Dengue Outbreak 2012: Geo Mapping and Snapshot of Clinical Course from a Tertiary Referral Center in South India

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Abstract

Background: Using technology to track endemic areas of communicable diseases is possible nowadays. Effectual use of such facilities, especially in developing countries, will increase earlier detection of cases as well as aid in the formulation of effective prevention strategies.

Methods: A retrospective data analysis was carried out by collecting the details of patients presented with positive dengue serology, during the outbreak season in the second half of 2012, at Kovai Medical Center and Hospital, Coimbatore, India. Clinical variables were analysed statistically using SPSS 20 and geographical mapping of the cases was carried out using EPI INFO 7 software.

Results: 1004 dengue positive cases were identified during the study period. Geographical mapping of the case clusters showed specific areas in the city as well as neighbouring districts, which were an indirect evidence of the causative mosquito’s endemic breeding places. Overall mortality noted in this group was 1.3% and mortality in cases with severe thrombocytopenia was 4 in 1000 cases. Severe thrombocytopenia (Plat≤10,000) on admission increased odds ratio for mortality i.e. around 10 times higher than the rest of the cohorts.

Conclusion: Identification of endemic mosquito breeding places and implementation of proper preventive measures is always a crucial step in the prevention of further outbreaks. Effective registry using softwares by tertiary care hospitals will be obligatory to track the location of the cases as these hospitals are the nodal point of care for most of the cases in developing countries.

Introduction

Vector borne diseases inflict a heavy toll in developing countries. In the Indian sub-continent, arthropod borne diseases, especially malaria, dengue and filaria cause an unacceptable public health burden. While it is unrealistic to expect either to eradicate the vector or the virus, the basic minimum goal should be to reduce the vector population below which an epidemic can be sustained. This needs novel, “out of the box” thinking to find inexpensive solutions in resource poor settings that can help us to achieve the basic minimum goal.

Geographic Information System, a system for input, manipulation and output of geographic information, is an inexpensive, powerful tool in combating vector borne diseases. Such a tool has been used to visualise and model spatial patterns of risk for exposure to malaria and dengue in different parts of the world. This provides crucial information for allocation of resources to areas most in need for vector and disease control. We present the first reported use of a geographical information system in India during a dengue outbreak in 2012 along with a snapshot of the clinical course of dengue fever in a tertiary hospital setting.
Material and Methods

Settings

A retrospective data analysis was carried out at Kovai Medical Center Hospital, a tertiary care multispeciality hospital at Coimbatore, Tamilnadu. Identification of the dengue positive cases was made using the data provided by the Microbiology Department. The Microbiology Department sends regular surveillance report of communicable diseases to the State Health Authority. Dengue positivity from any one or combination of serological tests like ELISA IgM, ELISA NS1, RAPID IgM and RAPID NS1 was considered for inclusion into the study. Records of all the patients who got diagnosed with dengue positivity and got treated either at the out-patient departments or as an in-patient in our hospital during the outbreak in the second half of 2012 were obtained from the Medical Records Department of the hospital. Patients whose blood sample was sent to the laboratory just for testing dengue serology from other referring hospitals were excluded from the study as further details of these patients could not be tracked.

Geographical Mapping

Epi Info 7, software provided by CDC Atlanta, was used to plot the geographical mapping of residence of patients. Although this software allows us to create forms virtually and keep track of the patient’s record, it was not used for that purpose in our study. Latitude and longitude of individual addresses were identified separately by obtaining them through an online resource found at itouchmap.com/latlong.html and were then fed into the Epi Info 7 software to produce a final result. This method of search was handled due to the inability of the inbuilt ‘Get Coordinates’ module of the software to exactly locate the latitude and longitude for the mentioned address in remote villages around Coimbatore.

Statistical Methods

Descriptive statistics was employed to assess continuous variables in the study. Categorical variables were analyzed using cross tabulation and Pearson’s Chi squared test. Wilcoxon Signed Ranks test was performed to establish the difference between the admission platelet count and the lowest platelet count detected during the hospital stay. The admission platelet count and the lowest platelet count during the hospital stay were categorized into normal and low based on the lower most limit of platelet count i.e. 150,000 cells/mm^3; also they were categorized into groups with platelet count less than or equal to 10000 cells/mm^3 to identify the total number of patients who had severe thrombocytopenia. Odds ratio with 95% confidence interval was calculated for exploring the risk of mortality among certain categories. SPSS Version 20 was used for performing all the above mentioned analyses.

Results

Total patients identified by linking the data from the microbiology surveillance reports were 1106. Of this 102 patients were referred to this hospital just for testing dengue serology by their treating physicians from neighbouring hospitals. This finally left us with 1004 patients of serology proven dengue cases; who attended the hospital on OP basis or got admitted and treated here. The residential addresses of these patients were presented in the form of latitude and longitude to EPI INFO 7 software. The output obtained from the data provided is presented in Figures 1 and 2. The pictures show that the referral hospital which is at Coimbatore, a district at the north western border of Tamilnadu had almost 90% of the patients flocking in from most of the neighbouring districts like Erode, Dindigul, Salem and Namakkal as well as from parts of Kerala, giving an indirect evidence about high dengue infection at these areas. Figure 2 gives a clear picture of geographical area inside the Coimbatore district where patients with dengue positivity were residing.

The baseline characteristics of study patients are outlined in Table 1. The mean (SD) age of the group was 30 (16) years with the youngest patient diagnosed with dengue being 4 months old and the oldest person was 78 years of age. The distribution was positively skewed with the median age of 27.5 years stating that 50% of the cases were below that age. So this disease affected mostly children, adolescents and young adults. In-patient care was needed for 941 (93.7%) cases; 63 (6.3%) cases were treated on out-patient basis. Overall 51 (5.1%) cases required Intensive care treatment. Almost 85% of dengue positivity was identified using ELISA IgM serology testing followed by Rapid NS1 test which came out to be positive in 16.2% of cases. There were no strict criteria for conducting these tests and it was only based on physician’s request with regard to patient’s clinical condition and date of presentation from the onset of fever.

The mean (SD) duration taken by patients to present at the center from the onset of fever was 5 (2.5) days; the same for hospital stay and ICU stay was 6 (4.3) days and 5 (8.4) days respectively. The average platelet count on admission was 93,375 cells/mm^3 and that for the lowest value observed during the hospital stay was 71,504 cells/mm^3. Wilcoxon Signed Ranks test (Table 2) was carried out to identify the difference in the lower most platelet count value observed during the hospital stay and the admission platelet value; non parametric analysis was carried out here as the distributions of the platelet values were positively skewed. In 426 subjects it was similar where as in 550 subjects there was a drop in platelet count.
Thrombocytopenia (Plat<150000) was noted in 79% of cases during admission; further 8% of cases got converted to the thrombocytopenic range during their hospital stay. Severe Thrombocytopenia (Plat≤10000) was noted in 3.8% of subjects during admission but almost double the cases were found to be in severe thrombocytopenic range during their hospital stay. Alteration in Liver Function Tests (LFT) and Renal Function Test (RFT) was noted in 45.2% and 3.3% of cases respectively stating that dengue related hepatitis was more common than renal abnormalities.

Adverse clinical events seen in the patients included haemorrhagic manifestations in 5.6% of cases, secondary bacterial infections in 3% of cases, Shock in 2.2% of cases, ARDS in 2% of cases and...

Table 1: General characteristics of the cases

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values (Mean and SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cases</td>
<td>1004</td>
</tr>
<tr>
<td>Age</td>
<td>30 (16) yrs</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>523:481; 1:1:1</td>
</tr>
<tr>
<td>Admission date from fever onset</td>
<td>5 (2.5) days</td>
</tr>
<tr>
<td>Duration of hospital stay</td>
<td>6 (4.3) days</td>
</tr>
<tr>
<td>Duration of ICU stay</td>
<td>5 (8.4) days</td>
</tr>
<tr>
<td>Platelet count on admission</td>
<td>93375 (67256) /cu.mm</td>
</tr>
<tr>
<td>Platelet count lowest value after admission</td>
<td>71504 (61797) /cu.mm</td>
</tr>
</tbody>
</table>

Table 2: Analytical assay: Wilcoxon signed ranks test

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count lowest in comparison to admission platelet count:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No change</td>
<td>976</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Negative change</td>
<td>550</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Chi square analysis

<table>
<thead>
<tr>
<th>Timing of observation</th>
<th>No. of cases</th>
<th>Dead</th>
<th>Alive</th>
<th>ODDS Ratio</th>
<th>95% CI</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count on admission</td>
<td>975</td>
<td>0.9%</td>
<td>99.1%</td>
<td>10</td>
<td>2.5-39.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;10000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelet count during hospital stay</td>
<td>975</td>
<td>6.5%</td>
<td>93.5%</td>
<td>8.9</td>
<td>2.5-31.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;10000</td>
<td></td>
<td></td>
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</tbody>
</table>

After admission making this statistically significant with Z=-20.3 and p<0.001.
MSOF in 1.7% of cases. Cross positivity to Leptospirosis was seen in 17 patients followed by Typhus in 8 patients and rest as listed in the table. Overall mortality in this group of patients was 13 (1.3%); among them total mortality with severe thrombocytopenia was 4 (0.4%) which could be considered as clear cases of dengue related deaths. Patients who presented with severe thrombocytopenia on admission had increased odds ratio for mortality than who were subsequently diagnosed to have severe thrombocytopenia during their hospital stay, i.e. 10 and 8.9 both being statistically significant with P<0.001 (Table 3).

**Discussion**

With current estimates of around 50 million infections and 500,000 hospitalisations each year, the dengue viruses are probably the most important arthropod borne viral infections both from a public health as well as a medical perspective. A global strategy that includes effective use of modern technology for mapping and spatial modelling to aid targeted vector control programs, early accurate diagnosis and development of an effective vaccine are the urgent need of the hour. We present the first reported use of geographical mapping in India to generate “risk maps” that would be extremely helpful to target vector control programmes in the future.

*Aedes aegypti* mosquitoes, the culprit vector for transmission of dengue viruses, have many characteristics that make them ideal for virus dissemination. Relevant factors, especially in our part of India include population growth, poorly planned urban landscape, increasing reliance on plastic containers where standing water easily collects, modern transportation and more importantly the need for effective mosquito control programmes. In the absence of an effective vaccine or anti-viral drugs, targeted vector control programmes are essential to reduce virus transmission to low levels. However, effective control of *Aedes aegypti* is notoriously difficult due to the biology of the mosquito. Increasingly, user friendly software and mapping technologies provide new insights on entomological and epidemiological data to generate risk models and locations for effective public health programmes.

With dengue, there are good reasons to focus on epidemiological data as opposed to vector data. Entomological data depends on various indices and fine scale aerial photography that have their own limitations. Breteau Index (number of positive containers per 100 houses inspected) and House Index (percentage of houses infested with larvae and/or pupae) are not necessarily correlated with dengue incidence. Novel projects aimed at testing aerial photography as a surveillance tool in identifying residential premises at high risk of breeding *Aedes aegypti* have not been successful in accurately predicting the breeding risk. Finally, the risk of dengue outbreaks not only depend on the abundance of *Aedes aegypti* female mosquitoes but also on the herd immunity against dengue virus serotypes 1-4 in the population at risk. Therefore, vector data gives a snapshot of potential dengue risk rather than actual risk. In contrast, epidemiological data seems to represent actual risk as the presence of a dengue case demonstrates human contact with an infected vector.

Mapping approaches are useful tools in epidemiology for delivery of vector and dengue information. Maps not only provide a visual stimulus but they are powerful tools of information delivery. In our study, geographical mapping showed clustering of cases predominantly around the towns of Tiruppur, Erode, and Coimbatore (Figure 1). Within the city of Coimbatore, we were able to map the blocks where the outbreaks had occurred (Figure 2). Such information has multiple uses. This can be helpful to alert the public about areas in the city with a higher risk of dengue exposure. The details will inform local policy makers and governmental organisations so that allocation of vector control budgets can be targeted to specific areas of higher exposure. Mapping capacity can aid with the operational logistics of directing vector control teams to homes of dengue infected patients in high risk areas. Many studies have demonstrated the presence of dengue infected mosquitoes in homes of dengue infected patients. Targeted indoor application of insecticides to these homes may result in destruction of infected mosquitoes thereby preventing a vicious cycle of new visitors getting infected and potentially propagating the disease in a new area. In addition, mapping allows visualisation of case locations as well as perimeters to devise Priority Area Classification (PAC). With our geographical mapping data, we can now rationalise our strategy if another outbreak occurs, in conjunction with governmental agencies. This would entail activating a PAC based emergency response so that high risk areas are prioritised before low risk areas. In the meantime, the mapping data will help us devise a regional strategy to concentrate on high risk areas to prevent an outbreak from happening in this first place.

With nearly a thousand patients admitted, our study provides important clinical insights in terms of the clinical course and outcomes of dengue fever. The burden of the disease, both from the financial and resource aspects during the outbreak was significant as nearly 93% of patients needing hospital admission, with a mean intensive care unit stay of five days for those needing critical care. Thrombocytopenia was much more commoner in our population,
consistent with another study in children done during the same period in an adjacent state in India\(^9\) compared to other studies from South East Asia.\(^10\) Importantly, the platelet count dropped further in a significant number of patients during the course of hospital stay. Platelet counts of < 10,000 both on admission and during the course of stay was a marker for poor outcome. However, the overall mortality was 1.3% with serious complications reported only in approximately five percent of patients. Most of the patients improved with supportive care. The dengue outbreak of 2012 created a flurry of interest in Siddha medicines (native Indian herbal concoction made from Andrographis paniculata) which were given freely in Government run hospitals. This treatment was not used in our hospital though there have been reports of improved platelet counts with administration of Carica papaya leaves extract.\(^21\) More research is needed to evaluate such simple herbal treatments which may have a role in reducing the intensity of symptoms in dengue fever.

**Conclusion**

In summary, we present the first reported use of geographical mapping following the dengue outbreak of 2012 in South India. We hope to use this data in conjunction with Government agencies to prioritize vector control policies to reduce the chances of a further outbreak. Effective registry using softwares by tertiary care hospitals will be obligatory to track the location of the cases as these hospitals are the nodal point of care for most of the cases in developing countries. We also report one of the largest series of clinical outcomes from India following dengue fever with particular emphasis on the severity of thrombocytopenia as a marker for poor clinical outcomes.

**Conflict of Interest**

None

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**References**