SHORT COMMUNICATION

Age of initial cohort of dengue patients could explain the origin of disease outbreak in a setting: a case control study in Rajasthan, India

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Abstract Dengue fever (DF) and dengue hemorrhagic fever (DHF) is a public health problem with 390 million cases reported in world annually. In Rajasthan, DF with DHF is being reported for about two decades. For undertaking interventions into disease transmission, locating origin of transmission is very important. Present paper reports retrospective analysis of the hospital reported cases of dengue during the year 2013–2014 undertaken in Barmer, Rajasthan. To address task of investigating outbreak, detailed analysis of the data on serological test results (Mac-ELISA assay of NS1, IgG and IgM) performed by local hospital, Balotra was made. The domestic breeding containers were examined for the presence of larvae and adult forms of *Aedes aegypti* by visiting individual households as well as common places of human aggregation like schools and hospitals. The analysis showed that first dengue cases started from the lot of school going

children and then followed by adults and finally during peak period of infection only children around 1–2 years got infected. The subsequent entomological investigations during the outbreak showed school as principal source of mosquito breeding. Present investigations highlight that schools (March to April) play the role of primary sites of disease transmission and should be preferred for undertaking vector control operations to prevent dengue transmission from getting aggravated.

Keywords Dengue · Age of patients · Vector · Dengue transmission

Dengue fever (DF) with dengue hemorrhagic fever (DHF) has emerged as a public health problem with an estimated number of 390 million cases reported annually world wide [1]. India is one of the endemic countries where 36,486 cases with 92 deaths in 2014 and 75,808 cases with 194 deaths in 2013 have been officially reported [2]. In the North-western desert part Rajasthan, DF with DHF is being reported for about two decades. In the year 2013, 4415 cases with 10 deaths were reported from Rajasthan, India [2].

At community or village level, a particular disease burden due to dengue is actually the consolidation of individual clusters of patients resulting from man and infected vector interaction, at household level. The actual transmission settings of disease therefore are those sites where infected mosquito, carrying virus by horizontal or vertical transmission [4, 3] and susceptible humans interact and patients are resulted. For public health intervention into dengue transmission it becomes very important to know the age of patients reported during the beginning of an outbreak in a setting. If age of initial patients is below

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5 years then transmission may start from households, if age of patients during initial phase of outbreak is school going children then due to day biting nature of *Aedes aegypti*, we can expect that transmission is taking place in schools. Keeping in view these facts, transmission dynamics of dengue in any setting has to be understood in two phases; first to study how it was originated and then how it has spread horizontally?

In one of the villages, Balotra of desert district Barmer, Rajasthan, India, an outbreak of DF and DHF was reported from January, 2013 till January, 2014. More than 300 cases of DF/DHF were reported (Unpublished data). The affected village was selected as the model to study transmission dynamics of dengue with reference to how it has originated and subsequently then spread from one to another sub setting of town. The investigations showed that school aged children formed the primary cohort of patients followed by patients of other age groups. Present paper reports results of investigations undertaken from January, 2013 till January, 2014.

Balotra is situated in the central part of north-west border district Barmer in Rajasthan, India. The town represents a typical desert ecosystem characterised by sparse vegetation, dry climate and scarce rainfall. The study area had one school situated within about 500 meters distance from all the households of the village.

Emergence of cases of dengue was started from Balotra, Barmer, Rajasthan, India since January, 2013. As a Reference Virological Laboratory and one of the Surveillance Centres of National Sentinel Surveillance Network in Rajasthan for vector borne diseases (as identified by the National Vector Borne Disease Control Programme, Government of India), Desert Medicine Research Centre (DMRC) was requested to investigate the outbreak situation and provide the diagnostic support for conducting Mac-ELISA test on the serum samples tested positive for NS1, IgM and IgG by the local hospital laboratory. To address task of investigating outbreak, detailed analysis of the data on serological test results (NS1, IgG and IgM) performed by local hospital, Balotra since January, 2013 till January, 2014 was made. A case was recorded as dengue case when either dengue IgM antibodies or NS1 protein or both were present in the test conducted. Relevant statistical test were applied to ascertain degree of association.

During the field investigations, the domestic breeding containers were examined for the presence of larvae or pupae and adult forms of *A. aegypti* by visiting individual households as well as common places of human aggregation like schools and hospitals. Mac-ELISA test was performed on the dengue suspected serum samples referred by local hospital, Balotra, Rajasthan, using the IgM antibody test kits developed and supplied by the National Institute of

Virology, Pune, India. The steps as described in the kit's protocol were followed.

Figure 1 shows the monthly occurrence of dengue cases from January, 2013 till January, 2014. In the month of January, 2013, during 2nd week, only one case of dengue was reported from the town which belonged to the age of school age children (6–17 years) (as shown by red coloured circle). In the months of February and March, no case of dengue was reported (as shown in figure by red dotted circle). In the month of April, during 4th week, only case of dengue in the age group of school age children was reported. In the first week of month of May, 2 cases in school age children and 3 cases in adults were observed, whereas in 2nd, 3rd and 4th week of May 2013, 2, 3 and 3 cases respectively of dengue among school age children were reported. In the month of June, 2013 again one case of dengue was reported among school age children and in July no case of dengue was reported in the town. In the month of August 2013, 3 cases of dengue, one each in 1st, 3rd and last week of month were observed. All the 3 cases in this month belonged to the age group of school going children. In the month of September 2013, 8 cases of dengue were reported in school age children whereas 4 cases among adult age group (>18 years). In 2nd week 4 cases of dengue and all belonged to school age children. During 3rd week of September 2013, 17 cases of dengue were reported which belonged to school age group whereas 5 cases were from adult age group. During 4th week of September 2013, 9 school age children were infected and 7 cases belonged to adult age group. During last week of September, 2013 first case of dengue appeared in the form of a child less than 5 years of age. In the month of October, 2013, during first week itself, 5 dengue patients belonging to the age group of >5 years were reported, whereas, 12 cases belonged to age group of school age children and 7 patients from age group of adults. During 2nd week of October, 2013, one case belonged to the age group of >5 years, 19 cases from school age children and 18 cases from adults were reported. During 3rd week of October, 2013, 2 cases belonged to the age group of <5 years, 16 cases from school age children and 15 cases from adult age group were reported. During 4th week of October, 2013, as many as 7 cases of dengue belonging to the age group of <5 years were reported, 20 cases from age group of school children were reported and 17 cases belonging to adult age group were reported. During last week of October, 2013 no case of dengue was reported from the town. In the month of November, 2013, during 1st week 4 cases of dengue belonging to adult age group were reported whereas no case from children below 5 years or school age children was reported. During 2nd week of November, 2013, 12 cases belonging to school age children and 19 cases belonging to adult age group were reported.

Fig. 1 Monthly occurrence of dengue cases from January, 2013 till January, 2014. [The red dot represents school going aged cases of dengue and the red circle represents non-school going aged cases of dengue] (colour figure online)

Table 1 shows observations on entomological investigations undertaken in selected households of dengue affected localities in the town. The breeding was observed either in the underground water storage tank of school or the houses located adjacent to the school.

Usually epidemiology investigations into any outbreak situation of dengue includes sero-epidemiological studies on the patients to characterize infection and study disease distribution. In addition, during routine outbreak investigations, entomological observations are also made to trace the disease transmission pathways. In present study, we have studied dengue outbreak as an anthropo-ecosystem and have attempted to study as to what could be the possible point of origin of infection?

Observations made during present investigations show that during initial phase of dengue in the study village, it is school children who represented primary lot of dengue

patients. The detailed analysis showed that first dengue cases started from the lot of school going children and followed by adults and finally during peak period of infection only children around 1–2 years got infected. Depending upon age associated infection of dengue it can be inferred that in the study village, infection started from schools and then travelled to houses where indigenous transmission got established, as evident by the infection among infants and young children. Entomological investigations made in houses of dengue patients and also in schools and canteen supported that disease outbreak had originated from schools and more transmission was actually taking place in schools and hospital canteen where availability of patients as well as *Aedes* mosquitoes was observed.

Present investigations are significant from the stand point as to what should be the priority of our efforts to

Table 1 Entomological indices observed for the study setting

No. of houses searched	No. positive for adult <i>Aedes aegypti</i>	House index (%)	No. of houses examined for <i>Aedes</i> breeding	No. of houses positive for <i>Aedes</i> breeding	Breeding index (%)	No. of containers examined	Container index (%)
80	2	2.5	80	17	21.5	595	4.5

target origin of infection? Based on present observations it is suggested that during the month of March to April, schools should be the primary sites for undertaking vector control operations so that transmission of dengue can be prevented from getting aggravated.

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