

Models for automatic detection of infectious diseases at an early stage in disease progression

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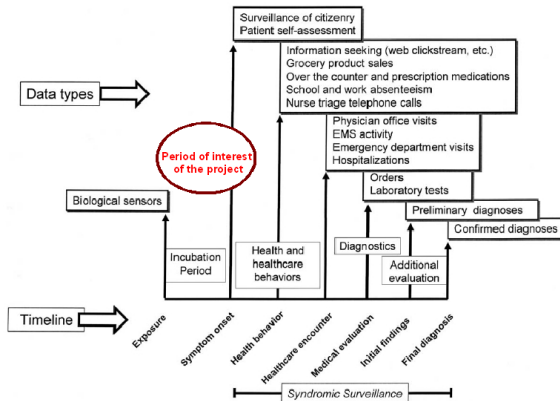
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- Today, when a disease outbreak is detected, many people may already be infected.
- An infected person may be contagious before the first symptoms appear.
- In the period of disease evolution, this person can infect several other individuals before consulting a doctor.

- Therefore, a system is needed that can detect an epidemic outbreak at a very early stage (to prevent spread of infections).
- Such a system should prevent large outbreaks of infectious diseases.



Progression of useful data sources as related to the underlying infection and associated behaviours



[K.D. Mandl, 2004] Kenneth D. Mandl, et al.

Implementing Syndromic Surveillance: A Practical Guide Informed by the Early Experience
Journal of the American Medical Informatics Association, 2004.

- We explore different possibilities for very early detection, before the symptom onset period or in the early stages thereof.
- There has been little epidemiological research on detection at such an early stage.
- The methods that will be used should be based on research on patients, and the connection between changes in their physiological state and the occurrence of infection.
- This research will involve the development of models translating physiological functions to non-trivial information about the well-being of a community.

Number of people with a potential infection on which we can base our research.

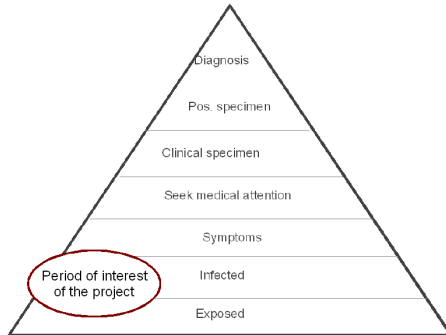


Figure: Preben Aavitsland's pyramid of surveillance



[Aavitsland, 2005] Preben Aavitsland, et al.

Surveillance, an introduction.

Presentation at the advanced course in epidemiology of infectious diseases (EpiTrain_{II}) 2005

Timeliness in which measures against an outbreak could be taken.
 Benefit for both number of infections as costs.

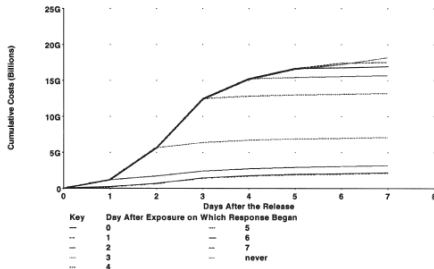


Figure: Cumulative impact with and without post-attack treatment following a hypothetical anthrax attack on a population of 100,000



[Wagner, 2001] M.M. Wagner, et al.

The emerging science of very early detection of disease outbreaks.
Journal of Public Health Management and Practice, 2001.

- To detect the epidemic before the stage of symptom onset, we need to have access to the data of people that are infected, but are not yet aware of it.
- Preference for data from a group of subjects that are taking measurements on a regular basis already.
- Diabetes patients measure their blood glucose levels up to several times a day to minimise long-term complications.

- There is an indication that the blood glucose levels of diabetes patients rise, when they have an infection.



[Botsis, 2007] T. Botsis, et al.

Blood glucose levels as an indicator for the early detection of infections in type-1 diabetics.
Advances in Disease Surveillance, 2007.



[Botsis, 2007] T. Botsis, et al.

Disease surveillance systems for sensitive population groups.
Advances in Disease Surveillance, 2007.

- By collecting blood glucose data from diabetes patients we want to make a prediction about whether they have an infection.

- To measure the occurrence of infections, we could initially ask diabetes patients to additionally measure their white blood cell count.
- With the data collected we want to create a model representing the interaction between infections and white blood cell counts and blood glucose levels.

- Other parameters could be considered as indicators for a disease outbreak.
- Other groups of people suffering from chronic diseases need to measure physiological values on a regular basis.
- As part of this project we will focus on
 - identifying the group(s) that could give us the most accurate prediction and
 - on developing a system in which data collected from these individuals could be translated into a prediction of epidemics and into direct feedback to the user of the system.

Currently we are doing a pilot study in which we measure vital statistics for three (healthy) individuals.
This study will give us insight in the usability of different kinds of equipment

Input

Vital statistics of a group of patients

Input

Vital statistics of a group of patients

Output with information about a single patient

- sick/healthy
- scale of well-being
- prediction about specific infections

Input

Vital statistics of a group of patients

Output with information about a single patient

- sick/healthy
- scale of well-being
- prediction about specific infections

Output for a community

- regional
 - total count of infections
 - kind of infections
 - alarming values
- global
 - epidemic
 - pandemic
 - total count of infections
 - growth
 - direction of spread