National Communicable Disease Surveillance System: A review on Information and Organizational Structures in Developed Countries

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ABSTRACT

Introduction: To obtain necessary information for managing communicable diseases, different countries have developed national communicable diseases surveillance systems (NCDSS). Exploiting the lesson learned from the leading countries in development of surveillance systems provides the foundation for developing these systems in other countries. In this study, the information and organizational structure of NCDSS in developed countries were reviewed. Methods: The study reviewed publications found on the organizational structure, content and data flow of NCDSS in the United States of America (USA), Australia and Germany that were published in English between 2000 and 2016. The publications were identified by searching the CINAHL, Science Direct, ProQuest, PubMed, Google Scholar databases and the related databases in selected countries. Results: Thirty-four studies were investigated. All of the reviewed countries have implemented the NCDSS. In majority of countries the department of health (DoH) is responsible for managing this system. The reviewed countries have created a minimum data set for reporting communicable diseases data and information. Conclusion: For developing NCDSS, establishing coordinator centers, setting the effective policies and procedures, providing appropriate communication infrastructures for data exchange and defining a communicable diseases minimum data set are essential. Keywords: Communicable diseases, surveillance system, data content, data flow, organizational

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1. INTRODUCTION

Over the centuries, communicable diseases have always been as one of the main threats for human health. These diseases often spread quickly (1) and resulted in high mortalities (2, 3, 4). Between 2011 and 2014 respiratory infectious diseases, diarrhea, AIDS and malaria have constantly been on the top 10 causes of death worldwide (5, 6).

Effective management of communicable diseases requires developed systems which provide timely, comprehensive and updated information (7). At the end of the last century, many countries implemented NCDSS for the ongoing, systematic collection, analysis and interpretation of the communicable diseases data (8, 9). Surveillance systems should be capable of laying the foundation for effective controlling and managing of communicable diseases (10, 11). Some of these capabilities that have been identified by WHO are: the capability of providing key and supportive services of surveillance system, having the appropriate structure and high quality information (12, 13, 14, 15).

WHO specifically emphasizes on provision of timely, comprehensive and reliable data and information by surveillance systems and notes that effective management of data and information at different levels, is related to high quality data content and timely exchange of data with related organizations (16). Establishing effective communication among related organizations, centers, individuals and departments during the data generation and exchange process is of particular importance for timely and quick data exchange for communicable diseases.

A mechanism should be defined to release data for decision makers and policy-making centers (1, 17). Development of electronic system for collecting and reporting communicable diseases data provides timely exchange of such data (16). Many of developed countries have created a national communicable diseases surveillance system and saved the collected data in a centralized data warehouse. In these countries, the ministry of health is directly in charge of coordinating and supporting this system. Different organizations at the local and state levels work with the ministry of health for data exchange (14).

In every country the creation and implementation of surveillance systems is essential for effective controlling and managing of communicable diseases (16, 17). Therefore, the awareness of the NCDSS structure in developed countries and using the experiences of these countries could pave the road for promotion of surveillance systems in other countries, especially in developing countries. Thus this research aims to review the organizational structure, data content and data flow of NCDSS in developed countries.

2. METHODS

Data were collected through search in CINAHL, Science Direct, ProQuest, PubMed and Google Scholar databases as

well as the publications of the USA Center for Disease Control and Prevention, Germany's Robert Koch Institute and Australian Department of Health and Aging. The studies that described the NCDSS in terms of organizational structure, data content and flow in selected countries (USA, Australia and Germany) during 2000-2016 period and published in English were included in this study. The USA and Australia were selected for their progressive development in reporting and launching communicable diseases surveillance systems. They have employed such systems for almost a century (18, 19). Germany was selected for the highest rate of information reporting to the European Surveillance System (TESSy) among European countries (20). The search terms included, but not restricted to, communicable diseases, surveillance system, data content, data flow, organizational structure, and developed countries. Thirty-four studies from the USA, Germany and Australia were retrieved used in the findings.

3. RESULTS

The Organizational Structure of Surveillance Systems in Selected Countries

There is a National Notifiable Diseases Surveillance System (NNDSS) in the US which saves the communicable diseases data and information received from across the country. This system encompasses reports on 172 diseases of which more than 57 of them are infectious.

Office of Infectious diseases (OID) as a division of Center for Diseases Control and Prevention (CDC) is tasked with managing communicable diseases and the NNDSS. The mission of the Office of Infectious Diseases is to lead, promote, and facilitate science, programs, and policies to reduce the burden of infectious diseases in the United States and globally (18, 21, 22, 23).

The Council of State and Territorial Epidemiologists (CSTE) is a leading center working with CDC. CSTE Pro-

Component of organizational structure	Australia	United States of America	Germany
National Communi- cable diseases surveil- lance system	National Notifiable infec- tious diseases surveillance system	National Notifiable infectious diseases surveillance system	ServNet@RKI
Leading organiza- tions at national level	-Department of Health and Ageing -Communicable Diseases Network Australia (CDNA) and Public Health Laboratory Network (PHLN)	Department of Health and Human Services Center for Diseases Control and Prevention Office of Infectious Diseases	-Robert Koch Institute -department of Infectious Diseases, -department of Epidemiology and Health monitoring
Policy-Maker organi- zations	-territorial and state health authorities -Office of Health Protection -Health Protection Policy Branch	-Council of State and Ter- ritorial Epidemiologists, in collab- oration with Centers for Disease Control and Prevention	-department of Epidemi- ology and Health moni- toring in collaboration with specialized committees on epidemiology of infectious diseases
Active organization in data gathering	-Public health units -Territorial health authorities -State health authorities -Department of Health and Ageing	-Territorial health depart- ments -State health departments -Centers for Disease Con- trol and Prevention	-local health departments - state health departments - RKI Divisions
Responsible centers for information management	Surveillance and Epidemi- ology Section	-Division of Health Infor- matics and Surveillance (DHIS)-Territorial health de- partments -State health departments	surveillance Unit and man- agement unit as divisions of Department of infec- tious disease Epidemiology

Table 1. Organizational Structure of National Communicable Disease Surveillance System in selected countries

vides technical advice and assistance to partner organizations and to federal public health agencies such as the Centers for CDC. This council is responsible for creation and revise of notifiable conditions annual list (24, 25). CDC's are working actively in all states and territories in the US and are tasked with leading and managing communicable diseases at these levels (Table 1) (26).

DHIS supports NNDSS by receiving, securing, processing, and providing nationally notifiable infectious diseases data to disease-specific CDC programs (27, 28). National Notifiable Disease Surveillance system (NNDSS) of Australia was launched in 1991 as the primary surveillance system of this country. The Australian Government manages NNDSS under the auspices of the Communicable Diseases Network Australia (CDNA) and coordinates the surveillance of 69 infectious diseases and conditions were nationally notifiable (29, 30, 31).

Communicable disease surveillance in Australia operates at the national, state and local levels. Department of Health and Ageing (DoHA) is in charge of coordinating a response to national or multi-jurisdictional outbreaks; detecting outbreaks and identifying national trends; providing guidance for policy development and resource allocation at the national level.

Office of Health Protection as a division of Australian DoHA holds key roles as a coordinator of national action in response to communicable disease outbreaks, and as a leader in the development of best practice guidelines and national public health policy. There is a Health Protection Policy Branch (HPPB) in DoHA which provides national leading, policy-making, analysis, coordination and communications, formulation of care strategies and responses to the threats posed by emerging infectious diseases (32, 33, 34, 35).

The Australian Health Protection Principal Committee (AHPPC) as one of the several active committees of

HPPB provides overarching national leadership on emerging health threats related to communicable diseases (34). The AHPPC reports to the Australian Health Minister's Advisory Council (AHMAC), an Australian Governments' Standing Council on Health (SCoH). Reporting to AHPPC are six Standing Committees with a key role in national health protection issues. The two networks with the broadest scope to oversight communicable disease control are Communicable Disease Network Australia (CDNA) and Public Health Laboratory Network (PHLN). All public health units, territories and state health centers and centers affiliated with DHoA are involved in the management process of communicable diseases. Also, Surveillance and Epidemiology Section of DHoA has been tasked with information and technical supports (32).

Since its inception in 1981, Robert Koch Institute (RKI) has been assigned to managing infectious diseases in Germany. According to Infektionsschutzgesetz Act (IfSG), RKI as one of the leading health institutes of Germany is responsible for collection, analysis and interpretation of epidemiological data of infectious diseases forwarded from across Germany (Table 1) (36, 37, 38).

In 2001, the Robert-Koch-Institute (RKI) implemented a new electronic surveillance system for infectious disease outbreaks (SurvNet) in all administrative levels of the German Public Health system. This system was primarily intended to assure the exchange of data of communicable diseases among healthcare institutions at local, state and federal levels. This system was adopted in 2006 by 431 local

levels. This system was adopted in 2006 by 431 local health departments, the 16 state health departments and RKI itself (39, 40).

In Germany, the data surveillance and data management units which have been defined as divisions of RKI's department of epidemiologic of infectious diseases are responsible for informational and technical supports of SurvNet@RKI. In compliance with Infektionsschutzgesetz Act, The surveillance unit has been tasked with implementing the reporting system. Data Management Unit is responsible for designing, developing and managing IT projects in relation to infectious diseases (Table 1) (41, 42).

The Information Structure of Communicable Diseases Surveillance Systems in Selected Countries

Regarding data content, the results revealed that core data which include demographic, treatment, laboratory, vaccination, epidemiologic and pharmaceutical data are gathered and recorded in all of the reviewed countries (43, 44, 45).

In the US, demographic, treatment, laboratory and epidemiologic data are reported to local health departments and then state centers from their sources of origin (surgeons' offices, hospitals, dentist's offices and etc.). Then data are sent to CDC for further action and analyses. Reporting of notifiable diseases is mandated only at state level. National Electronic Diseases Surveillance System (NEDSS) is tasked is tasked with e-transfer of data of the surveillance system from the healthcare sector to the public health sector. In fact it is assigned to transfer the data to NNDSS (46, 47, 48, 49).

Compared Information Component	United States of America	Australia	Germany
Data Sources	-Physician offices -Hospitals -Health maintenance organizations -Blood transfusion centers -Blood banks -Health care organizations -Veterinarians -Health care practitioners -Laboratory departments -Schools -Prisons/reform schools -Dentist offices -Nursing care facilities -Medicolegal -Registration of vital statistics -Day-care clinics	-Physician offices -Laboratory offices -Private and public HospitalsDay-care clinics -Children Keeping House -Schools	-Physician offices -Laboratory offices -Private and public Hospitals -Veterinarians care centers
Data Content	-Demographic -Clinical -Diagnostic -Epidemiological -Microbiological -pathological -Risk factors -Immunization -Para clinical -Environmental	-Demographic -Clinical -Microbiological -Vaccination -Risk factors -Mortality -Personal and family History -Geographical Lo- cation	-Vaccination -Demographic -Clinical -Time and date -Location -Diagnostic -Criteria for case definition -Risk factors
Reporting Levels	-Territorial -State -Local	-National -State and territorial -Local	-Federal -State -District
Types of Results Dis- semination	Mortality and Morbidity Weekly Report(MMWR)	Communicable Diseases Intelli- gence(CDI)	SurvStat@RKI RKI Web Site

Table 2: Data Sources, Data Content and Reporting Levels of Communicable diseases Data in Selected Countries

In the US, in collaboration with NNDSS, the DHIS prepares a brief report that contains the information and the last status of communicable and non-communicable diseases to be published in the mortality and morbidity weekly reports (MMWR) (Table 2) (27).

In Australia, demographic, treatment, personal and family information as well as microbiological data are forwarded on a daily basis from their sources of origin to local health centers and then to state or regional centers. In the next stage, the authorities send their reports to the national level (50, 51, 52).

In DoHA, the unit for separation of personal specifications as a division of office of epidemiologic of communicable diseases sorts out the reports planned to be forwarded to the Office for Aging and the Aged Care and then posts them on Australia's quarterly journal for Communicable Diseases Intelligence (Table 2) (30).

In Germany, demographic, treatment, vaccination, diagnostic and risk factors are electronically forwarded to state SurvNet@RKI as the set of minimum data from their sources of origin i.e. public and private hospitals, laboratories and other healthcare providers. Then the data are sent to federal SurvNet@RKI for further action and analyses (Table 2) (6, 53).

4. DISCUSSION

The results showed that the reviewed countries have developed their electronic systems for storing data of communicable diseases at a national level (23, 30, 39). There is world-

wide consensus on the need for improvement and upgrade the current surveillance system relative to emerging infectious diseases. Electronic communicable diseases surveillance system can speed up the reporting process of diseases; facilitate data aggregation and managing bulks of data (54, 55).

In spite of advantages of electronic reporting systems and despite the fact that national communicable diseases surveillance systems have been in place, the results revealed that the electronic surveillance systems of the studied countries are far from the desirable state at both local and state levels.

The experience and profiles of developed countries indicate that such systems could not be initiated so long as the proper infrastructures are not implemented for data exchanges across different centers (23, 31, 37, 38).

Poor communication among the centers and organizations related to management of communicable diseases at different levels was one of the drawbacks detected in the studies countries (10, 14, 16). In his study, Tucker suggests that defining a certain center for leading and coordinating the entities involved in control and prevention of communicable diseases is one of the most important requirements for launching communicable diseases surveillance systems (56).

In his review study of surveillance systems, Dato suggests that a number of centers should be set up at different levels for feeding information and technical information into the communicable diseases surveillance system of. These centers must be assigned to management and assessment of surveillance system data, constant analysis of communicable diseases data, defining criteria for inclusion of diseases into the surveillance system and dissemination of information about the diseases (10, 57).

Relative satisfaction was expressed regarding the surveillance systems in the studied countries. A number of issues such as shortages of human resources and underfunding, poor coordination among entities involved at different levels, poor informatics skills of the surveillance staff, failure to implement proper standards for data exchange and security and failure of higher levels to give feedbacks to lower tiers had prevented the systems from winning the full satisfaction of the clients (22, 29, 36). The results revealed that the minimum data set, i.e. demographic, laboratory, clinical and vaccination data are recorded and reported in the studies countries (43, 46, 49, 52). In these countries, data of most communicable diseases are first sent to local or territorial health departments which have them forwarded to national surveillance systems. Therefore, making sure that the collected data are consistent, comprehensive and comparable at different levels is a critical point (29, 36). European center for Disease control and prevention has defined a list of essential data for European countries for reporting cases of communicable diseases which include epidemiological, demographic, clinical, laboratory and risk factors (58).

WHO has made it clear in its manual of monitoring and assessment of communicable diseases surveillance and reporting that every country has the task of collecting essential data such as demographic, clinical, risk factors, geographical and epidemiological data and submit cumulative reports to that organization about the rate of incidence and outbreaks of such diseases, their fatality rates and mortality statistics of each disease (12).

Data source is a place where initial disease information is collected and forwarded to public health centers (58). Laboratory, general practitioners' offices and hospitals are known as conventional sources of reporting cases of communicable diseases (59). The results of this study revealed that data sources at least included Laboratory, general practitioners' offices and hospitals and healthcare providers (41, 47, 49). Every organization, center and interested entity that is involved in the process of recording, diagnosing, treatment and dissemination of communicable diseases data must establish close communication with surveillance systems. Weak contribution of the private sector in the management of communicable diseases was one of the challenges in the studied countries (15, 18).

5. CONCLUSION

In developed countries, control and management of communicable diseases have departed from paper-based systems and moved towards electronic systems. For this, a large number of developed countries have started implementing national electronic surveillance systems. However, they are far from satisfactory initiation of such electronic system at lower levels. Using the experience of these countries could give other countries a shortcut to implementing effective surveillance system with the ultimate goal of successful management of communicable diseases.

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