WEEKLY EPIDEMIOLOGICAL REPORT

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Geographic Information System and Public Health: Disease surveillance and outbreak investigation

Disease surveillance is the systematic collection, compilation, analysis, interpretation of the data and dissemination of the information generated following analysis to the relevant stakeholders for necessary action on a given disease. Disease surveillance is regarded as one of the primary duties of public health work. The main purpose of disease surveillance activities is to study the pattern of disease occurrence and the characteristics of the population who contract the disease. This kind of information is needed for further investigation of the disease, implementation of control and preventive measures for the diseases where they are already available. In other instances surveillance data can be used to study the natural history, epidemiology and clinical spectrum of novel diseases. Surveillance data can also be used to monitor prevention and control activities which are already in place.

However much the health authorities strengthen their surveillance activities followed by preventive and control activities, there are instances where diseases are occurring in large numbers than expected which is known as an outbreak or epidemic. These incidences occur may be due to weakness in surveillance and control activities, change of virulence of the pathogen, change of vector if any, change of behavior of the host or combination of causes. Therefore, investigation into the increase in number of disease occurrence is of utmost importance to find out the cause for outbreak of the disease. This is one of the duties of an epidemiologist under immense pressure because of cause and sources are sometimes unknown for the outbreak of diseases, hence prompt action against outbreak might be delayed.

Geographic Information System (GIS) is a system that consists of computer hardware, software programs and trained personnel who operate it. The computer system is designed for data collection, storage, manipulation, analysis and presentation of data in a geographic context. The data attributes that are linked with geographic coordination are technically known as spatial data. The spatial data are commonly gathered by means of Global Positioning System (GPS) and Remote Sensing (RS). Digitizing a scanned map can also be used for spatial data collection.

When coming into the health arena, GIS functions that are needed for public health applications, three broad categories of functions can be identified for public health application. Such as,

- Spatial database management
- Visualizing and mapping of data
- Spatial analysis

Any database management system has four main core functions. They are the modeling language, data structure, database query language, and transaction mechanisms. The main feature that differentiate GIS database from all other databases is simply the presence of geographic location as a field in GIS database. With this addition of location attribute to the database, GIS user can do the visualization and analysis of available data with reference to the geography. Theoretically it is quite possible to convert an available "non GIS database" to GIS database just by adding the geographic coordinate fields to the existing database.

When a database consists of geographic coordinates it is a matter of few mouse clicks to visualize on a georeferenced map using GIS software. There are many methods to present them in a visually appealing manner, giving first sight impression as well as easy understandability. GIS also gives the capability of automatic updating a map by linking dynamically with the database.

When coming to analysis, there are five ma-

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jor classes of spatial analytical methods that are available for public health worker to be used. They are as follows,

- Measurement
- Topological analysis
- Network analysis
- Surface analysis
- Statistical analysis

Under each of these major classes there are many other functions that can be used to analyze public health data in a specific way to find the solutions for specific problems.

World Health Organization is also now using the GIS capabilities to manage many communicable disease conditions throughout the world. Among them are HIV/ AIDS, malaria and recent H1N1 influenza pandemic. These applications have shown the promising capabilities of GIS in disease surveillance and outbreak management. WHO has developed its own GIS software known as *Health Mapper* specially to address public health problems. According to the WHO following are the uses of GIS in public health.

- Determining geographic distribution of diseases
- Analyzing spatial and temporal trends
- Mapping populations at risk
- Stratifying risk factors
- Assessing resource allocation
- Planning and targeting interventions
- Monitoring diseases and interventions over time

One of the core areas that build the public health as a discipline is epidemiology. Epidemiology is defined as the study of determinants and distribution of the disease frequency in the context of time, place and person. Therefore the full extent of an epidemiological description of a disease should contain a balance account of time, place and person. Though that is what the theory expects, in reality poor description of place or the geographic location was noted due to the absence of the exact location of the individuals who are affected by the disease event under scrutiny. Therefore, it is a felt need for a system that supports the analysis data based on the geography and that is what GIS exactly does.

In addition, human beings are more visually oriented when considering senses. This gives a good opportunity to use maps for better presentation other than words or tables.

When the definitions for the GIS and Surveillance are examined, both are consisting of data collection, compilation, manipulation and analysis components. Therefore, GIS can be used to create and maintain a disease surveillance database in its simple use. When considering the advanced spatial analytical capabilities of the GIS, they can be efficiently used for analysis of the disease surveillance data. This will give the opportunity for better description of the disease patterns in time, place and person attributes and generating information visually for dissemination; fulfilling the functions of a basic surveillance system.

Disease surveillance data collected in a GIS enabled database and link to an area map with auto updating capabilities gives the opportunity to identify disease clustering, path of propagation of the disease as well as to calculate the epidemiological rates needed. This scenario helps to emit early warning of a possible outbreak to its user by the GIS system. This is the expected output of a surveillance system. This enables the user to curtail the outbreak efficiently. It also gives the advantage of resource management. According to the area affected, resources that are needed for the management of the outbreak can be directed from the adjacent localities in a cost effective manner using the geographic information such as distance, barriers for transportation etc. It is also possible to analyze the geography of the area under the outbreak and using those findings look for such similar areas where the outbreak risk is high. This gives the much needed edge of advantage in time to take additional measures to prevent an outbreak at those locations.

Although computers and GIS were not available, examples of use of GIS in public health can be found even in the 19th century though it is not fitting fully with the present day definitions. The famous example of use of GIS in the public health field is the spot map of Dr. John Snow which he had used in cholera epidemic in 1854 in London. Use of cartographic and GIS techniques for epidemiological work was remarkably demonstrated in his exercise. He used a map to describe the cholera epidemic in epidemiological terms by using the exact geographic locations in addition to other data attributes of each reported cholera case from the city of London. In addition, he had the buildings, roads, water sources marked on the map exactly at the place they appeared in real geography. This map allows Snow to identify the cluster of cholera cases. Then he analyzed other attributes that are common to those clusters. By doing so he must have come to the conclusion that water from the Broad Street pump had used by many of the cases in those disease clusters and Snow developed the hypothesis that water from the Broad Street pump was causing the disease. Then he was able to prove the hypothesis just by removing the pump handle. This account shows the basic use of GIS in disease surveillance, outbreak investigation and management by Dr. Snow. He has developed a database by going to each house and converted it to GIS database by taking the exact location of the cases placed in real geography. Then he used a map showing the objects in the same locality such as roads, buildings, water sources etc. With the technology in his era he had put all these items in one paper. Present day the computer system can use each of these items separately as isolated layers (e.g. road layer, building layer, water layer etc.) to introduce into the map or remove it from the map as the user wishes.

The present day examples for use of GIS in public health can be found even within Sri Lanka. This technology is currently being used to track the chronic kidney disease patients in the North Central province and malaria patients in an island wide manner to have better description of disease spread over the geography. This will specially help to find the causes for chronic kidney disease which is a unsolved problem for many decades.
In conclusion, if appropriately use, the GIS will enhance the surveillance systems currently in place for disease surveillance while responding to disease outbreaks efficiently, setting the ground for better control over communicable diseases and non communicable diseases as well.

This article was complied by Dr. Chathura S Edirisuriya, Registrar (Community Medicine)

Table 1: Vaccine-preventable Diseases & AFP

13th - 19th March 2010(11th Week)

Disease	No. of Cases by Province									Number of cases during current week in 2010	Number of cases during same week in 2009	Total number of cases to date in 2010	Total number of cases to date in 2009	Difference between the number of cases to date in 2010 & 2009
	W	C	S	N	E	NW	NC	U	Sab					
Acute Flaccid Paralysis	00	00	00	00	00	00	00	00	00	00	01	21	14	+ 50.0 %
Diphtheria	00	00	00	00	00	00	00	00	00	00	00	00	00	-
Measles	01	02	00	01	00	00	01	00	00	05	02	53	32	+ 65.6 %
Tetanus	00	00	00	00	00	00	00	00	00	00	01	06	07	- 14.3 %
Whooping Cough	00	00	00	00	00	00	00	00	00	00	00	04	17	- 76.5 %
Tuberculosis	117	02	06	11	03	04	18	00	46	207	252	2188	1762	+ 26.2 %

Table 2: Newly Introduced Notifiable Disease

13th - 19th March 2010(11th Week)

Disease	No. of Cases by Province									Number of cases during current week in 2010	Number of cases during same week in 2009	Total number of cases to date in 2010	Total number of cases to date in 2009	Difference between the number of cases to date in 2010 & 2009
	W	C	S	N	E	NW	NC	U	Sab					
Chickenpox	13	16	12	04	05	06	16	06	04	92	643	876	2841	- 69.2 %
Meningitis	02 KT=1 GM=1	02 NE=2	03 GL=3	01 JF=1	02 BT=1 TR=1	01 KG =1	01 PL=1	01 BD=1	01 RP=1	15	17	379	214	+ 91.7 %
Mumps	04	01	03	01	01	04	00	01	02	17	28	379	405	- 06.4 %
Leishmaniasis	00	00	01 HB=1	00	00	00	01 AP=1	00	00	02	13	82	315	- 74.0 %

Key to Table 1 & 2

Provinces: W: Western, C: Central, S: Southern, N: North, E: East, NC: North Central, NW: North Western, U: Uva, Sab: Sabaragamuwa.

DPDHS Divisions: CB: Colombo, GM: Gampaha, KL: Kalutara, KD: Kandy, ML: Matale, NE: Nuwara Eliya, GL: Galle, HB: Hambantota, MT: Matara, JF: Jaffna, KN: Killinochchi, MN: Mannar, VA: Vavuniya, MU: Mullaitivu, BT: Batticaloa, AM: Ampara, TR: Trincomalee, KM: Kalmunai, KR: Kurunegala, PU: Puttalam, AP: Anuradhapura, PO: Polonnaruwa, BD: Badulla, MO: Moneragala, RP: Ratnapura, KG: Kegalle.

Data Sources:

Weekly Return of Communicable Diseases: Diphtheria, Measles, Tetanus, Whooping Cough, Chickenpox, Meningitis, Mumps.

Special Surveillance: Acute Flaccid Paralysis.

Leishmaniasis is notifiable only after the General Circular No: 02/102/2008 issued on 23 September 2008.

Table 4: Selected notifiable diseases reported by Medical Officers of Health

13th - 19th March 2010(11th Week)

DPDHS Division	Dengue Fever / DHF*		Dysentery		Encephalitis		Enteric Fever		Food Poisoning		Leptospirosis		Typhus Fever		Viral Hepatitis		Human Rabies		Returns Received
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	%
Colombo	65	1329	6	33	0	4	0	16	0	5	19	162	0	3	0	18	0	1	**92**
Gampaha	73	1393	1	8	0	7	0	10	0	2	12	124	0	1	1	23	0	0	**87**
Kalutara	16	327	2	39	0	4	0	5	0	16	28	84	0	0	0	12	1	1	**83**
Kandy	12	435	3	71	0	0	1	6	0	1	8	18	3	46	1	20	0	0	**78**
Matale	4	283	13	159	0	0	0	7	0	57	0	25	0	0	1	14	0	0	**92**
Nuwara	4	49	5	28	0	0	3	35	0	3	0	6	1	23	0	12	0	0	**100**
Galle	15	164	2	41	0	3	0	0	0	5	2	10	0	2	0	4	0	2	**95**
Hambant	18	244	0	11	0	2	0	1	2	3	0	20	2	37	0	3	0	0	**91**
Matara	4	112	3	30	0	1	0	1	0	35	11	89	2	60	2	9	0	0	**100**
Jaffna	12	1795	4	40	0	1	5	249	0	5	0	0	1	93	2	23	0	1	**58**
Kili-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Mannar	5	60	1	13	0	0	2	20	0	0	0	0	0	0	0	8	0	0	**100**
Vavuniya	19	462	0	13	0	1	0	23	4	5	0	0	0	0	0	5	0	0	**75**
Mullaitivu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Batticaloa	59	736	5	32	0	1	3	8	0	9	0	1	0	1	0	0	0	0	**85**
Ampara	7	37	0	20	1	1	1	3	0	6	0	15	0	0	0	6	0	0	**100**
Trincomal	24	630	1	43	0	4	0	3	0	7	0	8	0	4	2	8	0	0	**80**
Kurunega	23	417	2	59	0	2	0	9	2	3	4	122	1	18	2	32	0	1	**75**
Puttalam	28	445	0	21	0	3	1	29	0	114	0	45	0	0	2	3	0	0	**100**
Anuradha	19	641	0	18	0	0	0	3	21	21	2	16	1	13	2	18	0	4	**58**
Polonnar	12	99	1	19	0	1	1	1	0	2	4	31	0	0	0	13	0	0	**100**
Badulla	17	177	1	47	0	0	1	30	0	10	1	18	1	20	4	18	0	0	**87**
Monaraga	18	124	2	54	0	0	0	16	2	3	0	12	0	14	9	12	0	0	**82**
Ratnapur	38	375	5	83	0	3	1	5	0	8	11	96	0	25	0	33	0	1	**67**
Kegalle	16	293	2	17	0	4	2	19	13	15	5	69	1	5	0	32	0	0	**82**
Kalmunai	16	372	0	38	0	0	0	4	0	0	0	0	0	0	0	7	0	1	**69**
SRI LANKA	**524**	**10999**	**59**	**937**	**01**	**42**	**21**	**503**	**44**	**335**	**107**	**971**	**13**	**365**	**28**	**333**	**01**	**12**	**81**

Source: Weekly Returns of Communicable Diseases WRCD).
*Dengue Fever / DHF refers to Dengue Fever / Dengue Haemorrhagic Fever.
**Timely refers to returns received on or before 19th March, 2010 Total number of reporting units =311. Number of reporting units data provided for the current week: 205
A = Cases reported during the current week. B = Cumulative cases for the year.

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