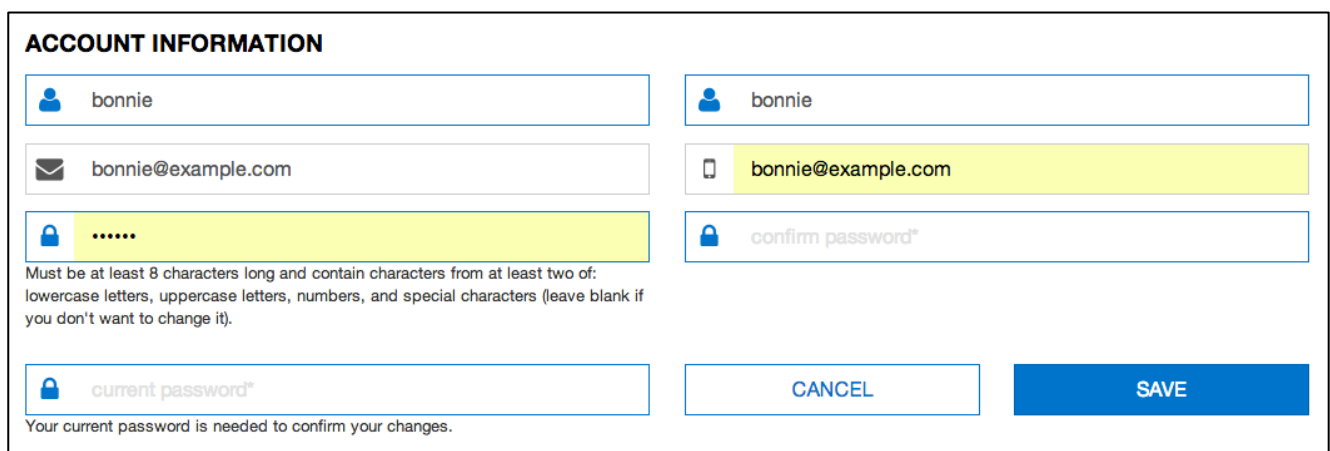
[+ register](#)

[+ sign in](#)

Figure 3: Password Reset Page

## Account Management

Once a user has logged into the application, the user can change the information associated with their account by accessing the account management page (Figure 4). The account management page can be opened by clicking on the “account” link in the header of the application. The application header is shown in Figure 5 labeled as user interface element number 9. The account management page allows the user to change the information provided during the registration process and allows the user to select a new password for their account.



**ACCOUNT INFORMATION**








 bonnie	 bonnie
 bonnie@example.com	 bonnie@example.com
 .....	 confirm password*
<small>Must be at least 8 characters long and contain characters from at least two of: lowercase letters, uppercase letters, numbers, and special characters (leave blank if you don't want to change it).</small>	
 current password*	<b>CANCEL</b> <b>SAVE</b>
<small>Your current password is needed to confirm your changes.</small>	

Figure 4: Account Management Page

## Measure Dashboard

### Overview

The Measure Dashboard page (Figure 5) is the initial page a user is presented with when they log into the application. This page displays the set of measures the user currently has loaded into the system along with the sub populations and stratifications associated with the measures. Additionally the Measure Dashboard shows the calculation status of each measure loaded into the system. The calculation status shows how many patients have been built for the measure, whether the measure is currently passing or failing, and how many patients are passing or failing for each measure. The Measure Dashboard also allows users to navigate to the details of individual measures, to upload a new measure, or do update the definition of an existing measure.

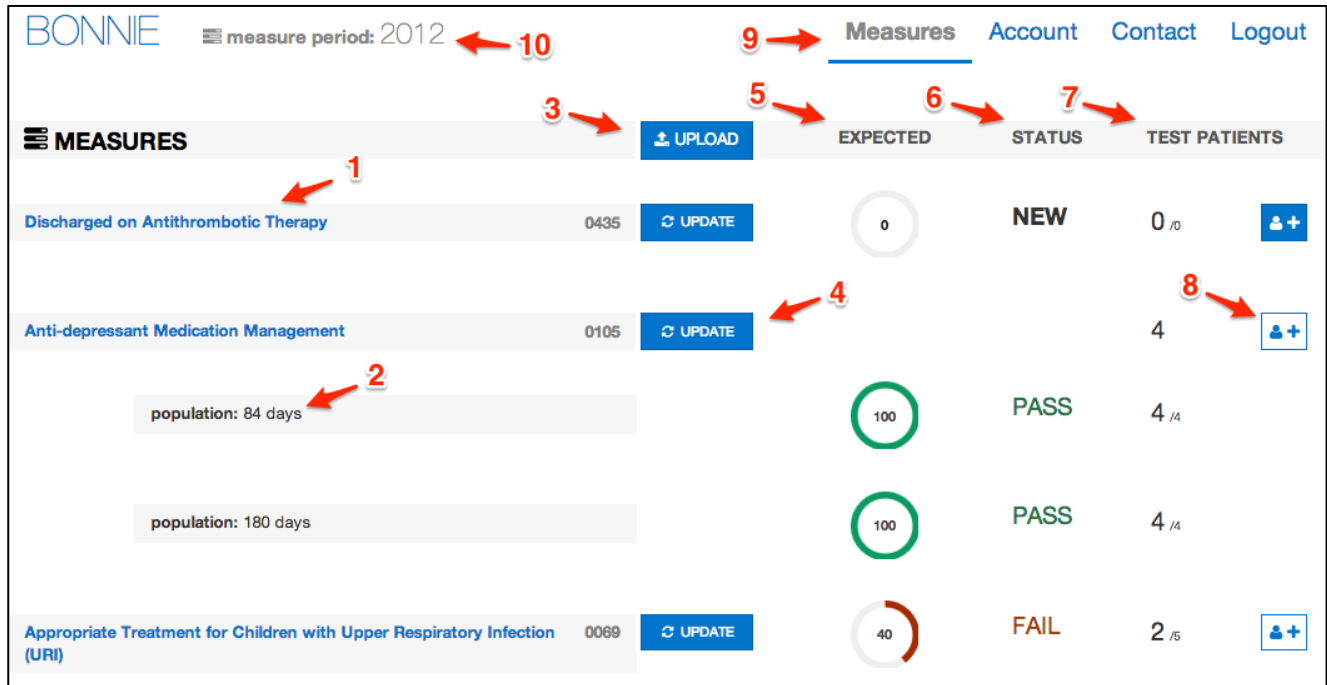


Figure 5: Measure Dashboard

### User Interface Elements

1. Measure Title – Displays the title for the measure and allows navigating to the measure view.
2. Sub population and stratification titles – Displays the titles for sub populations or stratifications of a measure.
3. Upload Button – Allows the user to upload a new measure.
4. Update Button – Allows the user to update a previously loaded measure.
5. Expected Column – Displays the percentage of passing patients for the measure.
6. Status Column – Displays the current status of the measure (New, Pass, Fail)
7. Test Patient Column - Displays the number of patients passing out of the total number of patients.
8. Add Patient Button – Allows the user to start building a new patient for a measure.
9. Header – Allows the user to access account information, send a support email (Contact), and log out of the application.
10. Measure Period Date – Displays the measurement period that is used for calculating measures.

## Loading a New Measure

When a user logs into the system for the first time there will be no measures associated with the account. The first step for a user is to load a measure into their account so that they can begin testing the measure with the Bonnie application.

The steps for loading a new measure are:

1. Click the “upload” button (#3) on the Measure Dashboard, this opens the “new measure dialog”
2. On the “new measure dialog (Figure 6)
  - a. Choose a MAT export zip file
  - b. Specify if the measure is eligible professional or eligible hospital
  - c. Specify if the measure is Patient based or Episode of care
  - d. Click the “Load” button

Clicking the load button in the “new measure dialog” uploads the measure to the application for processing. If the measure being loaded is episode of care or has multiple populations, the user is presented with the finalize measure dialog (Figure 7). The finalize measure dialog allows the user to specify the episode(s) of care for the measure and to provide titles for sub populations. Once the finalize measure fields have been filled out, the user clicks the “done” button to finish loading the measure. Once measure loading is complete, the user is taken to the measure dashboard (Figure 5) with the new measure available. If your measure is not episode of care or does not have sub populations, then the user will not be presented with the finalize dialog as no additional information is required to load the measure.

**New Measure** [X]

**Measure Data:** [Choose File] 05\_DischargedonAntithromboticThe\_Artifacts.zip

**Measure Type:**

- ☐ Eligible Professional (EP)
- ☒ Eligible Hospital (EH)

**Calculation Type:**

- ☐ Patient Based
- ☒ Episode of Care

[CLOSE] [LOAD]

Figure 6: New Measure Dialog



Finalize Measure

Discharged on Antithrombotic Therapy

Episode(s) of Care:

- Encounter, Performed: Inpatient Encounter
- Encounter, Performed: Emergency Department Visit
- Intervention, Ordered: Palliative Care
- Intervention, Performed: Palliative Care

DONE

Figure 7: Finalize Measure Dialog

## Updating a Measure

Once the measure has been loaded, the testing process may identify issues with the measure. When issues are identified with a measure the logic must be updated in the MAT to resolve these issues. Alternatively, the measure could be updated in the MAT as part of an annual update. Once a measure has been updated in the MAT, that measure may need to be updated in Bonnie for testing. The following steps allow a measure to be updated:

1. Click the “update” button (#4) on the measure dashboard, this displays the “update measure dialog (Figure 8).
2. Select a new MAT export zip with the updated measure definition.
3. Update the episode of care if it has changed.
4. Click the “load” button to load the new version of the measure.

Discharged on Antithrombotic Therapy

Measure Data:
 No file chosen

Measure Type: Eligible Hospital (EH)

Calculation Type: Episode of Care

Episode(s) of Care:

- Encounter, Performed: Inpatient Encounter
- Encounter, Performed: Emergency Department Visit
- Intervention, Ordered: Palliative Care
- Intervention, Performed: Palliative Care

CLOSE
LOAD

Figure 8: Update Measure Dialog

### Creating synthetic test records

Once a set of measures have been loaded into the Bonnie application, the user can start building test patients for the measures. The user can start building a test patient from the measure dashboard (Figure 5) by clicking the “add patient” button (#8). Clicking the add patient button opens the patient builder (Figure 13). See “Building a Patient Test Record” for more information.

### Calculation results

After synthetic test patients have been created for measures, the user will begin seeing calculation results on the measure dashboard (Figure 5). These results represent the summary results of the patients associated with each measure, and the results are listed for each measure that has been loaded by the user. UI elements #5, #6, and #7 on the measure dashboard (figure 5) provide the summary results for each measure. The “expected” column (#5) displays the percentage of patients associated with the measure whose calculated values meet the expectations set for the patient. The “status” column (#6) indicates if the measure is currently in the state of passing, failing, or new. A measure is in the passing state if all associated patients are meeting expectations. If one or more patients is not meeting expectations, then the measure is in a failing state. New measures that have not had patients associated with them are in the new state. Finally, the “Test Patients” column (#7) displays the number of passing patients over the total number of patients as a fraction. The measure dashboard provides summary calculation results, more detailed results for a measure can be viewed on the measure view (Figure 9).

## Measure Results View

### Overview

The Measure View page (Figure 9) displays the detailed information, associated patients, and calculation results for a single measure. The measure view can be accessed by clicking on the measure title link (#1) on the measure dashboard (Figure 5). This page displays the title (#1) and description (#2) of the measure along with the logic for the measure (#3). Additionally the currently set of test patients associated with the measure are listed in the column on the right hand side of the page. This column displays the summary calculation results for the patient test deck associated with the measure along with the list of patients with the individual calculation results for each patient. This page allows displaying the results of calculation for a single patient along with an overlay of the calculation results on the measure logic. Finally, this page allows the user to add new patients to a measure, update a measure, and delete a measure.

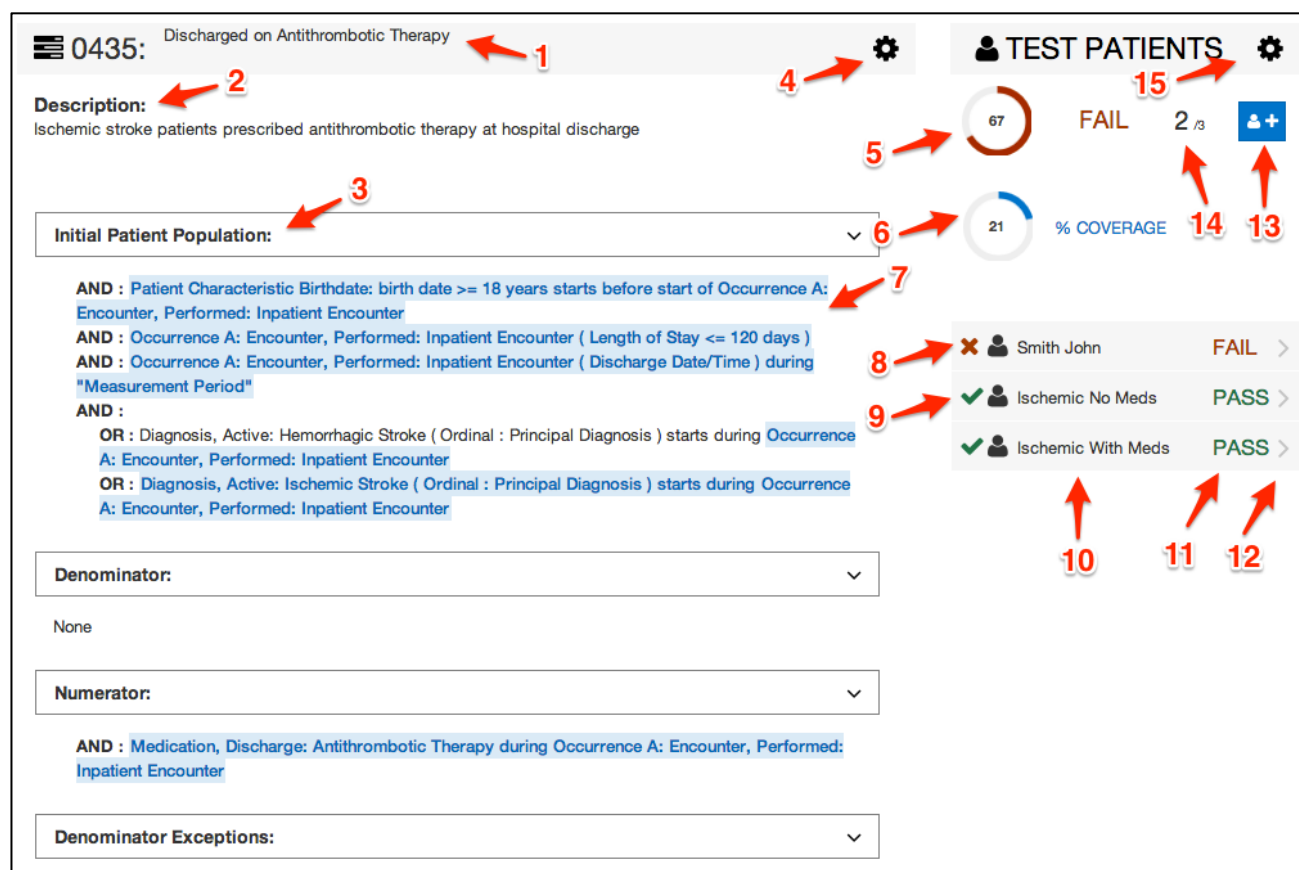


Figure 9: Measure View

#### User Interface Elements

1. Measure Title – Displays the title of the measure
2. Measure Description – Displays the description of the measure
3. Measure Logic – Displays a representation of the logic for the measure.
4. Measure Actions – Allows the user to delete or update a measure definition.
5. Percent Successful – Displays the percent of patients currently meeting expectations for the measure.
6. Test Coverage – Displays the percentage of the measure logic that has evaluated to true for the patient test deck. This provides a method for determining how much of the logic has been tested.
7. Logic Highlighted With Coverage – Displays the logic for the measure highlighting which lines of the measure are covered by the test patients.
8. Failing Patient – An example of a patient that is not currently meeting expectations for the measure
9. Passing Patient – An example of a patient that is meeting expectations.
10. Patient Name – Displays the name that has been given to the patient.
11. Patient Status – Displays PASS or FAIL to indicate if the patient is meeting expectations.
12. Expand Patient Results Button – Allows displaying the details of the calculation of a patient. This will show the expected and actual values for the patient against the measure.
13. Add Patient Button – Allows adding a new patient to the test deck for this measure.
14. Patients passing count – Displays the current number of patients meeting expectations over the total number of patients in the test deck for the measure.
15. Patient Actions – Allows the user to export patient records.

## Measure Logic

The left hand side of the Measure View contains the measure title, description and a representation of the logic. The representation of the measure logic is similar to the human readable display for the measure provided in the MAT measure exports. There are some differences in the structure of the logic that are a result of restructuring that is done while parsing the measure logic from the HQMF specification. The most notable of these differences is that relative timings applied to logical groups are distributed down into the statements of the logical group rather than being displayed at the level of the grouping.

The measure logic section can be used to verify that the measure logic has been properly loaded from the HQMF without the loss of any logical conditions. The logic can also be used to evaluate the nature of the calculation of a test patient against the logic (see Calculation Results) and to visualize the test coverage of the measure logic.

## Creating a new test record

The user can start building a test patient from the measure view (Figure 9) by clicking the “add patient” button (#13). Clicking the add patient button opens the patient builder (Figure 13). Once a patient record has been created the user will be returned to the measure view and can evaluate the results of calculating the patient against the measure.

## Calculation Results

Once a test patient record has been constructed, the measure view can be used to calculate that patient against the logic of the measure. High level results are calculated automatically when the measure view (Figure 9) is loaded. These high level results can be seen under the test patients section on the right hand side of the view. The high level results include the percent of patients passing (#5), the test coverage (#6), individual statuses for each patient (#8, #9, #11), and the passing patient count (#14).

In addition to these high level results, detailed results can be displayed for an individual patient by clicking the “Expand Patient Results” button (#12). This displays a table of expected and actual results for the patient covering each population listed in the measure and shows whether that population is currently meeting or failing expectations.

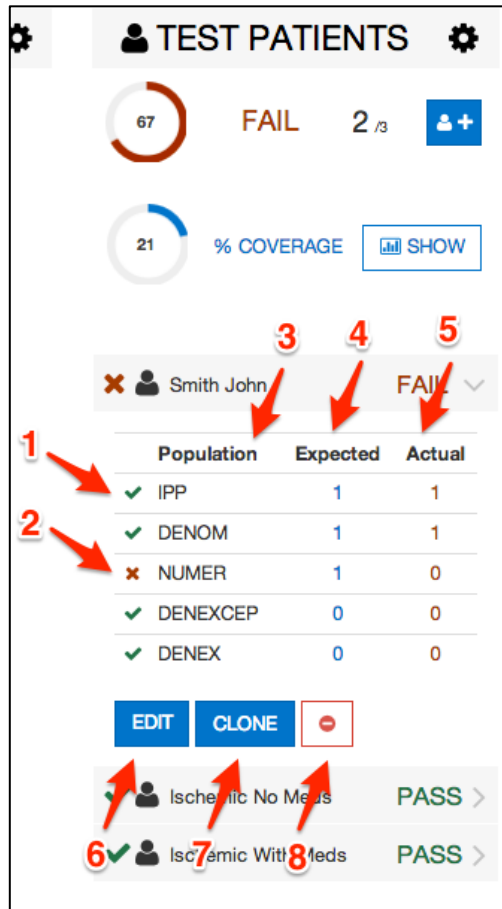


Figure 10: Expanded Results View

#### User Interface Elements

1. Passing Population – A population for which the patient passes.
2. Failing Population – A population for which the patient fails.
3. Population Column – A Listing of the population types.
4. Expected Value – The user defined expected value for the population.
5. Actual Value – The calculated value for that population.
6. Edit Patient Button – Allows editing the selected patient
7. Clone Patient Button – Allows Cloning the selected patient.
8. Delete Patient Button – Allows Deleting the selected patient.

Clicking the “Expand Patient Results” button (#12 in Figure 9) also displays the results of how the patient is calculating against each line of logic. This is displayed in the measure logic section (#3) through the highlighting of the lines of logic. An example of the highlighting of the logic can be seen in Figure 11 and Figure 12.



Figure 11: Logic Calculation Highlight - Passing

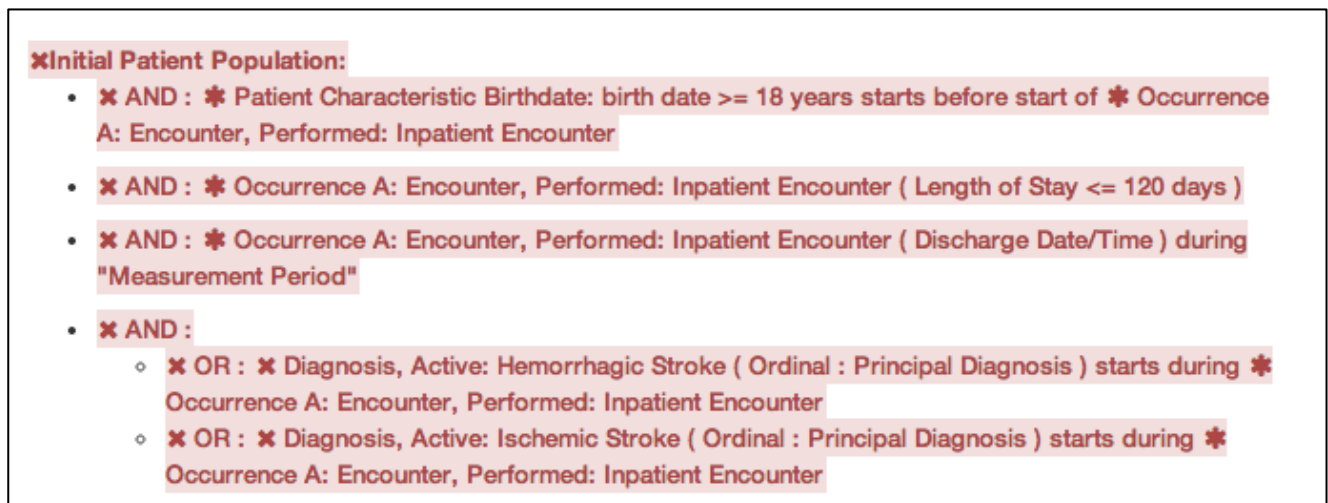


Figure 12: Logic Calculation Highlight - Failing

Figure 11 shows the results of a single patient calculated against the measure logic. The measure logic highlighting for calculation is intended to provide a clearer understanding of why a patient is calculating to a specific population. The highlighting of the logic uses the following indications of status:

- **Logic evaluated to TRUE** – green highlighting of the logic text along with a check mark icon
- **Logic evaluated to FALSE** – red highlighting of the logic text along with an x icon
- **Unaligned Specific Occurrences** – red highlighting of the logic text along with an asterix icon

The results of the calculation in Figure 11 are that the patient aligns with the logic of the the initial patient population (IPP). Looking at the highlighting of the logic in this figure, it can be seen that every AND condition evaluated to true and at least one condition from each OR evaluated to true. This results in the IPP evaluating to true for the patient.

In Figure 12, the result of calculating the selected patient is that the patient is not included in the IPP. In this figure it can be seen that all the logical statements are highlighted in red, indicating that all statements evaluate to false. Additionally, unaligned specific occurrences can be seen in Figure 12. This state indicates that the line of logic would evaluate to true if it were not for specific occurrences. However, since all logical lines related to a specific occurrence must evaluate to true for any to evaluate to true, the line does not evaluate to true. Therefore, this third indication related to specific occurrences helps to identify which lines referencing that occurrence may be causing the calculation to evaluate to false.

### Editing a test record

The user can edit a test patient from the measure view (Figure 9) by clicking the “edit” button. The “edit” button (#6 in Figure 10) can be accessed by clicking the “Expand Patient Results” button (#12 in Figure 9) for a patient. Clicking the edit patient button opens the patient builder (Figure 13) with the data populated for the patient being edited. Once a patient record has been edited and saved the user will be returned to the measure view.

### Cloning a test record

The user can clone a test patient from the measure view (Figure 9) by clicking the “clone” button (#7 in figure 10). The “clone” button can be accessed by clicking the “Expand Patient Results” button (#12 in Figure 9) for a patient. Clicking the clone patient button opens the patient builder (Figure 13) with the data populated for the patient being cloned. The difference between editing a patient and cloning a patient is that the clone process creates a new patient based on an existing patient while the edit process updates the data for an existing patient. Once a patient record has been cloned, edited, and saved the user will be returned to the measure view.

### Deleting a test record

The user can delete a test patient from the measure view (Figure 9) by clicking the “delete” button (#8 in figure 10). The “delete” button can be accessed by clicking the “Expand Patient Results” button (#12 in figure 9) for a patient. Deleting a patient requires a two step process for confirmation. Clicking the initial delete button displays a second delete button that must be clicked to confirm the deletion of the patient. Deleting patient records cannot be undone once completed.

### Updating a Measure

The user can update a measure by clicking the update measure button. The update measure button can be accessed by clicking the measure actions icon (#4). The update button displays the update measure dialog (Figure 8). The update measure dialog allows the user to specify a new zip package for a measure exported from the MAT. Once the new measure package has been entered, the user clicks the load button which updates the measure definition and returns the user to the measure view with the updated measure definition.

### Deleting a Measure

The user can delete a measure from the measure view (Figure 9) by clicking the “delete” button for a measure. The “delete” button for a measure can be accessed by clicking the measure actions icon (#4). Deleting a measure requires a two step process for confirmation. Clicking the initial delete button displays a second delete button that must be clicked to confirm the deletion of the measure. Deleting a measure cannot be undone. Once the measure has been deleted, the measure dashboard is displayed with the deleted measure removed.

## Building a Patient Test Record

### Overview

The Patient Builder Page (Figure 13) allows adding and editing clinical data for a synthetic test patient record. The patient builder can be accessed by clicking on the add patient button (#5) on the measure dashboard (Figure 8), or by clicking the add, edit, or clone patient buttons from the measure view (Figure 9).

This page provides fields to either add new data or edit existing data for a patient. The patient first and last name can be defined using the associated edit fields (#1), characteristics such as gender, birthdate, race, and ethnicity can be set in the characteristics section (#5), and QDM elements (#2) can be added to the patient history section (#4) by dragging and dropping an individual element (#3) onto the patient history section.

In addition to defining the patient data, the patient builder also allows the user to set expectations on the patient using the expectations section (#6). Expectations represent how the user expects the patient being defined to calculate against the measure. The expectations section will be different based on the type of measure for which the patient is being built. Patient based measures provide a check box to select the appropriate populations (numerator, denominator, etc.) that the patient is expected to be included in. Episode of care based measures allow selecting the number of episodes of care that are expected to be included in each population using a number picker, and continuous variable measures allow defining the expected value(s) the measure is expected to calculate for the patient.

Additionally, the patient builder displays the logic of the measure the patient is being constructed against in the logic section (#7). As data is entered, the patient is continuously calculated against the measure logic and the results are displayed against the measure using the logic highlighting. Additional information related to the logic highlighting based on calculation results can be found in the descriptions of Figure 11 and Figure 12.



The screenshot shows the 'TEST PATIENT' interface. On the left, a sidebar contains 'ELEMENTS' with categories: CONDITIONS, Diagnosis, Active: Hemorrhagic Stroke, Diagnosis, Active: Ischemic Stroke, INTERVENTIONS, ENCOUNTERS, and a medical bag icon. The main area is divided into two sections: 'PATIENT CHARACTERISTICS' and 'PATIENT HISTORY RELATIVE TO MEASURES'. The 'PATIENT CHARACTERISTICS' section includes fields for LAST NAME (Ischemic), FIRST NAME (No Meds), PAYER (Other), GENDER (Male), DOB (mm/dd/yyyy), LIVING STATUS (Deceased), RACE (American Indian or Alaska Native), and ETHNICITY (Not Hispanic or Latino). The 'PATIENT HISTORY RELATIVE TO MEASURES' section displays a table with two rows: 'ENCOUNTER' (Encounter, Performed: Inpatient, Date: 02/05/2012 - 02/07/2012) and 'DIAGNOSIS' (Diagnosis, Active: Ischemic Stroke, Date: 02/06/2012 - 02/06/2012). On the right, the 'MEASURE ASSOCIATED' section shows 'Discharged on Antithrombotic Therapy' and an 'EXPECTED VALUE' section with input fields for IPP, DEN, NUM, and EXCP. Below this is the 'MEASURE' section, which displays the logic for the measure, including 'Initial Patient Population' and various 'AND' and 'OR' conditions. At the top right, there are 'CANCEL' and 'SAVE' buttons. Red arrows and numbers 1 through 8 point to specific elements: 1 points to the LAST NAME field, 2 points to the ELEMENTS sidebar, 3 points to a specific QDM element, 4 points to the PATIENT HISTORY section, 5 points to the PAYER field, 6 points to the EXPECTED VALUE section, 7 points to the MEASURE logic section, and 8 points to the SAVE button.

Figure 13: Patient Builder

## User Interface Elements

1. Patient Name section – Allows the entry of a first and last name for the patient record.
2. QDM Elements – A list of QDM elements by category extracted from the measure.
3. QDM Element – An individual QDM element that can be added to the patient history.
4. Patient History – Displays the QDM elements that are associated with this patient.
5. Patient Characteristics – Allows defining characteristics data for the patient.
6. Expectations – Allows setting the calculation expectation for each population of the measure.
7. Measure Logic – Displays a representation of the logic for the measure.
8. Actions – Allows saving a patient records or canceling.

## Building a synthetic patient

The first step to building a synthetic patient is defining the name of the patient. The first and last name of the patient can be set in the patient name section (#1). Once the patient has a name defined, the next step is to define the expectations for how the patient will calculate against the measure. The expectations can be set for the patient in the expectations section (#6).

In the expectations section the user defines how they expect the patient to behave against the measure. If the patient that will be built is expected to align with the initial patient population logic, then that expectation should be set in the expectations section. Expectations are used throughout the application to determine if a patient is passing or failing against the measure.

If the expected results set while building the patient align with the actual results from calculating the patient against the measure logic, then the patient passes. If the expected results do not match the actual calculated results, then the patient fails. This provides the ability to build patients and set expectations for those patients based on the intent of the measure, then once the measure is calculated, the passing state indicates that the measure logic aligns with the intent, while the failing state indicates that either the measure logic does not align with the intent, or the patient has been improperly constructed.

Once expectations have been set for the patient, the next step is to define patient characteristics. Patient characteristics can be set in the patient characteristics section (#5). Characteristics for the patient include data such as birthdate, race, ethnicity, gender, payer, and living status.

After the patient characteristics have been defined, the next step is to build a patient history. The patient history is built from QDM elements that were extracted from the measure. The available elements from the measure are listed in the elements section (#2) organized by category. The user can click on a category to expand the list of available elements. Expanding this list allows the user to click and drag an individual element (#3) onto the patient history (#4).

In Figure 13 two events based on data elements from the measure can be seen on in the patients history, an encounter and a diagnosis. When a QDM element is added to the patient history it becomes an event in the patients history, therefore, it has a duration and associated fields. When an event is first created it is given default start and end date/times, and it is associated a code from each value set associated with the source QDM element. These defaults as well as additional data can be edited by expanding the event. Figure 14 shows an example of an expanded event from the patient history that can be edited. Clicking on the expand/collapse details icon (#4) allows editing the details of the element.

## Building the patient history

The screenshot shows the 'Edit Clinical Element' interface. At the top, a header bar displays 'encounter: Encounter, Performed: Inpatient Encounter' with a collapse/expand icon (arrow 4). Below this, the 'START' section contains date and time pickers for '02/05/2012' and '3:00 PM' (arrow 1). The 'STOP' section contains date and time pickers for '02/07/2012' and '3:00 PM' (arrow 2). A checkbox labeled 'UNDEFINED' is located between the start and stop sections (arrow 3). The 'VALUE' section includes a dropdown menu set to 'Scalar', a text input field containing 'input', and a 'units' button with a plus sign (arrow 5). The 'FIELD VALUE' section shows a text input field containing 'DISCHARGE\_DATETIME: 02/07/2012 3:00 PM' with a clear button (arrow 6). Below this is another 'Scalar' dropdown and text input field. At the bottom, there is a checkbox labeled 'NOT PERFORMED' (arrow 7) and a red square button with a minus sign (arrow 8).

Figure 14: Edit Clinical Element

### User Interface Elements

1. Start date/time – Allows setting the start date/time for an element.
2. End date/time – Allows setting the end date/time for an element.
3. Undefined End – Allows specifying that the end date/time is undefined (ongoing event).
4. Expand/Collapse details – Allows hiding or expanding the details of an element.
5. Value Section – Allows adding values to the element (i.e., lab result values).
6. Fields Section – Allows adding fields to the element (i.e., ordinality).
7. Negation Section – Allows indicating that the element is not done with a reason.
8. Delete button – Allows deleting an element from the patient history.

There are several fields that can be edited for an event in the patient history using the controls shown in figure 14. These include the start date/time of the event (#1,#2), values (#5), various fields (#6), and negation rationale (#7). The start and end date times can be set for an event by either typing into the text fields directly or by using the date/time pickers that are displayed when the field is selected. Additionally, an undefined end time can be set for the event (used for active or ongoing events) by selecting the “undefined” checkbox (#3). Selecting the undefined check box clears the end date/times indicating that the event has not ended.

Additionally, values, fields, and negation rationale can be set for an event. Values can be set using the values section (#5) by selecting the type of the value (scalar or coded), and then entering a scalar

value or selecting a coded value from a drop down listing all the value sets associated with the measure. Fields such as ordinal, severity, discharge date/time, etc., can be added using the fields section (#6). Fields are added by selecting the type of the field (scalar, coded, or time) and then entering in a scalar value, selecting a value set, or entering a date.

Negation rationale can also be defined for the event to indicate that the event was not done for a specific reason. Negation rationale is added by clicking the “Not Performed” checkbox in the negation section (#7) and then selecting a value set representing the reason the event was not done.

Finally, events can be removed from the patient history by clicking on the delete button (#8). Deletion requires a two step process. Once the delete button is pressed, a secondary delete button is displayed to confirm the intended deletion.

### Incremental Calculation

The final section of the patient builder is the logic section. This section displays a representation of the logic for the measure the patient is being constructed against. The logic can be used as a reference to help to inform the details of the data that should be added to the synthetic patient being build.

Additionally the logic section continuously displays the results of calculating the patient against the measure using the logic highlighting shown in figures 11 and 12. Any modification made to a patient triggers a re-calculation of the patient against the measure updating the results of the calculation displayed by the highlighting of the logic. This allows the user the ability to inspect the behavior of the logic relative to the patient as the patient is being constructed.

Once the user has completed the construction of a synthetic patient clicking the “save” button (#8) in the patient builder adds the patient to the test deck for the measure and returns the patient to the measure view. After the first patient has been created, additional patients can either be created from scratch, or patients can be cloned from existing patients to extend the coverage of the test deck against the measure.

### Feedback and support

An issue tracker and feedback email list are available to support the resolution of issues and to answer questions related to the Bonnie application. The Bonnie issue tracker is available on the ONC Jira system using the following URL:

<http://jira.oncprojecttracking.org/browse/BONNIE>

The issue tracker should be used to report bugs encountered when using the Bonnie application, to ask questions, or to request new features. In order to add an issue a login account must be created in the Jira system. Once an issue has been entered, it will be reviewed by the Bonnie team and prioritized. Alternatively, questions can also be addressed to the Bonnie feedback list [bonnie-feedback-list@lists.mitre.org](mailto:bonnie-feedback-list@lists.mitre.org). The bonnie feedback list email can be accessed using the “Contact” link in the main Bonnie navigation menu at the top of every page.