RODS Version 4.2 User Manual

Chapter

1

Overview

RODS automatically collects public health surveillance data from multiple sources, analyzes them for possible outbreaks, notifies users and has a web-based user interface to examine the data..

The Real-time Outbreak and Disease Surveillance (RODS) system was first deployed in 1999 at a single hospital in Pittsburgh, Pennsylvania. Its use has grown steadily since then. Milestones of RODS include its use in the 2002 Winter Olympics, a visit to see RODS by President G.W. Bush, inclusion of over-the-counter medication sales data from the National Retail Data Monitor (NRDM), and licensing of RODS as open source software.

As of 2006, RODS performs emergency department surveillance for multiple states (California, Illinois, Kentucky, Michigan, New Jersey, Nevada, Ohio, Pennsylvania, Utah and Wyoming) through an ASP model at the University of Pittsburgh, and through local installations in Taiwan, Canada, Mississippi, Michigan, California and Texas. It also serves as the user interface for national over-the-counter medication sales surveillance data collected through the NRDM.

This user manual introduces concepts of the RODS system, how to navigate the user interface, and specific instructions for viewing NRDM or Healthcare Registration data.

Conceptual Architecture of the RODS system

RODS collects data from multiple data sources (currently Healthcare Registrations and Over-the-Counter Medications). These data are stored in a database and data warehouse where they are made available to outbreak algorithms and the RODS user interface (See Figure 1).

What is a data warehouse? A data warehouse is a collection of data designed to support management decision making. In the RODS system the data warehouse is updated very frequently (as frequently as every hour) and is used to determine if a possible outbreak exists and provide fast data access to the user interface.

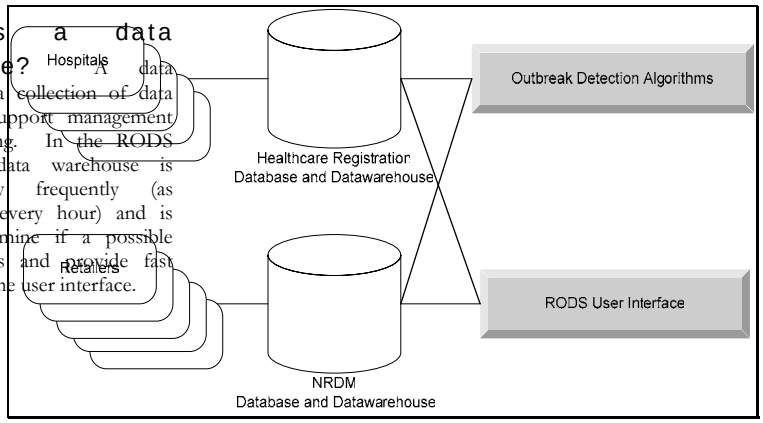

Figure 1: Conceptual Architecture of the RODS system

The National Retail Data Monitor

The NRDM collects over-the-counter (OTC) medication sales data nationally. Each retailer sends RODS the number of sales for each OTC medication. We group the individual medication sales data spatially by zip code according to store location and categorically into one of 18 OTC categories.

Eighteen over-the-counter medication categories

Antidiarrheal: Products taken for the relief of diarrhea. All sizes and forms (tablets, liquids, etc.). Includes bismuth (Pepto Bismol and like products), attapulgite, subsalicylate, and loperamide HCL products.

Antifever Pediatric: Includes all products intended for children that are taken orally for the relief of fever.

Antifever Adult: Includes all products intended for adults that are taken orally for the relief of fever.

Bronchial Remedies: Products intended for the relief of Bronchial asthma. Includes products similar to Bronkaid and Primatene.

Chest Rubs: Creams, lotions, gels, balms, etc. Chest rubs are applied externally to the chest, throat or head for the relief of common colds.

Cold Relief Adult Liquid: Adult cold remedies in liquid form. Includes plain cold liquids remedies as well as antihistamines, decongestants and night-time liquid cold relief products.

Cold Relief Adult Tablet: Adult cold remedies in tablet form. Includes plain cold tablets as well as antihistamines, decongestants and allergy relief products.

Cold Relief Pediatric Liquid: Pediatric cold remedies in liquid form. Includes plain cold liquids remedies as well as antihistamines, decongestants and night-time liquid cold relief products.

Cold Relief Pediatric Tablet: Pediatric cold remedies in tablet form. Includes plain cold tablets as well as antihistamines, decongestants and allergy relief products.

Cough Syrup Adult Liquid: Adult liquid cough remedies including any cough whip products. Includes all cough syrups that are recommended for relief of cough in adults.

Cough Syrup Adult Tablet: Includes all adult cough tablets, capsules, squares, etc., of cough syrup strength that are recommended for relief of cough.

Cough Syrup Pediatric Liquid: Pediatric liquid cough remedies including any cough whip products. Includes all cough syrups that are recommended for relief of cough in children.

Electrolytes Pediatric: Solutions of primarily electrolytes and glucose used for fluid replacement in children suffering from dehydration. Includes products in liquid and freezer pop form.

Hydrocortisones: Anti-inflammatory topical corticosteriods used to relieve itching rashes.

Nasal Product Internal: Products that are for the relief of nasal congestion or stuffiness. Includes only products in the form of spray, drops, sticks, or gels. Nasal sprays and drops are generally .5 oz. - 1 oz. in size.

Thermometers: All thermometers, designed for both pediatric and adult use, including electronic and "ear" aka tympanic membrane thermometers used for health reasons. Also includes non intrusive fever detectors and replacement sheaths for electronic thermometers.

Throat Lozenges: Products in solid form as a throat lozenge or drop that dissolve in the mouth.

Healthcare Registration Data

RODS collects healthcare registration data in real time from participating hospitals via a standard called Health Level 7 (HL7). HL7 is the most widely used messaging standard in healthcare. It enables healthcare applications to exchange key sets of clinical and administrative data. Specifically, healthcare registration data consist of the age, gender, home zipcode, date/time of admission, and a free-text chief complaint of the patient.

Complaint Coder (CoCo)

A natural language processing (NLP) program built into RODS called the Complaint Coder (CoCo) processes these free-text chief complaints. CoCo takes each chief complaint (ex. "I can't breathe") and classifies it into one of the RODS prodrome categories (ex. respiratory).

Seven healthcare registration prodrome categories

Gastrointestinal: pain or cramps anywhere in the abdomen, nausea, vomiting, diarrhea, and abdominal distension or swelling.

Constitutional: non-localized, systemic problems including fever, chills, body aches, flu symptoms (viral syndrome), weakness, fatigue, anorexia, malaise, lethargy, sweating (diaphoresis), light headedness, faintness and fussiness.

Respiratory: problems of the nose (coryza) and throat (pharyngitis), as well as the lungs. Examples of Respiratory include congestion, sore throat, tonsillitis, sinusitis, cold symptoms, bronchitis, cough, shortness of breath, asthma, chronic obstructive pulmonary disease (COPD), and pneumonia. The presence of both cold and flu symptoms is counted in this category, not constitutional.

Rash: any rash, such as macular, papular, vesicular, petechial, purpuric, or hives. Ulcerations are not counted as Rash unless consistent with cutaneous anthrax (an ulcer with a black eschar).

Hemorrhagic: bleeding from any site, e.g., vomiting blood (hematemesis), nose bleed (epistaxis), hematuria, gastrointestinal bleeding (site unspecified), rectal bleeding, and vaginal bleeding.

Botulinic: ocular abnormalities (diplopia, blurred vision, photophobia), difficulty speaking (dysphonia, dysarthria, slurred speech), and difficulty swallowing (dysphagia).

Neurological: non-psychiatric complaints that relate to brain function. Included are headache, head pain, migraine, facial pain or numbness, seizure, tremor, convulsion, loss of consciousness, syncope, fainting, ataxia, confusion, disorientation, altered mental status, vertigo, concussion, meningitis, stiff neck, tingling and numbness.

What's new in RODS 4.2

- Access to CoCo syndrome analysis of free text, queries, and data files
- Beta tool (SyCo) to classify chief complaint data by symptoms
- Outbreak simulation and algorithm analysis through HiFIDE
- Improved map interface and graphics
- Ability to view laboratory data through EpiPlot
- Aerosol anthrax release detection via BARD service

Chapter

2

RODS User Interface

The RODS user interface is a secure web-based interface for displaying public health surveillance data.

The RODS user interface (UI) is divided into seven sections – main, epiplot, mapplot, alerts, tools, options, help and contact.

Logging In

Using Internet Explorer 5 or higher, Mozilla or Firefox visit the following website:

https://www.rods.pitt.edu/rods/

RODS Login Page

On the login page you will see login fields where you enter your username and password. Pressing the login button will submit your username and password to the system for verification (See Figure 2).

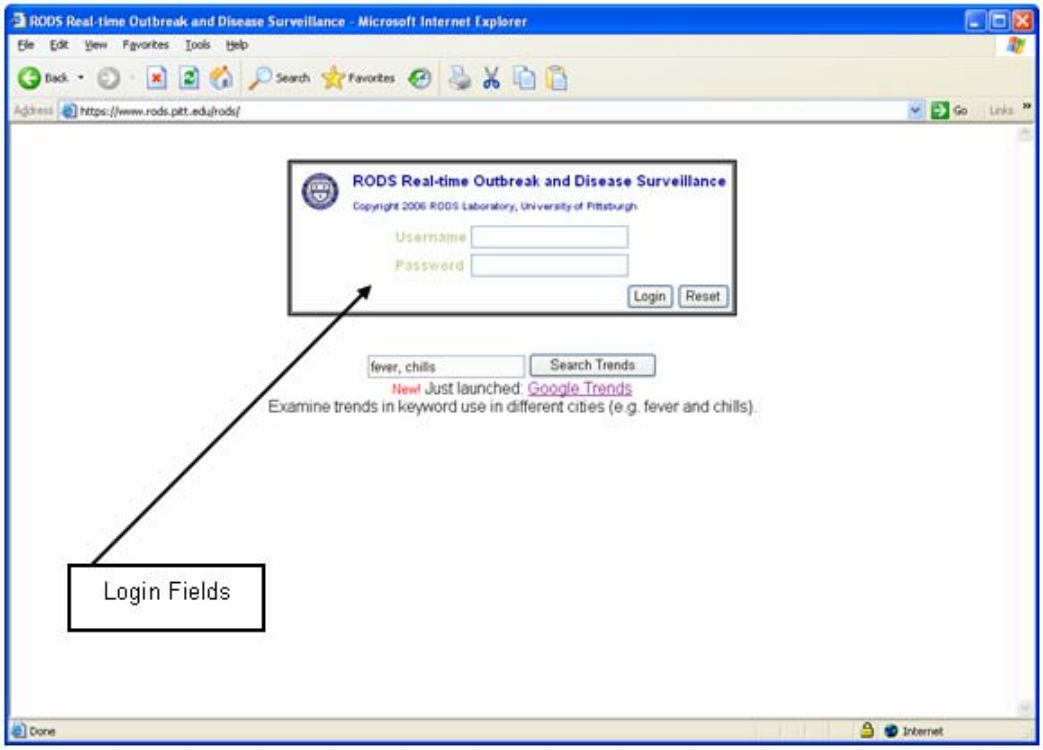

Figure 2: RODS Login Page

Screen Navigation Area

The screen navigation area offers eight selections to choose from: Main, Epiplot, Mapplot, Alerts, Tools, Options, Help and Contact.

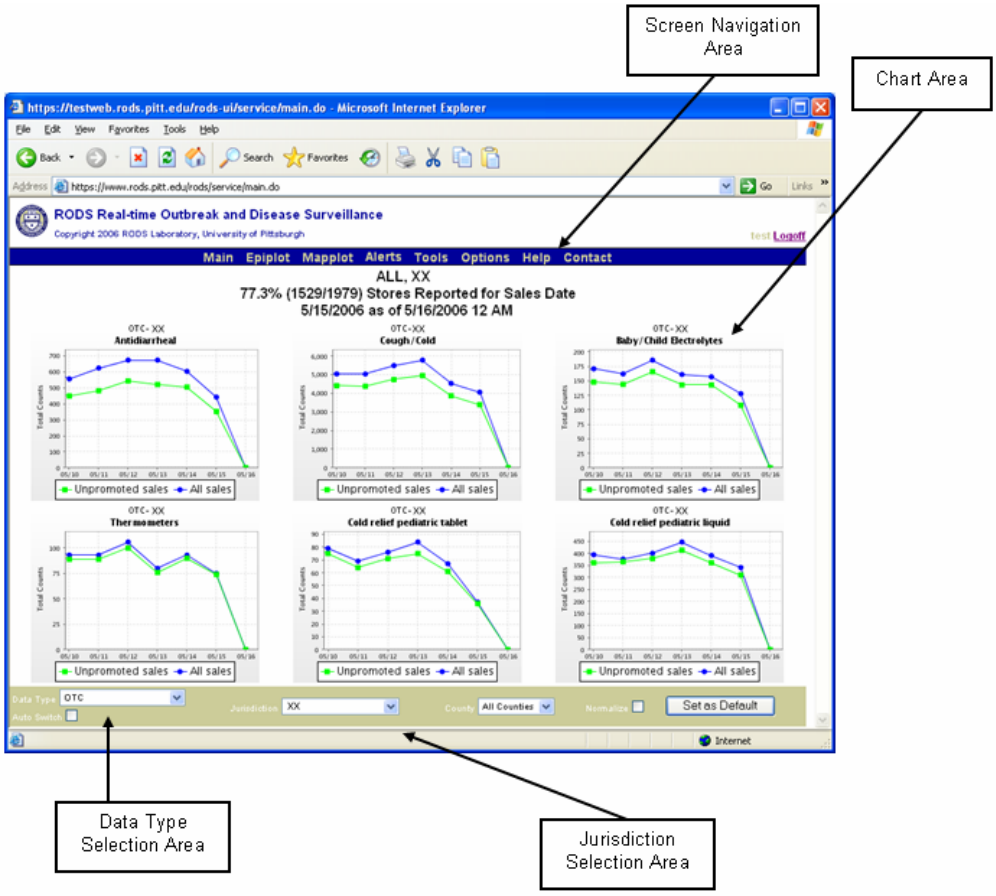

Figure 3: Main Screen

Main

The first time you log into the RODS system, you will see the Main Screen (See Figure 3). The intention of the Main screen is that of a "threat" board in a situation room. This main screen will refresh itself every two minutes if you leave it displayed.

> The intention of the Main screen is that of a "threat" board in a situation room.

Data Type Selection Area

The default "data type" is "OTC" unless you are a hospital-specific RODS user. Checking off "Auto Switch" will automatically alternate between the over-the-counter medication screen and the healthcare registration screen every two minutes given that both types of data are available in your area.

Access for most states is limited to OTC data; therefore you may want to switch the data type to "OTC" to avoid switching to the healthcare registration screen.

Default state/jurisdiction is your jurisdiction.

Default County is set to "All Counties". The drop down list allows viewing of one county at a time.

Normalize

You can also "normalize" the frequencies of the charts. For OTC data, normalizing the charts divides the 18 specific product daily frequencies by the sum over all OTC categories monitored. For healthcare registration data the normalize function divides the number of visits over a 24 hour period for a specific prodrome category by the total number of visits in the same 24 hour period.

Chart Area

Six OTC medication sale frequency charts are automatically shown on the OTC Main Screen. If healthcare registrations are selected, six charts are also shown. (Individual types of medication and prodrome categories cannot be selected from the OTC Main Screen, this function can be performed in the RODS EpiPlot Screen). Additionally, the time periods shown on the charts are limited to the last seven days on this screen.

Epiplot

EpiPlot gives you more control and choices regarding the charts shown in the chart area (See Figure 4).

Whereas the RODS Main Screen is limited to viewing six OTC or Healthcare Registration charts for the last seven days, EpiPlot lets you control which medications and/or prodromes are charted, what time period to chart, and particular geographic regions (down to the zipcode) to chart. Also, you can download data in Epiplot to use in Excel, SAS, etc. Laboratory data is now available through Epiplot in jurisdictions that provide this data type.

Clicking on "EpiPlot" in the screen navigation area will bring you to the EpiPlot main screen.

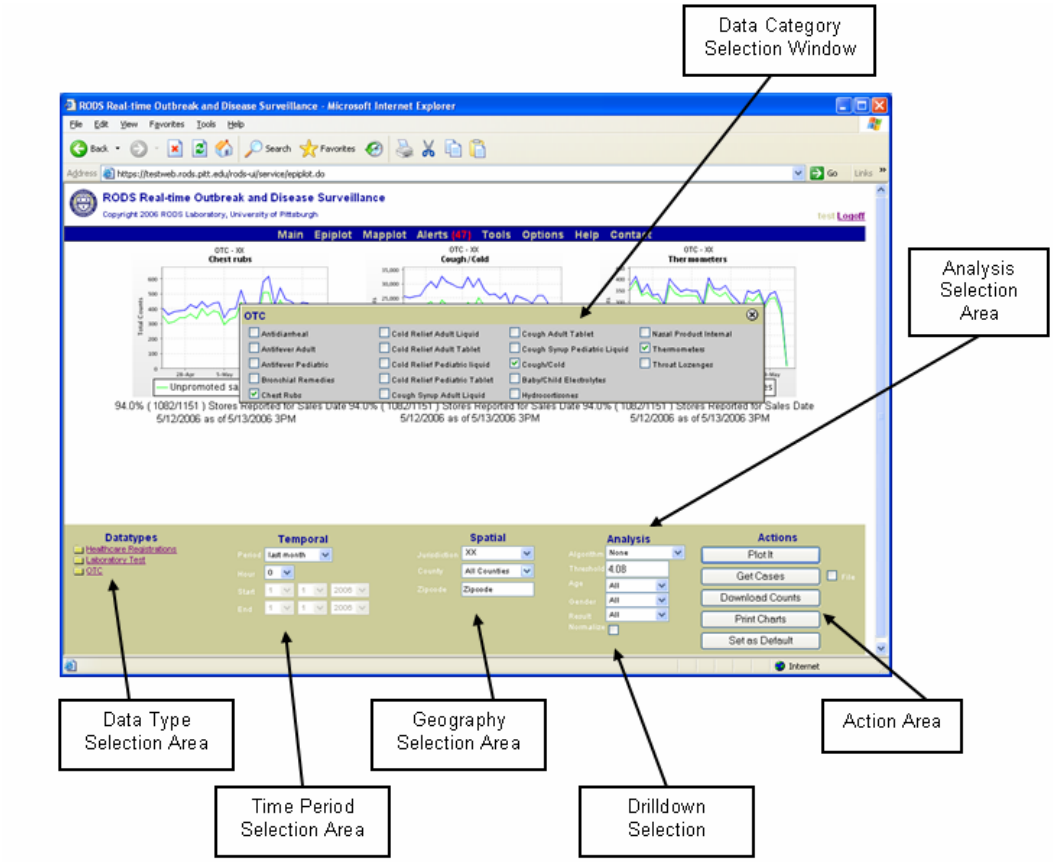

Figure 4: Epiplot

Creating Charts

1. Choose a data type using controls in data type selection area.

a. After clicking on a datatype (Healthcare Registrations, Laboratory Data, or OTC) a data category selection window will appear in the middle of the screen.

b. Choose any combination data types. Multiple data categories can be selected by checking the corresponding check boxes.

c. On the Healthcare Registrations window, the "Aggregate by" selector can be used to indicate whether the data is analyzed by the patient's home zip code or the hospital's zip code location (See Figure 5). This function is useful when the majority of the patients utilizing the hospitals are visitors or tourists.

d. By clicking on the "Set as Default" button in the action area you can have RODS remember the data categories you want to see whenever you login to the system.

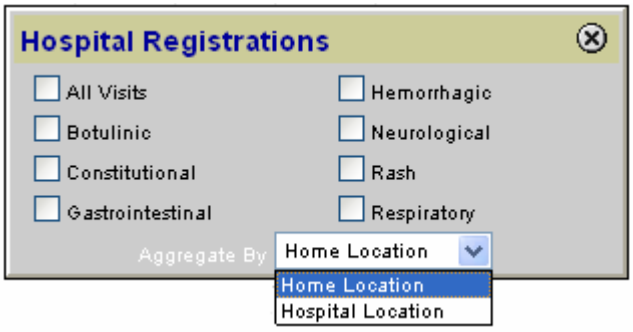

Figure 5. "Aggregate by" function

The "Aggregate by" selector tells the system whether it should utilize a patient's home zip code or the hospital's zipcode location as the geographic indicator.

2. Choose a time period from the time period selection area.

a. The period field drop down selection button offers multiple time period options. Select the time period you are interested in charting. Additionally, custom time period can be chosen using the start and end date drop down buttons.

b. The hour selector indicates the hour when the data warehouse was updated (i.e., 0 hours refers to 12 midnight and 14 refers to 2pm.). The hour selector is particularly useful when reviewing a healthcare registration alerts and you wish to see the actual data that triggered an algorithm to send out an alert.

Note: The earliest date available for the OTC surveillance system is the first week in February, 2003.

The hour selector indicates the hour when the data warehouse was updated (i.e., 0 hours refers to 12 midnight and 14 refers to 2pm.)

3. Choose the geography from the geographic selection area.

a. The default and only state available for most users is the state under your jurisdiction. For example, in Pennsylvania the only available state is "Pennsylvania" and the default County is "All Counties".

b. Choose a particular county by pressing the drop down button for the county field and highlighting a specific county. You can also chart data for one or more zip codes (separated by commas) by entering (a) zip code(s) in the zip code field.

4. Optionally, you can analyze the data using one of four algorithms—CuSUM with EWMA, RLS, Wavelet or Moving Average.

Please note that applying an analysis algorithm will take additional time for processing (when you select an algorithm, RODS performs an analysis of every single data point displayed!).

Four on-the-fly analysis algorithms in the User Interface

Moving Average – The moving average algorithm computes the average of the last 120 days for each point in a historical times series. Next, the algorithm calculates the prediction errors between the moving average values and the time series values. Using the prediction errors and algorithm threshold (expressed in number of standard deviations) the moving average algorithm computes a threshold value. This algorithm is useful for detecting sharp spikes in time series that have only mild trends. Moving Average has an alert threshold of 4.02.

Recursive Least Square – The Recursive-Least-Square (RLS) algorithm operates by converging on a set of coefficients (for a weighted linear equation) that best predicts historical values. The algorithm uses these coefficients to predict the current value. Next, the algorithm calculates the prediction errors between the predicted values and the time series values. Using the prediction errors and algorithm threshold (expressed in number of standard deviations) the RLS algorithm computes a threshold value. This algorithm is ideal for detecting spikes of cases when there is little historical data. RLS has an alert threshold of 4.0.

Wavelet – The wavelet algorithm operates by modeling the long-term trend in the time series data. The algorithm subtracts this trend from the time series data to obtain a residual time series. Using the trend, the residual time series and algorithm threshold (expressed in number of standard deviations), the wavelet algorithm computes a threshold value. This algorithm is useful when there are long term trends in the historical data and there are abrupt changes in the time series. Wavelet has an alert threshold of 4.0.

CuSUM with Exponentially Weighted Moving Average – The CuSUM with Exponentially Weighted Moving Average algorithm uses two techniques to calculate the value for the threshold line. Firstly, it uses an exponentially weighted moving average to predict the current value of the time series. Then, the algorithm computes a cumulative sum statistic from the historical prediction errors that is used with the user-specified algorithm threshold to compute the value for the threshold line. This algorithm is well-suited for detecting gradual changes in the time series (i.e., slowly developing outbreaks). CuSUM has an alert threshold of 4.08.

To create a baseline for analysis, set the threshold for any of the above algorithms, with the exception of CuSUM, to zero. As the threshold dictates the allowable number of standard deviations from the expected value, a threshold of zero represents the expected value based on the selected algorithm.

Below the algorithm drop down box and zip code field, is the gender and age selection area. These values are only used to aggregate healthcare registrations by age and/or gender. They are not used for OTC data.

The Gender and Age selection area are used to aggregate healthcare registrations by age and/or gender and are not used for OTC data.

Example: Plot Cough/cold medications and thermometer sales for the past 3 weeks in Ming County, XX (See Figure 6).

1. Check off cough/cold and then thermometer in the OTC data type window accessed in data type selection area,

2. Click on "X" in upper right corner of selection box,

3. Choose last three weeks from period field drop down list,

4. Choose "Ming" from the County field drop down list, and click on "Plot it." Two graphs are shown. The green line indicates sales that have not been flagged by the retailer as a promotion-related sale. The blue line indicates all sales regardless of any promotions.

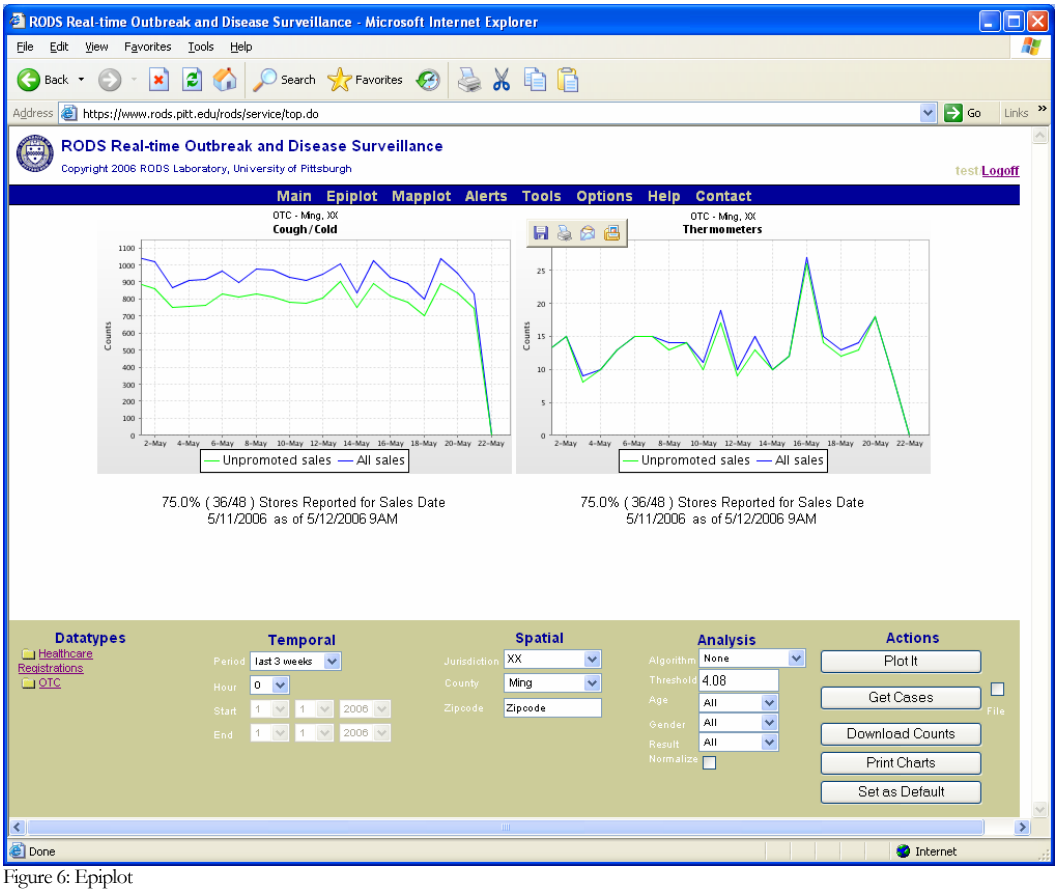

Figure 6: Epiplot

MapPlot

MapPlot gives you a geographic view of the daily frequency of OTC sales (See Figure 7). The default map is your state or jurisdiction.

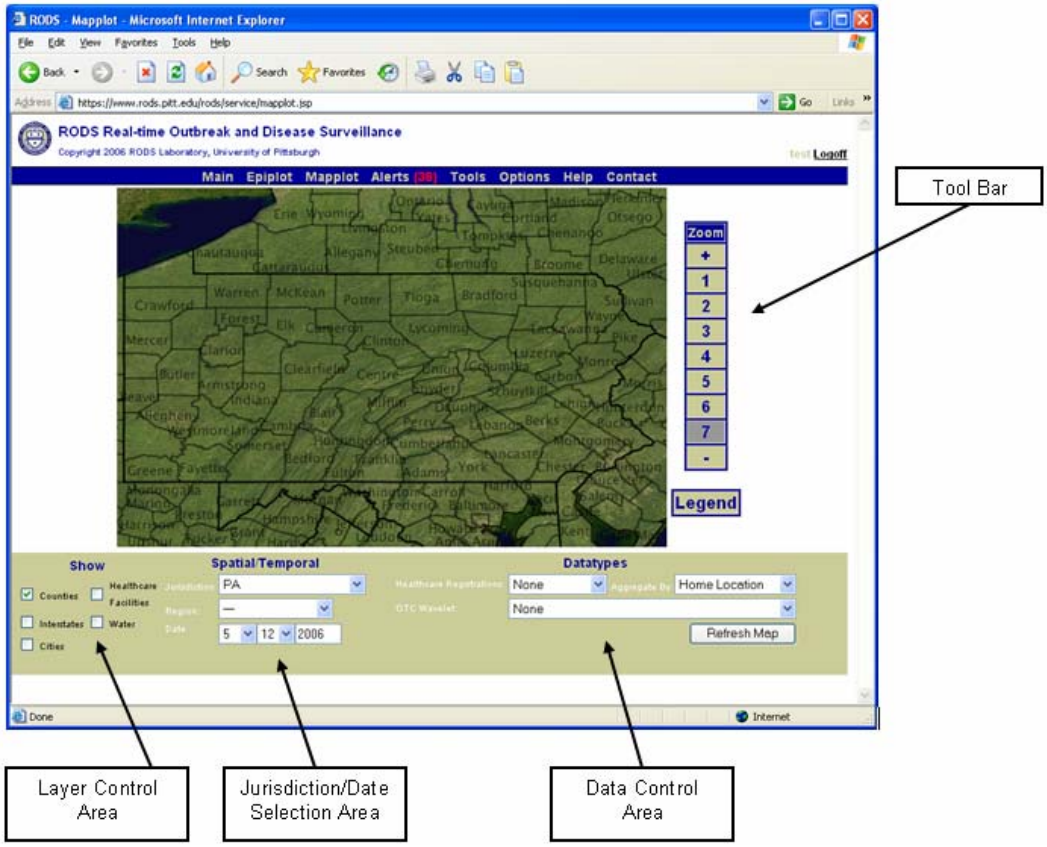

Figure 7: Mapplot

State / Jurisdiction / Date Selection Area

The State / Jurisdiction / Date selection area allows you to first choose a jurisdiction to view. You are restricted to maps of your jurisdiction or state. You can look at county-level sales of OTC data for the entire US by selecting US in this area. This area also enables you to select the day you wish to view.

Toolbar Area

The toolbar allows you to perform certain functions with the map, such as zooming in or out and displaying a legend list. Use the mouse pointer to pan. Clicking on a particular area of the map will move this point to the center of the display.

Layer and Data Control Areas

The layer and data control areas allow you to set which map layers are visible, the data source to map, and the method of aggregation. The types of data available and their descriptions are in Table 1. OTC data is analyzed by 11pm daily, set the date to one day prior if it is past 11pm (local time) and two days prior if it is before 11pm.

You can select layers and data to show in the Layer Control and Data Control areas.

Table 1. Data types available in mapplot

Healthcare Registrations <syndrome>	Hospital Surveillance Data. (currently available for select areas of Pennsylvania, Utah, Ohio, Illinois, New Jersey, and Nevada) Percentage of visits out of all visits to emergency rooms for each syndrome category based on natural language processing of patient chief complaints.
OTC-Wavelet <sales category>	Available in state specific maps. Regions with unusually high number of sales "flagged" using wavelet time-series prediction and analysis. The result of this analysis is the number of standard deviations sales in a region are from predicted.

To view a particular area, such as a county, zoom in by choosing the zoom function and clicking on an area of the map. The closer you zoom in, the more detailed the map area gets (See Figure 8).

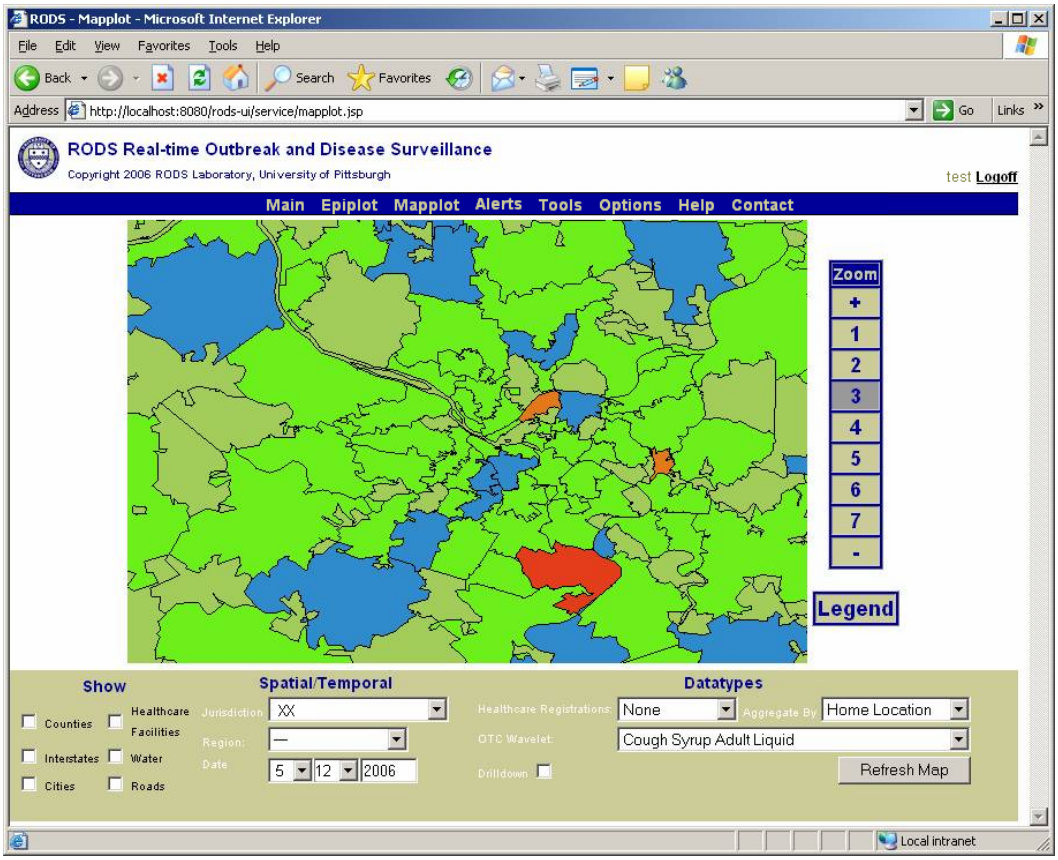

Figure 8: Mapplot zoom in

When displaying OTC data in mapplot, each color applied to the regions represent a different range of standard deviations. Click on the "Legend" in the toolbar to view these colors and corresponding ranges.

When displaying Healthcare Registration data in mapplot, darker areas are regions where there are increased frequencies of visits for a particular prodrome. Click on "Legend" in the toolbar to view the specific ranges of standard deviations.

Drilldown

The Drilldown function can be used to find out more information about the OTC or Healthcare Registrations of a particular area.

1. In order to access this function, you must zoom in to level 3 on the Mapplot toolbar.

2. After zooming in, check the box next to "Drilldown" which will appear in the data control area.

3. Click on the area of the map for which you want more information. A popup screen containing an Epiplot graph will automatically appear. (See Figure 9)

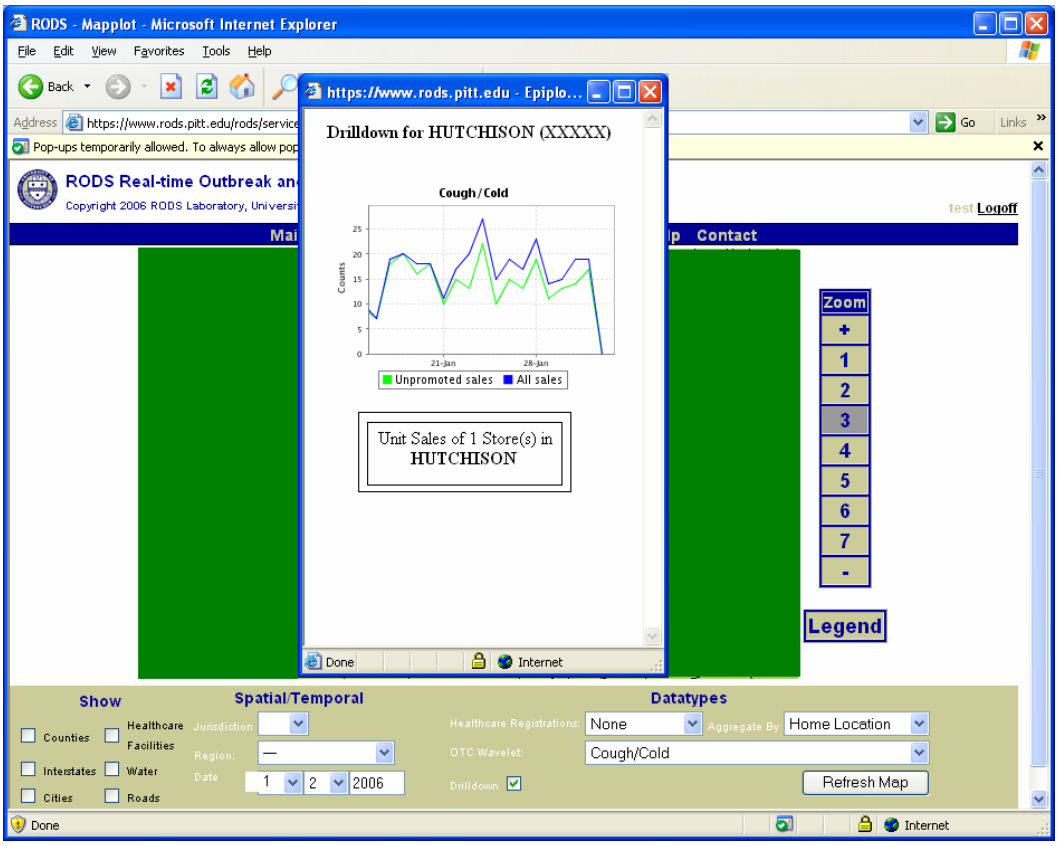

Figure 9: Mapplot drilldown

Alerts

An alert is registered each time data collected exceeds the threshold set by one or more of the four algorithms in use. The Alerts page provides detailed information about each alert for a defined jurisdiction (See Figure 109). Please note: Currently, alerts are only available for Healthcare Registrations. Alerts for OTC data will be available in the future.

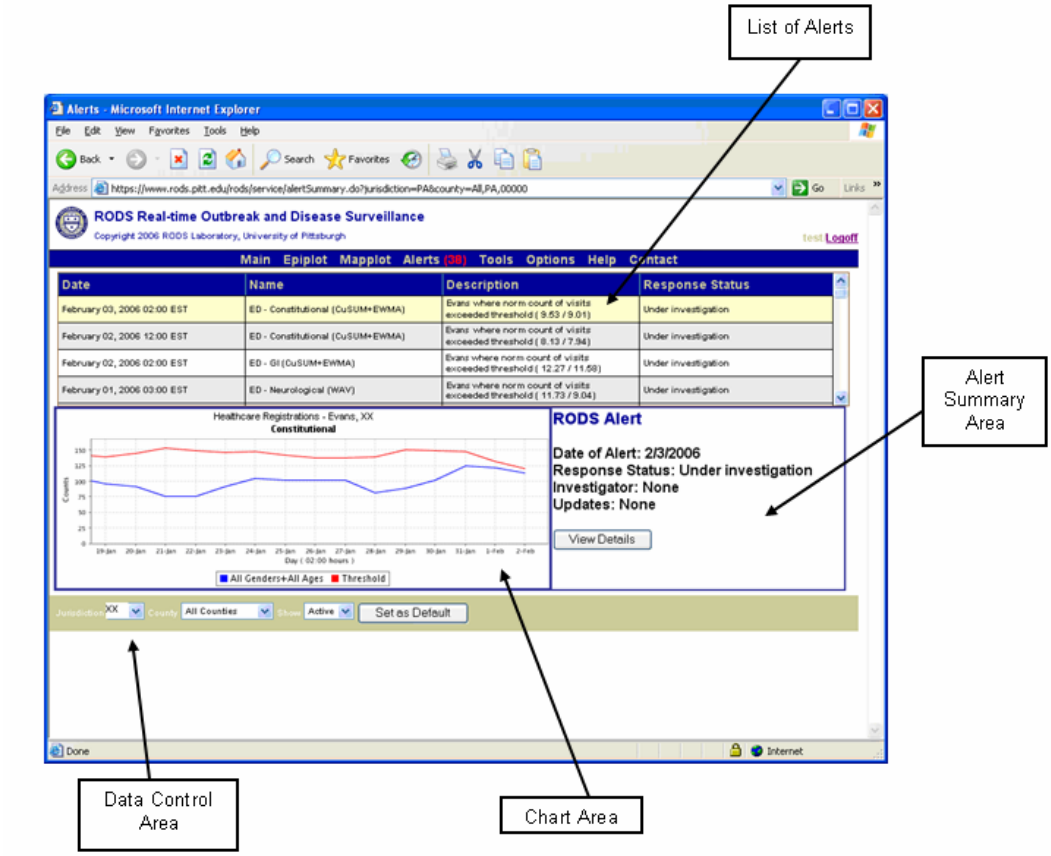

Figure 10: Alerts Screen

Use the Data Control Area to select the jurisdiction for which you want to view alerts. You can then use the "Show" drop down box to select "Active" or "All." By choosing "Active," only new alerts and those currently under investigation will be displayed. In order to display more information about a particular alert in the Chart and Alert Summary Areas, click directly on the alert line. The alert corresponding to the chart and summary will become highlighted in yellow.

Click "View Details" in the Alert Summary Area to obtain additional information and to update the status of a particular alert (See Figure 11).

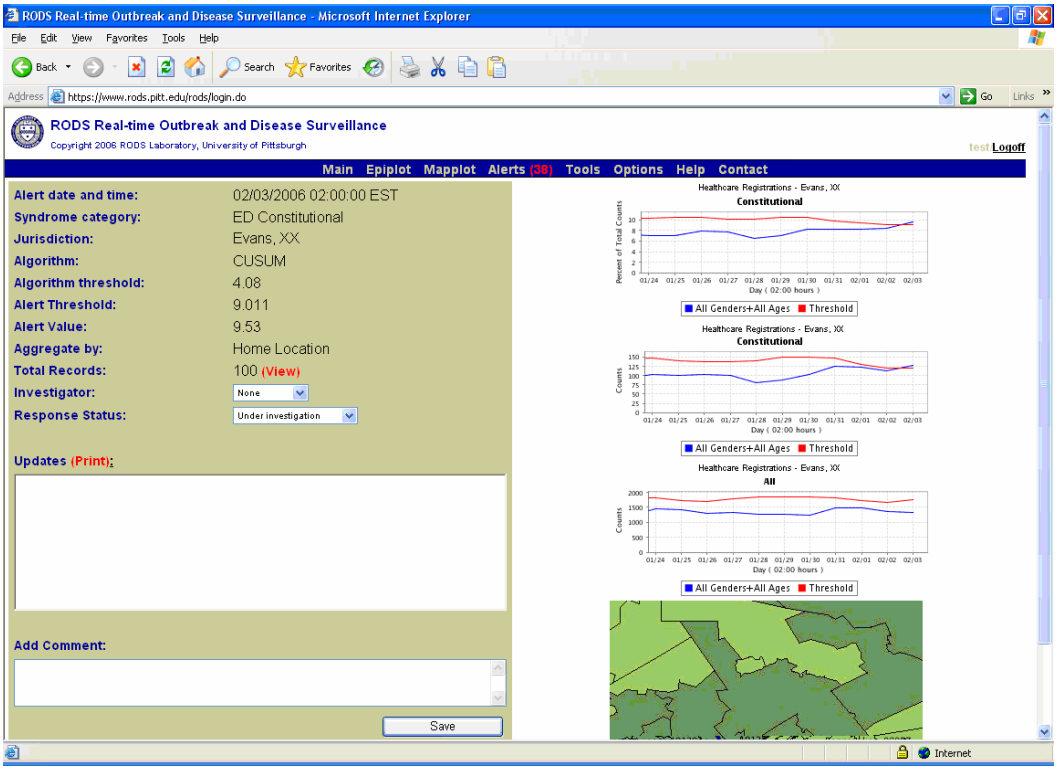

Figure 11: Alerts detail

Comments on a particular alert can be typed into the "Updates" box and the status can be updated through the "Response Status" drop down box. When making a comment, please select your username from the "Investigator" drop down box.

BARD Alerts

Alerts generated by BARD (Bayesian Aerosol Release Detector) are also available through the Alerts page (See Figure 12). BARD detects and characterizes outbreaks of inhalational anthrax due to atmospheric dispersion of *B. anthracis* spores in a timely, sensitive, and specific manner. BARD analyzes (1) counts of emergency department (ED) visits for respiratory complaints from the RODS System, (2) recent meteorological data, and (3) spatial and population information about the region being monitored to determine whether today's ED data are more consistent with usual levels of respiratory disease or with an outbreak of inhalational anthrax superimposed on usual levels of respiratory disease. If the latter, it estimates the geographic scope of the outbreak, the time and location at which spores were released, and the mass of spores released.

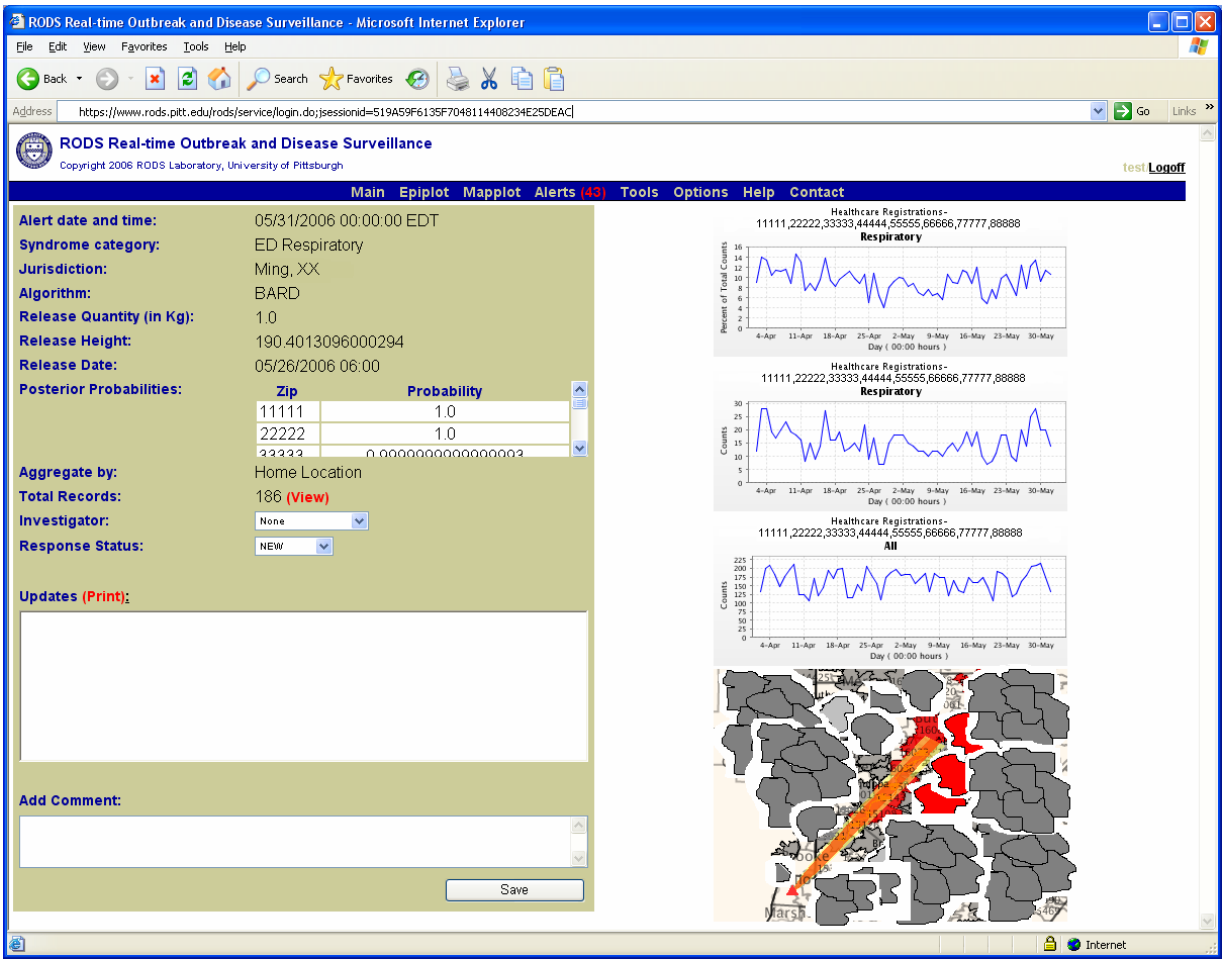

Figure 12: BARD Alert Detail

Tools

Various tools exist to further analyze hospital registration based on chief complaint and symptoms (See Figure 13):

- Chief Complaint Coder (CoCo): This tool provides end user access to the results of CoCo syndrome analysis for free text, queries, and data files
- Symptom Coder (SyCo): This tool classifies chief complaints by symptom. This beta version serves as a tool to examine the EpiPlot data of 17 symptoms
- HiFIDE: This is a web-based version of the HiFIDE tool. HiFIDE allows users to examine the sensitivity of various algorithms using RODS data and synthesized outbreak injections

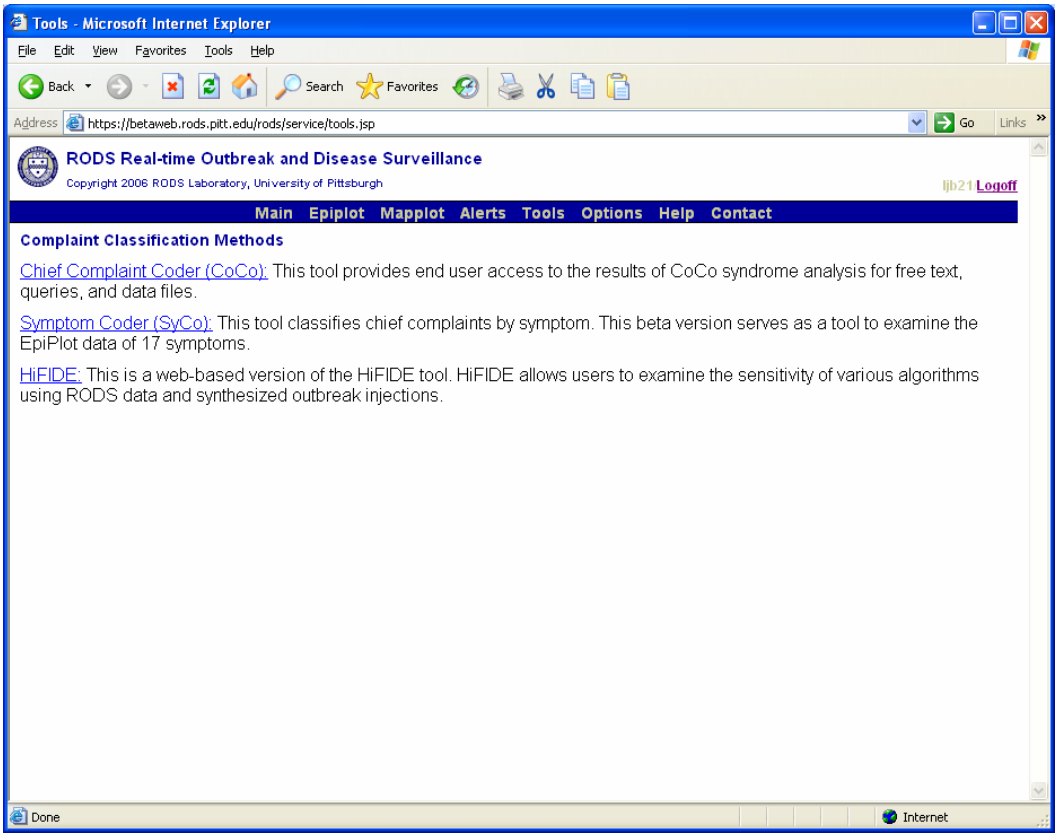

Figure 13: Tools page

Chief Complaint Coder (CoCo)

There are three ways to submit data to CoCo: (1) text complaint entry, (2) actual complaints query, and (3) complaints from a file

Text Complaint Entry

Use this option to determine which prodrome CoCo will select for a specific chief complaint. After entering a chief complaint as free text, the results then indicate which of the seven prodrome categories CoCo would use to classify the chief complaint entered. If the term does not fit into one of the prodrome categories, the results will indicate "other."

1. Enter a free text chief complaint (ie. "cough") in the text complaint entry field

2. Click the 'Analyze' button

3. Results will return above (See Figure 14).

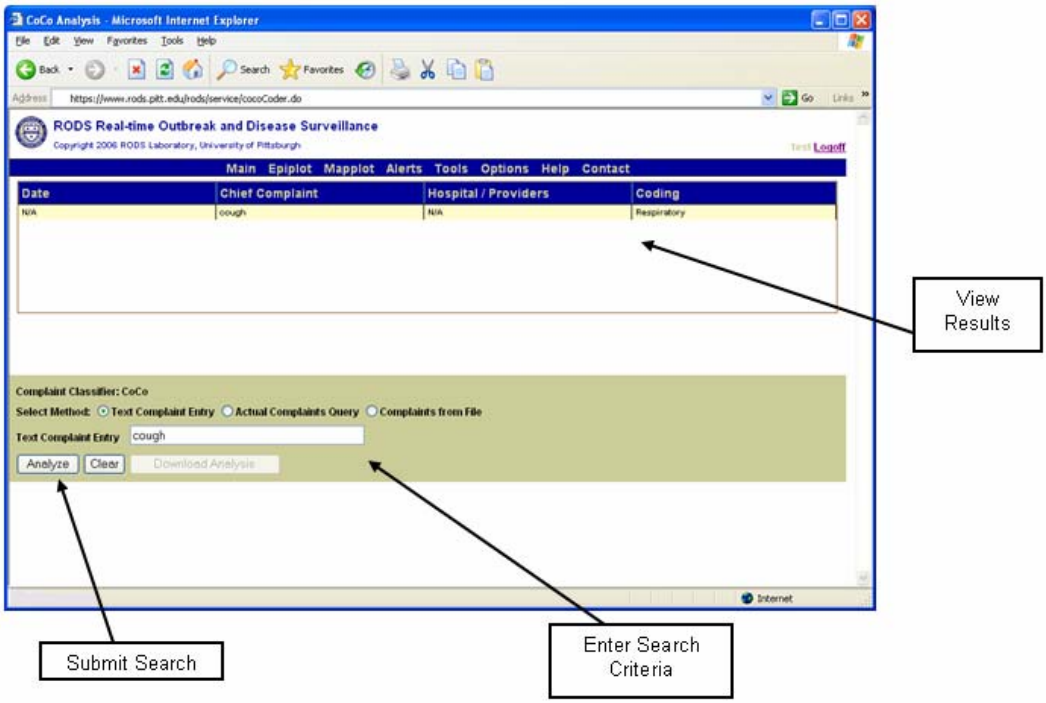

Figure 14: Text Complaint Entry

Actual Complaints Query

This method of searching returns all Emergency Department visits for a particular day within a specific jurisdiction based on chief complaint.

1. Select a date and jurisdiction.

2. Enter a chief complaint (PLEASE NOTE: If you wish to search by more than one chief complaint, enter a comma between each (ie. cough, headache, fever) – this will return all visits that contain the chief complaint cough, headache, OR fever).

3. Click the 'Analyze' button

4. Results will return above (See Figure 15).

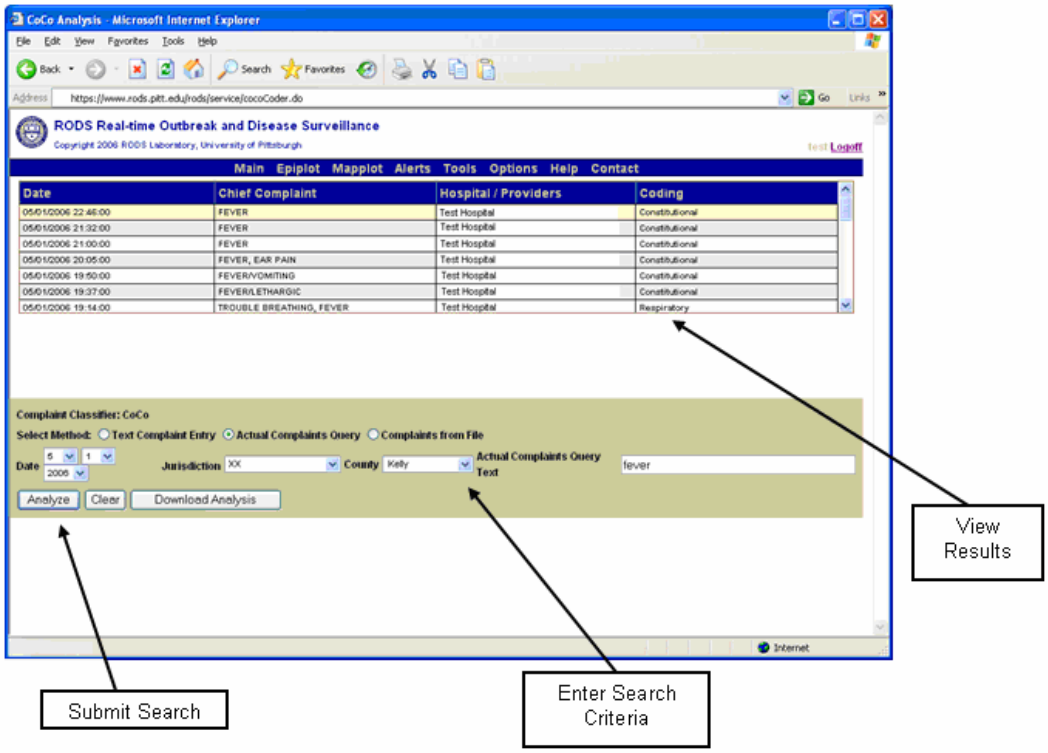

Figure 15: Actual Complains Query

Complaints from File

Use this feature to view downloaded healthcare registration files from Epiplot (these files must be saved in the .CSV format). After obtaining an EpiPlot file, upload the document through the 'Browse' box and click 'Analyze.' (PLEASE NOTE: The file will not load properly if it is open on your desktop. Close the Excel document you wish to upload before clicking 'Analyze'). A list of each visit will appear in the top portion of the screen (See Figure 16).

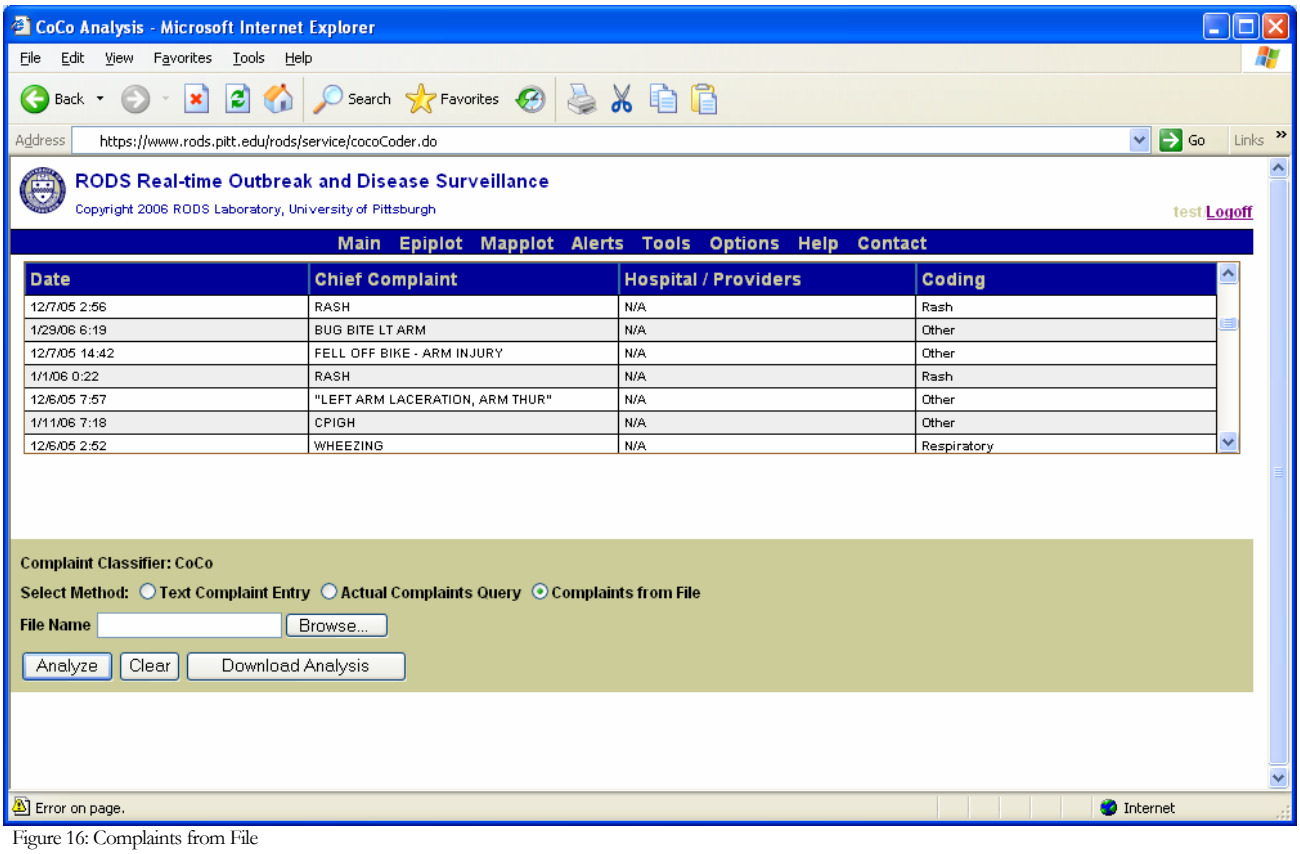

Figure 16: Complaints from File

Symptom Coder (SyCo)

The Symptom Coder enables the generation of EpiPlot graphs by both symptom and syndrome. (See Figure 17).

1. Select symptom(s) on the left area of the screen
2. Check the box above 'Syndromes' to activate the corresponding dropdown box; select a syndrome
3. Select a jurisdiction, time period, and analysis method (optional)
4. Click 'Plot It' to view the corresponding graph

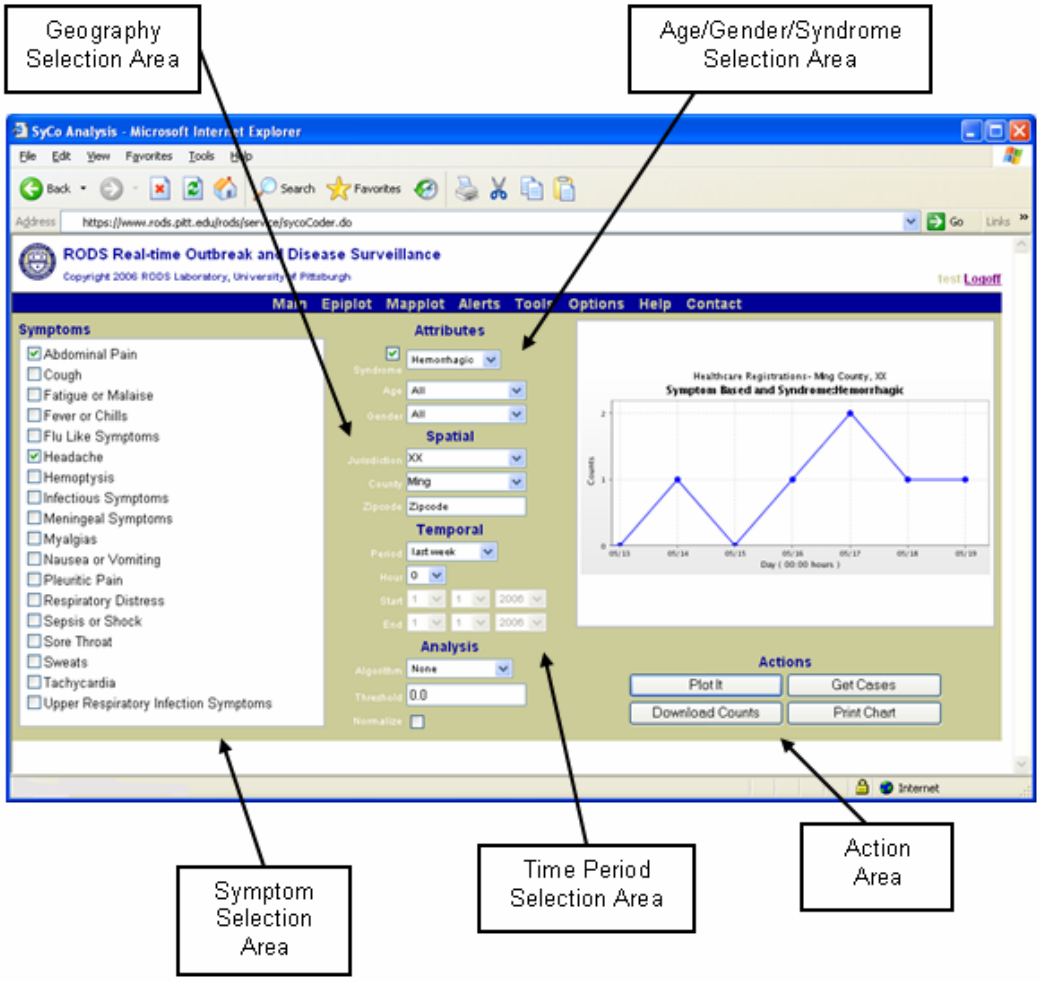

Figure 17: Symptom Coder

High-Fidelity Injection Detectability Experiments (HiFIDE)

HiFIDE injects synthetic outbreak data (spikes) into real surveillance data from a particular jurisdiction. However, rather than simply injecting spikes with arbitrary geometric shapes, HiFIDE takes the novel approach of injecting spikes whose shapes have been derived from real surveillance data collected during outbreaks that occurred in other regions. HiFIDE then rescales the spike in a manner that preserves the relationship between the size (numbers of cases) of the real outbreak and the strength of the signal it produced in the surveillance data. In contrast to existing methods that inject a geometric spike, the HiFIDE spike is both high-fidelity in contour and in scale enabling inferences about minimal detectable outbreak size (e.g., number of cases) rather than minimal detectable spike size (e.g., number of unit sales of over-the-counter medications).

HiFIDE is separate from the RODS application and will open in a secondary window. It can take several minutes to initialize as HiFIDE must load massive amounts of data.

Begin by specifying data type, jurisdiction, and analysis time. Click the 'Launch' button to open the HiFIDE window (See Figure 18).

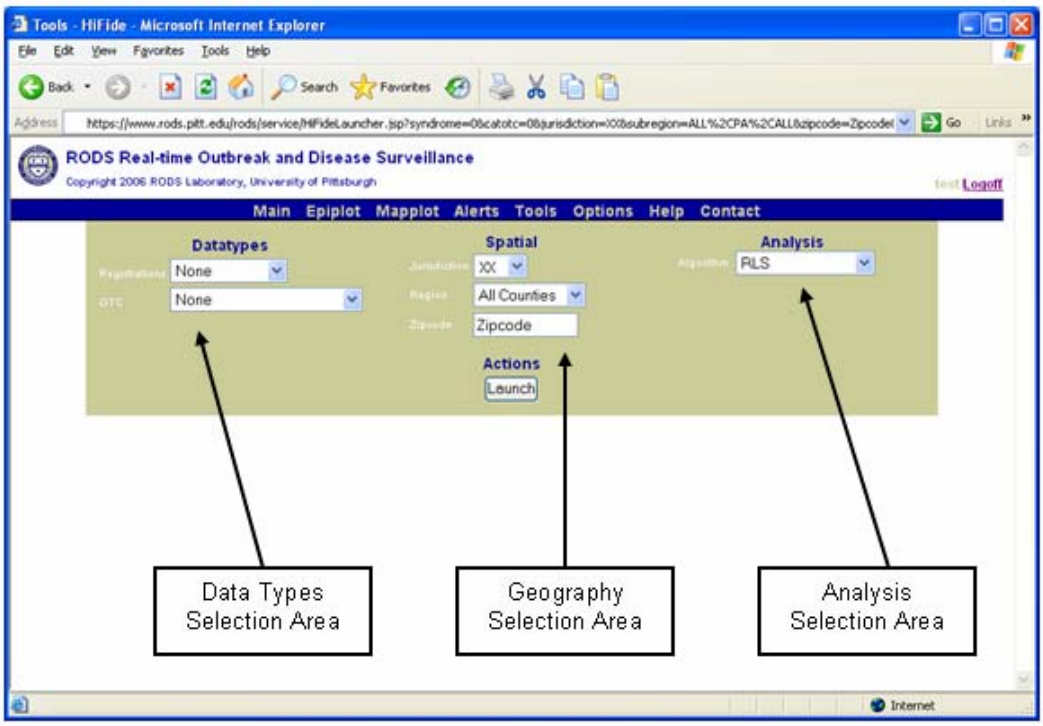

Figure 18: HiFIDE

Once the HiFIDE window is open, the type of injection can be selected by clicking 'Select Inject Type' and choosing from the dropdown menu. Inject size and duration can also be specified. Select algorithm type by clicking either of the 'Change' buttons under the 'Algorithm' heading. Click 'Create Inject' to refresh the graph on the right portion of the screen (See Figure 19).

Figure 19: HiFIDE Window

Use the 'Select Plot' button at the top of the graph to select the type of data displayed.

Options

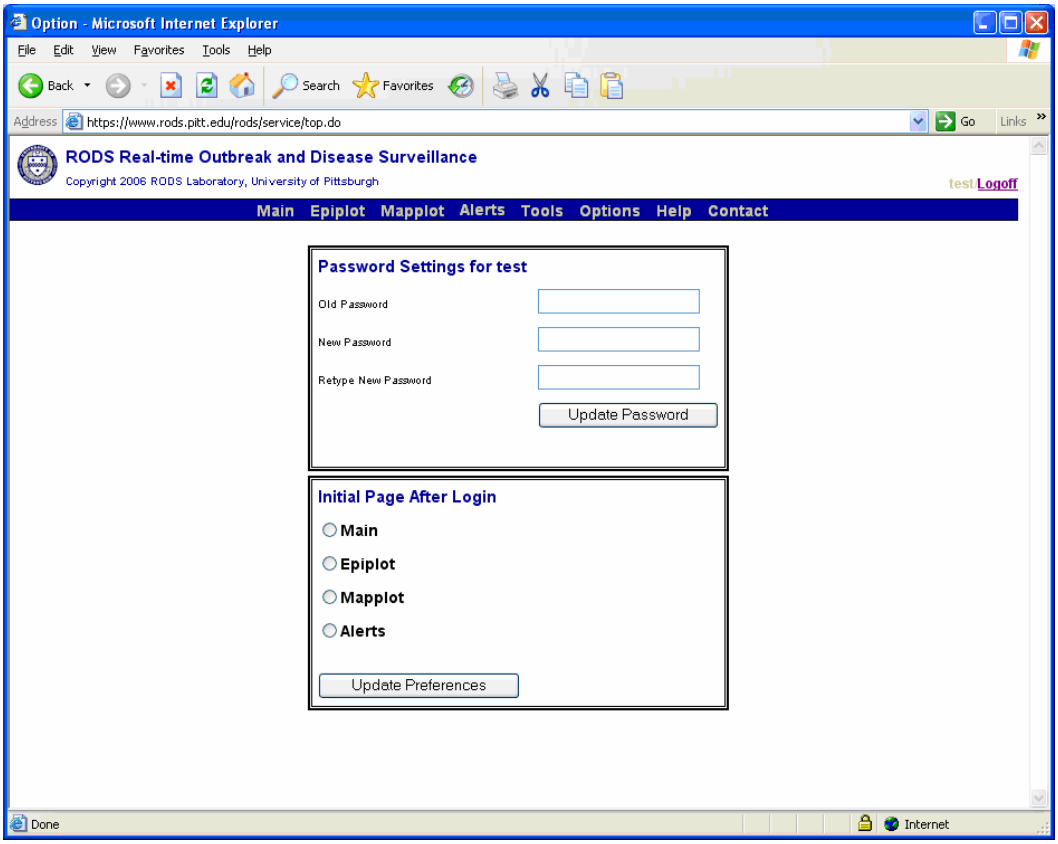

Figure 20: Options page

The options screen is used to change your password and adjust your preferences (See Figure 20).

[N.B. In the future this screen will also allow you to setup the parameters for automatic alerts.]

To change your password, enter your old and new passwords and click on Update Password.

In the "Initial Page After Login" area you can change the default initial page after you login. After changing any of these initial settings, click on "Update Preferences."

Help

The help button displays documentation pertaining to the function you are accessing. You can select help from the Main, Epiplot, Mapplot, and Alerts pages to receive information specifically about the features included on each page.

Contact

Pressing the contact button, directs your system to the RODS Laboratory Issue Tracker system (See Figure 21). Here you can create bug reports and feature requests. You will be automatically updated with the status of such requests.

To utilize the issue tracker **you will need to sign up for an account**. Follow the "sign up" link on the initial screen to create an account. Please use your existing RODS/NRDM account username and password. In the future, the account database of these systems will be unified and using the same username will facilitate this process.

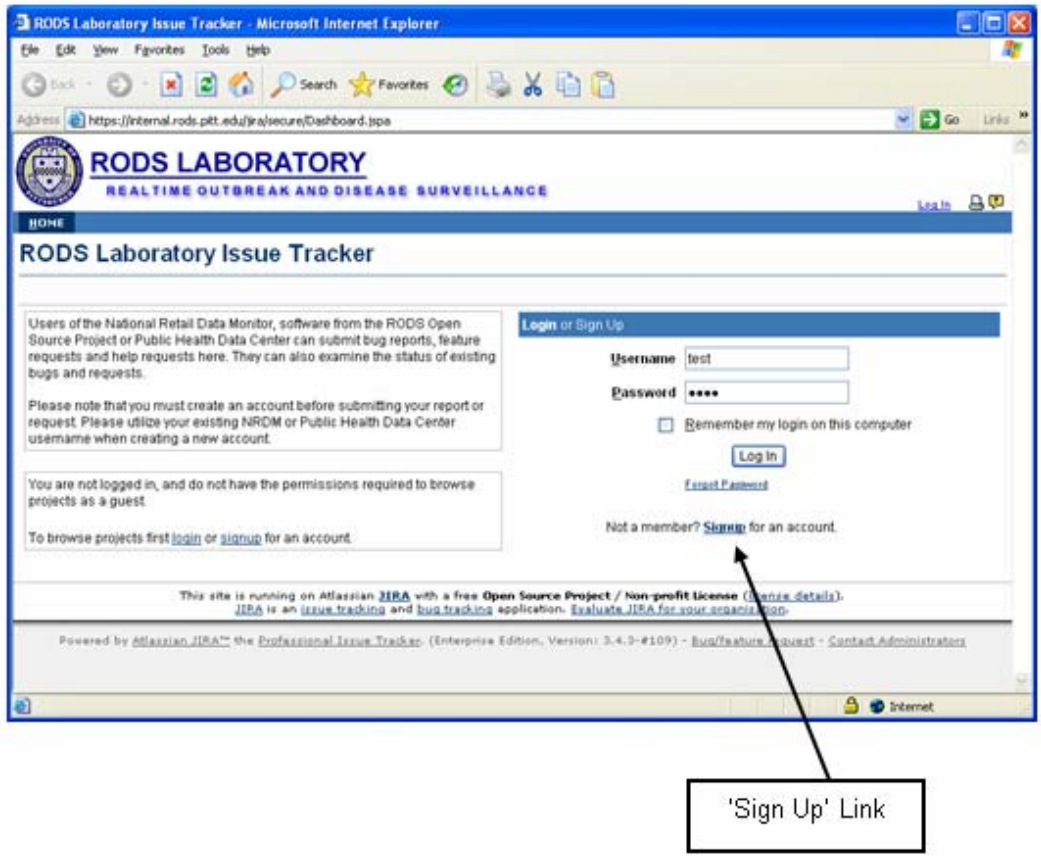

Figure 21: RODS Laboratory Issue Tracker Login Screen

Once you log into the Issue Tracker System, you can enter any bug reports or feature requests by selecting "Create New Issue." (See Figure 22).

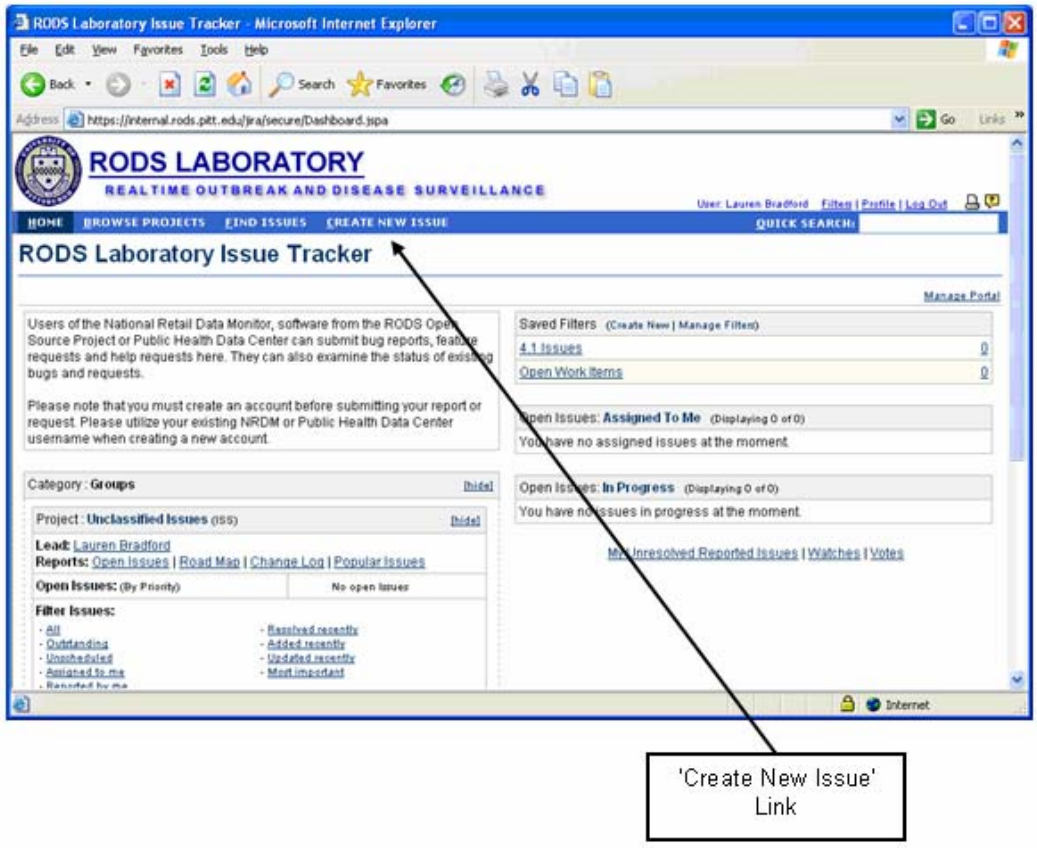

Figure 22: RODS Laboratory Issue Tracker "Create New Issue"

Logout

The logout button logs your account out of the system. In order to use the system again you have to re-login using the login page. After clicking the logout button, you will receive confirmation that the logout was successful. (See Figure 23). You will then be automatically re-routed to the login page

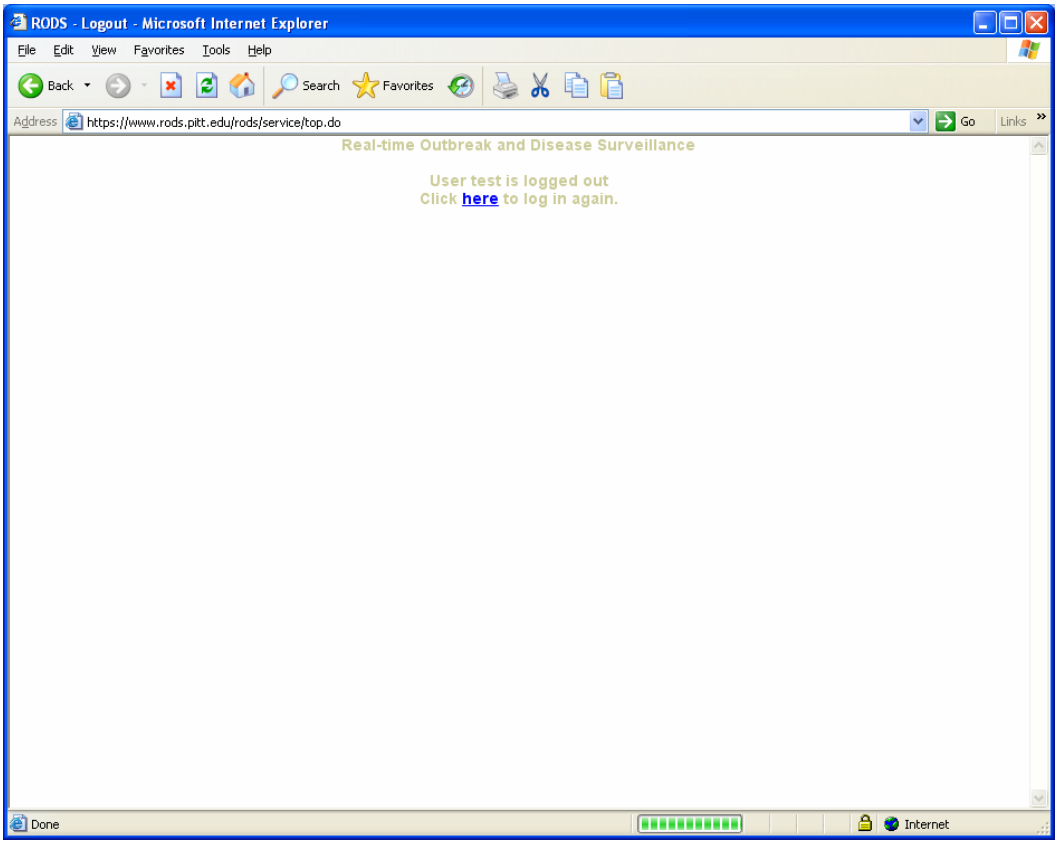

Figure 23: Logout screen

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