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The application of aberration detection methods to disease surveillance data

A common problem in interpreting variations in disease incidence is to determine whether they represent a real change or random statistical fluctuations. Aberration detection methods are important tools to address this issue.

The underlying principle of using statistical aberration detection methods to detect unusual disease clusters in infectious disease surveillance is similar to that of detecting clusters of defective items in manufacturing quality control. The current observed values (e.g., disease incidence or number of defective items) are compared to some forecast values based on historical baseline data. This allows us to detect unusual number of occurrences indicating a departure from what is expected in the normal situation.

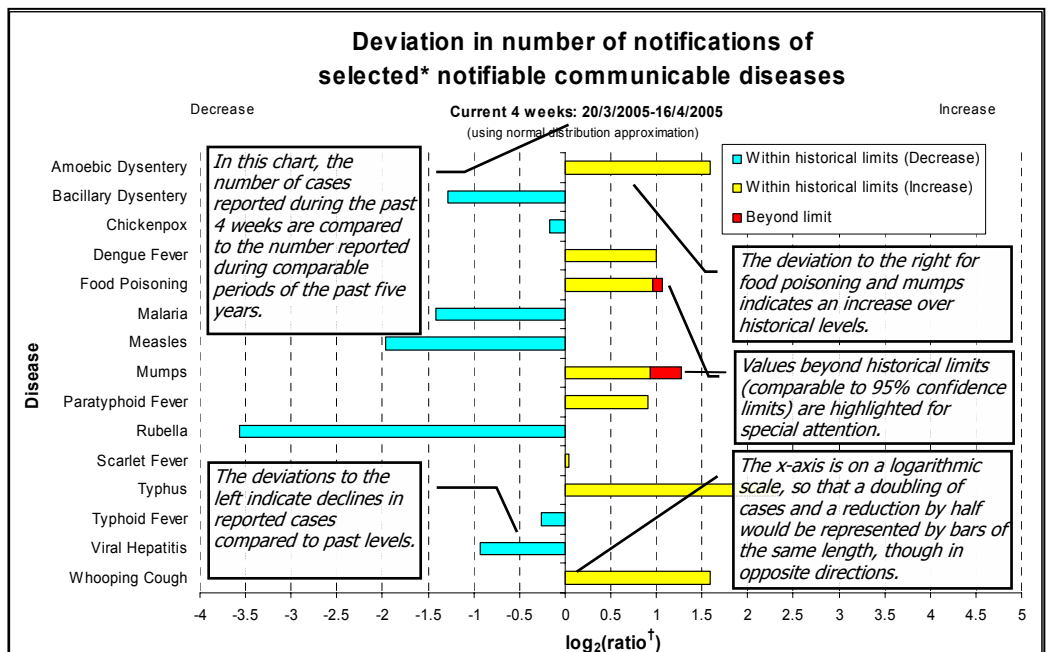


Figure 1 – Deviation bar chart showing the level of 15 notifiable diseases reported for the period April 11-16, 2005

We introduce here two examples of aberration detection methods currently used in the CHP: the deviation bar chart (DBC), and the exponentially weighted moving average (EWMA).

The DBC is designed for analyzing conditions with a historical trend of at least five years. The number of reported cases for a given health event in a defined current time period is compared with historical data on the same condition from the preceding few years. The DBC will yield statistically significant signals if the current activity of a condition increases/decreases beyond values expected for the same period of the year in the past. It has the advantage of graphically showing deviations in disease occurrence, both positive and negative, from a baseline. Figure 1 shows an example of DBC with the level of 15 notifiable diseases reported for the period April 11-16, 2005 in Hong Kong. In this figure, food poisoning and mumps are highlighted for changes beyond their corresponding historical limits.

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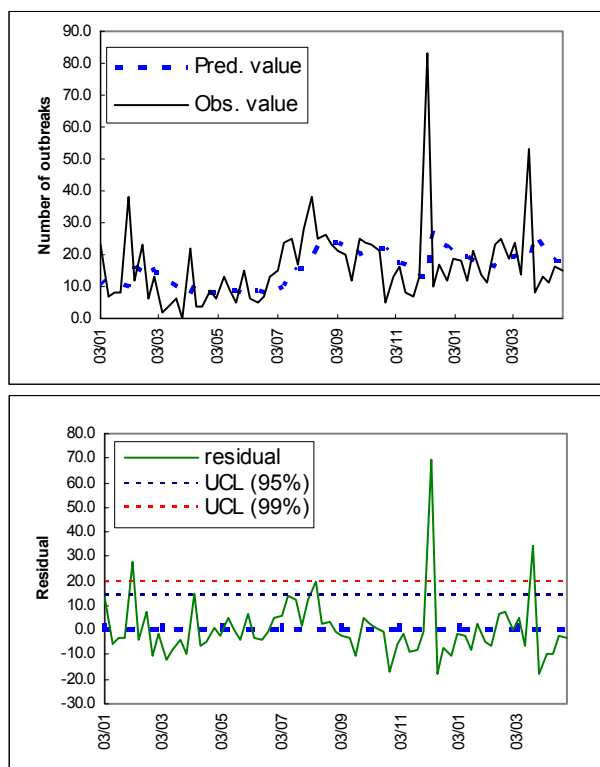


Figure 2 (above) Observed and predicted weekly values (EWMA) of food poisoning outbreak cases, in 2004-05, up to 23 April; (below) The difference between the observed and predicted values yield the residuals of food poisoning outbreak cases, which are compared to 95% and 99% upper control limits (UCL) for aberration detection.

In contrast to the DBC, the EWMA is more sensitive in identifying the most recent changes in disease activity. This method generates a forecast value for each time period by taking into account previous data in a way that gives more weight to more recent data and less weight to older data. When this forecast value is compared to the observed disease incidence, the resultant prediction error is analyzed using conventional control charts for significant changes. Figure 2 shows an example of the EWMA analysis of food poisoning data from January 2004 to April 2005, showing several aberrations indicating probable food poisoning outbreaks.

Ideally, an aberration detection method is able to identify all outbreaks in a sensitive, specific and timely manner. In actual practice, each method analyzes data from a slightly different angle and no single method is ideal and suitable for analyzing all types of surveillance data. Analytic methods should thus be selected and configured to meet different surveillance goals and a combination of different aberration detection methods may be required to fully analyze the trend and activity of any infectious diseases. For instance, in the above examples for food poisoning cases in the period April 11-16, 2005, an aberration signal is detected by the deviation bar chart but not by EWMA, suggesting that although the level is higher than historical limits in previous years, there is no significant increase in disease activity comparing with recent weeks.

As an ever-expanding volume of surveillance data become available, automatic aberration detection methods become more versatile in sipping through the data and generating signals of potential outbreaks. Aberration signals from different surveillance systems need to be put together for interpretation by trained public health professionals. An outbreak alarm triggers further investigative actions or an alert to inform the public for sake of health protection.

*Reported by Dr Dennis Ip, Disease Modelling Specialist, Surveillance and Epidemiology Branch, CHP. ****

Streptococcus suis infections, January 2004 – April 2005

CHP received five reports of sporadic *Streptococcus suis* infection since January 2004 (See Table 1). All were males aged from 48 to 66 years old. They presented with symptoms of septicaemia, meningitis or endocarditis. One patient had history of diabetes mellitus and another patient had history of cirrhosis. The other three patients had good past health. Three patients were diagnosed by positive blood culture of *Streptococcus suis* while two patients were diagnosed by positive culture in the cerebrospinal fluid (CSF). All except one patient recovered with antibiotic treatment. This patient died of an unrelated cause. Two had complications of hearing loss and mitral and aortic valve destruction respectively.

Table 1 - Summary of 5 cases of *Streptococcus Suis* infection notified to CHP (Jan 2004 –Apr 2005)

Notification date	May 2004	September 2004	October 2004	November 2004	March 2005
Sex / Age	M/51	M/66	M/49	M/49	M/48
Occupation	Merchandiser	Retired for 8 years	Dim sum kitchen worker in Chinese restaurant	Butcher in slaughter house	Pork seller in wet market
Past Health	DM on insulin	Good	Good	Cirrhosis not on treatment	Good
Clinical presentation	Meningitis	Sepsis	Meningitis	Sepsis	Endocarditis
Laboratory findings	CSF culture positive for <i>S. suis</i>	Blood culture positive for <i>S. suis</i>	CSF culture positive for <i>S. suis</i>	Blood culture positive for <i>S. suis</i>	Blood culture positive for <i>S. suis</i>
Outcome	Recovered, complicated by bilateral hearing loss	Died due to unrelated cause	Recovered without complication	Recovered without complication	Recovered, complicated by mitral and aortic valve destruction, which required valvular replacement
Exposure history	No definite exposure history to pigs or raw pork	No definite exposure history to pigs or raw pork	Frequent contact with raw pork at work, uncovered cut wound at left index finger	Frequent contact with raw pork	Frequent contact with raw pork

Concerning occupational history, three cases had history of contact with raw pork during work within the incubation period. One patient made dim sum in a local restaurant and had an uncovered cut wound at his left index finger. The second patient was a butcher in a slaughter house. The third patient was a pork seller in a wet market. There was no occupational exposure identified for the remaining two cases.

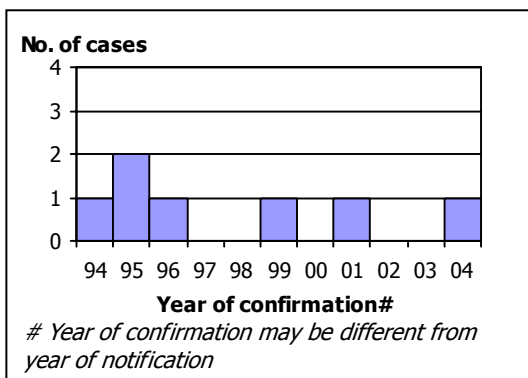


Figure 3 - No. of confirmed occupation related cases of *Streptococcus suis* 1994-2004

Streptococcus suis infection is a notifiable occupational disease under the Occupational Safety and Health Ordinance and cases should be reported to the Labour Department. The notification form can be downloaded from the Labour Department's homepage at <http://www.labour.gov.hk>, or it can be obtained from the Occupational Health Service (OHS) of the Labour Department (Tel: 2852 4041 / Fax: 2581 2049). It is also a prescribed occupational disease, compensable under the Employee's Compensation Ordinance.

The number of cases notified to OHS and confirmed to be occupation related is shown in Figure 3. From 1994 to 2004, the OHS confirmed 7 cases of occupation related *Streptococcus suis* infection. To reduce the risk of *Streptococcus suis* infection, people with frequent contact with pigs or raw pork should use protective gloves, wash hands after handling pig or raw pork, cover wounds, and reduce the chance of injury while processing meat.

Reported by Dr Edmond Ma, Ms Doris Choi, Dr TY Wong, CHP and Dr HK Kong, Occupational Health Service, Labour Department. ***

What is *Streptococcus suis* infection?

Streptococcus suis is an important pathogen of pigs. The bacterium is carried in the tonsils of young weaned pigs, and spread among pigs by nose-to-nose contact or by aerosol over short distances. Human infection by *Streptococcus suis* occurs mainly among adults and is often related to occupational exposure through the cutaneous portal of entry, e.g., cuts or abrasions while handling infected pig carcasses. Common occupations at risk include pig breeders, abattoir workers, meat processing and transport workers, butchers, and cooks. Patients infected by *Streptococcus suis* are usually healthy adults. However, patients with asplenia, diabetes mellitus, alcoholism and malignancy are at greater risk of infection.

The disease may present as meningitis, septicaemia, and less commonly endocarditis, arthritis and bronchopneumonia. The characteristic complication of *Streptococcus suis* infection is deafness which is likely to remain permanent. Bilateral hearing loss is more common than unilateral. *Streptococcus suis* is generally susceptible to penicillin. Physician should include *Streptococcus suis* in the differential diagnosis of meningitis and septicaemia occurring in an adult having occupational exposure to raw pork.

Risk Communication Digest

The CHP has undertaken the following risk communication exercises during the past two weeks:

Press releases	Number
Dengue Fever	1
Food Poisoning	4
Influenza	1
Legionnaires' Disease	1
Leptospirosis	2
Meningococcal Infection	1
Media Interviews	
Avian Influenza	1
Influenza Preparedness Plan	1
Tuberculosis	1
Media Stand-ups	
Influenza	1

News

Cluster of leptospirosis associated with a tour to Sabah, Malaysia

Between April 19-25, 2005, the CHP confirmed 3 cases of leptospirosis, including one man and two women aged 24 - 54 years. Their conditions were stable and they have already been discharged from the hospital. The three cases were all members of a tour involving 28 participants who traveled to Sabah, Malaysia during March 24 - 28. They all have taken part in rafting and hiking activities during the five-day trip.

The risk of leptospirosis is usually from occupational or

recreational water exposures, such as water contaminated with urine of infected animals. The risk can be minimized by covering open wounds properly and avoiding contact with urine of live mammals and objects contaminated by them as well as polluted water. In Hong Kong, a cluster of 4 cases of leptospirosis associated with outdoor water recreational activities was reported last year.

A case of Legionnaires' disease

On April 19, CHP confirmed a case of Legionnaires' disease (LD) involving a 38-year-old man living in Mainland China. He had symptoms of fever, cough, nocturnal sweating and was hospitalized on March 21 in stable condition. Investigation did not reveal a local source of infection. The total number of LD cases in recent years remained low with three cases per year in 2003 and 2004 respectively.

A sporadic case of meningococcal infection

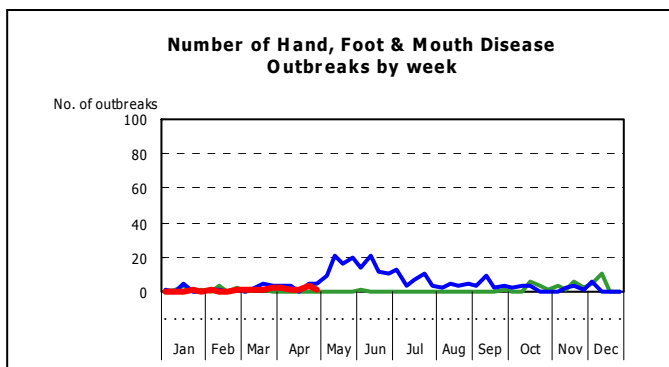
On April 19, CHP confirmed the second sporadic case of meningococcal infection in 2005. Laboratory results revealed that the case was a serogroup B infection. The 29-year-old woman developed fever, chills, headaches, vomiting and malaise on April 13, and was hospitalized on April 16 in stable condition. Prophylactic treatment was given to household contact. The total number of meningococcal infection cases in recent years was stable with three and four reported cases in 2003 and 2004 respectively.

Meningococcal infection is caused by a bacterium known as meningococcus. It is transmitted by direct contact, including droplets from the nose and throat of infected persons. Although severe meningococcal infection can sometimes be fatal, early cases can be treated effectively with antibiotics.

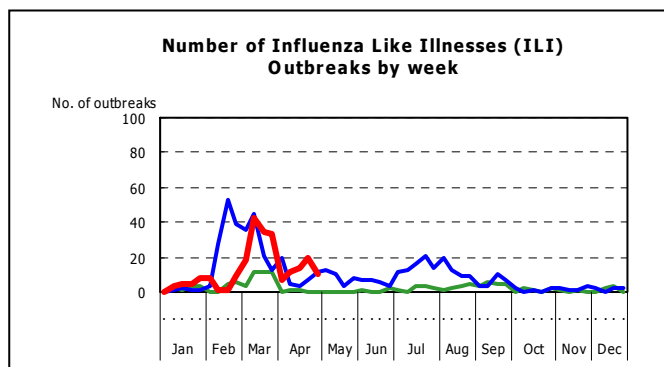
Data contained within this bulletin is based on information recorded by the Central Notification Office (CENO) and Public Health Information System (PHIS) up until April 30, 2005. This information may be updated over time and should therefore be regarded as provisional only.

Summary of selected notifiable diseases and outbreak notifications (Weeks 17 - 18)

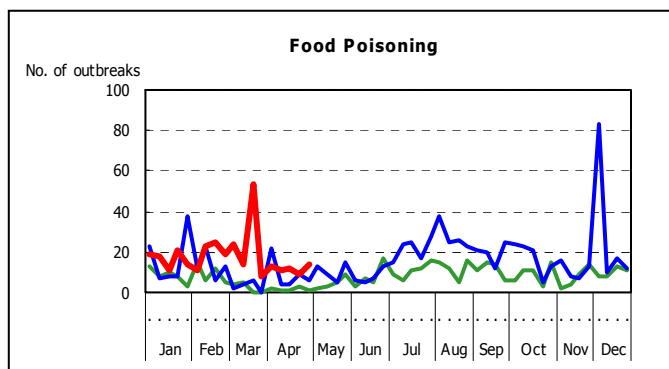
— 2003 — 2004 — 2005



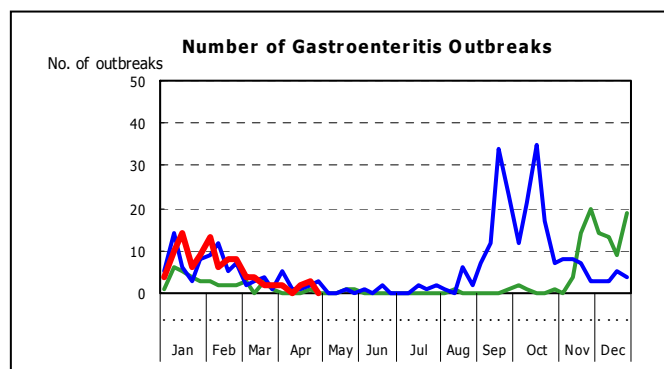
Week 15 : 1 outbreak **Week 17 :** 4 outbreaks
Week 16 : 1 outbreak **Week 18 :** 1 outbreak



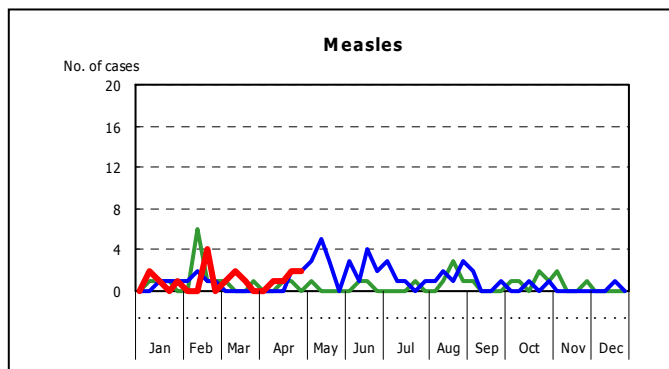
Week 15 : 11 outbreaks **Week 17 :** 20 outbreaks
Week 16 : 14 outbreaks **Week 18 :** 10 outbreaks



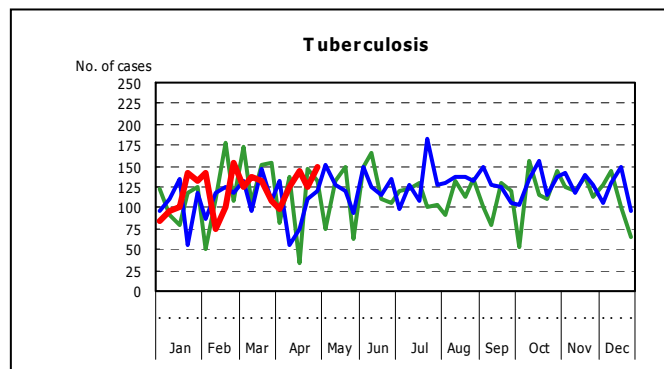
Week 15 : 11 outbreaks **Week 17 :** 9 outbreaks
Week 16 : 12 outbreaks **Week 18 :** 14 outbreaks



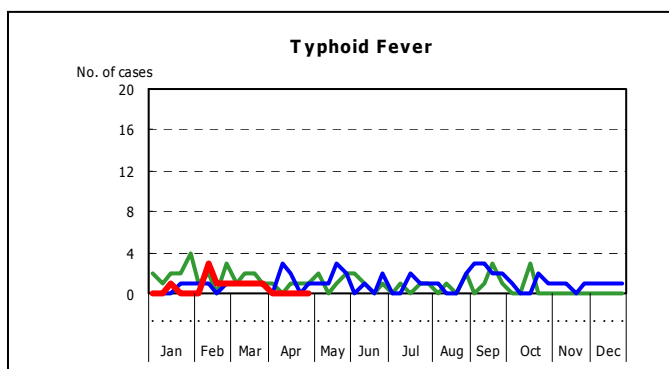
Week 15 : 0 outbreak **Week 17 :** 3 outbreaks
Week 16 : 2 outbreaks **Week 18 :** 0 outbreak



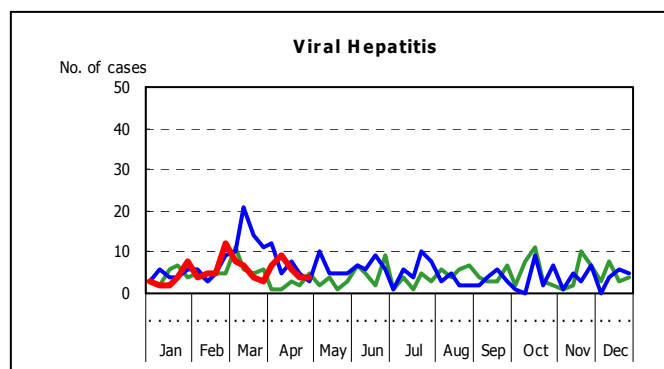
Week 15 : 1 case **Week 17 :** 2 cases
Week 16 : 1 case **Week 18 :** 2 cases



Week 15 : 124 cases **Week 17 :** 126 cases
Week 16 : 145 cases **Week 18 :** 150 cases



Week 15 : 0 case **Week 17 :** 0 case
Week 16 : 0 case **Week 18 :** 0 case



Week 15 : 9 cases **Week 17 :** 4 cases
Week 16 : 6 cases **Week 18 :** 4 cases