Health System Cost for Dengue Control and Management in Colombo District, Sri Lanka in 2012

Dengue Tool Surveillance Project, Epidemiology Unit
Ministry of Health

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March 2013

Foreword

This report is a fulfillment of a long felt need to assess the health system cost for dengue control and management, especially those which are of multiple burdens of a major public health problem. Although the emphasis of this work is on cost assessment of a disease, it contains much that will be of interest to those outside this field and to the students and researchers of health economics.

The researcher has carried out types of various analyses related to dengue case management cost for his study, which are interesting and need further attention. I am sure that there would be many angles to be looked into based on this piece of study for anyone with a fascination with the cost assessment of a major public health problem such as dengue with international implications.

Although this represents only a small sample of the world of health economics, it amply illustrates the importance of this field of study to mankind. It is also a unique tribute to the researcher of this study who was involved in various public health related studies of this nature. I think that the researcher can be confident that there will be many grateful readers who will gain a broader perspective of the disciplines of cost assessment as a result of his efforts.

I gratefully admire the effort of Dr. Neil Thalagala as the Principal Consultant of this exercise. Support given by Dengue Tool Surveillance Project is remembered with thanks.I would also thank Prof. Annelies Wilder-Smith (International Coordinator), Dr. Yesim Tozan (Health Economist), Dr. Hasitha Tissera (Principal Investigator), Dr. Ananda Amarasinghe (co-Principal investigator) for their support, encouragement and technical inputs and Dr. Anuradha Ambagahawita for his role in data collection and editorial assistance.

Undoubtedly, the findings reaped from this assessment will be helpful to the administrators, professionals and policy makers in the health care set-up throughout the country. I hope they would make the maximum use of this effort.

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May, 2014

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Abbreviations

BHT–   Bead Head Tickets

CMC–   Colombo Municipal Council

DF –   Dengue Fever

DHF –   Dengue Haemorrhagic Fever

DS–   Divisional Secretary

MOH –   Medical Officer of Health

PHFO–   Public Health Field Officers

PHI –   Public Health Inspector

PPE–   Personal Protective Equipment

RDHS –   Regional Directorate of Health

SMO–   Spray Machine Operators

SPHI –   Supervising Public Health Inspector

Acknowledgment

Summary

Dengue has become a major public health problem in Sri Lanka. In the year 2012, a total of 44,456 cases of dengue have been reported around the country. Of them the largest proportion (22.5%) was reported from the Colombo District. Ministry of Health is considered as the main stakeholder of the national dengue response and as a result the ministry had to invest a considerable amount of resources in this regard. The cost of dengue related preventive and curative efforts have never been studied so far. Therefore this study was conducted to have insight on amount of resources used by the interventions related to dengue prevention and case management. Considering the relative case load of the district and feasibility of obtaining reliable data, study's focus was limited to the health system cost on dengue response in the Colombo district in 2012.

The structure and functions of dengue control and curative programmers were thoroughly reviewed and various cost elements were enumerated. Then these cost elements were examined to identify variable and fixed costs pertaining to each activity within each element. Relevant data items were gathered from the sources in the primary health care system and 7 hospitals that treated dengue inward patients from the Colombo district. Total and disaggregated costs of dengue control and management were estimated.

Health system cost of dengue prevention activities in the Colombo district reached a total of 127 million rupees. Of them 79% were spent on staff remunerations. Further 15 % were spent on fuel and insecticides used in fumigations. Per capita cost of dengue control was around 55.10 rupees.

The total health system cost of dengue inward case management in the Colombo district hospitals in 2012 was around 325.6 million rupees. The cost of managing a case varied by age, type of dengue and place of treatment. If an adult patient with DHF had to be managed in an Intensive care unit, the health system had to spend an average cost of 113,379.13 per patient. An average cost for managing a pediatric patient with DHF in an intensive care unit was around 79,656.40 rupees. The respective costs for DF patients was lesser. Managing patients in ward settings was also relatively less.

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1   Background

Dengue has become a major public health problem in Sri Lanka. In the year 2012, a total of 44,456 cases of dengue have been reported around the country. Of them the largest proportion (22.5%)was reported from the Colombo District. Colombo is the capital city of Sri Lanka. Colombo district is the most urbanized and most densely populated district of the country. According to the latest census data around 2,309,809 people live in this district and this account for 11.4% of the total population of the country. Colombo district is situated in the wet zone of the country and receives an average annual rainfall of 2424 mm, mostly during the south western monsoon period that falls between May and September. The monsoon period often seems to coincide with dengue epidemics. The rainfall during inter monsoon period extending from October to November is also considerable. The following figure presents the patterns of dengue case reporting and monthly rainfall within Colombo district and the pattern of dengue cases reporting in the whole country, during 2012,

Figure 1. Trends in the number of dengue cases reported in Colombo district during 2012.
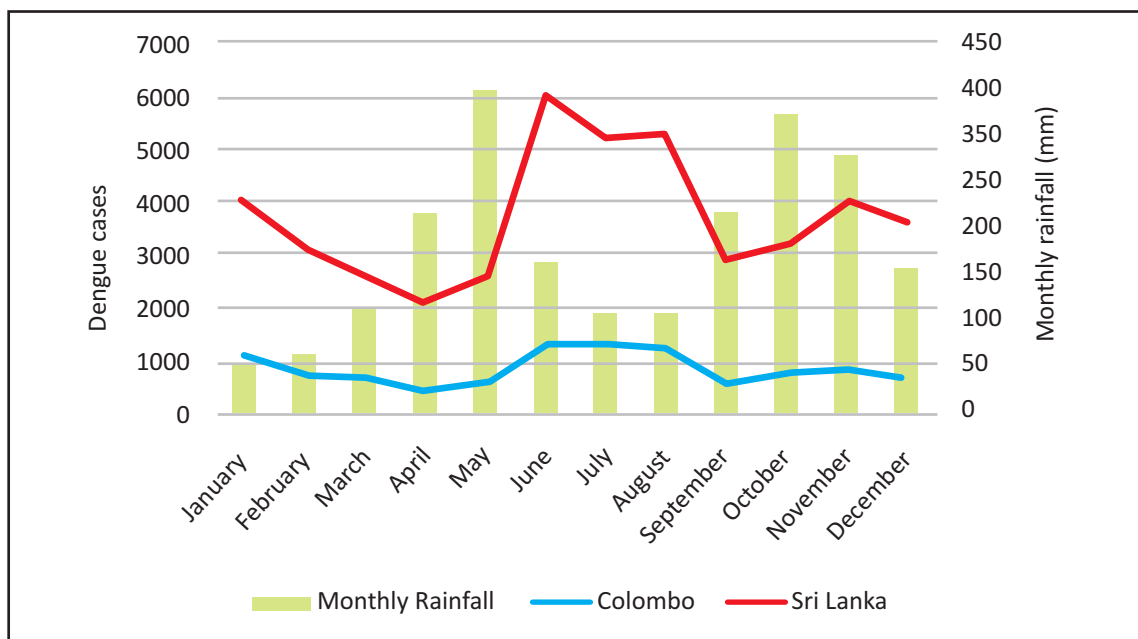
The 2012 epidemic of dengue in the Colombo district started in late March and settled around mid August.The incidence began to rise again within the onset of inter-monsoon rains.

The Ministry of Health Sri Lanka is the major stakeholder of the National Dengue response, which is implemented under a directive of a Special Presidential Committee. This includes dengue preventive activities implemented by the Medical Officer of Health (MOH) teams, and case management activities carried out by primary and secondary level hospitals. The following list indicates the major elements of dengue preventive and curative activities.

1. Integrated vector control
   a. Source reduction programmes
      i. Social mobilization by MOH team/centre / Other sector officials
      ii. Routine and case response by PHIs
   b. Fogging
   c. Larval reduction activities (Lavivorous fish/ Temephos)

2. Vector surveillance
   a. Sentinel sites (Field & Lab) surveillance
   b. Breeding site surveys

3. Disease surveillance
   a. Passive surveillance by MOH staff
   b. Sentinel surveillance / Special surveillance
   c. Cases/Death reviews

4. Management of cases
   a. Institutionalized DF/DHF/DSS cases
   b. Outpatient cases

5. Dengue prevention and management at national level
   a. By Epidemiology Unit
   b. By Dengue Control Unit

Dengue prevention and case management interventions are relatively new to the Sri Lankan health system. These were added to the system on intermittent basis, based on opportune needs. So far the burden that dengue prevention and case management poses on the health system has not been assessed. Currently considerable resources and time are vested on dengue related activities. Proper cost assessments deemed to be useful for meaningful planning, fund allocation, and choice of potential future preventive interventions such as vaccines.

Hence, the Ministry of health with the collaboration of a special project titled "Innovative tools and strategies for surveillance and control of dengue" has decided to assess the health system cost of the dengue prevention and case management. Initially it was decided to cost the dengue related activities in Colombo District. The Colombo district was selected due to: a) it is the district producing the largest share of dengue cases; b) the district having a comprehensive dengue programme that is supported by a sound data gathering system.

1.1 Health system involvement in the dengue control & management in the Colombo District

Two main administrative systems are responsible for dengue control activities of the Colombo District. The Regional Directorate of Health (RDHS) Colombo oversees the dengue control in the 12 MOH areas of the Colombo District. Health Department of the Colombo Municipal Council (CMC), oversees the dengue control activities in the Colombo City. Table 1 & figure 2 present the distribution of MOH areas in the Colombo district classified by systems responsible for dengue control and corresponding administrative divisions, Divisional Secretary (DS) areas.

Table 1 Distribution of MOH areas and DS divisions of the Colombo district classified by systems responsible for Dengue Control

System responsible for dengue control	DS Area	MOH area
RDHS Colombo	Dehiwala- Mt Lavinia	Dehiwala- Mt Lavinia
	Moratuwa	Moratuwa
	Kolonnawa	Kolonnawa
	Nugegoda	Kotte
	Maharagama	Maharagama
	Kesbewa	Piliyandala
		Boralesgamuwa
	Kaduwela	Kaduwela
	Homagama	Homagama
	Padukka	Padukka
	Hanwella	Hanwella
Health Department –CMC	Colombo	CMC health areas
	Thimbirigasyaya	

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Figure 2 Map of Divisional Secretary areas of the Colombo District demarcating two dengue management systems.
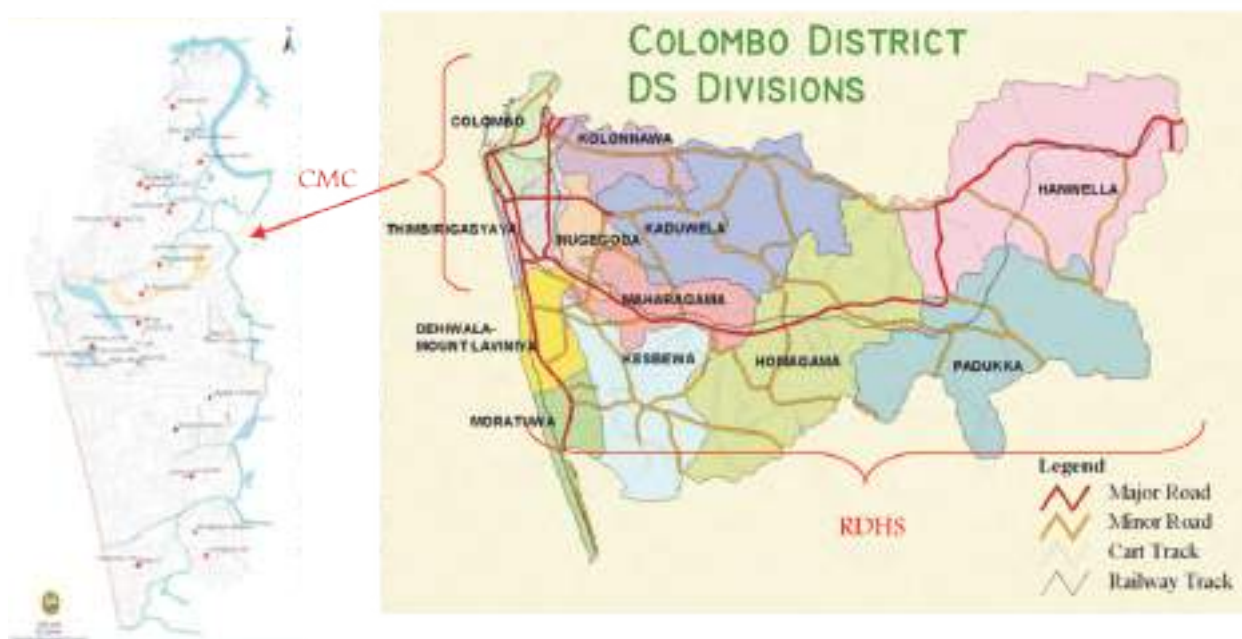
Dengue related preventive activities in Colombo & Thimbirigasyaya Divisional Secretary areas are handled by the Health department of the CMC. CMC has a separate dengue control unit. Dengue preventive activities in other areas of the Colombo district come under the administrative purview of Regional Directorate of Health in the Colombo District.

The functional arrangements and data availability of these two systems are slightly different. Hence, different approaches had to be adapted to cost the health system burden of dengue control and case management of these 2 systems.

Almost all dengue patients, who require inward treatment utilize, 7 secondary care hospitals in the district. Ambulatory patients may seek care at 59 Primary care hospitals and the 7 secondary care hospitals in the district. Considerable number of private general practitioners also known to provide care for ambulatory dengue cases in the district. There is no system to capture the statistics related to ambulatory cases at the moment. Hence, it was not possible to involve them in the costing exercise.

Once, the clinical diagnosis of dengue is made a patientis admitted to a hospital. It is mandated that the hospital Officer in Charge reports this case to the area MOH. The area MOH is supposed to investigate reported dengue cases with the help of the area Public Health Inspector (PHI).

The area PHI is supposed to visit the household of the patient and confirm the case and carry out dengue control activities in surrounding areas of the index household.

The MOH sends a weekly summary of all dengue cases to the Epidemiology Unit along with other notifiable diseases in the MOH area. Hospitals also send a weekly consolidated report of dengue cases to the Epidemiology Unit of the Ministry of Health.

Most dengue control activities of 12 MOH areas of Colombo district are implemented by the MOH team: MOH, PHIs, Spray machine operators (SMO) assisted by staff from Paradeshiya Sabha(Local government), Police, and voluntary members of the public. The main activities include, source reduction campaigns where a team of people systematically visit the households in the field for inspecting potential breeding sites, making the people aware and encouraging and obligating them to clean breeding sites. This activity is supported by a cabinet approved dengue control act, where litigations can be carried out for those who do not comply. In addition PHIs conduct daily inspections of the potential breeding sites in their work areas and supervise daily cleaning activities of local government workers. Fogging of insecticides, larvicide spraying and introduction of larvivoruos fish are mainstays of adult mosquito control strategies used by MOH teams. These activities are undertaken by MOHs with the help of their respective PHIs and SMOs. The Regional Dengue Control unit provides the technical and logistical support for these activities. The vector control activities are based on the need assessed by vector index (Breteau index (BI): number of positive containers per 100 houses inspected) monitored by the regional dengue control unit. Dengue related education activities are integrated in to the routine health education sessions by PHMs and PHIs in clinic settings as well as in schools.

The regional dengue control unit coordinates and supplements the dengue control activities conducted by MOHs. This unit consists of 2 medical officers, an entomologist, a PHI, 02 Public Health Field Officers (PHFO), 03 SMOs, 100 Health Assistants (dengue prevention),a management assistant and 2 labourers. The unit has 2 vehicles and 2 drivers as well. The main functions of this unit include the conduct of larval surveys, breeding site inspections and litigation, logistic management and supply of consumables related to dengue control and maintainenance the surveillance. This unit also conducts fogging and larval spraying whenever MOH teams find it difficult to meet the routine demand.

2   Purpose and Objective

Purpose of this study was to have an insight on the health system cost of Dengue Control and case management in the Sri Lankan context.

The objective was to make an assessment of financial cost incurred by the health system on the dengue prevention activities, and treating patients in the Colombo District during the year 2012.

3   Methods

3.1   Scope of the analysis & Costing elements

The scope of this cost analysis was limited to the health system cost. The direct and indirect cost borne by patients and family members were not considered in this analysis.

Four main costing elements were considered:

1. The cost of dengue control activities implemented by MOH teams. They include
   a. Vector control
      I. Source reduction activities & awareness campaigns carried out by MOH team and members of other sectors
      ii. Routine source reduction activities done by PHIs with the support of local government staff.
      iii. Larval reduction activities
      iv. Fogging activities.
   b. Disease surveillance
      i. PHI case investigation
      ii. Dengue reviews

2. The cost of vector surveillance and control activities conducted by the regional dengue control unit
   a. Breeding site surveys
   b. Fumigations

3. Porgramme management costs : Advocacy & awareness, capacity building, reviews, & monitoring & evaluation

4. Cost of managing dengue patients

3.2 Costing procedures

Data gathering systems and paying systems required costs pertaining to preventive and curative activities were considered separately.

Costs incurred in the above mentioned cost elements (e.g.Source reduction campaigns, fumigations, vector surveillance, treating a patient etc.) were disaggregated as variable and fixed costs. Figure 3 presents this framework.

Figure 3 Cost categories based on health system blocks
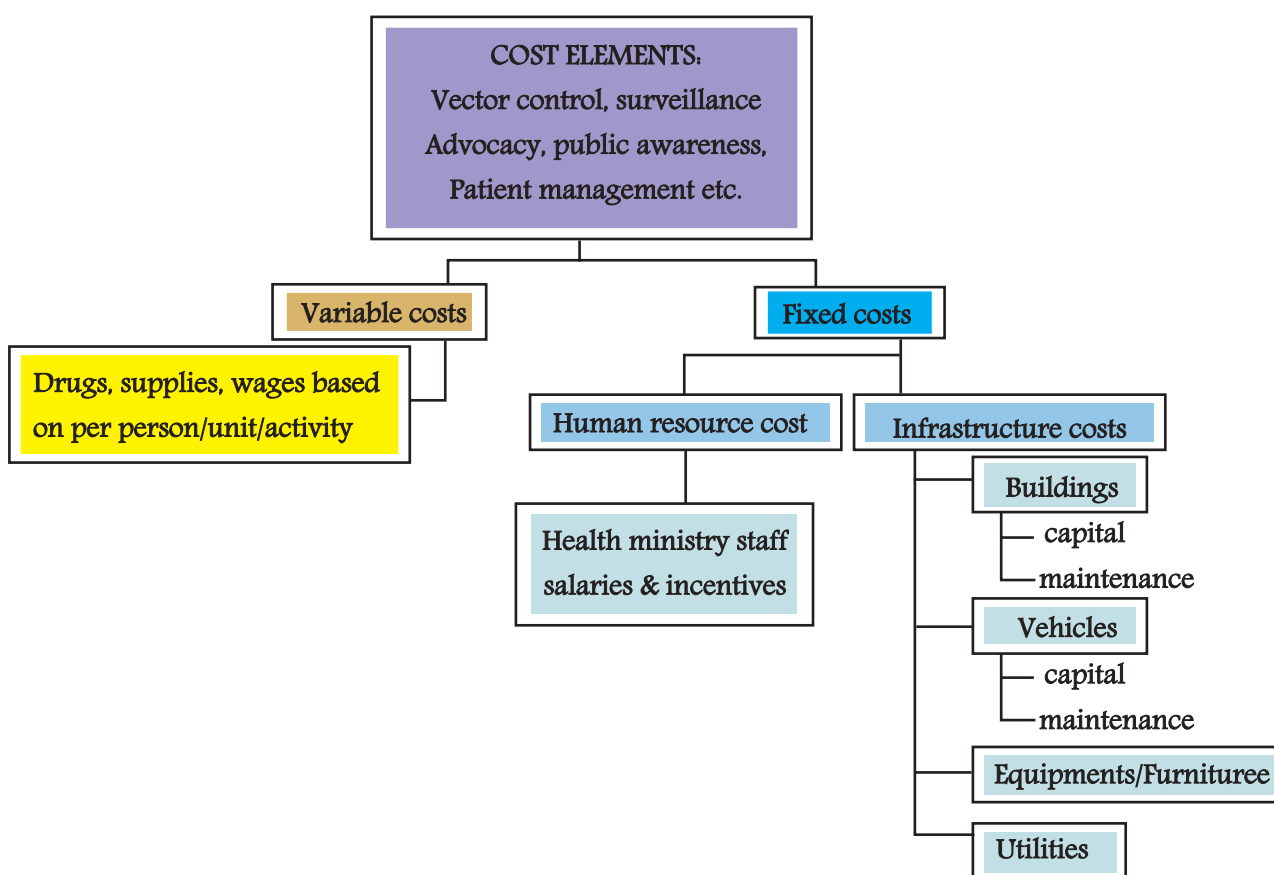
Variable costs: Drugs, supplies, hire purchase costs, daily paid wages, programme management costs (capacity building, advocacy and awareness, reviews, M& E activities) were considered as variable costs. These were the cost items that varied by the number of activities, households or patients.

Fixed costs. These are the cost items that do not vary by the number of preventive activities or number of patients. Fixed costs include cost items such as salaries of health system employees, capital and maintenance cost incurred on buildings, vehicles, equipment, furniture and other utility costs. The amount of cost incurred on these items do not vary by the number of dengue related activities conducted during a year. They are fixed expenses.

Further, these personnel or assets were often shared between programmes (maternal health, child health, etc…) or diseases. Hence, in deciding their dengue related fixed costs, the overall cost incurred on acquiring and maintaining them, have to be apportioned based on a proxy that reflects the relative contribution of these resources to dengue related activities. Costs incurred on personnel who exclusively work for dengue control/management activities devote their entire efforts to dengue programme. Hence, 100 % of the cost incurred on employing them should be included in costs.

The dengue programme did not incur additional capital costs for the health system infrastructure of the Colombo district in the year 2012. Hence, only maintenance costs of the relevant infrastructure facilities were included in the costing.

4   Cost Analysis

Figure 4 presents the costing protocol adapted for this study. Fixed and variable costs of each cost element was calculated separately and later summed up to obtain the total cost for the element.

Assessing the variable costs:

Variable costs pertaining to each cost element was computed by multiplying the average cost of an activity by total number of activities.

Variable cost of patient management was obtained by computing an average cost of drugs and other materials used in the management of a dengue patient. The average was obtained by reviewing the actual number of these drug items, investigations, and procedures among approximately 100 adults, and 100 paediatric patients and averaging each item and subsequently costing them. This number was recommended to provide adequate precision of the estimate. The cost of drugs was obtained from the National Drug Supply Unit. The cost of investigations was added as for the contemporary cost of such investigation in the private sector.

A per patient unit cost was calculated for other utility costs pertaining to hospital stay that includes charges for electricity, communication, meals, water, cleaning and considered as a variable cost. This unit cost was calculated by summing up the annual cost that the hospital incurred on these items and averaging it based on total inpatient days.

Assessing the fixed costs:

Fixed costs were computed by multiplying the average cost of each fixed cost item by the total number of such items involved in the dengue programme of the Colombo district in 2012. The cost of fixed items that were not exclusively meant for dengue programme (e.g. MOHs, PHIs, MOH Vehicles, MOH buildings, salaries of hospital doctors & nurses, Hospital equipment, buildings, maintenance and utility bills) were weighted by a suitable parameter (Table 2) that adjusts for their relative contributions to dengue related activities.

In the case of MOHs and PHIs this contribution was the proportion of total time of these categories of staff utilized for dengue related activities. This proportion was determined by assessing it by using a work diary maintained for a period of one month by them. A diary format (annexure 8.2) prepared for this purpose was given to all MOH and 2 PHIs from each 12 MOH areas after a training session conducted on the purpose and how to fill the format by the costing consultant. The MOH's relative contribution was also used as a proxy measure of the contributions made by other MOH resources such as vehicles, service bills etc..

The ratio between total dengue inpatient days and total patient inpatient days of the hospital was used as the proxy for hospital related proxies.

The variable and fixed cost estimates would ultimately merged to compute the total cost of dengue programme in the Colombo district in 2012. Calculations were carried out by using excel spread sheets.

The following formulae depict the basis of these calculations.[8]

Expenses for variable costs components $_{(i)}$ =

      (Average variable cost of activity/treatment $_{(i)}$ x number of activities/patients per year $_{(i)}$)

Expenses for fixed cost components:

For a person

      (Annual salary + allowances per staff category $_{(i)}$ x number of staff in category $_{(i)}$ x % share of their total work time)

For an item: equipment/infrastructure /vehicles).

      (Annual value of an item category $_{(i)}$ x number of items in the category $_{(i)}$ x % share of their total use)

Total costs will be calculated by adding up all sub component costs.

Table 2 Proxies used for adjusting the overall fixed costs to suit dengue related share

Item	Proxy
MOH/SPHI/PHI salary	Proportion of total work time of MOH/SPHI/PHI vested on dengue related activities
MOH infrastructure usage (buildings, vehicles, equipment, and utility bills)	Proportion of total work time of MOHs vested on dengue related activities
District dengue control unit (Some of the members of this unit had anti filarial work as well)	Proportion of total time used by each type of staff.
Hospital resources (doctors, nurses, other staff, buildings, equipment, utility bills)	Proportion of total inpatient days covered by dengue patients

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Figure 4   Process of costing different dengue cost elements

Define cost element:
E.g. Source reduction campaign, treating a patient

Identify variable cost items & fixed cost items for each activity

Variable cost items

Calculate average consumable cost per item:
E.g. Average supply & hire purchase cost per source reduction campaign / average drugs/investigation cost per patient

Fixed cost items

Calculate average annual cost adjusted for shared contribution to dengue related functions per item

eg. Adjusted Salary of MOH, adjusted infrastructure cost Building cost

Multiply average consumable cost by the number of relevant variable units
e.g:
Average Source reduction campaign cost x number of Source reduction campaigns,
Average patient consumable cost x Number of patients

Multiply average adjusted fixed costby the number of relevant fixed units
e.g: Average annual salary of MOH x number of MOHs x proportion of time vested on dengue control,

Sum up variable and fixed costs

4.1 Variables, data sources

The following table shows variables on which data has to be gathered to conduct costing of various cost elements.

Table 3 Cost variables, sources of variable and fixed cost items

1. Dengue control & prevention activities at MOH level		
1.1 Vector control		
Cost element	Sources of variable cost items	Sources of fixed cost items
a. Source reduction campaigns	i. Refreshments & meals ii. Other transport vehicles iii. Tractors & other garbage vehicles *(These items were not financed by the health sector, they were mostly funded by community donors. Hence not included in the cost)*	i. MOH salaries and allowances ii. PHI salaries and allowances iii. SMO salaries and allowances iv. MOH Drivers salaries and allowances v. RE Salaries and allowances vi. MOH vehicle vii. Regional dengue control unit staff salaries, incentives & vehicles
b. Routine source reduction by PHIs & Central dengue control unit staff	i. Larvicides	i. PHI salaries and allowances ii. SMO salaries and allowances iii. Regional dengue control unit staff salaries, incentives & vehicles iv. Spay machines

c. Fogging activities	i. Diesel ii. Kerosene oil iii. Petrol iv. Insecticide	a. PHI salaries and allowances b. SMO salaries and allowances c. MOH Drivers salaries and allowances d. MOH vehicle e. Regional dengue control unit staff salaries, incentives & vehicles f. Fogging machines g. Personnel protective equipment (PPE)
d.Common cost elements	i. Utility costs (Electricity, water,Telephone) of MOH & regional dengue control unit	

1.2 Disease surveillance

Cost element	Sources of variable cost items	Sources of fixed cost items
a. Case investigation by PHI	i. Notification forms ii. Postage (this is not an addition due to dengue- not included)	i. PHI Salary
b. Dengue death reviews	No variable costs borne by the health system	i. MOH Salary & allowance ii. PHI salaries and allowances

2. Programme management

2.1 Public awareness programmes

Cost element	Sources of variable cost items	Sources of fixed cost items
a. By MOH staff	No variable costs borne by the health system	i. MOH Salary & allowance ii. PHI salaries and allowances

2.2 Capacity building

a. Training programmes for MOH staff	No variable costs borne by the health system	i. MOH Salary & allowance ii. PHI salaries and allowances iii. Dengue control unit staff salary

3. Vector surveillance by Central team		
3.1 Breeding site sampling & Lab work		
Cost element	Sources of variable cost items	Sources of fixed cost items
	i. Lab equipment ii. Chemicals iii. Stationeries	i. Salaries of vector surveillance staff , Entomologists, & PHFOs, labourers
4. Cost of managing dengue patients		
Cost element	Sources variable cost items	Sources of fixed cost items
a. Paediatric	i. Drugs, injections, investigations, procedure materials ii. Utility costs	i. Doctors, Nurses and other staff salaries ii. Infrastructure maintenance
b. Adult	i. Drugs, injections, investigations, procedure materials ii. Utility costs	i. Doctors, Nurses and other staff salaries ii. Infrastructure

4.2   Data collection

The data from MOH system was gathered by Supervising Public Health Inspectors (SPHIs) of each MOH area. A data collection sheet was prepared for this purpose (Annexure 1). This was prepared by the Principal Investigator after reviewing the dengue programme related activities present during the study period in the Colombo district. Then the preliminary data sheet was presented to a group of (n=28) of MOHs, SPHIs, Regional Epidemiologist Colombo, and a Consultant from the Epidemiology Unit. Each item in the tool was reviewed with the group and necessary revisions and additions were carried out.

Subsequently, the revised sheet was pre tested in one MOH area.   It included questions relevant to variable items pertaining different cost elements. In addition a working diary (Annexure 2) was given to a sample of PHIs (n=24) and all MOHs (n=12) in the Colombo district to assess their time utilization in relation to dengue related activities.

Dengue control data for the CMC area was extracted from the annual cost compilation sheets of the CMC public Health department.

Data on patient management related to variable cost items was carried out using another data collection sheet (Annexure8.3). This was prepared after reviewing a number of Bed Head Tickets (BHT) (n=20)of dengue patients managed in both ward and intensive care settings by a medical officer. This sheet included the type and number of different oral and IV drugs, investigations and procedures used for dengue patients. The sheet was then presented for review by a medical specialist who had experience in treating dengue patients. Trained group of Medical Pre interns gathered data. Data were extracted from the BHTs of both types of retrospective cases.

The data on personnel and other fixed costs was directly obtained from Regional Directorate Colombo, Regional dengue control Unit, CMC public health department and 7 Hospitals in the Colombo district.

5 Health system cost of dengue control and management in the Colombo District in 2012.

5.1 Dengue control programme cost of the Colombo district

The various variable and fixed costs related to dengue control activities could be summarized to 5 cost categories (Table 4). Fumigation consumables included, kerosene oil, diesel, petrol, and insecticides (Technical Malathion, Deltacide, Pesgard FG 161). Larval reduction consumables included Abate granules and liquids, BTI local and BTI Bativec liquids. Fogging machines, spray machines, personal protective equipment (PPE), microscopes and pipets used by PHFOs included the equipment used in dengue control activities. Altogether 14 vehicles belonging to the health system were used in dengue control activities in the Colombo district. These included 12 vehicles of MOHs and 2 vehicles used in the Central dengue control unit. Annual utility/maintenance cost of infrastructure facilities included electricity, water, and telephone expenses of MOHs and central dengue control unit. Health system paid staff relevant to dengue control included, MOHs (n=35), SPHIS (12), PHIS(n= 83), PHFOs (n=2), SMOs (n=23), drivers (n= 14), Labourers (n= 14), Medical officers of central dengue control unit (n=2),Health assistants (dengue) (n=100) an entomologist, and a Regional Epidemiologist.

The consumables related to source reduction campaigns including refreshments, additional transport, and IEC materials such as leaflets, banners and posters were usually funded using local donations. Hence these were not included in the health system cost. As only the health system cost of dengue programmes was in focus, payments of other department officials who participated in source reduction programmes (police, military) who were paid by other sectors were also not considered. Consumable costs related to programmer management activities such as meals provided for capacity building activities, and review meetings were also not funded by the health system resources and therefore not included.

Table 4 Annual (2012) cost for dengue control activities in the Colombo district.

Cost item	Annual cost		
	LKR	US$	%
1. Fumigation & Larval reduction consumables	19,764,058.13	151,101.36	15.5
2. Equipment (Maintenance & annual capital)	2,973,824.67	22,735.66	2.3
3. Transport (Maintenance only)	1,910,659.09	14,607.49	1.5
4. Utility/maintenance cost of infrastructure facilities	1,661,757.70	12,704.57	1.3
5. Staff salaries (adjusted for dengue related activities)	100,937,867.18	771,696.23	79.3
Total cost	127,248,166.77	972,845.31	100.00

(Exchange rate 1US$ =130.80Rs.)   19

The total dengue control cost borne by the health system in sustaining a dengue control programme in the Colombo district in the year 2012 was around 127.2 million rupees. The largest expense (79%) on dengue control was vested on paying the health system staff, where the second highest expenses was for purchasing of consumable items used for fumigation and larvicidal activities (figure 5).

Figure 5 Cost of dengue control in the Colombo district in 2012 – Cost of various elements in millions and as a percentage of the total cost.
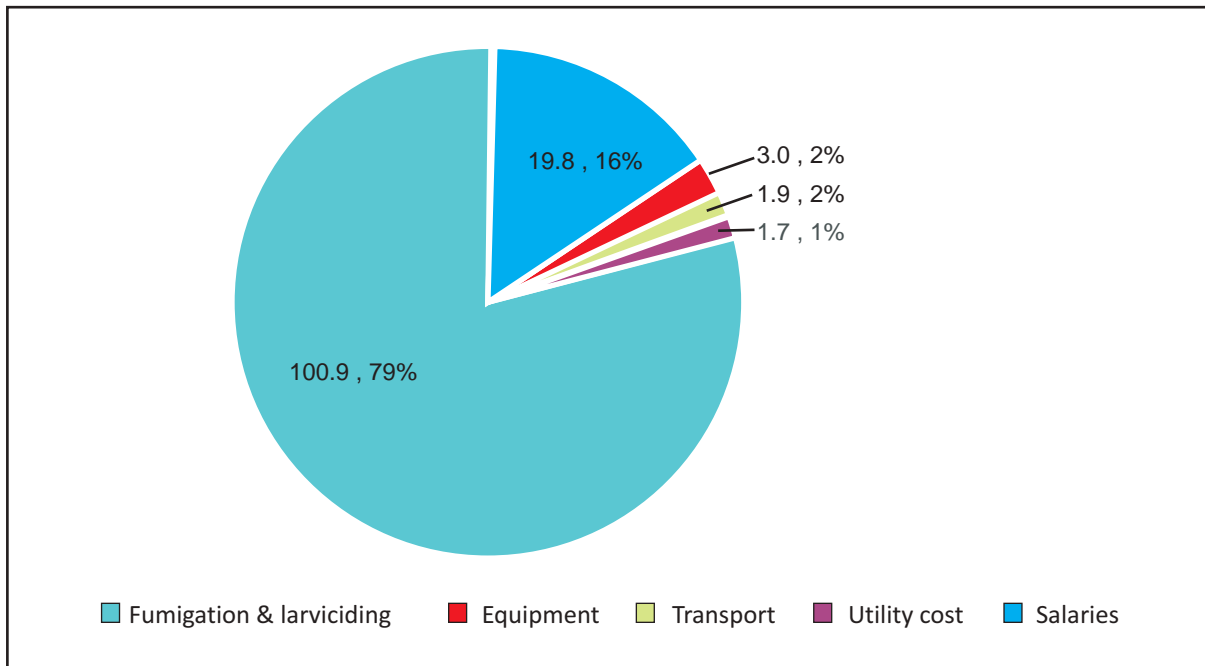
The dengue control programme was intended for preventing dengue infection in the people from the Colombo district. Hence, the per capita cost of dengue control in Colombo district in 2012 is of interest. This amounts to 55 .10 Sri Lankan Rupees(LKR 55.10). On the other hand the control programme had to be sustained due to approximately 10017 reported cases during the year 2012. The dengue control cost per reported case of dengue from the Colombo district in 2012 was 12,716 Sri Lankan rupees.

5.2   Dengue case management cost

Preliminary inquiries indicated that dengue management cost may vary by diagnosis (DF/DHF), age (paediatric vs adult) and the place of treatment within the hospital (ward only or ward & ICU). Hence, it was decided to consider these factors in calculating patient management costs.

Total of 10017 dengue inward cases were reported from the 7 hospitals in the Colombo district in 2012. Their diagnosis (DF or DHF), age disaggregation and place of treatment within the hospital (ward or ICU) were not available. Based on the sentinel surveillance data it was estimated that 66 % of dengue cases in 2012 were under 12 years (paediatric) of age. According to this figure, the number of paediatric and adult dengue patients treated in Colombo District hospitals were assumed as 6611 and 3406 respectively. Hospital data showed approximately 1 % of adult patients and 2% of paediatric dengue patients are treated in an ICU. Further, it was also shown that in a paediatic ward about 57.6 % of patients were having DF while the rest was having DHF. The DF percentages for adult's wards were 44.6%. Hence, Table 5 presents the estimated distribution of 10017 reported dengue cases according to these proportions.

Table 5 Estimated distribution of 10017 reported cases of dengue patients by patient category and place of treatment (Ward / Ward & ICU)

Patient category	Ward		ICU		Total
	DF	DHF	DF	DHF	
Paediatric	3732	2747	8	124	6611
Adult	1504	1868	6	28	3406
Total	5236	4615	14	152	10017

The average cost of drugs and supplies used in two levels of managing paediatric and adult dengue patients in a ward alone and in a ward and an ICU were separately calculated. The unit cost of drug and supplies for different treatment situations are as follows (Table 6).

Table 6 Average cost of drugs and supplies for treating a paediatric and an adult dengue patient (DF/DHF) by place of management

Patient type	Diagnosis	Place	Average Cost	
			LKR	US$
Paediatric	DF	Ward	6,717.10	51.35
Paediatric	DHF	Ward	16,985.11	129.86
Paediatric	DF	ICU	10,378.26	79.34
Paediatric	DHF	ICU	58,179.80	444.80
Adult	DF	Ward	4,210.99	32.19
Adult	DHF	Ward	11,965.42	91.48
Adult	DF	ICU	43,256.07	330.70
Adult	DHF	ICU	91,902.81	702.62

(Exchange rate 1US$ =130.80Rs.)

Hospital cost of utilities that include electricity, water, telephone, meals, laundry, maintenance of infrastructure and other supplies were averaged to a per patient value and this value also was added as a variable cost for each patient. This average utility cost per stay amounts to 6677.00 Sri Lankan Rupees (US$ 51.40).

Human resource cost of managing patients were separately calculated.

Table 7 presents the dengue patient management costs of the Colombo district in 2012.

Table 7. Dengue patient management cost in Colombo district in 2012.

Cost item	Annual cost	
	LKR	US$
Drugs & supplies	110,541,184.27	845,116.09
Human resource cost (salaries & allowances)	148,247,613.32	1,133,391.54
Utility and maintenance cost (infrastructure)	66,883,509.00	511,341.81
Total cost	325,672,306.59	2,489,849.44

(Exchange rate 1US$ =130.80Rs.)

The average cost of managing a dengue patient was dependent on age (paediatric vs. adult) and type of illness (Dengue fever /Dengue haemorrhagic fever) and the place of management (Ward or ICU). Hence, in per patient cost of managing dengue was calculated separately for the subcategories created by these 3 variables.

The total emoluments of each category of staff was adjusted for their respective contributions to managing dengue patients. The cost of drugs and supplies per category were separately calculated. Total human resource and management (utilities) costs were assigned according to the probabilities proportionate to number of patient days in each category. Table 8 & Figure 6 present these per person costs.

Table 8 Per patient cost (LKR, US$) of patient management by age, type of dengue illness and place of management

Type of patient	Average cost	
	LKR	US$
Paediatric DF in the ward	28,193.70	215.55
Paediatric DHF in the ward	38,461.71	294.05
Paediatric DF in the ICU	31,854.86	243.54
Paediatric DHF in the ICU	79,656.40	608.99
Adult DF in the ward	25,687.59	196.39
Adult DHF in the ward	33,442.02	255.67
Adult DF in the ICU	64,732.67	494.90
Adult DHF in the ICU	113,379.41	866.82

(Exchange rate 1US$ =130.80Rs.)

Figure 6 Per patient cost (US $, LKR) of patient management by age, type of dengue and place of management
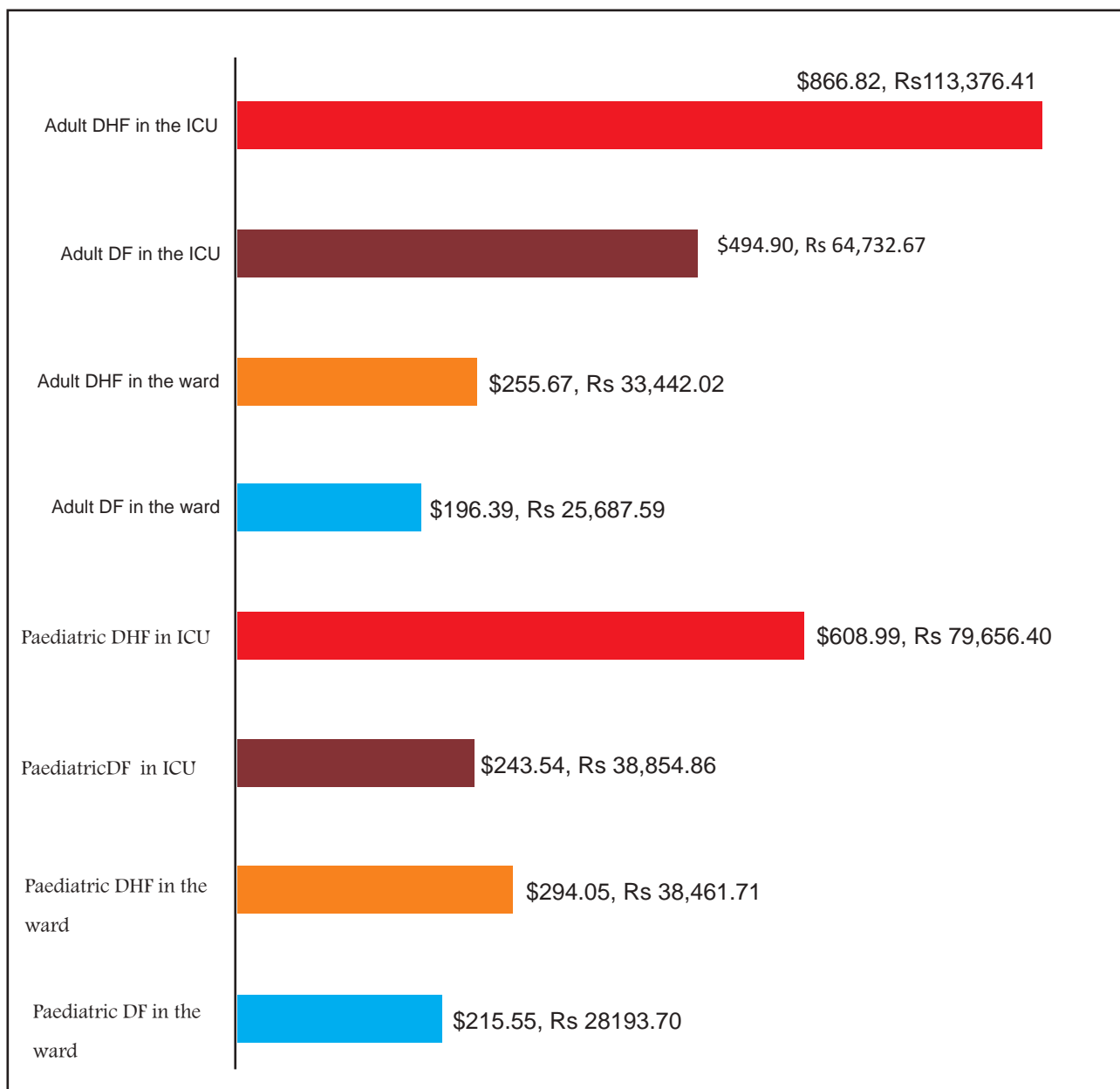
On average in both paediatric and adult ages managing a patient in an ICU set up required relatively higher costs than that required for managing them in ward alone.

5.3 Overall health system financial burden on dengue management

The total cost of dengue response borne by health system budgets in 2012 amounted to 452.9 million Sri Lankan Rupees (US $3.5 million.). The per capita cost of dengue response in the Colombo district in 2012 was 196.09 Sri Lankan Rupees (US$ 1.5) (Figure 7).

Figure 7 Overall health system cost(US$, LKR) of dengue response disaggregated by preventive and curative programmes
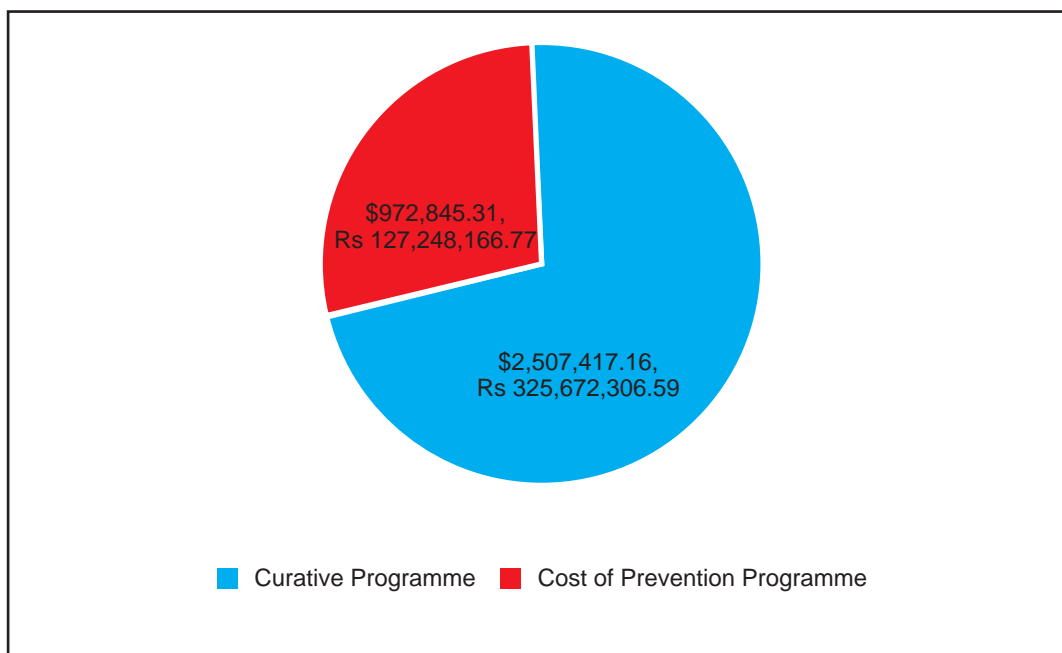
6   Discussion

This study estimated the overall health system cost of the dengue response in the year 2012 in the Colombo district in Sri Lanka. It should be noted that Colombo district, though the most dengue prevalent district,is only one of 25 administrative districts of the country. Hence the total health system cost at national level may be much higher than this.

The study had to be mostly based on retrospectively collected data, hence might have suffered minor inevitable biases.

There were several important changes made to the health system's dengue responses in Sri Lanka since 2012 to date. Preventive programme has been more streamlined, data gathering systems were updated and strengthened, preventive interventions were made evidence based than it was earlier.Standard guidelines of dengue case management were introduced to physicians which most of them are adhering to. These may have changed the 2012 based expenses outlook considerably.

The insight gained through this study can be used to identify important data requirements that should be mainstreamed to routine data collection systems so that future cost studies would have better inputs.

The probable changes in the per capita costs of dengue case management based on newly introduced guidelines should be further evaluated in relation to quality improvement of case outlooks which would have been brought about. The addition of direct and indirect cost came out of users pockets and the costs borne by allied sectors should also be looked into future studies. The national cost of dengue response can also be studied.

7　References

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8 Annexures

8.1 Annexure 1. Data collection sheet. MOH based activities

HEALTH SYSTEM COST OF DENGUE PROGRAMME

QUESTIONNAIRE FOR DATA COLLECTION IN MOH PROGRAMME

1) **Background data**

1.	MOH				
2.	Name (contact number) of SPHI				
3.	Number of dengue cases reported in 2012				
	Paediatric (< 12 years)	DF	DHF	All	
	Adult (> 12 years)	DF	DHF	All	
4.	Total number of PHIs in 2012				
5.	Number of MOHs worked in 2012				
6.	Other officers related to dengue (2012)				
	FAS				
	Spray machine operators (health department)				
	Other (please specify)				

2) **Source reduction campaigns (house to house visits in multidisciplinary groups)**

1.	Number of campaigns (number of days) in 2012	
	DETAILS OF AN AVERAGE PROGRAMME	
2.	Types of participants	Number (get an average)
	MOH	
	SPHI	
	PHI	
	Police	
	Other department officials	
	Volunteers	
	MC laborers	

3.	Tractors/ lorries (number)	
4.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)	
5.	Refreshments (number of participants)	
6.	Announcements (loudspeakers)	
7.	Use of larvicidal chemicals (mention type & amount)	
	Type	Amount (l or Kg)
	Tempos	
8.	Use of leaflets	Amounts
9.	Other expenses (specify)	

3) **Regular cleaning campaigns** (Cleaning campaigns regularly done under PHI supervision)

1.	Number of campaigns (number of days) in 2012	
DETAILS OF AN AVERAGE PROGRAMME		
2.	Types of participants	Number (get an average)
	MOH	
	SPHI	
	PHI	
	Police	
	Other department officials	
	Volunteers	
	MC laborers	
3.	Tractors/ lorries (number)	
4.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)	
5.	Refreshments (number of participants)	
6.	Announcements (loudspeakers)	

7.	Use of larvicidal chemicals (mention type & amount)	
	Type	Amount (l or Kg)
	Tempos	
8.	Use of leaflets	Amounts
9.	Other expenses (specify)	

3) **Regular cleaning campaigns** (Cleaning campaigns regularly done under PHI supervision)

1.	Number of campaigns (number of days) in 2012	
	DETAILS OF AN AVERAGE PROGRAMME	
2.	Types of participants	Number (get an average)
	MOH	
	SPHI	
	PHI	
	Police	
	Other department officials	

		Volunteers	
		MC laborers	
3.	Tractors/ lorries (number)		
4.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)		
5.	Refreshments (number of participants)		
6.	Announcements (loudspeakers)		
7.	Use of larvicidal chemicals (mention type & amount)		
	Type		Amount (l or Kg)
8.	Use of leaflets		Amounts
9.	Other expenses (specify)		

4) Awareness programmes organized by MOH

1.	Number of programs (number of days) in 2012	
DETAILS OF AN AVERAGE PROGRAMME		
2.	Types of participants	Number (get an average)
	School children	
	Factory workers	
3.	Refreshments (number of participants)	
4.	Announcements (loudspeakers)	
5.	Use of leaflets / IEC materials	
6.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)	
7.	Other expense (specify)	

5) Awareness programmes organized by public

1.	Number of programmes(number of days) in 2012	
DETAILS OF AN AVERAGE PROGRAMME		
2.	Types of participants	Number (get an average)
	School children	
	Factory workers	
3.	Refreshments (number of participants) (only if MO provides funds)	
4.	Announcements (loudspeakers)	
5.	Use of leaflets / IEC materials	
	Type	Amounts
6.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)	
7.	Other expenses (specify)	

6) Fogging activities

1.	Number of fogging activities (number of days) in 2012	
DETAILS OF AN AVERAGE PROGRAMME		
2.	Types of participants	Number (get an average)
	PHI	
	SMO	
3.	Refreshments (number of participants)	
4.	Announcements (loudspeakers)	
5.	Use of leaflets / IEC materials	
	Type	Amounts

6.	Other outside transport vehicles (cabs /vans)(except the MOH vehicle)	
7.	Use chemicals (mention type & amount)	
	Type	Amount (l or Kg)
	Kerosene oil	
	Petrol	
	Diesel	
8.	Insecticides	

7) Training programmes

1.	Number of dengue related training in MOH (number of days) in 2012	
DETAILS OF AN AVERAGE PROGRAMME		
2.	Types of participants	Number (get an average)
	PHI	
	SMO	
	PHM	
3.	Refreshments supplied or not	Supplied / Not supplied
4.	Perdiem given or not	Given / Not given
5.	Source of funding	Ministry of health / Sponsored
4	IEC materials given	
	Type	Number

8) Litigations

1.	Total number of litigations on dengue in 2012		
2.	Amount of income to the GOSL		
3.			

9) Any other expenses of dengue activities

Please describe

....

....

....

Health System Cost of Dengue Prevention

MOH diary for determining the share of work

Month: August– 2013

Date	Dengue related activity for the day	Time Utilized for the activity
Example (31 July)	Participation in source reduction campaign Dengue lecture – Primary school Halpita(travel – & work)	90 min 60 min
1-Aug		
2-Aug		
...Aug		
31-Aug		

Health System Cost of Dengue Prvention

PHI's diary for determining the share of work

Month. August- 2013

Date	Dengue related activities of the day	Time spent on the activity.
Eg. (July 31)	Case confirmation ~No 12 halpita) And reporting Lecture on dengue at Halpita primary school	90 minutes 60 minutes
Aug -1		
Aug- 2		
Aug - ...		
Aug 30		

8.3 Annexure 3. Data collection sheet. Patient management

Health System Cost of Dengue Programme

Data Collection Sheet: Dengue Case Management

Instructions to investigators: (Please read instructions carefully before gathering data)

i.   Please extract the data from the equal number of dengue patients who were admitted to the ICU as well as those who were managed only in the ward (+/- HDU).

ii.   When you extract the data for the patient managed in the ICU, the drugs and other item usage for them for both in the ward d /HDU as well as the ICU period has to be considered.

iii. The overall aim is to determine the total number of units of drugs/IV solutions/ investigations/ procedures used for the patient during the total hospital stay (both in the ward, HDU. /ICU). Therefore make sure this information is obtainable form your filled questionnaires

iv.   The items are alphabetically ordered for the convenience of locating them. If any item is not in the list is found under the following headings please add it in the end and indicate the numbers used.

v.   When recording number of investigations, record the number of times physicians ordered respective tests not the number obtained counting the investigations reports attached to the BHT.

Background details

1	Hospital		LRH ☐ /		IDH ☐ /		BHH ☐	
2	BHT no							
3	Date of Admission		..../..../.............. dd/mm/yyyy	4	Date of Discharge		..../..../.............. dd/mm/yyyy	
5	Number of inpatient days:	i	In Ward :					
		ii	In ICU :					
		iii	In HDU :					
6	Date of Birth		..../..../.............. dd/mm/yyyy	7	Age (in years)			
8	Diagnosis		Dengue Fever ☐ / Dengue hemorrhagic fever ☐					

Oral drugs *(The aim is to determine the total number of tablets used by the patient during the hospital stay)*

	Drug	Total Tablets/doses used in the hospital stay (ward +/- ICU)
1	Amoxicillin tablet (500 mg)	
2	Cagluconate_tablet (500 mg)	
3	Ca resins tablet	
4	Calcium carbonate tablet (500 mg)	
5	Cephalexin tablet (500 mg)	
6	Co-amoxiclav tablet (625 mg)	
7	Domperidone tablet(10 mg)	
8	Famotidine tablet (40 mg)	
9	Frusemide tablet (40 mg)	
10	Lactulose (10 ml –dose)	
11	Mefenemic acid tablet (500mg)	
12	Omeprazole tablet (20 mg)	
13	Oral glucose 50% dextrose(50 ml vial)	

	Drug	Total Tablets/doses used in the hospital stay (ward +/- ICU)
14	Oral rehydration solution (I packet)	
15	Oral salt (5 mg –dose)	
16	Pantaprozole tablet (20 mg)	
17	Paracetamol_syrup (5ml- dose)	
18	Paracetamol_tablet (500 mg)	
19	Promethazine tablet (50 mg)	
20	Ranitidine tablet (150 mg)	
21	Tranaexemic acid tablet (500mg)	
22	**Other drugs (please add)**	
A		
B		
	Other contd…	
C		
D		

IV drugs

	Drug	Total units used in the hospital stay (ward +/- ICU)
1	Dextrose (5%)	
2	Adenosine vial (3 mg-dose)	
3	Amikacin vial (500 mg-dose)	
4	Amiodarone vial (150 mg-dose)	
5	Cefotaxime vial (1 g–dose)	
6	Ceftazidime vial (1 g-dose)	
7	co-amoxiclav (1.2 g-dose)	
8	Cryoprecipitate(100cc-dose)	
9	Dextran 40% (100 ml-dose)	
10	Dextrose (10%	
11	Dobutamine vial (5 mg-dose)	
12	Fentanyl vial (2 mg-dose)	
13	FFP(100cc-dose)	
14	Frusemide vial (40 mg)	
15	Heartmann's (500 ml bottle)	
16	IV Glucose %? (10 ml-dose)	
17	KCL vial(80mEq/20ml)	
18	Mannitol 25% vial(50 ml)	
19	Meropenum (1 g-dose)	
20	Metaclopromide vial (2ml)	
21	Metronidazole(500 mg-dose)	
22	MgSO4 50% vial (1 ml dose)	
23	Midazolam vial (5 mg-dose)	
24	Mixtard insulin vial (units)	
25	N-acetyl cysteine (bottle-dose)	

	Drug	Total units used in the hospital stay (ward +/- ICU)
26	NaHCO3 (8.4%)(5ml-dose)	
27	Noradreanaline vial (4 mg-dose)	
28	Normal (1/2) Saline (500 ml bottle)	
29	Normal Saline (500 ml bottle)	
30	NS + 5 % Dextrose(500 ml bottle)	
31	Omeprazole vial (40 mg)	
32	Packed Red cells (100cc-dose)	
33	Platelets(100cc –dose)	
34	Ranitidine vial (2 ml)	
35	Recombinant VIII(100cc-dose)	
36	Soluble Insulin vial (units)	
37	Teicoplanin (400 mg-dose)	
38	Tetrastarch 6%(100 ml-dose)	
39	tranaexemic acid vial (500 mg-dose)	
40	Vassopressin vial (10 ml-dose)	
41	Vitamin K vial (10 mg-dose)	
	Other please add below	
A		
B		
C		
D		
E		

Procedures

	Procedure	Total number of times the procedure is carried out while in ward +/- ICU
1	CVP line	
2	Exchange transfusion	
3	Intubation	
4	IV Access (add total number of IV cannulas used)	
5	Nebulization	
6	Oxygen	
7	Peritoneal tap	
8	Peritoneal Dialysis	
9	Radial arterial line	
10	Respiratory functions	
11	Therapeutic Pleural aspiration	
12	Urinary catheterization	
13	Ventilation	
	Other please add below	

Investigations

	Ordered Investigation	Total number of times the TEST is carried out while in ward +/- ICU
1	ALP (Alkaline phosphatase)	
2	Antibiotic sensitivity test	
3	APTT (Activated Partial Thromboplastin Time)	
4	Bilirubin	
5	Blood culture	
6	Blood picture	
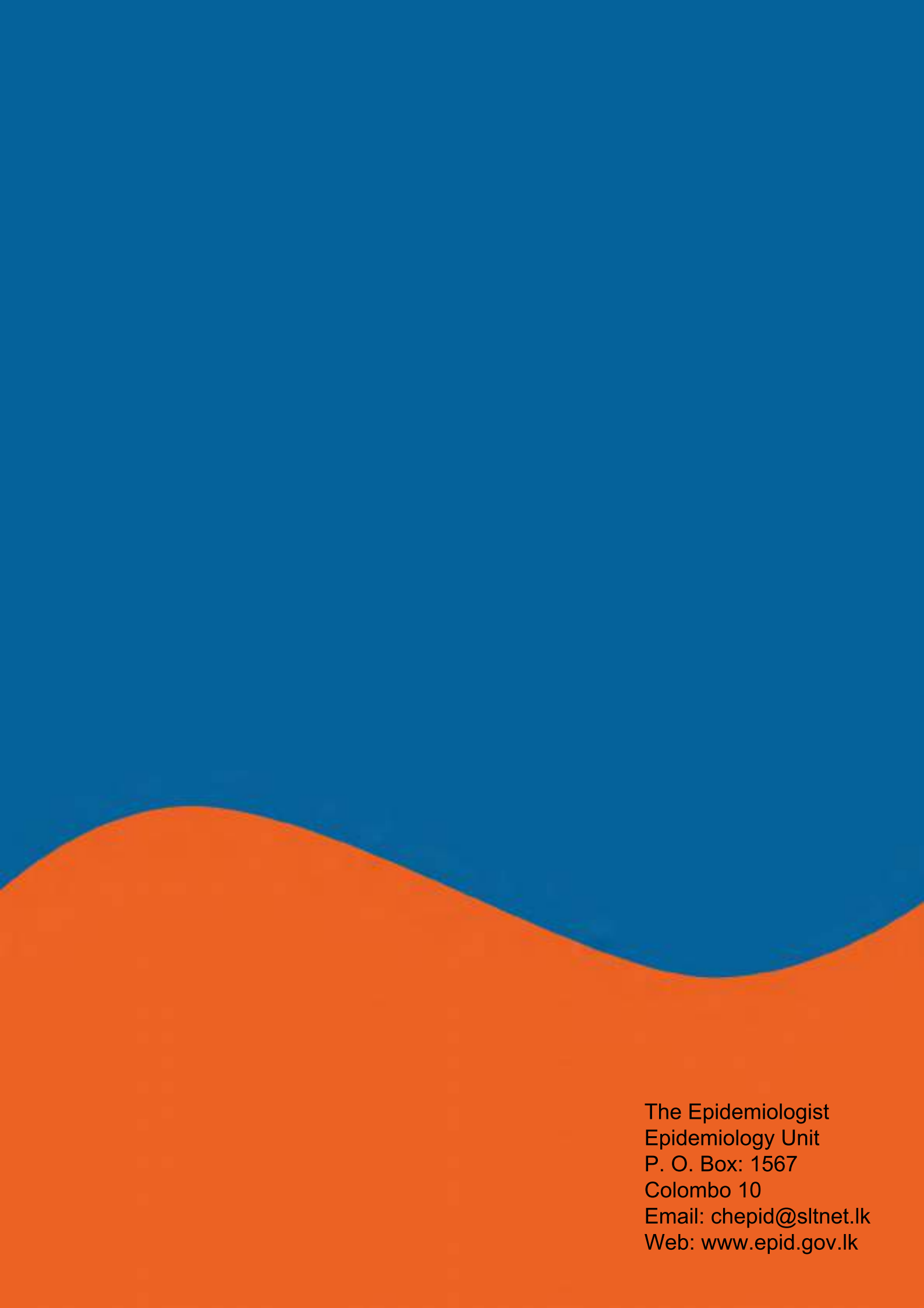
	Ordered Investigation	Total number of times the TEST is carried out while in ward +/- ICU
7	Blood sugar	
8	Blood urea	
9	Capillary Blood sugar	
10	Clotting Profile	
11	corrected Calcium	
12	CPK (Creatine phosphokinase)	
13	CRP (c-Reactive protein)	
14	d-dimer levels	

	Ordered Investigation	Total number of times the TEST is carried out while in ward +/- ICU
15	Dengue antibody screening (IgG)	
16	Dengue antibody screening (IgM)	
17	Dengue Antigen (NS1)	
18	ECG	
19	Echocardiogram	
20	ELISA	
21	FBC (Full blood count)	
22	Fibrinogen levels	
23	GP/DT (Blood grouping & DT)	
24	PCV (Lab)	
25	PCV (ward)	
26	PT/INR	
27	S.Albumin	
28	S.Ammonia	
29	S.Calcium	
30	S.Cholesterol	
31	S.Creatinine	
32	S.Magnesium	
33	S.Protein	
34	Serum Electrolytes	
35	SGOT/SGPT	
36	Troponin C	
37	Troponin I	
38	Troponin T	
39	U culture	
40	UFR	
41	USS abdomen	
42	VBG (Venous blood Gas)	

	Ordered Investigation	Total number of times the TEST is carried out while in ward +/- ICU
43	X-Ray	
	Other – Please add below	
A		
B		

41

Other items not mentioned above that you may think is bearing cost

	Item	Total number of items used during ward+/- ICU stay
A		
B		
C		
D		
E		
F		

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