BIOSENSE

REAL-TIME HOSPITAL DATA
User Guide

APPLICATION VERSION 2.11

November 2007

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Background Information

The vision for BioSense is to build a national, real-time biosurveillance system that can be used for early event detection and health situational awareness by all levels of public health and the health care community.

Specifically, BioSense focuses on:
- **Data transmission**: assuring the secure, timely, routine receipt of health data for public health surveillance
- **Data analysis**: utilizing advanced analytic methods to detect events and to enable cities and states to use these methods to interpret results in as close to real time as possible
- **Data reporting**: on a near real-time basis, providing useful views of the data, including time-series analysis and geospatial displays, for colleagues in state and local health departments as well as for Centers for Disease Control and Prevention (CDC) program staff
- **Public Health Response**: providing local data to state and local public health officials and supporting their use and interpretation of the data for investigations, outbreak responses, and public health interventions

Data Types and Pre-processing

- **Foundational data types**: patient chief complaint, physician diagnosis, supporting patient demographic data, daily hospital census.
- **Additional data types**: emergency department (ED)-specific clinical data, microbiology test orders and results, radiology orders and results, medication orders.
- **Patient populations**: ED, hospital inpatient, ambulatory care outpatients.
- **Mapping of International Classification of Diseases, Clinical Modification (ICD-9-CM) coded data to 11 syndromes**: data in ICD-9-CM form are mapped to 11 syndromes based on a mapping schema created in 2003 by a multi-agency working group (Appendix 1).
- **Mapping of ICD-9-CM coded data to 78 sub-syndromes (Appendix 2)**: developed by BioSense medical expert staff, sub-syndromes allow surveillance of more granular events than is possible using the 11 syndromes mentioned above.
- **Parsing of free-text data to sub-syndromes**: accomplished by a text word search and continually improving the keyword search list by examining the original free text and its corresponding mapping results.
  - Most keywords in the chief complaint to sub-syndrome mapping table were derived from the Early Aberration Reporting System (EARS) Text String Search method. It contains both English and certain Spanish keywords and includes regular terms, misspellings, word fragments, and abbreviations. Keywords were modified during the initial implementation period.
  - The majority of the keywords in the free-text physician diagnosis to sub-syndrome mapping table were derived from terms that appeared in ICD-9-CM descriptions.
  - Where appropriate, sub-syndromes are mapped to syndromes (Appendix 3).

Data Analysis

Summary
- Two methods are used, W2count and W2rate.
- For W2count, the expected value for a weekday is the mean of the previous 7 weekday values, with a 2-day lag. The expected value for a weekend day is the mean of the previous 7 weekend values, with a 2-day lag. The standard deviation is calculated by usual methods.
- For W2rate, the days on which the expected values are based is the same but the expected value is calculated by accounting for total visits to the facility each day. Since there is no obvious formula to calculate the standard deviation for W2rate, an estimated standard deviation is used.
- For both W2count and W2rate, a minimum standard deviation of 1 is used.
- The W2c and W2r statistics are calculated as the number of standard deviation units that the observed value differs from the expected value.
- Empiric recurrence intervals are calculated based on frequency distributions of the W2c and W2r statistics.
- For Department of Veterans Affairs and Department of Defense data, 11 holidays are recognized, and these holidays are treated as if they are weekend days for purposes of these calculations. No holidays are used for BioSense Hospital data.

Notes
- This document summarizes the data analysis method currently implemented in version 2.11 of the BioSense Application.
- The method is undergoing continued evaluation and may be modified in future releases.
- Table 3 with empiric recurrence interval designations will be updated periodically.

W2count
- W2 is a modified version of the EARS C2 statistic in which the expected value (7-day moving average) is separated into weekdays and weekends/holidays.
- As with C2, the two days immediately preceding the index day (day for which an expected value is calculated) are skipped.
- If the index day is a weekday, ignore the preceding 2 days and calculate the mean of the previous 7 weekdays (Table 1).
- For a weekend day, ignore the preceding 2 days and calculate the mean of the previous 7 weekend days (Table 2).
- At least 4 days of data are required before an expected count is calculated.
- The residual is the observed count minus the expected count.
- The standard deviation is calculated by the usual formula.
- If the standard deviation is less than 1, then use 1 as the standard deviation.
- The W2c statistic equals the residual divided by the standard deviation.
- The recurrence interval corresponding to this value of W2c is looked up in Table 3.

W2 Rate
- The purpose of this method is to account for the total number of visits in addition to the syndrome count. This allows calculation of a more accurate expected value. Also, an expected value can be calculated when only partial data for a given day is available.
- For the index day (day for which we calculate an expected value), the syndrome count = n and the total visits for the day=d (including those binned and not binned to a syndrome).

- The previous 7 weekday or weekend days (with a 2-day lag) are used as for W2count. The 7 observed count values are totaled (=N) and the 7 total visits values are totaled (=D). (Tables 1-2)
- The average rate during the 7 day period = N/D.
- The expected count for the index day = d *(N/D).
- At least 4 days of data are required before an expected count is calculated.
- The residual is the observed count minus the expected count.
- Since there is not a simple formula for the standard deviation, the standard deviation is estimated as the mean absolute residual for the days upon which W2rate is based.
- If the standard deviation is less than 1, then use 1 as the standard deviation.
- At least 4 days of expected values are required before an estimated standard deviation is calculated.

Empiric Recurrence Intervals

- Standard parametric methods (e.g., the normal distribution) do not fit this type of data well, especially for extreme results (i.e., high residuals and low p-values). Statistically significant results occur far more commonly than would be expected based on the normal distribution.
- The recurrence interval is the reciprocal of the p-value, e.g., if p=0.01 is equivalent to a recurrence interval of 100 days.
- The empiric recurrence intervals are created as follows:
    - A large number of observations are used to calculate W2c values and a frequency distribution of W2c is made.
    - The recurrence interval for any W2c value is determined from the frequency distribution, e.g., the top 1% of W2c values is the cutoff value for a recurrence interval of 100 days (Table 3).
    - A separate distribution and recurrence interval values are made for W2r (Table 3).
- Notice (in Table 3) that a W2c value of 3.5 is approximately equivalent to a recurrence interval of 100; this means that in historical data we found that the observed count was 3.5 standard deviations above the expected value on average every 100 days.
- The frequency distributions used to calculate the recurrence intervals will be updated periodically.

Table 1: Sample W2Count and W2Rate Calculations (Weekday)

Note: Today is a Wednesday 12/15 and the current syndrome count is 94.

Date	Day of Week	Visits	Count	Include	Expected Value W2Count	Expected Value W2Rate	Residual W2Rate
12/02	**Thursday**	**329**	**71**	**Yes**	**82.7**	**81.2**	**10.2**
12/03	**Friday**	**327**	**54**	**Yes**	**85.7**	**79.5**	**25.5**
12/04	Saturday	275	75	No (weekend)	70.8	64.5	10.5
12/05	Sunday	313	71	No (weekend)	70.8	73.4	2.4
12/06	**Monday**	**381**	**86**	**Yes**	**74.9**	**84.4**	**1.6**
12/07	**Tuesday**	**332**	**73**	**Yes**	**74.9**	**73.6**	**0.6**
12/08	**Wednesday**	**325**	**74**	**Yes**	**74.9**	**72**	**2.0**
12/09	**Thursday**	**304**	**72**	**Yes**	**75.9**	**66.5**	**5.5**
12/10	**Friday**	**315**	**64**	**Yes**	**74.6**	**67.3**	**3.3**
12/11	Saturday	310	64	No (weekend)	71.5	74.1	10.1
12/12	Sunday	240	64	No (weekend)	71.5	57.4	6.6
12/13	Monday	252	61	No (lag day)	70.6	53.8	7.2
12/14	Tuesday	435	117	No (lag day)	70.6	92.9	24.1
12/15	**Wednesday**	**394**	**94**		**70.6**	**84.1**	**9.9**

W2Count
- Expected value= mean of (71,54,86,73,74,72,64) = 70.6
- Standard deviation = std dev of (71,54,86,73,74,72,64) = 9.8
- Residual = 94-70.6 = 23.4
- W2c = residual/standard deviation = 23.4/9.8 = 2.4
- Look up recurrence interval for 2.4 in Table 3=30 days

W2Rate
- N = sum of (71,54,86,73,74,72,64) = 494
- D = sum of (329,327,381,332,325,304,315) = 2313
- Expected value = (N/D)*visits = (494/2313)*394 = 84.1
- Estimated standard deviation = mean of (10.2, 25.5, 1.6, 0.6, 2.0, 5.5, 3.3)=6.9
- Residual = observed-expected = 94-84.1 = 9.9
- W2r = residual/est standard deviation = 9.9/6.9 = 1.4
- Look up recurrence interval for 1.4 in Table 3=10 days

Table 2: Sample W2Count and W2Rate Calculations (Weekend)

Note: Today is a Sunday 5/20 and the current syndrome count is 81.

Date	Day of Week	Visits	Count	Include	Expected Value W2Count	Expected Value W2Rate	Residual W2Rate
4/22	**Sunday**	**295**	**69**	**Yes**	**60.1**	**61.2**	**7.8**
4/23	Monday	368	62	No (weekday)	68.6	71.9	9.9
4/24	Tuesday	356	63	No (weekday)	68.6	69.5	6.5
4/25	Wednesday	360	101	No (weekday)	68.6	70.3	30.7
4/26	Thursday	386	72	No (weekday)	66.9	72.4	0.4
4/27	Friday	338	56	No (weekday)	69	65.4	9.4
4/28	**Saturday**	**297**	**67**	**Yes**	**59.3**	**61.3**	**5.7**
4/29	**Sunday**	**329**	**60**	**Yes**	**59.3**	**67.9**	**7.9**
4/30	Monday	403	77	No (weekday)	69.9	78.7	1.7
5/1	Tuesday	331	59	No (weekday)	69.9	64.7	5.7
5/2	Wednesday	344	72	No (weekday)	69.9	67.2	4.8
5/3	Thursday	331	74	No (weekday)	71.4	64.2	9.8
5/4	Friday	342	65	No (weekday)	70	65.9	0.9
5/5	**Saturday**	**247**	**46**	**Yes**	**64.3**	**52.7**	**6.7**
5/6	**Sunday**	**313**	**60**	**Yes**	**64.3**	**66.7**	**6.7**
5/7	Monday	398	88	No (weekday)	67.9	76.4	11.6
5/8	Tuesday	343	73	No (weekday)	67.9	65.8	7.2
5/9	Wednesday	302	73	No (weekday)	67.9	58	15
5/10	Thursday	319	67	No (weekday)	70.1	63	4
5/11	Friday	370	70	No (weekday)	72.6	75.4	5.4
5/12	**Saturday**	**311**	**51**	**Yes**	**60.1**	**62.6**	**11.6**
5/13	**Sunday**	**281**	**63**	**Yes**	**60.1**	**56.6**	**6.4**
5/14	Monday	433	92	No (weekday)	72.9	91.8	0.2
5/15	Tuesday	357	69	No (weekday)	72.9	75.7	6.7
5/16	Wednesday	382	76	No (weekday)	72.9	81	5
5/17	Thursday	355	77	No (weekday)	75.4	74.8	2.2
5/18	Friday	374	80	No (weekday)	76	78.9	1.1
5/19	Saturday	326	52	No (lag day)	59.4	65.4	13.4
5/20	**Sunday**	**335**	**81**		**59.4**	**67.2**	**13.8**

Table 2 (continued)

W2Count
- Expected value= mean of (69,67,60,46,60,51,63) = 59.4
- Standard deviation = std dev of (69,67,60,46,60,51,63) = 8.3
- Residual = 81-59.4 = 21.6
- W2c = residual/standard deviation = 21.6/8.3 = 2.6
- Look up recurrence interval for 2.6 in Table 3=40 days

W2Rate
- N = sum of (69,67,60,46,60,51,63) = 416
- D = sum of (295,297,329,247,313,311,281) = 2073
- Expected value = (N/D)*visits = (416/2073)*335 = 67.2
- Estimated standard deviation = mean of (7.8,5.7,7.9,6.7,6.7,11.6,6.4)=7.5
- Residual = observed-expected = 81-67.2 = 13.8
- W2r = residual/est standard deviation = 13.8/7.5 = 1.8
- Look up recurrence interval for 1.8 in Table 3=10 days

Table 3. Empiric Recurrence Intervals, by Values of W2c and W2r (updated June 13, 2007)

W2c	W2r
low-1.309=0	low-1.336=0
1.309-1.942=10	1.336-1.954=10
1.942-2.302=20	1.954-2.332=20
2.302-2.577=30	2.332-2.594=30
2.577-2.801=40	2.594-2.799=40
2.801-2.984=50	2.799-2.975=50
2.984-3.143=60	2.975-3.116=60
3.143-3.286=70	3.116-3.255=70
3.286-3.429=80	3.255-3.371=80
3.429-3.513=90	3.371-3.477=90
3.513-4.309=100	3.477-4.198=100
4.309-4.857=200	4.198-4.674=200
4.857-5.31=300	4.674-5.017=300
5.31-5.716=400	5.017-5.312=400
5.716-6.053=500	5.312-5.572=500
6.053-6.429=600	5.572-5.814=600
6.429-6.714=700	5.814-6=700
6.714-7=800	6-6.178=800
7-7.429=900	6.178-6.358=900
7.429-7.714=1000	6.358-6.533=1000
7.714-8=1100	6.533-6.701=1100
8-8.308=1200	6.701-6.862=1200
8.308-8.571=1300	6.862-7=1300
8.571-8.857=1400	7-7.108=1400
8.857-9.167=1500	7.108-7.257=1500
9.167-9.488=1600	7.257-7.413=1600
9.488-9.714=1700	7.413-7.545=1700
9.714-10=1800	7.545-7.69=1800
10-10.275=1900	7.69-7.833=1900
10.275-high=2000	7.833-high=2000

Access

- BioSense is intended for local, state, and federal public health officials' and hospital partners' use. Users could include epidemiologists, bioterrorism response coordinators, and hospital infection control personnel.
- Each public health jurisdiction or facility has a BioSense Administrator to authorize access to BioSense for appropriate staff within their jurisdiction or hospital.
- Users access BioSense through the CDC Secure Data Network, which requires a digital certificate. A user profile is established authorizing access to data pertaining to that jurisdiction.
- Data from a given facility is viewable by personnel at the facility. State or metropolitan reporting area (MRA) officials may view data for all facilities in their jurisdiction.

BioSense Application: Hospital Data Modules

Chief Complaint/Diagnosis

- *Purpose*: Quick overview of syndrome activity by day for chief complaint and diagnosis data stratified by patient class, indicating statistically significant syndrome counts.
- *Display*: Table of syndrome counts for the reason for visit, chief complaint, reason for admit, working diagnosis, and final diagnosis data (stratified by patient class) for a single day.
- *Options*: Select Options (analysis method, recurrence interval threshold, and time period); Select Data (jurisdiction and/or hospital).
- *Navigation*: To move to the time series grouped by data type and stratified by patient class for that syndrome, click a count in the table.

Statistical Anomalies

- *Purpose*: Identifies anomalies found by automated statistical testing.
- *Display*: Line list of statistical anomalies for syndrome count and rate; analyses are performed for individual facilities as well as all facilities in a MRA or state. To sort, click a column heading. (Note: You can sort up to three columns.)
- *Options*: Select Options (analysis method, recurrence interval threshold, and time period; Select Data (jurisdiction and/or hospital).
- *Navigation*: To move to the time series grouped by data type and stratified by patient class for that syndrome, click an anomaly in the line list.

Time Series

- *Purpose*: Displays trends and statistical anomalies over time for a disease indicator.
- *Display*: Graph of number of counts and/or rate per 1,000 visits by day. Statistical anomalies are indicated by stars on the graph lines. Each Monday is indicated by a vertical line, and each holiday is shaded blue. The default time series is grouped by data type and stratified by patient class (although other options are available within Select Data). To select a particular data type and patient class, either click on the graph line of interest or make changes to the Select Data options. Beneath the graph is a table for each day; it includes date, day of the week, count, rate, total records, and links to the Patient Map and Patient List.
- *Options*: Select Options (analysis method, recurrence interval threshold, graph lines (counts, rates, total visits and their corresponding expected values, and graph line color), and time period; Select Data (jurisdiction and/or hospital, data source, data type, event type, event, race, age, gender, group by, and stratify by).
- *Navigation*: To move to the Patient List, which displays a line list of patient visits comprising the point on the graph, click the desired graph point. To move to the Patient Map or Patient List for the selected day, click the corresponding links to the map and patient list in the table beneath the graph.

Patient List

- *Purpose*: Examines epidemiologic patterns for clinical and demographic data for a group of patient visits.
- *Display*: Line list of patients' information including location, demographic, and clinical data. To sort, click a column heading. (Note: You can sort up to three columns.) To save the Patient List to Excel, click on the disk icon above the table on the right side. To navigate between pages of the Patient List, click to move forward or backward using the options available above the table on the right side.
- *Options*: None.
- *Navigation*: To move to Patient Detail, click the desired row within the Patient List.

Patient Detail

- *Purpose*: Provides all detailed data for an individual patient.
- *Display*: Detailed information organized by facility, patient, visit, and clinical data type (chief complaints, diagnoses, procedures, ED clinical, radiology, and pharmacy.).
- *Options*: None.
- *Navigation*: None.

Patient Map

- *Purpose*: Displays disease indicator geographic distribution by zip code of patient residence.
- *Display*: Map indicating numbers of patients by zip code.
- *Options*: Select Options (Map Layers (Highways, State Borders, County Borders, Zip Borders, and their corresponding labels) and number of levels to which patient visit counts will be categorized).
- *Navigation*: To view geographic distributions for previous days, use the date navigation tool. To zoom in and out, use the zoom tool.

Describe

- *Purpose*: Provides basic descriptive statistics for a group of patient visits.
- *Display*: Patient distributions (counts and percents) by Hospital Facility, Age Group, Gender, Race, Hour of Day, Patient County, Hospital Patient Class by Data Type, Sub-syndrome, and Syndrome in a series of thumbnail graphs.
- *Options*: Select Options (time period, graph bar color); Select Data (jurisdiction and/or hospital, data source, data type, event type, event, race, age, and gender).
- *Navigation*: None.

Hospital Census

- *Purpose*: Provides daily inpatient hospital census data.
- *Display*: Hospital-level census data includes occupancy rate, admission count, discharge count, and death count. Unit-level census data includes occupied beds and available beds.
- *Options*: Select Options (analysis method, recurrence interval threshold, and time period); Select Data (jurisdiction and/or hospital).
- *Navigation*: None.

Glossary

- **Analysis Visit ID**: Created by BioSense to provide a consistent definition of a visit regardless of how a visit is defined by a given hospital. Combines patient visits, if they occur within 24 hours of each other. Does not contain personally identifiable information.
- **Anomaly Location**: Location of an anomaly identified by statistical algorithms. Example: Single facility, State/MRA (combining data for all facilities within a state or MRA).
- **Anomaly**: See "Statistical Anomaly."
- **Artifact**: An anomaly that can be explained by factors other than true disease, e.g., miscoding of data at the source, receipt of duplicated data, or a new influx of data.
- **BioIntelligence Center**: BioSense personnel who monitor the BioSense application, track data anomalies, support state and local BioSense users, and assist with troubleshooting and improvements.
- **BioSense Patient ID**: Uniquely distinguishes a patient across all visits to a single facility or across all visits to a healthcare system when a common patient identification system is used. Can be used by the healthcare facility to associate BioSense patient data to the patient's medical record. The Patient ID, displayed in BioSense, includes a string of numbers separated by a carat (^). The Patient ID portion of this identifier is on the left side of the carat, and an identifier for the integrator at the facility or hospital system sending data to CDC is on the right side of the carat. Does not contain personally identifiable information. Example: 12345^1234.
- **BioSense Visit ID**: Used to uniquely distinguish a patient visit based on the healthcare facility account identifier. Created to reflect the visit as defined by the healthcare facility. Does not contain personally identifiable information.
- **Disease Indicators**: Variables evaluated for a statistical increase in temporal trend (e.g., 11 syndromes or 78 sub-syndromes).
- **Early Event Detection**: Recognition of an outbreak or other public health emergency at as early a stage as possible. Emphasis is placed on detecting the very first upswing of the epidemic curve.
- **Electronic Biosurveillance**: The use of information in computer databases to perform public health surveillance.
- **Expected Value**: The number of disease indicator events expected during a given time period, usually an extrapolation of the number of such events that have occurred in the past. Example: The W2 statistic uses the mean count of the previous 7 weekday or weekend/holiday days (with a 2-day lag) as the Expected Value.
- **Geo Area**: Geographic area basis upon which jurisdictional public health access to BioSense is granted. Example: state, region, or MRA.
- **Observed Value**: Actual number of disease indicator events during a time period. Examples: number of patient visits meeting the respiratory syndrome; number of positive blood cultures.
- **Observed/Expected (Relative Risk)**: Ratio of the Observed Value divided by the Expected Value. A measure of the magnitude of disease activity. If the Expected Value equals zero, the BioSense application indicates this ratio is undefined. An alternative method adds one (1) to both the Observed and the Expected to complete the calculation.
- **Outbreak**: An epidemic, i.e., the occurrence, in a community or region, of cases of an illness, specific health-related behavior, or other health-related events clearly in excess of normal expectancy.
- **Patient Class**: The setting for a patient visit. Examples: Emergency Department, Ambulatory Care, Inpatient.
- **PHIN**: Public Health Information Network. At the core of PHIN and BioSense are commonly accepted health data standards including Health Level Seven (HL7), Systematised Nomenclature of Medicine (SNOMED), and Logical Observations Identifiers, Names, Codes (LOINC). For more detail, refer to the PHIN standards website: (http://www.cdc.gov/phin).
- **Rate (per thousand visits)**: Number of events divided by total number of patient visits multiplied by 1,000.

- **Recurrence Interval**: Expected time (days, years) of surveillance needed for one such event of at least the observed magnitude to occur. This is a user-defined setting to increase or decrease the sensitivity of statistical algorithms. For example, if the recurrence interval is 100, an event of at least this magnitude would be expected every 100 days.
- **Residual**: Observed – Expected; measures the difference between the Expected count (calculated, for example, by the W2 method) and the Observed count. A high residual may indicate a data anomaly.
- **Situational Awareness**: Literally, the ability to know what's going on; accomplished by monitoring the extent of disease or disease indicators over time and geographically, especially in an emergency context. Emphasis is placed on monitoring after the initial upswing of the epidemic curve.
- **Statistical Anomaly**: Something different, abnormal, or unusual in data found by statistical analysis. Statistical significance does not necessarily imply epidemiologic or clinical significance.
- **Sub-syndrome**: Set of 78 disease indicators, developed for use in BioSense, to allow for surveillance at a more granular level than would tracking the 11 syndromes (Appendices 2-3). Examples: abdominal pain, allergy.
- **Syndromes**: Set of 11 disease indicators developed by a multi-agency working group to represent prodromes of certain potentially bioterrorism-related diseases (Appendix 1).
- **Syndromic Surveillance**: Performing surveillance for syndromes (as opposed to confirmed or suspect cases of disease); commonly performed to facilitate early outbreak detection and situational awareness.

Appendix 1: Syndromes

Data in the BioSense application are organized into the following 11 syndromes.

- Botulism-like
- Fever
- Gastrointestinal
- Hemorrhagic Illness
- Localized Cutaneous Lesion
- Lymphadenitis
- Neurological
- Rash
- Respiratory
- Severe Illness/Death
- Specific Infection

Definitions of these syndrome categories and lists of ICD-9-CM codes included in each syndrome can be found at: http://www.bt.cdc.gov/surveillance/syndromedef/index.asp. ICD-9 codes are divided into three categories based on overall association with a syndrome or a specific disease and by observed frequency of code usage in three clinical data sources (representing discharge diagnoses for outpatient visits and emergency department visits). The following categories within syndrome groups were defined:

- **Category 1** – Codes that reflect general symptoms of the syndrome group including codes for bioterrorism diseases of highest concern or diseases highly approximating them.
- **Category 2** – Codes that might normally be placed in the syndrome group but for which daily volume could overwhelm or otherwise detract from the signal generated from the Category 1 code set.
- **Category 3** – Codes that reflect specific diagnoses that fit into the syndrome category but that occur infrequently or have very few counts. These codes may be excluded to simplify syndrome category code sets.

*Specific Infection contains all Category 3 codes, while Category 1 and Category 2 codes are placed into their respective syndrome groups.

Appendix 2: ICD-9-CM Codes Grouped to Sub-syndromes

ICD-9-CM Codes	Sub-syndrome
789.0, 789.6	Abdominal pain
995.3	Allergy
780.0	Alteration of consciousness
280-285	Anemia
783.0	Anorexia
493	Asthma
E906	Bites, animal
466, 490	Bronchitis and bronchiolitis
940-949	Burns
986	Carbon monoxide poisoning
426-427, 785.0	Cardiac dysrhythmias
430-438	Cerebrovascular disease
786.5	Chest pain
320-326	CNS, inflammatory disease
286	Coagulation defects
780.01	Coma
780.3	Convulsions
491-492	COPD (Chronic Obstructive Pulmonary Disease)
786.2	Cough
782.5, 799.0	Cyanosis and hypoxemia
798	Death
276.5	Dehydration
250	Diabetes mellitus
787.91	Diarrhea
780.4	Dizziness
787.2	Dysphagia
786.0	Dyspnea
782.3	Edema
E880-E888	Falls
780.6	Fever
003.0, 003.9, 005	Food poisoning
800-839	Fractures and dislocation
781.2, 781.3	Gait abnormality
578	Gastrointestinal hemorrhage
784.0	Headache
410-414	Heart disease, ischemic
E900	Heat, excessive
786.3	Hemoptysis
459.0	Hemorrhage
401, 405	Hypertension
458	Hypotension
487	Influenza-like illness
959	Injury, nos (not otherwise specified)

ICD-9-CM Codes	Sub-syndrome
910.4, 910.5, 911.4, 911.5, 912.4, 912.5, 913.4, 913.5, 914.4, 914.5, 915.4, 915.5, 916.4, 916.5, 917.4, 917.5, 919.4, 919.5	Insect bites
009	Intestinal infections, ill-defined
782.4	Jaundice
683, 785.6	Lymphadenopathy
780.7	Malaise and fatigue
781.6	Meningismus
290-319	Mental disorders
346	Migraine
E810-E819	Motor vehicle traffic accidents
729.1	Myalgia
787.0	Nausea and vomiting
140-239	Neoplasms
782.0	Numbness
870-879	Open wound
381-382	Otitis media
342, 344	Paralysis
368.13	Photophobia
511	Pleurisy
480-486, 513	Pneumonia and lung abscess
960-979	Poisoning by medicines
630-677	Pregnancy, childbirth, puerperium complications
287, 782.7	Purpura and petechia
782.1	Rash
518.8, 799.1	Respiratory failure
079.6, 466.11, 480.1	RSV (respiratory syncytial virus)
038, 790.7	Septicemia and bacteremia
785.5	Shock
680, 681, 682, 684, 686	Skin infection
438.1, 784.5	Speech disturbance
840-848	Sprains and strains
780.2	Syncope and collapse
460-465	Upper respiratory infections
590, 595, 599.0	Urinary tract infection
079.99	Viral infection, unspecified
369	Visual impairment

Appendix 3: Sub-syndrome Mapping

Sub-syndromes That Map to Syndromes

- **Botulism-like**: Paralysis; Speech disturbance; Dysphagia
- **Fever**: Fever; Septicemia and bacteremia; Viral infection, unspecified
- **Gastrointestinal**: Abdominal pain; Anorexia; Diarrhea; Food poisoning; Intestinal infections, ill-defined; Nausea and vomiting
- **Hemorrhagic Illness**: Coagulation defects; Gastrointestinal hemorrhage; Hemorrhage; Purpura and petechia
- **Localized Cutaneous lesion**: Insect bites; Skin infection
- **Lymphadenitis**: Lymphadenopathy
- **Neurological**: Alteration of consciousness; Central nervous system (CNS) inflammatory disease; Convulsions; Gait abnormality; Headache; Meningismus; Photophobia
- **Respiratory**: Asthma; Bronchitis and bronchiolitis; Chest pain; Cough; Cyanosis and hypoxemia; Dyspnea; Influenza-like illness; Otitis media; Pleurisy; Pneumonia and lung abscess; Respiratory failure; RSV; Upper respiratory infections; Hemoptysis
- **Rash**: Rash
- **Severe Illness and Death**: Coma; Death; Shock

Sub-syndromes That Do Not Map to Syndromes

- **Injury**: Bites, animal; Burns; Carbon monoxide poisoning; Falls; Fractures and dislocation; Heat, excessive; Injury, not otherwise specified (nos); Motor vehicle traffic accidents; Open wound; Poisoning by medicines; Sprains and strains
- **Chronic Disease**: Cardiac dysrhythmias; Cerebrovascular disease; Chronic obstructive pulmonary disease (COPD); Diabetes mellitus; Heart disease, ischemic; Hypertension; Neoplasms
- **Other**: Allergy; Anemia; Dehydration; Dizziness; Edema; Hypotension; Jaundice; Malaise and fatigue; Mental disorders; Migraine; Myalgia; Numbness; Pregnancy, childbirth, puerperium complications; Syncope and collapse; Urinary tract infection; Visual impairment