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Seasonal dengue surge: Providers' perceptions about the impact of dengue on patient volume, staffing and use of point of care testing in Indian emergency departments

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ABSTRACT

Background: Global health emergencies, such as from diseases like dengue fever, can lead to rapid surges in visits to emergency departments. The objective of our study was to evaluate the impact of dengue on factors that could impact emergency department flow, including patient volume and staffing, on Indian emergency departments.
Methods: This was a prospective cohort study of Indian emergency providers. Respondents were queried via online survey about a number of domains including practice environment, use of rapid testing, changes in ED volume and ED staffing adjustments occurring during dengue season. Data was analyzed using multivariate analysis.
Results: We had a total of 210 respondents to our online survey. Less than half of respondents reported that their institutions used rapid point of care testing. When asked how dengue impacted ED flow, the most common response was that dengue increased the total number of ED visits (84%). Despite this increase, only about 32% of respondents reported that their institutions increased hospital staffing. In multivariate analysis, respondents at hospitals that experienced ED visit surges over 40% of baseline were more likely to also report that their institutions also increased staffing during this time (OR 3.28, 95% CI 1.44–7.46).
Conclusions: Our study shows that despite increases in visits during dengue season, ED providers noted that their EDs did not respond with staffing increases. More research is needed to better understand how emergency departments can adjust to dengue to provide optimal care for patients in India.

Introduction

Emergency departments (EDs) are often at the forefront in facing global health threats [1]. Disease outbreaks such as dengue, zika, chikungunya and influenza can lead to rapid surges in ED volume, taxing an already stressed system [1–4]. For example, during the pandemic H1N1 influenza outbreak in 2009, EDs in the United States had marked increases in wait time, length of stay and number of visits [4]. When such surges in capacity occur, EDs may become overcrowded and less effectively equipped to address other life-threatening diseases that may also present during the surge period [2–5].

Much can be learned about ED approaches to addressing surge from dengue fever given its incidence, affecting approximately 2.5 billion people, or 40% of the world's population [6]. The World Health Organization (WHO) estimates that there are approximately 50 million dengue infections annually across the globe, an incidence that has risen 30-fold in the last 50 years, with an increasing geographic expansion from urban to rural settings [6]. Rates of dengue in India are among the highest worldwide [7,8]. The eco-

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nomic costs associated with dengue in India have been estimated to be between $25.7–29.1 million dollars (in United States currency equivalent) [9]. In 2016, there were over 100,000 cases of dengue reported in India [10,11]. However, dengue is thought to be vastly underreported due to misdiagnosis of infection cases, asymptomatic infections, failure of patients to present to healthcare settings with symptoms and deaths in rural areas before medical care was received [10,11]. Dengue, zika and chikungunya are flaviviruses, transmitted mainly by arthropods, most often by the Aedes mosquito vector [12]. Outbreaks of these diseases occur around monsoon season in India, typically in the months of August through November [10,11]. Climate, as well as increased crowding in urban areas, have increased the incidences of diseases such as dengue and diseases transmitted by vectors since close conditions encourage transmission and often poverty impedes treatment [13]. These diseases are not only prevalent in India, but have also increased worldwide, particularly in tropical climates. The World Health Organization estimates that there are 390 million cases of dengue globally each year. While typically the most severe cases had been reported in Southeast Asia, the Western Pacific as well as in the Americas, dengue is now endemic to more than 100 WHO countries; recently outbreaks have been reported in areas which had traditionally not been affected, such as Portugal and France [14].

Because of the potential increases in ED visits that may occur during dengue season, it is important for EDs in India to be equipped with a number of modalities to increase patient flow. These modalities include a number of clinical approaches, such as the use of point of care testing to provide a rapid and timely diagnosis. However, hospitals may have wide variations in diagnostic testing approaches, which may further contribute to delays in diagnoses and slow throughput through the ED. One of the most widely used tests is the IgM antibody with ELISA assay because of its high sensitivity and specificity, however it can take several hours to get results from this test [10]. Other diagnostic tools, such as viral cultures, real time polymerase chain reaction (RT-PCR), and hemagglutination Inhibition (HI) tests, are also time consuming and may be associated with a high cost, which is problematic in a resource-limited environment [15]. Rapid testing, which can provide results in 15 min, may have particular appeal in environments that rely on fast turnaround and high patient loads, such as EDs. [16]. There are a number of commercially available rapid dengue tests available, including those that test IgM, IgG and dengue nonstructural protein (NS1) antigen [16]. The Indian Society of Critical Care Medicine Tropical Fever Group management guidelines recommend a rapid card test (NS1 antigen detection) and IgM & IgG serology as first line-methods for diagnosing dengue [17]. There are significant differences in when these markers are useful for diagnosis. The NS1 antigen is usually present between 1 and 9 days after the onset of fever in dengue. On the other hand, the IgM marker is positive starting between days 3 and 5 and up to 3 months after infection. The IgG maker appears by day 14 but will be present for the duration of the patient's lifetime [18]. Dengue typically has 3 phases: a febrile phases with high viremia between 2–7 days after the initial fever; a critical phase in which patients have a high amount of plasma leakage presenting with fluid shifts, hypovolemia and hypotension which lasts when the fever starts to subside for 1–2 days; and a convalescent phase in which symptoms improve, which lasts for 2–4 days [19]. The rapid test is helpful particularly in the febrile phase, and can potentially help alert the clinician early to help control further symptoms of the disease, which often can be fatal.

While rapid testing may potentially help expedite diagnostics during surges in emergency department volumes due to dengue, EDs also likely need to adjust operations in other ways as well to cope with the increase in caseload that occurs during dengue season. Increases or shifts in staffing may be needed to address the large volume of patients that may present to the EDs during this period. In addition, as they experience a rapid increase in patients, it is also important that EDs adhere to clinical practice guidelines to insure that care is provided in an appropriate and timely manner [6].

Despite the prevalence of dengue worldwide, very little is known about ED preparation and response to seasonal surge. The objective of our study was to evaluate the use of rapid dengue testing as well as the impact of dengue on perceived patient volume and levels of staffing in EDs in India. We hypothesized that use of dengue rapid testing is low and that there would be wide variation in adjustments in ED staffing and testing in India, with private hospitals and EDs with larger volumes more likely to use rapid testing modalities and having a greater propensity to adjust staffing in response to dengue-related patient volume.

Materials and methods

This was a prospective cohort study of a convenience sample of Indian emergency providers. We used previously validated demographic questions when available and piloted the survey on a small sample of emergency providers in our department prior to fielding the test on a larger sample. Recruitment occurred over an eight week period between November, 2014 and January, 2015. This time period was chosen because it was shortly after peak dengue season in a number of locations in India.

We disseminated a survey to emergency providers in India recruited through a number of sources: (1) targeted emails using a list serve of a large Indian emergency medicine physician specialty organization; (2) moderated closed groups on two popular social media platforms (Facebook and WhatsApp) and (3) at a national meeting of emergency medicine specialists held in Mumbai, India in November 2014. We attempted to control for selection bias by recruitment respondents using a number of approaches. First, respondents were given a link via email or via a postcard, which was accessible only once, to avoid multiple entries and to allow them to respond voluntarily. In addition, all responses were anonymous and confidential. As an incentive, completion of the survey enabled the respondent to enter a raffle for a 150 US dollar gift certificate, delinked to any survey responses.

Data was collected via a 37 question online survey using Survey Monkey [13]. Respondents were queried about a number of domains including practice environment (urbanicity of practice location, size of emergency department where practice occurred, whether hospital was a public entity, number of annual emergency department visits), use of rapid testing and other testing modalities, changes in ED volume (increase in visits during dengue season compared to baseline) and ED staffing adjustments occurring during dengue season (percentage of increase in ED visits at their institution and whether the ED adjusted staffing during this period).

We also asked respondents about whether they felt comfortable treating dengue, whether they felt that physician and ancillary staffing was adequately adjusted to accommodate the increase in ED volume due to dengue cases, whether their hospital had an adequate preparedness plan and whether their institution provided adequate testing. These domains were explored using a 5 point Likert scale with responses as follows: strongly disagree, disagree, neutral, agree or strongly agree.

We used multivariate analysis to evaluate factors associated with increases in staffing and use of rapid point of care testing. We controlled for a number of factors including urbanicity of practice (large/medium city size >1 million population versus smaller urban, rural or suburban locations), number of beds in the ED (>20 beds versus less than 20 beds), number of daily ED visits (<50, 51–100, >100), percent increase in visits during dengue season

Table 1
Demographics of our sample.

	n (%)
Total sample	210
Gender	
Male	169 (80.5%)
Age	
25–34	148 (70.5%)
35–44	37 (17.6%)
45–54	15 (7.1%)
55–64	5 (2.4%)
Other	5 (2.4 %)
Specialty	
Emergency medicine	171 (81.4%)
Level of training	
Consultant	50 (23.8%)
Junior consultant	22 (10.5%)
Resident/in-training	80 (38.1%)
Medical student	5 (2.4%
Nurse	8 (3.8%)
Paramedic	5 (2.4%)
Other	15 (7.1%)
Unknown	30 (14,3%)
Type of hospital	
Private	170 (81.0%)
Government/public	34 (16.2%)
Other	6 (2,9 %)
Hospital size (beds)	
<150	25 (11.9%)
150–249	24 (11.4%)
250–349	42 (40.0%)
350–449	22 (10.5%)
>450	97 (46.2%)
Emergency department size (beds)	
0–10	40 (19.1%)
11–20	98 (46.7%)
21–40	54 (25.7%)
>40	18 (8.6%)
Urbanicity	
Large urban city (>3 million)	121 (57,6%)
Medium urban city (1–3 million)	42 (20.0%)
Small urban city (<1 million)	28 (13.3%)
Suburban/rural	19 (9.1%)
Daily visits non-dengue season	
<50	104 (49.5%)
51–100	67 (31.9%)
101–150	19 (9.1%)
>150	20 (9.5%)

(<20, 21–40%, >40%), number of weeks in which ED visits increased because of dengue (>9 weeks, 5–8 weeks, <5 weeks) and type of hospital (government/public, private).

Results were analyzed using STATA Version 11 [14]. The George Washington University Institutional Review Board approved the study. Respondents participating in the study were consented prior to initiation of the survey.

Results

We had a total of 210 respondents to our online survey. Demographics of our survey respondents are shown in Table 1. The majority of respondents were male (81%) aged 25–34 (71%) and worked in large or medium urban cities (78%). Most specialized in emergency medicine (81%) and were consultants (24%), junior consultants (11%) or residents/in-training (38%). Most worked at private hospitals (81%) and over three quarters worked at large hospitals with over 250 inpatient beds. Nineteen percent of respondents worked in EDs with less than 10 beds and 47% worked at EDs with 11–20 beds.

Over three quarters of respondents reported the IgM ELISA as the most common form of diagnostic testing used. Less than half (47%) of respondents reported that their institutions used rapid point of care testing. About 13% [28] of persons used some type of NIS rapid testing, however a large proportion of respondents did not know the type of rapid testing used or available at their institution. The most common reason reported for not using rapid testing was that these tests were not available at their institutions (31%). Other reasons reported including restrictive costs (18%) and belief that such testing would not alter management (21%).

Respondents did report significant increases in ED visits during dengue season with 54% reporting up to a 20% increase in patient visit loads, a quarter of respondents reporting visit increases between 20 and 40% and over 18% reporting visits surges over 40% above the baseline number of ED visits during non-dengue season. There was wide variation in the number of weeks in which respondents reported experiencing an increase in visits due to dengue. About a third each reporting increases of less than 4 weeks, increases of 4–8 weeks and increases over 8 weeks.

When asked how dengue impacted ED flow, the most common response was that dengue increased the total number of ED visits (85%) and the total number of ED visits resulting in admission (80%). A significant number of respondents also reported increases in patient ED wait times (42%) and total ED length of stay (39%). Despite this increase, only about 32% reported that their institutions increased hospital staffing either by increasing the number of ED physicians on duty at any given time (12%) or increasing the number of ancillary staff (31%) (Table 2).

In multivariate analysis, when controlling for ED characteristics, no hospital, visit surge or urbanicity characteristics were associated with a greater likelihood of rapid dengue testing. These characteristics were also not associated with staffing increases during times of ED visits surge. Respondents at hospitals that experienced ED visit surges over 40% of baseline were more likely to also report that their institutions also increased staffing during this time in our multivariate analysis (OR 3.28, 95% CI 1.44–7.46; Table 3).

Table 4 shows whether respondents felt staffing increases were adequate during dengue season. Only 54% strongly agreed or agreed that physician staffing was adequate during dengue season and only 43% agreed or strongly agreed that ancillary staffing was adequate. About 50% of respondents felt that their hospitals had adequate preparedness plans in place to address surges in dengue cases.

Discussion

Our study showed that dengue is a widespread disease affecting a large percentage of respondents in our sample. Over 40,000 cases of dengue were reported during the year of our survey, making our study particularly timely [20].

Surprisingly rapid dengue testing was used by less than half of respondents in our sample despite prior data showing its promising potential to expedite diagnosis of dengue and therefore shorten patient ED throughput [15]. Most respondents in our sample reported that rapid dengue testing was not available at their institutions, did not change management or was prohibitive due to cost. Of note despite NS1 rapid testing being fairly sensitive (95–97%) and specific (97–100%), other rapid diagnostic tests, such as those that test IgG and Ig M are less effective. The cost of the Rapid NS1 test averages 400 Rupees, much higher in cost that the ELISA test (averaging 150 Rupees) [21]. The low rate of rapid testing in our sample may reflect a lack of knowledge or understanding about the effectiveness of various rapid dengue tests reflected by the larger

Table 2
Impact of dengue on EDs of sample respondents.

Increase in ED visits per day dengue season	
0%	6 (2.9%)
1–20%	114 (54.3%)
21–40%	52 (24.8%)
41–60%	24 (11.4%)
>60%	14 (6.7%)
Number of weeks visits increase during dengue season	
0	7 (3.3%)
1–4	66 (31.4%)
5–8	72 (34.3%)
9–12	39 (18.6%)
>12	26 (12.4%)
Impact of dengue on ED flow[a]	
Increases number of ED visits	178 (84.8%)
Increases patient wait time	88 (41.9%)
Increases admissions	168 (80.0%)
Increases ICU admissions	124 (59.1%)
Increases transfers to ED	82 (39.1%)
Increases transfers from ED	57 (27.1%)
Increases ED length of stay	82 (39.1%)
Increases number of people who leave without being seen	13 (6.2%)
Hospital increases staffing	67 (31.9%)
If staffing increases, how[a]	
Increase number of ED physicians	26 (12.4%)
Increase number of ancillary staff	64 (30.5%)
Use of rapid point of care testing	99 (47.1%)
Type of rapid point testing available at institution	
NIS: J Mitra Dengue or SD Bioline Dengue	28 (13.3%)
Ig G and Ig M: Transasia Erbo Den-go or Panbio early rapid testing	17 (8.1%)
Other	36 (17.1%)
Do not know	17 (8.1%)
Other tests used	
IgM enzyme linked immunosorbent assay (MAC Elisa)	156 (74.3%)
Real time polymerase chair reaction (RT-PCR)	20 (9.5%)
Viral culture	4 (1.8%)
Do not know	10 (4.8%)
Other	21 (10%)
Reasons for not using rapid point of care testing[a]	
Not available at institution	66 (31.4%)
Too expensive for patient	38 (18.1%)
Low specificity/sensitivity	21 (10.0%)
Does not change management	43 (20.5%)
Other/do not know	90 (42.9%)

[a] Respondents could answer more than one therefore responses sum to >100%.

Indian population. In 2015, a year after our study was completed, the Indian government banned use of rapid testing due to the perception that the test resulted in high rates of false positives [22]. In our sample of the small proportion of providers that used rapid testing, an even smaller number actually used NS1 rapid testing, which may reflect a need for greater uniformity and availability of highly sensitive rapid dengue testing methods. Prior studies are limited, but have shown that rapid testing can aid providers in confirming the diagnosis of dengue in the clinical setting [23,24]. In particular rapid testing may have a role in resource limited settings where diagnostic capabilities may be limited in helping providers identify cases that may need early referral for management [25]. Rapid testing has also been shown to have a role in other arboviruses, such as zika, where such testing was found to be helpful in early management of the disease, especially for pregnant women [26].

Most respondents in our sample reported that their institutions experienced moderate to large surges in ED visits during dengue season. Very few respondents reported that their hospital actually increased staffing during this time, unless they were at hospitals with large surges in visit volumes. However, only about half of respondents agreed with the statement that physician or ancillary staffing was adequate during this period.

Table 3
Multivariate analysis evaluating relationship of physician staffing and rapid dengue testing to ED characteristics.

	Increase in physician staffing during dengue season	Use of rapid dengue testing
City size		
Medium/large urban area	0.77 (0.37–1.62)	0.75 (0.38–1.48)
Small urban/suburban/rural	1.00	1.00
Type of hospital		
Government/public	0.80 (0.51–1.24)	1.15 (0.77–1.72)
Private/other	1.00	1.00
ED size		
Large (>20)	0.96 (0.49–1.91)	1.47 (0.78–2.76)
Medium/small (≤20)	1.00	1.00
Daily visits non-dengue season		
>100	1.28 (0.54–3.04)	0.66 (0.29–1.52)
51–100	0.59 (0.28–1.22)	0.59 (0.31–1.14)
<50	1.00	1.00
Increase in ED visits per day dengue season		
>40%	3.28 (1.44–7.46)	1.91 (0.86–4.21)
21–40%	1.76 (0.85–3.65)	1.37 (0.70–2.69)
<20%	1.00	1.00
Number of weeks visits increase during dengue season		
>9 weeks	0.71 (0.32–1.55)	1.13 (0.56–2.29)
5–8 weeks	0.99 (0.48–2.06)	0.71 (0.36–1.42)
<5 weeks	1.00	1.00

Table 4
Comfort level of respondents.

	Average Likert
Hospital has adequate physician staffing	
Strongly agree/agree	113 (53.8%)
Neutral	47 (22.4%)
Disagree/strongly disagree	50 (23.8%)
Hospital has adequate ancillary staffing	
Strongly agree/agree	90(42.8%)
Neutral	48 (21.9%)
Disagree/strongly disagree	74 (35.2%)
Hospital provides adequate preparedness plan	
Strongly agree/agree	105 (50.0%)
Neutral	58 (27.6%)
Disagree/strongly disagree	47 (33.4%)
Hospital has adequate testing for dengue	
Strongly agree/agree	165 (78.6%)
Neutral	24 (11.4%)
Disagree/strongly disagree	21 (10.0%)

Specialized approaches to managing large volumes of dengue patients may be needed in order to help alleviate the impact on staffing and emergency flow. In some countries, implementation of dedicated areas that focus on dengue management have helped providers target the specific needs of patients with dengue. For example, in Sri Lanka, “dengue treatment units” have been implemented [27]. In Malaysia, large hospitals took turns “cohorting” large volumes of dengue patients so that patients could be cared for by specialized teams who focused on the management of the

disease. Such care improved outcomes and decreased resource use in these patients [28]. This approach may have similar efficacy for managing other large scale outbreaks due to diseases such as zika and chikungunya as well.

Limitations

Our study had several limitations. It was a convenience sample and responses were at the provider level, rather than at the institutional level. We had a large proportion of respondents that were younger, male and residents in training, and therefore our responses may not be representative of the general population of ED providers in the country. Finally, our sample size was small and therefore may have contributed to the lack of significance found for many of the multivariate results. In addition, the small sample size may have introduced some sampling bias, affecting the generalizability of our sample. We attempted to use multiple data collection sources to help reduce this potential bias.

Conclusions

Our study is one of the first studies that evaluated Indian emergency providers opinions about surge, staffing adjustment and variation in the use of diagnostic testing in the setting of a dengue outbreak. It provides important insights about the burden of dengue in the country, the beliefs and practice of dengue testing by individual providers and how institutions respond to such burdens. More research is needed to better understand how emergency departments can best adjust to dengue to provide optimal care for patients in India. In addition, greater effort should be dedicated to understanding how rapid testing and staffing adjustments in the ED can improve patient flow and ultimately patient outcomes during dengue season.

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Competing interests

None declared.

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