

# **Syndromic Surveillance Using Chief Complaints from Urgent Care Facilities during the Salt Lake 2002 Olympic and Paralympic Winter Games**

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## **Introduction**

During a twelve-week period surrounding the Salt Lake 2002 Olympic and Paralympic Winter Games, Utah's health departments implemented several approaches to syndromic surveillance including a novel urgent care-based system that utilized free-text chief complaints to complement the concurrent hospital emergency department surveillance. This system tracked acute care encounters at 19 urgent care facilities (an urgent care is a clinic that accepts patients without appointments) located in a four-county region in Utah known as the Wasatch Front. It was designed to minimize on-site intrusion and facility staffing concerns, and utilized existing data sources with no additional (particularly paper) forms to fill out. Its directive was to protect confidential patient medical information appropriately but facilitate identifying individual patient

encounters as required by statutory health department authority, while providing timely analysis and reporting for identifying trends and sentinel events, and enabling correlation with subsequent billing data for validation and future system development.

## **Methods**

Data came from electronic registrations initiated by intake clerks who entered patients' chief complaints as free text. Key character strings were used to classify visits as syndromic. The monitored syndromes were analogous to those being tracked by the International Olympic Committee at the Games venues and Olympic medical facilities and were developed to detect bioterrorism and selected naturally occurring outbreaks (Table 1). Syndromic data were reported as both rates (using total visits as the denominator) and absolute volumes.

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Syndromes were tracked using incidence control charts (Figure 1). It was assumed (and later confirmed) that there were no substantial capacity constraints at the urgent care facilities and that syndromic encounters which may be associated with the Games would be incremental additional volume rather than displace other types of patient visits. Should such a capacity constraint exist, then syndromic rates may be artificially suppressed by the capacity ceiling. For this evaluation of the system, we used ICD-9 diagnosis data, which became available subsequently as part of the billing record. A panel of five expert reviewers were asked to identify ICD-9 codes for diseases or conditions that would present similarly to the diseases the syndromes were intended to detect. ICD-9 codes were included if identified by a majority of five expert reviewers. This “Gold Standard” was used to measure the sensitivity, specificity, positive likelihood ratio, and positive predictive value of the classifier for each syndrome. The complete list of codes is available upon request.

### Results

No evidence of outbreaks due to an external agent such as a bioterrorist introduction was found. An increase in respiratory syndrome incidence tracked closely the occurrence of influenza based on influenza surveillance (influenza-like illness, laboratory-confirmed influenza). The rates of the other syndromes remained relatively constant over the tracking period. We obtained over a 95% match rate between encounter and billing records, evaluating 59,404 visits to compare the syndromes derived from the chief complaint with those derived using the ICD-9 diagnosis “Gold Standard” for the syndromes of interest and an overall “any syndrome” indicator. The sensitivity, specificity, likelihood ratio positive, and positive predictive values were, respectively, 0.42, 0.90, 4, and 0.81 for the respiratory

syndrome; 0.46, 0.97, 14, and 0.19 for the gastrointestinal syndrome; 0.54, 0.98, 28, and 0.33 for the rash syndrome; 0.02, 0.99, 2, and 0.02 for the meningitis/ encephalitis syndrome; and 0.10, 0.998, 42, and 0.04 for the botulinic syndrome (Table 2).

### Conclusions

The accuracy of syndromic classification varied substantially among the syndromes. Complete evaluation of the suitability of this method would require consideration of the *a priori* probability of an outbreak of the diseases targeted by each syndrome as well as the relative costs of investigating increases in those syndromes. The system as it was operated during the Games required a fair amount of human intervention for data preparation and analysis. There is much promising research into automating the analytical processes, though clinical judgment needs to be applied in systems design. Effective acquisition of specific disease symptoms by searching free-text chief complaints requires knowledge of common disease manifestations, local information systems, and the abbreviations and linguistic conventions of the registration system operators. Opportunity for human error during data entry should be accounted for in a reasonably exhaustive manner and periodically reviewed based on new datasets. The most common complaints/ syndromes might be more consistently identified if clinicians or registration clerks selected chief complaints from a pick list rather than by typing (Table 3). In particular, reliable acquisition of the presence of fever would be helpful. For the three most common syndromes detected by this system—respiratory, gastrointestinal, and rash—the sensitivity appears likely to be sufficient for detecting large outbreaks of diseases that typically present with the symptoms captured by these syndrome categories.

**Table 1: Syndromic Categories**

| Flag | Syndrome  | Example Signs and Symptoms (keyword basis)  | Sample Keywords  |
|------|---|---|--|
| 1    | <b>Respiratory infection with fever</b>   | cough<br>shortness of breath, difficulty breathing<br>congestion<br>bronchitis, bronchiolitis, pneumonia, pneumonitis<br>chest pain (not trauma or cardiac)<br>chest tightness<br>Note: initial <u>absence</u> of <b>strep</b> and <b>RSV</b> | COUGH, CGH<br>SOB<br><br>PNEUMON<br>CHEST+PAIN, CP<br><br>STREP, RSV |
| 2    | <del>Bloody diarrhea</del>  | not tracked (hospital ED-based)   |  |
| 3    | <b>Gastroenteritis</b><br>(includes diarrhea with and without blood)                    | diarrhea<br>vomiting<br>combinations (e.g., "N/V/D")  | DIAR<br>VOM, THROW+UP<br>N/V/D, N&V                                  |
| 4    | <b>Rash Illness</b><br>(febrile illness with rash)                                      | rash (not diaper rash)<br>spots on arms or abdomen<br>measles, rubella, fifth's disease, chicken pox, varicella<br>dermatitis, exanthem<br>pustules or vesicles   | RASH<br><br>POX  |
| 5    | CNS Syndrome<br>(meningitis/ encephalitis or unexplained acute encephalopathy/delirium) | headache with fever<br>confusion<br>delirium<br>disorientation  | HEADACHE+FEVER   |
| 6    | Suspected viral hepatitis (acute)   | jaundice, yellow skin/looks yellow<br>hepatitis<br>icterus  | JAUNDICE<br>HEPATI   |
| 7    | <del>Sexually Transmitted Diseases</del>  | not tracked (NPC)   |  |
| 8    | <del>Sepsis or unexplained shock</del>  | not tracked (hospital ED-based)   |  |
| 9    | <del>Unexplained death with history of fever</del>                                      | not tracked (hospital ED-based)   |  |
| 10   | Botulism-like syndrome<br>(cranial nerve impairment and weakness)                       | double vision (diplopia), blurred vision<br>difficulty swallowing or speaking<br>paralysis<br>weakness (not with cough or fever)  | VISION<br>DIFF+SWAL  |
| 11   | Lymphadenitis with fever  | adenopathy, lymphadenopathy<br>swollen glands or nodes  | SWOLL+GLAND  |
| F    | <b>Fever</b>  | fever, chills, temp (tracked as a comorbidity)  | FEVER, FVR   |

**Table 2. Results**

Sensitivity, specificity, positive likelihood ratio (LR+), and positive predictive value (PPV) measurements comparing the keyword-based complaint syndromic classifier to the ICD-9 lists using up to 4 discharge diagnoses available for each urgent care encounter

| Syndrome               | ICD-9 List   | Sensitivity | Specificity | LR+       | PPV         |
|------------------------|--|-------------|-------------|-----------|-------------|
| <b>Respiratory</b>     | Respiratory / Influenza-like   | <b>0.42</b> | <b>0.90</b> | <b>4</b>  | <b>0.81</b> |
| Respiratory + Fever    | Respiratory / Influenza-like   | 0.11        | 0.98        | 5         | 0.82        |
| <b>Rash</b>            | Rash   | <b>0.54</b> | <b>0.98</b> | <b>28</b> | <b>0.33</b> |
| Rash + Fever           | Rash   | 0.05        | 0.998       | 29        | 0.341       |
| <b>Gastroenteritis</b> | Gastrointestinal   | <b>0.25</b> | <b>0.97</b> | <b>8</b>  | <b>0.24</b> |
| <b>Gastroenteritis</b> | Gastrointestinal without "Abdominal Pain" ICD-9 codes                    | <b>0.42</b> | <b>0.97</b> | <b>13</b> | <b>0.19</b> |
| <b>Gastroenteritis</b> | Gastrointestinal without "Abdominal Pain" and "Nausea alone" ICD-9 codes | <b>0.46</b> | <b>0.97</b> | <b>14</b> | <b>0.19</b> |
| CNS Syndrome           | Encephalitic-Meningitic  | 0.02        | 0.99        | 2         | 0.02        |
| CNS Syndrome           | Encephalitic-Meningitic without "Headache" ICD-9 Code                    | 0.14        | 0.99        | 12        | 0.00        |
| Botulinic              | Botulinic  | 0.10        | 0.998       | 42        | 0.042       |

**Table 3: Modified ICD-9 Diagnosis Code “Gold Standard” List for Gastroenteritis Syndrome** (cf. data line 7 from Table 2 above)

| <i>ICD-9</i> | <i>Description</i>           | <i>ICD-9</i> | <i>Description</i>              |
|--------------|------------------------------|--------------|---------------------------------|
| 001          | Cholera                      | 008.2        | Aerobacter Enteritis            |
| 001.0        | Cholera D/T Vib Cholerae     | 008.3        | Proteus Enteritis               |
| 001.1        | Cholera D/T Vib El Tor       | 008.4        | Bacterial Enteritis NEC         |
| 001.9        | Cholera NOS                  | 008.41       | Staphylococc Enteritis          |
| 002          | Typhoid/Paratyphoid Fev      | 008.42       | Pseudomonas Enteritis           |
| 002.0        | Typhoid Fever                | 008.43       | Campylobacter Enteritis         |
| 002.1        | Paratyphoid Fever A          | 008.44       | Yersinia Entrocolitica          |
| 002.2        | Paratyphoid Fever B          | 008.45       | Clostridium Difficile Enteritis |
| 002.3        | Paratyphoid Fever C          | 008.46       | Anaerbic Enteritis NEC          |
| 002.9        | Paratyphoid Fever NOS        | 008.47       | Gram-Neg Enteritis NEC          |
| 003.0        | Salmonella Enteritis         | 008.49       | Bacterial Enteritis NEC         |
| 004          | Shigellosis                  | 008.5        | Bacterial Enteritis NOS         |
| 004.0        | Shigella Dysenteriae         | 008.6        | Viral Enteritis NEC             |
| 004.1        | Shigella Flexneri            | 008.61       | Rotavirus Enteritis             |
| 004.2        | Shigella Boydii              | 008.62       | Adenovirus Enteritis            |
| 004.3        | Shigella Sonnei              | 008.63       | Norwalk Virus Enteritis         |
| 004.8        | Shigella Infection NEC       | 008.64       | Other Srv Enteritis             |
| 004.9        | Shigellosis NOS              | 008.65       | Calcivirus Enteritis            |
| 005          | Other Food Poisoning         | 008.66       | Astrovirus Enteritis            |
| 005.0        | Staph Food Poisoning         | 008.67       | Enterovirus NEC                 |
| 005.1        | Food Pois D/T C. Botulinum   | 008.69       | Other Viral Enteritis           |
| 005.2        | Food Pois D/T C. Perfringens | 008.8        | Viral Enteritis NOS             |
| 005.3        | Food Pois: Clostrid NEC      | 009          | Ill-Defined Intest Infection    |
| 005.4        | Food Pois: V. Parahaem       | 009.0        | Infectious Enteritis NOS        |
| 005.8        | Bact Food Poisoning NEC      | 009.1        | Enteritis Of Infect Orig        |
| 005.81       | Food Pois: Vibrio Vulnif     | 009.2        | Infectious Diarrhea NOS         |
| 005.89       | Oth Bacterial Food Pois      | 009.3        | Diarrhea Of Infect Orig         |
| 005.9        | Food Poisoning NOS           | 022.2        | Gastrointestinal Anthrax        |
| 007.1        | Giardiasis                   | 535.00       | Acute Gastritis W/O Hem         |
| 007.4        | Cryptosporidosis             | 535.01       | Acute Gastritis W Hem           |
| 007.5        | Cyclosporiasis               | 535.41       | Oth Spec Gastrit W/ Hem         |
| 008          | Intestinal Infection NEC     | 536.2        | Persistent Vomiting             |
| 008.0        | E. Coli Enteritis            | 558.2        | Toxic Gastroenteritis           |
| 008.00       | E Coli Intest Inf NOS        | 578          | Gastrointestinal Hemorr         |
| 008.01       | Entrpathogenic E Coli        | 578.0        | Hematemesis                     |
| 008.02       | Enterotoxigenic E Coli       | 578.9        | Gastrointest Hemorr NOS         |
| 008.03       | Enteroinvasive E Coli        | 787.0        | Nausea And Vomiting             |
| 008.04       | Enterohemorrhagic E Coli     | 787.01       | Nausea And Vomiting             |
| 008.09       | Other E Coli Enteritis       | 787.03       | Vomiting Alone                  |
| 008.1        | Arizona Enteritis            | 787.91       | Diarrhea                        |

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**Table 4: ICD-9 Diagnosis Code Prevalence from All Diagnoses Matched to Chief Complaints in Gastroenteritis Syndrome**

(2,266 billing record matches on 2,384 syndromic flags = 95.0% match rate)

| Percent of patients with diagnosis code of: |                   |                          |
|---|-------------------|--------------------------|
| <i>Code</i>                                 | <i>Prevalence</i> | <i>Description</i>       |
| 5589  | 18.23%            | NONINF GASTROENTERIT NEC |
| 4659  | 16.15%            | ACUTE URI NOS            |
| 3829  | 10.28%            | OTITIS MEDIA NOS         |
| 78703                                       | 8.61%             | VOMITING ALONE           |
| 78791                                       | 7.41%             | DIARRHEA                 |
| 2765  | 7.06%             | HYPOVOLEMIA              |
| 0340  | 6.84%             | STREP SORE THROAT        |
| 07999                                       | 6.66%             | VIRAL INFECTION UNSPEC   |
| 462   | 6.27%             | ACUTE PHARYNGITIS        |
| 4619  | 4.81%             | ACUTE SINUSITIS NOS      |
| 7806  | 4.32%             | FEVER                    |
| 78900                                       | 4.24%             | ABD PAIN UNSPEC SITE     |
| 38200                                       | 4.06%             | AC SUPP OTITIS MEDIA NOS |
| 4871  | 3.75%             | FLU W RESP MANIFEST NEC  |
| 4660  | 2.65%             | ACUTE BRONCHITIS         |
| 490   | 2.65%             | BRONCHITIS NOS           |
| 486   | 2.43%             | PNEUMONIA, ORGANISM NOS  |
| 7862  | 2.43%             | COUGH                    |
| 78701                                       | 1.90%             | NAUSEA AND VOMITING      |

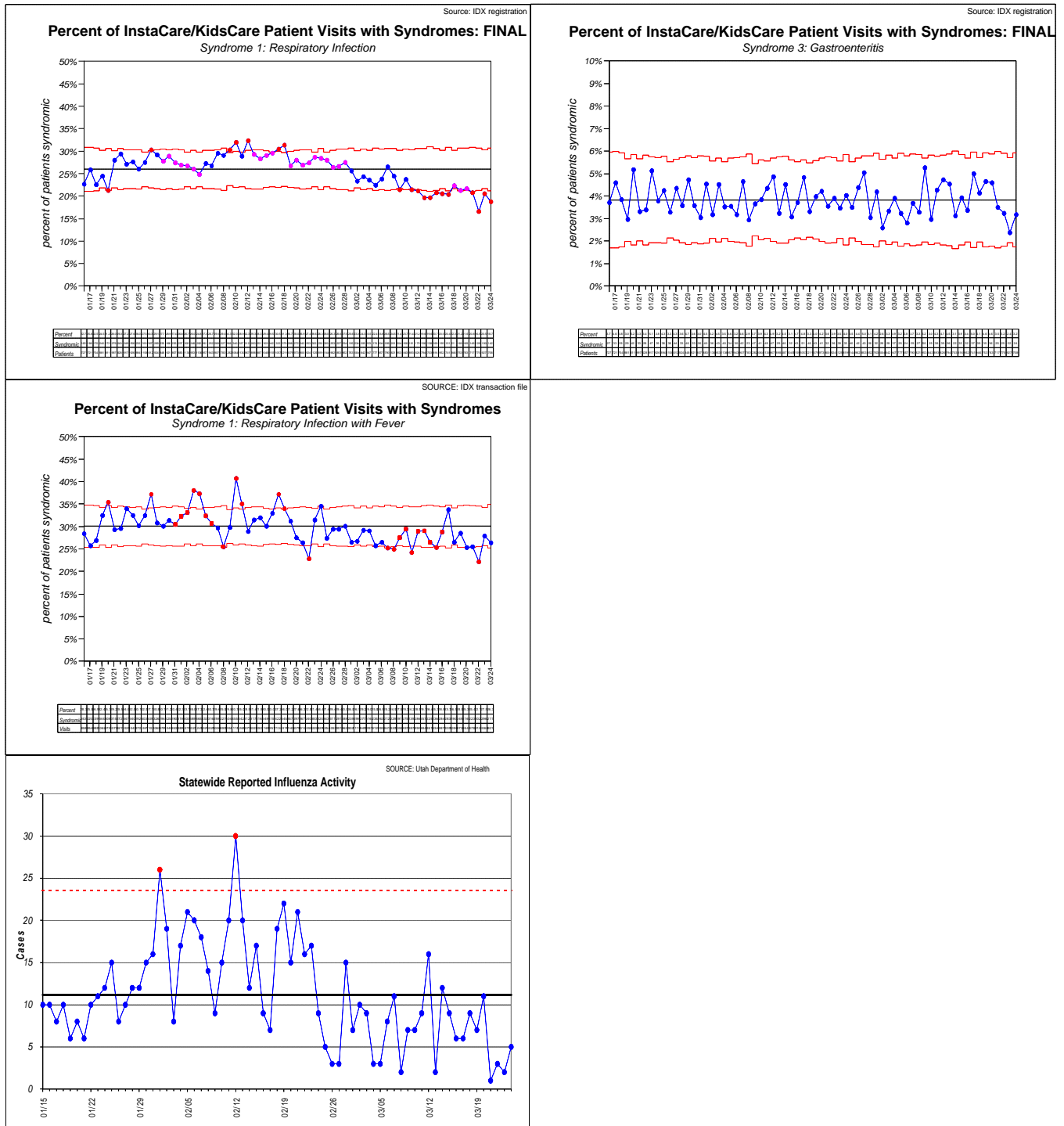
**Table 5: Example (mis)spellings (excluding abbreviations)**

*In alphabetical order:*

|            |           |
|------------|-----------|
| DIAHERRA   | DIARHEAA  |
| DIAHERREA  | DIARHHEA  |
| DIAHHREA   | DIARHIA   |
| DIAHREA    | DIARRAHE  |
| DIAHREEA   | DIARREA   |
| DIAHRREA   | DIARREAH  |
| DIARAHEA   | DIARREHA  |
| DIAREA     | DIARRHA   |
| DIAREAH    | DIARRRHEA |
| DIAREAHA   | DIHAREA   |
| DIAREHA    | DIHARREA  |
| DIAREHEA   | DIHRREA   |
| DIAREHHA   | DIRREAH   |
| DIAREHRHEA | DIRRHEA   |
| DIARHEA    |           |

With only one or two exceptions, all of the entries above occurred multiple times, so they cannot reasonably be attributed simply to typing error.

**Figure 1. Example Incidence P-Charts for Respiratory and Gastrointestinal Syndromes**



*The complete set of incidence p-charts for all syndromes is available from the authors on request.*