Research paper

Episodes of the epidemiological factors correlated with prevailing viral infections with dengue virus and molecular characterization of serotype-specific dengue virus circulation in eastern India

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ABSTRACT

Background: Dengue is one of the most important and widespread viral infection comprises 4 related serotypes (DEN-1, 2, 3, and 4). Infection with one serotype does not protect against the others, and sequential infections put people at greater risk for dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). This study determines the epidemiology of prevailing viral infections with dengue and molecular characterization of serotype-specific DENV circulation in Odisha of eastern India.
Methods: During the year 2013, 1980 blood samples with suspected dengue cases were obtained between days 1–10 of illness and analyzed by NS1 Ag-RDT, NS1 Ag-ELISA, and RT-PCR. The differential detection of dengue infections and DENV serotyping were carried out by IgM/IgG Ab-ELISA and RT-PCR, respectively.
Results: Of the 1980 samples, 733 (37.0%) were positive for dengue RNA by RT-PCR. The confirmed cases of dengue were more in males (73.6%) in comparing to females (26.4%). The age group of 15–44 years (527 cases, 71.9%) were more susceptible to dengue infections. 656 (89.5%) cases had infected with monotypic infection by different DENV serotype and 77 (10.5%) cases had multitypic infections by multiple serotypes of DENV. Of the total multitypic infections, there were 74 (10.1%) cases had infected with DENV-2 and DENV-3 serotypes at a time; and only 3 (0.4%) cases had the concurrent infections of all three serotypes that were, DENV-1, DENV-2, and DENV-3. Of the 28 DHF cases, there were 17 (2.3%) cases had infected with multitypic infections and 11 (1.5%) cases had infected with monotypic infection.
Conclusion: Dengue infections have prevailed from the month of July and grasped it's the peak in September. Rain, temperature and relative humidity have favored the dengue infections. Young adults and males are more susceptible to dengue infections. Serotypes DEN-2 followed by DEN-3 was dominant among the confirmed dengue cases. Co-circulation of multitypic infections with multiple DENV serotypes and the emergence of DHF cases suggested that eastern Indian state Odisha was becoming a hyper-endemic province for dengue; therefore, continuous surveillance is suggested for understanding the epidemiology of the diseases and monitoring the changes in the characteristics of circulating DENV strains.

1. Introduction

Dengue viral infections are one of the most important arboviral diseases within the family *Flaviviridae* and comprise four serotypes, designated as DENV-1, DENV-2, DENV-3, and DENV-4 (OhAinle et al., 2011). Infection with any of these serotypes causes a mild and self-limiting febrile illness (classical dengue fever (DF)); a few cases are severely developing to life-threatening dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS).

During the past few years, dengue has become one of the leading causes of morbidity and mortality in tropical and subtropical regions throughout the world posing a major public health problem (Kyle and Harris, 2008). Overall, two-fifths of the world populations are living in regions with the risk of dengue infections (WHO, 2017; Bhatt et al., 2013; Guzman et al., 2010). Dengue infects about 284–528 million individuals and handles 500,000 hospitalizations with 24,000 deaths worldwide every year (WHO, 2017). Of these, 10,000 infant deaths caused because of DHF and DSS (Halstead, 1988). Southeast Asia and Western Pacific are representing about 75% of the global dengue burden (World Health Organization, 2009).

In India, dengue virus (DENV) was first isolated in 1945 and several outbreaks have been reported thereafter (Balaya et al., 1969; Rodrigues et al., 1972). Dengue is endemic in Odisha state. The first case of dengue was documented in the state in 1998, and several epidemics due to dengue were precipitated after 2005. In the year 2011, an outbreak of dengue occurred in the Angul district of Odisha in August and September. During this period, 1846 DF cases had detected in Odisha. Of these, 33 death cases were occurring with the epicenter at Talcher coalmine area in the Angul district (Anon., 2014). DF has described in the Angul district because of the vector species *Aedes* were obtained throughout the year in these provinces (Rao and Padhy, 2014).

Dengue viral infections are usually symptomatic. The epidemiology of dengue infections is an intricate phenomenon. It depends upon the correlation between the epidemiological factors, including the host, agent, and ecosystem. The intricacy of the relationships between these factors determines the level of dengue endemicity in an area (World Health Organization and National Vector Borne Disease Control Programme, 2015).

The exact causes of dengue severity are yet on doubtful for some instances even if there is an interaction takes place between the host and agent. Infecting cases plays a significant role in introducing the dengue virus by their movement towards newer areas. Because of limited studies were done in various regions of the Indian subcontinent, there is little scientific information available on circulating DENV serotypes or their molecular and epidemiological characterization (Mishra et al., 2015; Zangmo et al., 2015). Till date, systematic studies on the epidemiological risk factors of dengue viral infections, molecular detection of DENV, and serotype-specific DENV circulation in the eastern Indian state Odisha had not taken on.

Therefore, this paper presents an update report on the epidemiology of dengue infections, clinical features, and an episode of prevailing infections with DENV serotypes in eastern India.

2. Materials and methods

2.1. Study site

The district of Angul found in the central province of the Odisha state in eastern India lies between 20° 31′ N and 21° 40′ N latitude and 84° 15′ E and 85° 23′ E longitude. The geographical area of the Odisha state is 155,707 km^2. In the 2011 census of India, Odisha state had a population of 41,947,358 of which males 21,201,678 and females 20,745,680. With a brief winter, the climate of the district is subtropical with the temperature ranging from 6 to 47 °C (see Fig. 1).

2.2. Study period

To accomplish the aims of the research study was held out from January 2013 to December 2013.

2.3. Epidemiological factors correlated with dengue viral infections

The risk factors of dengue viral infections depend upon the correlation between the epidemiological factors, comprising the host (Human), agent (Virus), and ecosystem (Abiotic factors) (see Fig. 2).

2.4. Study population

The study population comprises of < 1 year, 1–14 years, 15–24 years, 25–44 years, 45–60 years and > 60 years of age groups are defined as infants, children, young adults, adults, middle-aged persons and senior citizens, respectively.

2.5. Clinical criteria for dengue viral infections

Dengue viral infections may be asymptomatic or symptomatic and clinical manifestations vary from undifferentiated fever, i.e. dengue fever (DF) to dengue hemorrhagic fever (DHF) with plasma leakage and that may lead to hypovolaemic shock (dengue shock syndrome, DSS) (World Health Organization and National Vector Borne Disease Control Programme, 2015; Dutta et al., 2011).

2.5.1. Dengue fever (DF)

A suspected dengue case comprised an acute febrile illness of 2–7 days duration of two or more of the following non-specific constitutional symptoms and signs: high fever, headache, retro-orbital pain, nausea/vomiting, myalgia (muscle pain), generalized skin rashes, arthralgia, and diarrhea in febrile phase; fatigue, pleural effusion, hypotension, ascites, and gastrointestinal bleeding in the critical phase; and itching, slow heart rate, seizures, and altered level of consciousness in recovery phase.

2.5.2. Dengue hemorrhagic fever (DHF)

DHF is characterized by a sudden rise of fever (38.3–39.4 °C), with a transient increase in vascular permeability resulting in plasma leakage, bleeding thrombocytopenia (Platelet counts ≤ 100,000/mm^3) and hemoconcentration or other signs of a headache, retro-orbital pain, conjunctival congestion, and facial flushing with fever sustaining for 2–15 days or melena (Equivalent to WHO classification of DHF grades I and II.).

2.5.3. Dengue shock syndrome (DSS)

DSS is characterized by a weak rapid pulse of narrowing of the pulse pressure (≤ 20% mm Hg (2.7 kPa), regardless of pressure levels, e.g. 100/90 mm Hg (13.3/12.0 kPa)), hypotension, cold clammy skin, and restlessness (Equivalent to WHO classification of DHF grades III and IV.).

2.6. Dengue virus

Dengue virus, the etiological agent of dengue, is separating out four different serotypes, designated as DENV-1, DENV-2, DENV-3, and DENV-4.

2.6.1. Monotypic infection of DENV serotype

Monotypic infection is defined as a single infection in an individual by any serotypes of dengue virus.

2.6.2. Multitypic infections of DENV serotypes

Multitypic infections are defined as concurrent infections in an individual with multiple serotypes of dengue virus.

2.7. Specimens

A total number of 1980 acute-phase blood samples collected from suspected cases of dengue infections under observation of non-specific constitutional symptoms (Zangmo et al., 2015; Dutta et al., 2011), coming to the various health departments in the Angul district, Odisha, was analyzed in the laboratory for diagnosing dengue infections using NS1 antigen RDT kit, enzyme-linked immunosorbent assay (ELISA) based on the NS1 antigen and molecular-based on reverse transcriptase-polymerase chain reaction (RT-PCR). The differential detection of dengue infections and DENV serotyping were carried out by ELISA-based IgM/IgG antibody and RT-PCR, respectively.

2.7.1. Detection of dengue infections using dengue NS1 Ag-RDT and NS1 Ag-capture enzyme-linked immunosorbent assay (MAC-ELISA) methods

Dengue infections are characterized by elevations in specific NS1 Ag levels 1 to 9 days after the onset of symptoms; this persists up to 15 days. Dengue NS1 Ag card is a rapid solid phase immunochromatographic test. All acute serum/plasma specimens were screened for the presence dengue infections using NS1 Ag-RDT and NS1