MISCELLANEOUS

Principles of public health surveillance: a revisit to fundamental concepts

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Abstract

The objective of this article focuses on fundamental concepts of public health surveillance, especially to graduate students and health professionals who are new to this discipline. The article initially explains how concepts of surveillance in public health have evolved over the period of six decades. Then the three major objectives of surveillance are further discussed in detail. With clear specification of the objective, surveillance system can be established to fulfill the goal. General considerations for establishing new surveillance system are therefore outlined. Methodical process of surveillance from information generation to the link to public health actions is thoroughly explained. Challenging issues and current technical advance in this field of epidemiological practice are additionally summarized.

Keywords: public health surveillance, epidemiological method, public health, disease control

Introduction

From the early concept of surveillance concentrating on detection of suspected act of crime commission, conception of surveillance has later been adopted into monitoring disease occurrence in individuals and progressively evolved into the current concept of ongoing observation on a certain population to gauge the change in defined health event and to determine whether a public health act is promptly needed for control or prevention of the altered health condition. Since the global trend of disease has shifted in terms of burden from infectious diseases to chronic non-communicable diseases, method of public health surveillance has thus been developed in response to this change. From the conventional surveillance approach, which concentrates on measuring disease occurrence (e.g., number of cases with a certain disease) and related consequence (e.g., mortality); extension to include observation of risk factors, environmental hazard, and positive health determinants–which precede the occurrence of disease or health outcome–has been made for comprehensive care of population health with a more preventive orientation.

This article focuses on fundamentals concepts of public health surveillance importantly in terms of its conceptualization and methodological principles. Conceptual development, objectives, general consideration for surveillance system establishment, and current method of public health surveillance are discussed in detail. Challenging issues and technical advance in practice of surveillance are additionally summarized. The aim of this article is to provide general overview of this epidemiological practice especially for graduate students in epidemiology and health professionals who may not be familiar to the discipline. More technical advance in this evolving field of public health surveillance, which maybe far beyond the scope of this article, can also be further explored with the prior foundation provided herein.

1. Defining and conceptualizing 'surveillance': from etymological basis to contemporary recognition in public health

'Surveillance'–a French word in origin believed to be adopted into English in 1802–is a noun simply defined as 'the act of oversight or watching over'. The term comprises two word elements including 'sur' (over or atop) and 'veiller' (to watch).[1] 'Surveillance' was introduced into English from terror in France where 'surveillance committees' were established in all municipalities in 1793 to monitor the act of suspected individuals.[1]

Surveillance was initially acknowledged as the act of close monitoring of individuals exposed to contagious or communicable diseases for timely detection of manifestations which further indicated control measures–such as quarantine.[2] Until 1950, perspective change in surveillance from the act of individual monitoring to population-based surveillance of disease occurrence.[2] This approach became prominent following the 1954 field trial of poliomyelitis vaccine (Salk's inactivated polio vaccine trial) in the US.[3] Population surveillance has also been approved as an integral responsibility of public health practice.[4] The approach comprised three fundamental features including systematic data collection (at local sources), data assembly and analysis (at surveillance centers), and dissemination of pertinent information and precise message through descriptive epidemiological reports.[5]

The notion of extending role of surveillance to indicate control activities was also considered.[6] In some WHO programs, information from surveillance has evidently been applied to specifying active control measures–such as extensive vaccination against smallpox.[6] Nonetheless, this concept of using the information from surveillance to determine what activity to be implemented was later objected.[6] It has been suggested that surveillance should only be a hint of feasible control activities while health authority should retain the right to make decision regarding practical control measure to be implemented in the actual context.[6] This suggestion is more relevant to the actual context of public health practice since health resources and contextual constraints are taken into consideration, and decision to act in what way can be justified by local health practitioners who understand local circumstance well.

Other terms including 'epidemiological surveillance' and 'public health surveillance' have also been proposed. The term 'epidemiological surveillance' was broadly defined as 'epidemiological study of disease–even incorporating epidemic investigation and research–as a continuous and ever-changing process'.[2] Nonetheless, this definition was opposed based on the reason that it seemed equivalent to how epidemiological practice has been defined.[2] Even though surveillance data may reveal gap of knowledge and hypothesis formulation leading to research, objective of research is different from that of surveillance and should be recognized separately.[7] Thacker and Berkelman thus later proposed the term 'public health surveillance' which conserved benefits of the initial term 'epidemiological surveillance' while excluding confusion with research.[2] Public health surveillance has thus been defined as a system comprising continuous data collection, data analysis and interpretation, dissemination of key information and message to the responsible personnel to timely urge public health action for control and prevention of disease or condition.[8] Public health surveillance does not incorporate specification of preventive and control measures. Public health surveillance is aimed essentially at providing hint of applicable control and preventive activities. In other words, public health rather provides information of public health situation for responsible personnel at all levels, guides feasible programs, and later eases program evaluation when outcomes are assessable.[8] For further discussion in this article, the term 'surveillance' refers to 'public health surveillance'. Summary of conceptual development of surveillance and major characteristics at each stage is provided in Table 1.

Table 1 Summary of conceptual development of surveillance at each stage and corresponding key features

Conceptual development	Unit of observation	Health event of interest	Key features
1) Personal surveillance (Individual monitoring)	• Individual	• Disease (especially infectious disease in man)	• Close monitoring of individual suspected of having disease • Detection of disease symptom • Information is used for indicating control measure such as quarantine.
2) Disease surveillance	• Population	• Disease (communicable and non-communicable) • Other health problems (e.g., environmental hazard)	• Ongoing observation of health event with organized process • The process comprises data collection, assembly, analysis and interpretation.
3) Epidemiological surveillance	• Population	• Disease • Other health problems	• Extended scope of surveillance to include epidemic investigation and research • The concept was objected since it misled understanding of surveillance practice to be equivalent to epidemiological practice.
4) Public health surveillance	• Population	• Disease • Other health problems • Unusual event (e.g., mass animal death) • Risk behavior • Various other conditions	• Organized system comprising data collection, analysis, interpretation, dissemination of information, and link to public health action • Information is used for decision making rather than dictate what action to take

Although 'surveillance' and 'monitoring' seem similar in meaning, these terms are actually different and should not be used interchangeably. Monitoring resembles surveillance in that its method also focuses on timeliness, practicability, and continued data collection on routine.[2] Nonetheless; surveillance allows impact assessment of disease in a certain population prior to and following implementation of health program, while monitoring focuses only on evaluating post-implementation outcomes.[2] The other distinction of these terms is according to their groups of focus. Surveillance focuses on relatively larger group of populations while monitoring commonly concerns individuals (e.g., monitoring of vital signs in a certain

patient) or specific groups (e.g., effectiveness evaluation of HIV/AIDS preventive program in female sex workers or monitoring of long-term glycemic control among diabetic patients attending a district hospital).[2]

The other difference to be remarked is between 'surveillance' and 'survey'. When data are not readily available in routine data collection of existing health service system–as that commonly found in surveillance, such data are then specifically collected for a certain reason or objective in an organized way called 'survey'.[9] Therefore, in terms of how survey is related to surveillance, survey can be one of the possible methods of obtaining data for surveillance. Nonetheless, survey adopts active approach of population-based data collection for a certain purpose; while surveillance, in general, passively adopts readily available data of a certain facility.[9] Survey is thus undertaken on occasion with specified value of budget and invested resources; whereas surveillance is rather a continued and less costly process in the long run.[9] Surveillance usually involves all health agencies from local health facilities to health authorities of higher levels: provincial, national, international.[2] The flow of information is usually in back and forth pattern: upward data reporting, downward policy suggestion for action, upward report on effectiveness of policy implementation, downward feedback and support, and others. Unlike surveillance, survey is occasionally funded for specified objective and its result is rather directed to funding provider or concerned agency.[9]

2. Objectives of surveillance

In general, the purpose of surveillance is to identify changes in distribution or trends to launch investigation or control activities.[10] To be more specific, three major objectives of surveillance can be listed as (a) to describe the dynamic pattern of disease occurrence which links to public health action, (b) to elucidate natural history and epidemiological profile of disease, and (c) to supply baseline data and relevant information.[2] Their features can be summarized as illustrated in Table 2.

Table 2 Objectives of surveillance and corresponding features

Objectives of surveillance	Key features
1) To describe the dynamic pattern of disease and link to public health action	Description of disease pattern is undertaken to: • detect immediate changes in disease occurrence and distribution *(e.g., disease outbreak, food poisoning)*, • identify disease trend and pattern *(e.g., increased incidence of ovarian cancer in younger Thai women)*, • anticipate possibility of getting disease by monitoring change in host or agent factors *(e.g., study of mutated pathogen)*, and • identify change in disease burden from healthcare practice *(e.g., increasing number of patients requiring dental extraction).* Information obtained from the description is used for: • decision to provide prompt action *(e.g., identifying agent causing disease outbreak and guiding control measure)* • healthcare planning *(e.g., focusing more on oral health prevention to control the problem of tooth loss)* • reorganizing health service system • evaluating effectiveness of the implemented program *(e.g., effectiveness evaluation of vaccination program)*[11]
2) To explain natural history and epidemiological profile of disease	• Aid in explaining natural course of a certain disease which has not been previously clarified • Allow description of epidemiological profile of disease in terms of 'persons' being affected, 'place' or risk environment, and 'time' of disease occurrence. • Provide information for planning of control and preventive measures
3) To supply baseline data for planning and evaluation of health program	• Allow estimation of impact from health program on target health outcome prior to implementation *(e.g., projection or predictive model development to anticipate effect of proposed health policy using disease trend data)* • Supply baseline data for comparison or evaluation of target health outcome after the health program is implemented *(e.g., measuring marginal benefits after implementing health program)*[11]

3. General consideration for surveillance system establishment

Establishment of surveillance system is appropriate only for some diseases or health-related events. This is mainly due to health resource constraint and additional burden on operating the system in the long run. Rational selection of diseases or events eligible to be put under surveillance is thus important for system establishment planning. In general, diseases or health events suitable for surveillance are those potentially causing severe health outcomes (e.g., death, disability, long-term suffering). Examples of diseases and conditions in this category are malaria, HIV/AIDS, tuberculosis, rabies, and hazardous chemical exposure.[12-15]

Highly transmissible diseases and epidemic or pandemic diseases of international concern are also considered for surveillance. Examples of these diseases are Ebola[16], hemorrhagic fever, measles[17], and influenza[18]. Some conditions or health events are put under surveillance for evaluation of health program implementation and related effectiveness. Examples in this category are surveillance of influenza vaccination coverage[19] and evaluation of poliomyelitis vaccine efficacy in field trial[3].

In addition to the selection of diseases or conditions eligible for surveillance, there are several other related issues to be considered. Data and information required for analysis and formulation of applicable policy and implementation must be well specified. The required data must also be feasible in terms of collection from appropriate sources and quality ascertainment. Regarding cost consideration, benefit of surveillance for a certain event should outweigh the cost burden arises from its operation. Cost containment–control of expenses according to budget constraints–is also a critical issue influencing sustainability of surveillance system operation, especially in the long run.

Box 1. Considerations for establishing surveillance system

- **Health resource constraints**
  (critical issue especially setting up system requiring long-term operation)
- **Disease or hazard**
  - **causing severe health outcomes**
    (e.g., rabies, radiation hazard)
  - **highly transmissible diseases**
    (e.g. Ebola)
  - **epidemics / pandemic**
    (e.g., influenza)
  - **disease outcome indicating success or failure in evaluation of interventional effectiveness**
    (e.g., vaccine efficacy trial)
- **Feasibility of obtaining quality data**
- **Cost containment**

4. Methodical process of surveillance

Methodical process of surveillance comprises several consecutive steps including data collection, data analysis, interpretation of analysis results, dissemination of information, and link to public health measures. Details of these steps are explained as followed.

4.1 Data collection

Data collection is the most critical phase of surveillance in terms of the greatest amount of budget

to invest and difficulty in obtaining quality data. Data for surveillance primarily vary according to 'health events' of interest. Data regarding some events can be obtained through population register or vital statistics system (e.g., mortality, cause-specific mortality, infant mortality).[20] Some events are recorded on routine medical practice (e.g., maternal and neonatal outcomes, congenital defects, communicable diseases, chronic diseases, mental illness, health practice, nosocomial infection, surgical site infections[21]). Surveillance is not only limited to detection of health problem once it occurs, but its range of data can also be extended to include factors influencing the health problem prior to its occurrence or manifestation.[22] These influencing factors can be health risk behaviors[22], environmental[23] and occupational health hazards[24], food contamination, disease vectors, animal reservoirs, and others. Some events are short-term consequences of catastrophe and these can be temporarily put under surveillance until the disaster is resolved. Examples of these events are occurrence of infectious diseases, injuries, effect on mental health, and demand of medical care after earthquake and tsunami.[25,26] Other unusual events can also be notified through to urge prompt information capture, assessment of potential risk to public health, and immediate action if required. Examples of these events are cluster of disease, deaths of unidentifiable cause, atypically severe case, mass animal deaths, and migration of wild animals.

Surveillance of some diseases can be undertaken at different stages; ranging from surveillance of risk behaviors, subclinical stages, clinical events, treatment outcomes, and to ultimate consequence of recovery or death. An example of diseases with comprehensive surveillance system is HIV/AIDS.[27] Surveillance of HIV/AIDS can be commenced from surveillance of risk behaviors. HIV sero-surveillance is conducted to determine HIV infection in laboratory investigation, early before the disease clinically manifests. HIV cases–classified by different case definitions for surveillance–are reported on routine patient care service to reflect burden of the disease and for planning of patient care (e.g., multiple antiretroviral drugs provision). Drug resistance surveillance is also an integral part of HIV/AIDS patient care and frequency of report primarily depends on level of infection and available health resources for conducting this periodic surveillance.

Numerous sources of data can be adopted for public health surveillance. Variation of data sources is on account of several factors; including availability and accessibility of data (e.g., routinely-collected data), budget constraint (e.g., funding for special effort of data collection), characteristics of health service systems (e.g., cooperation of public or private health service providers), quality and availability of facility (e.g., laboratory facilities, computer network), and personnel (e.g., medical specialists verifying case based on surveillance case definition).[2] To specify what data are needed, objective of surveillance must be first considered. The objective of surveillance would guide which data are rational to be collected–prior to checking feasibility to obtain the data in practical setting, specifying data collection approach, and anticipating action to be recommended by surveillance information. For instance, if the objective of surveillance is to detect a foodborne outbreak, evidences related to the suspected outbreak (e.g., abrupt increase in number of patients diagnosed with acute gastrointestinal disease, type of food shared in common among

cases) are needed. Approach of data collection (e.g., active surveillance approach to directly collect food specimen for laboratory investigation of causative agent) can then be specified. Surveillance data and their corresponding sources are exemplified in Table 3.

Table 3 Surveillance data and corresponding sources or settings of data collection

Surveillance data	Sources or setting of data collection
1. Mortality data	Death registry with record of accurate cause of death
2. Morbidity data	Case reporting (from routine medical service), Individual case report (e.g., case report of rare disease, case of emerging disease, usual variant of common disease), Compulsory report of case finding by legal regulation for some diseases (e.g., cholera, Ebola hemorrhagic fever)
3. Data for epidemic detection	Epidemic field investigation, Cluster of illness reported by community-based surveillance, Finding of unusual event (e.g., cluster of animal mass deaths)
4. Data for laboratory surveillance	Serological survey, Laboratory report for HIV sero-surveillance, Laboratory identification of etiologic agent for diagnosis of a certain disease
5. Data for analyzing disease occurrence and risk factors	Record of demographic data, Risk behavior survey, Finding of disease vector or animal reservoir
6. Data for healthcare and health system surveillance	Medical care statistics, Record from cooperative network of health professionals, Record of specified health indicators, Record of specified administrative data
7. Environmental data	Water quality assessment, Measurement of hazardous chemical exposure in factory

There are five data collection approaches in surveillance including passive surveillance, active surveillance, sentinel surveillance, community-based surveillance, and syndromic surveillance. Key features of these approaches are summarized in Table 4.

Table 4 Data collection approaches in surveillance and corresponding key features

Data collection approaches in surveillance	Key features
1) Passive surveillance	• Data reported by providers working in routine practice • Aim to measure magnitude of health problems • Economical and likely to be sustainable in a long run • Obtain only the data of individuals utilizing facility • Data can be used as baseline for further consideration of additional active surveillance.
2) Active surveillance	• Direct data collection from original source by personnel in surveillance system themselves of a certain objective • Aim to provide better estimate of prevalence or burden of disease from cases living in a specified community. • Require more budget, time, personnel, and other resources to conduct than required for passive surveillance • Preferably periodical undertaking
3) Sentinel surveillance	• Data specifically collected for analysis of disease pattern • Focus on data of a certain subgroup rather than the whole population, a certain catchment area, or a certain disease factor • Can be either passive or active surveillance (depending on the role of surveillance personnel in data collection)
4) Community surveillance	• Community residents act as data collector. • Report of unusual event or outbreak in community and further urge investigation. • Notably useful for initiation of outbreak investigation
5) Syndromic surveillance	• Focus on data of clinical syndrome occurring before complete progression to disease status, or signs and symptoms occurring prior to diagnosis of disease • Some signs and symptoms can be put under surveillance prior to certain diagnosis of disease. Examples of syndrome put under surveillance are Influenza-like illness (ILI) and Acute Flaccid Paralysis (AFP).

4.2 Data analysis

Data analysis approach in descriptive study is usually adopted for analysis of surveillance data. Typical aim of analysis is to reveal magnitude, pattern, and trend of a certain health problem. To achieve this goal, data are analyzed to primarily identify magnitude using appropriate indicator for health event of interest. Prevalence is a common measurement of magnitude in case of non-communicable disease. Incidence can also be of choice to identify magnitude in case of injury and cancer. In addition to identifying magnitude of problem, pattern and trend can be analyzed by person (person at risk), place (risk area), and time (time at risk).

Affected group of persons, or the 'person' element, is generally described by demographic factors (e.g., age, gender, socioeconomic status). Other characteristics can also be described, based on objective of surveillance. These characteristics are, for instance, presence of risk factor (e.g., smoking status), presence of protective factor (e.g., history of immunization), underlying systemic disease, and personal hygiene practice (e.g., tooth brushing habit).

The 'place' element of analysis is geographical analysis in relation to the health event. Urban and rural areas are different in terms of living environment, population density, availability and accessibility to health facility, and several other conditions. Geographical analysis would additionally provide information on area-specific factors which potentially influence health and disease in residents dwelling in the area. Specifying catchment area of interest would also allow measurement of disease frequency (e.g., prevalence and incidence). Disease occurrence only in a certain place would imply risk area which further urges investigation of area-specific factor which influence such occurrence.

Analysis of 'time' element is also important since natural course of disease requires time period to progress (e.g., induction period for non-communicable disease occurrence and incubation period for infectious disease). Moreover, dynamic change of disease occurrence can be observed overtime. There are four time trends commonly analyzed in epidemiology; including secular trend, seasonal pattern, cyclical trend, and epidemic disease occurrence.[2] Analysis of health event over a long period of time (e.g., years, decade) is recognized as 'secular trend analysis'. Graphical display of data is usually applied to reveal how occurrence of the health event in a defined population changes over the long observed period. 'Seasonal pattern' can be revealed when occurrence of health event exhibits a certain seasonal pattern. Dengue hemorrhagic fever is an example of disease with seasonal variation in terms of transmission. 'Cyclical trend' can be analyzed for health event hypothesized to have cycle of occurrence or repeat a certain pattern again and again overtime. An example of health event with cyclical trend is cyclical vomiting syndrome. 'Epidemic disease occurrence' is characterized by disease outbreak or disease occurrence which exceeds regularly expected occurrence rate in a particular period of time. The outbreak of acute foodborne gastrointestinal disease in Oswego County is a classic example for the epidemic occurrence of disease.28 Elements in analysis of surveillance data can be summarized in the following Box 2.

Box 2. Elements in analysis of surveillance data

- **Measuring 'magnitude' of problem**
  (using epidemiological measurements–incidence and prevalence)
- **Description of pattern and trend**
  - **Analysis by 'person' characteristics**
    - **Age** *(e.g., disease incidence by age)*
    - **Gender** *(e.g., lung cancer risk behavior by gender)*
    - **Ethnic groups** *(e.g., incidence of Tuberculosis among different ethnic group in the USA)*
    - **Marital status** *(e.g., cervical cancer incidence among single and married women)*
    - **Occupation** *(e.g., symptoms indicating pesticide exposure among chili farmers)*
    - **Socioeconomic status** *(e.g., malnutrition among children in low socioeconomic status families)*

  - **Analysis by 'place' characteristics'**
    - **International comparison** *(e.g., estimated numbers of HIV/AIDS cases among different Asian countries)*
    - **Intra-country comparison** *(e.g., comparison of infant mortality rate by regions in Thailand)*
    - **Urban-rural comparison** *(e.g., incidence of diabetes mellitus by area of residence in Thailand)*
    - **Local distribution of disease** *(e.g., spot map of dengue hemorrhagic fever cases in a certain district)*

  - **Analysis by 'time' characteristics'**
    - **Time onset** *(e.g., incubation period in infectious disease)*
    - **Secular trend** *(e.g., twenty-year trend incidence and mortality of cardiovascular disease in the United States)*
    - **Cyclical variation** *(e.g., mode of occupational injuries by month)*
    - **Seasonal pattern** *(e.g., seasonal pattern of dengue hemorrhagic fever)*
    - **Point epidemic** *(e.g., foodborne outbreak)*

4.3 Data interpretation

Interpretation of surveillance data is critical since the interpretation would further lead to consideration whether public health action is really needed. Key issues in data interpretation is the identification of accurate increase in disease occurrence–to a certain extent that extra public health action is promptly needed to timely control or prevent the disease.[2] Observed increase in disease occurrence can be confounded or influenced by other factors. The observed increase maybe due to the larger size of population investigated.[2] Disease screening campaign and improved diagnostic technique with better sensitivity can as well increase case finding.[2] Reporting system also determine the number of case to be found.[2] These factors should be rationally ruled out before making conclusive interpretation of data that the disease occurrence is actually increased.

Different epidemiological measures provide different information. Rational selection of these measures to give an answer to a specific question regarding situation of interested health event is thus crucial. Epidemiological measures commonly used in surveillance are incidence rate, incidence proportion, period prevalence, point prevalence, mortality rate, and case fatality rate. These measures must be well selected since they allow different implications and interpretation of the measures must be scientifically sound.

4.4 Data dissemination and link to public health action

Major issue in surveillance data dissemination is 'who need to know?'. Since the primary aim of surveillance is to provide information for public health action, authoritative health personnel who require information for decision whether to act are thus the ones must be informed. The pattern of data dissemination from local or subsequent levels to the higher hierarchies can be viewed as a 'down-top' dissemination of data. This direction of data dissemination usually link to public action in terms of 'planned response' or planning for control and prevention of disease.

Nevertheless, the health personnel at subsequent levels must also be well informed of the situation. This is due to the fact that local personnel must provide 'acute response' in case that prompt action is needed, such as the case of outbreak. Moreover, implementation of policy at local levels requires judgment and application which is relevant to the local context or setting by these personnel. This 'top-down' dissemination of data and policy can also provide feedback and stimulate improvement in surveillance data reporting at the local levels. The overall system of surveillance can be illustrated in the following Figure 1.

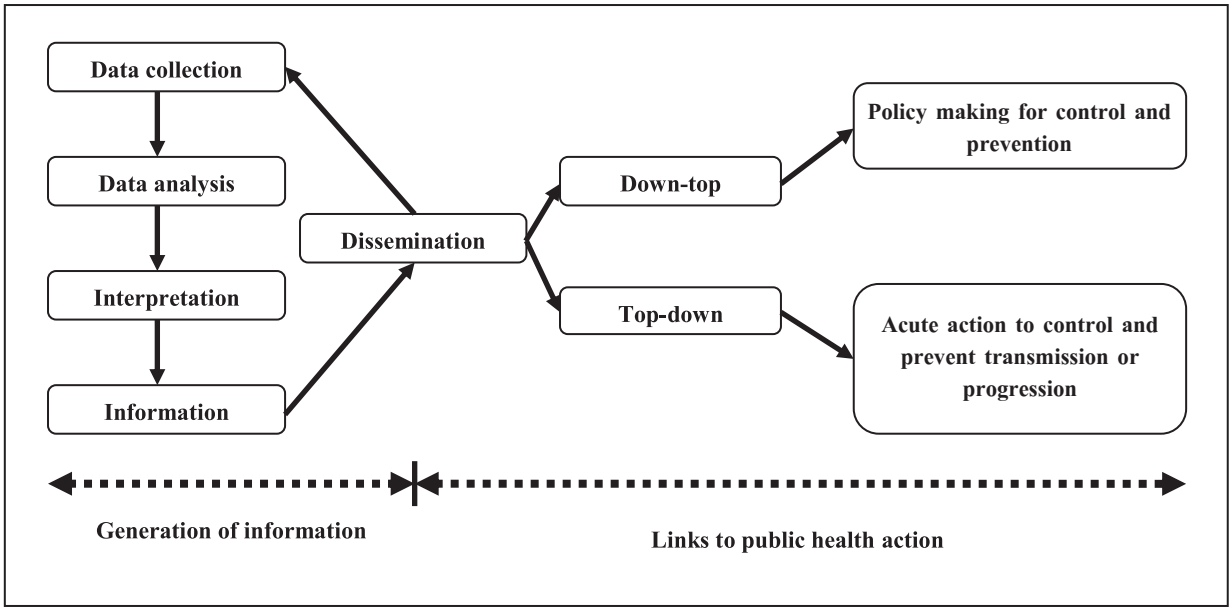

Figure 1 Overall system of surveillance and link to public health action

5. Challenging issues and technical advancement in surveillance

Practice of surveillance continuously evolves in response to the dynamic change in health and disease condition in population. From the early concept of detecting infected case, focus of modern approach in infectious disease surveillance has shifted to forecasting future incidence or outbreak with advanced techniques such as mathematical modeling.[29,30] This approach enables timely warning, preparation of health facilities, and preparedness of professionals to properly manage abruptly increased demand. Nonetheless, challenges in forecasting exist especially in terms of predictive accuracy of future occurrence.[31]

Surveillance of emerging and re-emerging infectious diseases is another field which rapidly evolves in accordance with dynamic change in lifestyle (e.g., drug abuse)[32], altered ecosystem (e.g., land use, deforestation, pesticide use)[33], food production (e.g., Escherichia coli O104:H4 contamination)[34], and globalization (e.g., Ebola pandemic)[35]. Since the disease emergence is influence by various factors, interdisciplinary collaboration and applying multiple strategies to strengthen corresponding surveillance system can be a solution. 'One health' disease surveillance, for example, is an approach combining expertise in several disciplines (e.g., veterinary and environmental sciences) to control diseases (e.g., zoonoses).[36] Advances in laboratory-based surveillance also contribute to near real-time recognition of outbreak in community.[37] In response to globalization, International Health Regulations (IHR) has been established for international community to co-operatively build up international surveillance system which timely detects, notify and response to public health risks–such as surveillance in international airports.[38]

Major challenges in implementing the IHR include requirement of expertise and resource, governance, international collaboration, and political barrier.[38]

Surveillance of non-communicable diseases is growing in its importance. Its modern paradigm has shift towards health promotion and prevention. With advances in causal research in epidemiology, risk factors of many non-communicable diseases have been revealed. Such knowledge further enables establishment of risk factor surveillance for major non-communicable diseases (e.g., cardiovascular disease).[39,40] Behavioral risk factors are also of interest in modern surveillance since many non-communicable diseases are related to lifestyle and personal health behavior.[41]

Conclusion

The concept of surveillance has long been developed from individual-based monitoring to population-based surveillance with organized system to generate quality information which links to public health action. Objective of surveillance must be specified prior to data collection since the objective would indicate which data are needed for the required information. Various health events can be put under surveillance and not only limited to disease occurrence. Different data collection approaches can be adopted to suit the context of surveillance. In analysis of surveillance data, descriptive epidemiological method is importantly adopted to reveal magnitude and pattern of health problem. Longitudinal data collection would additionally allow analysis of trend of such problem. Information obtained from interpretation is primarily disseminated to those in need of such information. Link to public health action can be either information for prompt action or information for planning. Since health and disease condition in population is dynamic; practice of surveillance is also advanced with medical and information technology, and the paradigm shift towards preventive health orientation.

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