EPIDEMIOLOGY

Surveillance for an Emerging Disease: Dengue Hemorrhagic Fever in Puerto Rico, 1988-1997

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ABSTRACT: Surveillance for emerging diseases is critically dependent on four factors: reporting methods, case definition, laboratory diagnosis, and knowledge of the disease among health-care professionals. The dengue hemorrhagic fever (DHF) surveillance system in Puerto Rico collects patient data from three sources: dengue case investigation (DCI) forms sent with diagnostic samples, clinical reports from hospital infection control nurses (ICNs), and hospital records. Recruitment of ICN reporting produced a marked increase in notifications (67 to 294). Hospital records of possible DHF cases showed that tests for ascertaining diagnosis (e.g.,blood in stool, serum albumin) were frequently not performed. DCI and ICN reports underestimated severity. After hospital record review, the ratio of total DHF cases to cases detected by surveillance was approximately 3:1, whether using clinical criteria or using clinical and dengue laboratory diagnosis. An important determinant for the low sensitivity (28.4%) and high specificity (96.5%) of the surveillance system was the World Health Organization (WHO) clinical definition for DHF. In spite of such limitations, DHF surveillance data in Puerto Rico provide abundant, reliable information for monitoring disease trends. These methods may be applied to other situations to define the characteristics and incidence trends of emerging infections. *Key words: Dengue, Dengue hemorrhagic fever, Population surveillance, Patient selection.*

Dengue fever is an acutely incapacitating illness with high fever, headache, and bone and joint pains. In contrast, dengue hemorrhagic fever (DHF) is characterized by fever, thrombocytopenia, hemorrhagic manifestations, and excessive capillary permeability that may lead to shock (dengue shock syndrome [DSS]) and death. The lethality rate of DSS may be over 10% (1). The four serotypes of dengue virus are transmitted by certain *Aedes* species mosquitoes in tropical and subtropical areas. Until 1981, DHF was a cause of hospitalization and death only in Asia and the Pacific region. Since then, it has produced large epidemics in the Americas (2,3).

Dengue is an emerging infectious disease, i.e. one "whose incidence in humans has increased within the past two decades or threatens to increase in the near future" (4). Surveillance for emerging diseases is critically dependent on four factors: reporting methods, case definition, laboratory diagnosis, and knowledge of the disease among health-care professionals. In addition, surveillance may need to be conducted in a situation in which the emerging infection may not be familiar to the sources of reports. Pro-active or anticipatory surveillance must examine the reported data as indices or signals of the occurrence of the syndrome of interest, to be used both to educate clinicians about a new disease, and to guide public health officials in their prevention and control efforts.

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Much has been written about the need for dengue surveillance, but no evaluation of a system has been published. We describe here the methods used in Puerto Rico to identify cases of DHF from 1988 to 1997. We compare data from different reporting sources, and evaluate the sensitivity and specificity of the surveillance system, giving special attention to the requirements in the case definition; the limitations of the methods for microbiologic diagnosis; and the awareness among health care personnel of the clinical characteristics of DHF.

Methods

Laboratory. Serum specimens collected less than 6 days after the onset of illness were either processed for virus isolation in C6/36 mosquito cell cultures or inoculated into *Toxorhynchites amboinensis* or *Aedes aegypti* mosquitoes (5-7). Dengue viruses were identified by the use of serotype-specific monoclonal antibodies in an indirect fluorescent antibody test on virus-infected cell cultures or tissues from inoculated mosquitoes (6). Serum specimens were tested for anti-dengue immunoglobulin M (IgM) by the IgM antibody-capture enzyme-linked immunosorbent assay (MAC-ELISA) (8-10). Because the measurement of IgM antibody may fail to diagnose about 5% of secondary dengue infections, specimens with borderline results by MAC-ELISA were tested by HI or IgG-ELISA in an attempt to confirm the diagnosis by detecting an anamnestic anti-dengue antibody response (11).

Laboratory case definitions. Confirmation of a current dengue infection was based on either of the following criteria: 1) dengue virus isolation from serum or autopsy tissue samples; or 2) seroconversion from negative to positive, or a four-fold or greater change, in anti-dengue antibody titers in paired serum samples (12). Demonstration of dengue virus antigen in autopsy tissue samples by immunofluorescence or immunocytochemical analysis was attempted but proved negative for the 1990-91 cases (13).

Probable dengue cases were those individuals who submitted a single serum sample that was IgM positive, or had an antibody titer by HI $\geq$1,280 or an IgG antibody titer by ELISA $\geq$163,840. These cases were considered only probable because the persons might have had dengue in the past 3 months (IgM may be present for 90 days or longer), and the symptoms at the time of blood collection might have been due to an illness other than dengue (8,9). Unless otherwise stated, probable and confirmed cases are considered together as laboratory-diagnosed or laboratory-positive cases. Single specimens negative for virus, and for IgM, if collected 5 or fewer days from onset of illness, were considered non-diagnostic, and the case was categorized as indeterminate. In specimens collected 6 or more days after onset of symptoms, the absence of IgM was considered to rule out the diagnosis of dengue, and the case was considered negative.

Surveillance. The Dengue Branch, Division of Vector Borne Infectious Diseases, CDC, receives diagnostic specimens from government clinics, public and private hospitals, laboratories, and physicians' offices throughout Puerto Rico (population 3.5 million, 1990 census). These specimens are sent directly, or are collected locally and delivered by personnel of the Puerto Rico Department of Health. The dengue case investigation (DCI) form includes information on patient symptoms, date of onset of illness, and date of sample collection. Puerto Rico experienced epidemics of dengue in 1963 and 1969, but it was not until 1975 that the first case of DHF was documented. In spite of epidemics in 1977 and 1978, and considerable investigative effort, other cases were not documented until 1982 and 1985 (14-18). Dengue is a reportable disease in Puerto Rico, but not DHF as a separate category. In 1981 a network of sentinel physicians, hospital infection control nurses (ICNs) and clinics was established to encourage reports of suspected DHF cases and the submission to CDC of diagnostic samples (19,20). During the 1986 epidemic, this system detected 29 laboratory-positive DHF cases, including 12 with shock and 3 deaths; in 1987, 17 cases (including one death) were documented (21).

Starting in 1989, an additional data collection method was instituted. ICNs at all hospitals were asked to provide a 40-item report of demographic and clinical information on patients discharged with a diagnosis (or consideration) of dengue fever. The ICNs provide the data voluntarily, because the DCI form already serves as a legally sanctioned dengue report, therefore some ICNs at large public hospitals do not participate routinely. Many ICNs complete the report early in the hospitalization and interview the patient, rather than review the record after discharge. Starting in 1991, reports from the Puerto Rico Forensic Medicine Institute and the Demographic (vital statistics) Registry were also included in these data, which are stored and analyzed using Epi-Info software (22). For the analysis of temporal trends, cases are assigned to the date of onset of symptoms.

We examined the geographic coverage of surveillance for severe disease for 1988 to 1991 by using a denominator independent of the data in the surveillance system. For the 78 municipalities in Puerto Rico (grouped into eight regions by the Puerto Rico Department of Health) we established a ranking of the discrepancy between a region's proportion of reporting hospitals compared to

its share of all general hospitals, and a similar examination of a region's proportion of the island population and its share of dengue case reports in that year.

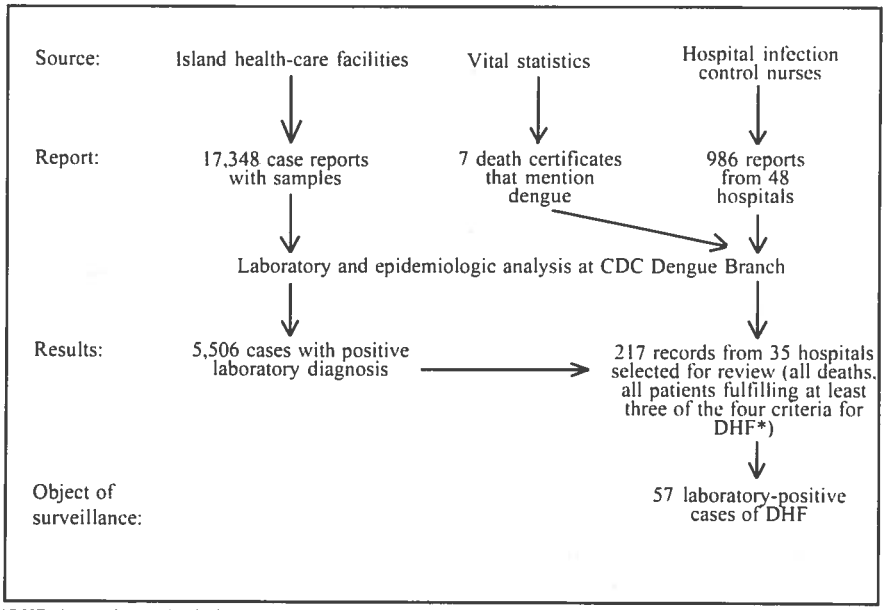
Clinical case definition of DHF. The World Health Organization's (WHO) criteria for reporting DHF at the time of this investigation were as follows: "(1) fever; (2) hemorrhagic manifestations including at least a positive tourniquet test (except in shock cases), and perhaps minor or major bleeding phenomena; (3) thrombocytopenia (100,000/mm^3 or less); (4) hemoconcentration: hematocrit increased by 20% or more, or objective evidence of capillary permeability" (2). Because a positive tourniquet test is such a mild hemorrhagic phenomenon, and its absence should not be used to rule-out DHF, we interpreted the second criterion above to mean any hemorrhagic manifestation (an interpretation subsequently adopted in the most recent WHO definition) (23). Following the 1986 WHO guidelines, hypoalbuminemia, pleural or abdominal effusions (documented by X-ray, ultrasound, or computerized axial tomography), or hemoconcentration were considered objective evidence of capillary permeability. Hemoconcentration was calculated as the ratio of the difference of maximum and minimal hematocrit values, divided by the minimal value. In consideration of the reference values used in local hospitals, hypoalbuminemia was defined as a serum albumin less than 3 g/dL. DSS was defined by the above criteria plus hypotension or narrow pulse pressure ($\leq$20 mm Hg) (2). It is important to highlight that the WHO criteria for reporting DHF do not require a positive laboratory test for dengue infection.

DHF incidence. Figure 1 indicates the origin, management, and number of reports used to identify laboratory-positive cases of DHF with onset in 1990 and 1991. A computer algorithm identified cases that fulfilled WHO criteria for DHF and DSS (C-DHF). Of the 986 reports from special surveillance in 1990-91, all deaths (n=11), and cases of C-DHF (n=33, including 3 deaths) or potential DHF (case reports in which any three of the four criteria were fulfilled, n= 181, including 3 deaths) were selected for complete medical record review. Two of the 219 records came from outpatients (non-fatal potential DHF cases) and were eliminated from further analysis because no hospitalization record was available for review.

Comparison of data from different sources. Hospital records were chosen as the best available standard for evaluation of the responses in the ICN and DCI forms, in spite of recognizing that each of the three documents was completed at a different stage of the illness. Therefore, we did not compare forms to determine relative "accuracy", but used odds ratios (in matched-pair analysis, with McNemar's test for significance) to examine which report was more useful for providing different types of clinical data. Binary (yes/no) categorical responses were recoded so that blank or "unknown" values were converted to "no." For numeric variables, the mean arithmetic difference between responses with non-blank values was calculated, and evaluated with the Student *t* test.

Results

From 95% to 100% of the 78 municipalities of Puerto Rico contributed reports and laboratory-positive cases of dengue every year. The analysis of geographic coverage showed that in 1988 the region with the greatest disparity between the percent of hospitalized suspected dengue cases compared with the region's share of the Puerto Rico population was San Juan (33% of the identified



*DHF -dengue hemorrhagic fever, including dengue shock syndrome.

Figure 1. Dengue case reporting in Puerto Rico, 1990 and 1991 - form and diagnostic sample flow, and case selection for hospital record review

hospitalized cases, and 24% of the island's population), while a comparison of each region's share of hospitals reporting severe cases with its share of all general hospitals showed no important discrepancy. However, after the institution of reports from ICNs in 1989, both measurements coincided in identifying the most affected regions (Mayagüez in 1989, Ponce in 1990, Caguas in 1991). The number of hospitals submitting ICN reports increased from 25 in 1989 to 48 in the 1994 epidemic, out of 56 acute-care institutions.

Table 1 shows the number of annual reports (1988-1997) accrued by each mechanism for dengue surveillance. The laboratory-based reporting system indicates an increase in the proportion of suspected cases reported as hospitalized, from 6.8% in 1988 to 31.1% in 1997. The number of cases reported by the special surveillance system increased markedly from 67 in 1988 (when the search for severe cases was initiated by Dengue Branch queries) to 294 the following year (hospital-based reporting by ICNs). The volume of reports in this system since 1989 is about 30-40% of the reports of hospitalizations according to diagnostic samples (except for 1993 and 1994, anomalous extremes of dengue reporting in this decade). It must be noted that the two reporting systems for hospitalizations are independent, and that they only overlap in about 45% of cases reported by ICNs. Therefore, as can be seen in the columns titled DHF/DSS, many of the cases for whom clinical information is reported do not have accompanying serum samples for dengue diagnosis.

Item-by-item reliability of forms. The hospital records frequently lacked information that is necessary for DHF diagnosis and management. For example, a tourniquet test was not performed in 182 (83.9%) of 217 patients, and no information was available on aspartate and alanine aminotransferase (AST, ALT), or bilirubin level in 24.0% to 34.1% of patients. Of the 217 patient records reviewed, 115 were found to be compatible with a clinical diagnosis of dengue fever, but many of them could not be further classified for lack of the following: fever history (2), tourniquet test (103), tests for blood in stool (97) or urine (4), repeat hematocrit (5), and serum albumin measurement(20).

In the comparison of ICN reports, DCI forms, and hospital records, we found that hospitalization was not mentioned in 51 (29.0%) DCI forms. Tables 2 and 3 include the symptoms and signs (ranked by order of odds ratio) that were reported in significantly different frequency, and those with a greater than 10% discrepancy (regardless of statistical significance) in a matched-pair comparison of the DCI or ICN forms and the hospital record for each patient. When the odds ratio was less than one, the discrepancy was mostly due to a form's not containing a finding that was present in the hospital record. If the odds ratio was greater than one, the discrepancy was mostly due to the hospital record's not having a

Table 1. Dengue in Puerto Rico, 1988-1997

Year	Reports with specimens		Reported in special surveillance*			Hospital record review, 1990-1991 DHF/DSS, Laboratory Positive
	Total	Reported as hospitalized (percent)	Total	DHF/DSS**		
				Clinical	Laboratory-positive	
1988	6,733	460 (6.8)	67	-	8/0	-
1989	7,683	806 (10.5)	294	-	12/1	-
1990	7,660	1,146 (15.0)	448	6/3	5/1	15/3
1991	9,688	1,290 (13.3)	538	21/3	12/2	34/5
1992	11,078	1,468 (13.2)	595	31/3	10/0	-
1993	6,266	481 (7.7)	423	14/3	7/2	-
1994	23,693	4,329 (18.3)	1,997	133/12	44/3	-
1995	6,491	1,549 (23.9)	436	45/3	23/0	-
1996	4,645	1,492 (32.1)	458	66/3	29/0	-
1997	7,393	2,301 (31.1)	690	65/5	30/2	-

*From 1989 on, special surveillance has been based on infection control nurse reports.
**DHF/DSS - dengue hemorrhagic fever or dengue shock syndrome.
Clinical - cases selected by computer algorithm as clinically compatible with DHF/DSS. Laboratory-positive - laboratory positive cases of DHF/DSS identified by computer algorithm. Hospital record review - DHF/DSS cases with data in hospital record to fulfill the criteria for DHF/DSS, and with positive dengue diagnostic studies.

Table 2. Comparison of symptom data from dengue case investigation forms or infection control nurse reports and hospital records, Puerto Rico,1990 and 1991

Symptom	Percent (n=217) In hospital record	Discrepant*	O.R.†	95% C.‡
From the Dengue Case Investigation Form				
Fever	97.2	23.3	0.05	0.01 < OR < 0.20**
Shock	6.8	7.4	0.08	0.00 < OR < 0.56**
Pleural or abdominal effusions	6.3	6.8	0.09	0.00 < OR < 0.63**
Petechiae	38.1	30.7	0.29	0.14 < OR < 0.55**
Nosebleed	13.1	11.4	0.54	0.18 < OR < 1.45
Rash	34.1	43.2	0.58	0.33 < OR < 1.06
Travel outside the municipality in the ten days before onset of symptoms	0.0	11.4	20.00	3.20 < OR < 828.96**
From Infection Control Nurse reports				
Pleural or abdominal effusions	5.5	4.1	0.13	0.00 < OR < 0.93**
Shock	8.8	6.5	0.17	0.02 < OR < 0.75***
Fever	96.8	7.8	0.31	0.09 < OR < 0.90**
Microscopic hematuria	41.5	21.7	0.38	0.19 < OR < 0.74***
Petechiae	36.9	28.6	0.94	0.55 < OR < 1.59
Gum bleed	10.6	12.0	1.36	0.59 < OR < 3.28
Rash	32.7	31.8	1.38	0.83 < OR < 2.31
Nosebleed	13.4	10.6	1.88	0.75 < OR < 5.11
Hematuria	5.5	13.8	4.00	1.59 < OR < 11.96***
Excessive bleeding at puncture wound	2.3	4.6	10.00	1.42<OR§ <433.98***

* Blank or "unknown" values were converted to "no."
† Mantel-Haenszel matched odds ratio
‡ Exact 95% confidence interval for maximum likelihood estimate.
§ Recalculated assigning a 1 to cells with a value of zero.
** $p < 0.05$
*** $p < 0.01$

finding that was reported in the form for the same patient. Both the DCI and the ICN forms underestimate the severity of the illness, less often mentioning extreme values for critical tests and life-threatening clinical events that occur late in the hospitalization. The difference in each of the ICN hematocrit readings (compared to the hospital record) resulted in an underestimation of hemoconcentration in 54.1% of patients and an overestimation in 11.4%. In contrast, the ICNs more often reported some hemorrhagic manifestations.

DHF incidence. For 1990 and 1991, 9 and 24 reports, respectively, were selected by computer algorithm, as compatible with the WHO definition for DHF (including DSS). For 1991, the 24 clinically compatible (C-DHF) cases reported to the surveillance system represent an incidence of 0.68 DHF/DSS cases per 100,000 population. Of the 33 cases for both years, 20 (61%) were laboratory-positive, and two of those died (10%). For the remaining computer-identified DHF (C-DHF) cases, either inadequate serum samples were submitted (10; 30%) or

Table 3. Comparison of dengue case investigation forms (DCI), infection control nurse reports (ICN), and hospital records, Puerto Rico, 1990 and 1991

Test*	Number of comparisons	Mean difference	Percent discrepant‡ from hospital record higher	lower	total
DCI - Min. hematocrit	75	-3.933†	89.3	6.7	96.0
ICN - Min. hematocrit	207	-0.751†	41.1	7.2	48.3
ICN - Max. hematocrit	185	0.726†	8.6	33.0	41.6
From ICN:					
Max. PT	124	0.637†	12.1	28.2	40.3
Max. PTT	121	2.705†	8.3	29.8	38.1
Adm. sodium	159	-0.579†	13.8	8.2	22.0
Adm. potassium	149	-0.020	10.1	14.4	24.5

*Abbreviations and units of measurement: Min. - minimum; Max. - maximum; Adm. - admission; hematocrit (percent); PT - prothrombin time (seconds); PTT - partial thromboplastin time (seconds); sodium and potassium (mEq/L).
†$p < 0.01$, Student t test
‡Blank or "unknown" values were omitted from the comparison.

dengue was ruled out (3; 9%). For these two years, there were similar sex ratios for C-DHF cases (1 male: 1.1 females) and for the other hospitalized patients with suspected dengue (1 male: 0.83 female). Cases in all age-groups were reported. The median age for C-DHF cases was 30 years in 1990 and 19 in 1991, and for the other hospitalized cases, 23 and 21 years, respectively. C-DHF patients resided most commonly (3 of 9) in the Bayamón region in 1990, and the Caguas region in 1991 (7 of 24).

In 1990 and 1991, an additional 179 cases fulfilled three of the four criteria for DHF; the most common missing criterion was evidence of a leaky capillary syndrome (72.6%, 130/179). We reviewed the hospital records of the 33 C-DHF patients, these 179 severe cases, and additional fatalities with disease onset in 1990 and 1991 (total, 217). Of them, 102 (47.0%) fulfilled the WHO criteria for DHF (91; 41.9%) or DSS (11; 5.1%), while 115 (53.0%) remained as clinically compatible with dengue fever. This last group also included two of the original 20 C-DHF laboratory-positive cases, because the records did not report fever and bleeding, respectively. The high case fatality rate in the presumed dengue fever group (6 deaths, 5.2%), with 3 of these deaths occurring among the 53 laboratory-positive dengue patients, suggests that many of these cases were truly DHF, but insufficiently documented. Regarding laboratory diagnoses, 110 of the 217 cases (50.7%) were positive, and 19 (8.8%) did not submit blood samples.

Of the 102 cases clinically compatible with DHF (30 for 1990 and 72 for 1991), 57 (55.9%), including two deaths, were laboratory positive for dengue; 16 (15.7%) were negative; 22 (21.6%), including two deaths, were indeterminate; and 7 (6.9%), including one death, did not have a blood sample submitted for testing. The clinical manifestations of the 57 laboratory-positive cases of DHF have been described elsewhere (24). Among them, 15 were confirmed and 42 were probable dengue cases. For both years, the most frequent region of residence (7 of 18, 38.9%, and 11 of 39, 28.2%, respectively) was Bayamón; the male-to-female ratio was 1.00:0.68, and the median age was 39 years in 1990 and 34 in 1991. The case-fatality rate among the laboratory-positive cases of DHF (2 of 57, or 3.5%) was markedly lower than the CFR based on surveillance (DCI and ICN) reports (10.0%).

The incidence of cases clinically compatible with DHF for 1990 and 1991 was 3.09 times greater than reported (102 vs. 33), while the incidence of DHF with laboratory positivity was 2.85 times greater than reported (57 vs. 20). Table 4 compares the computer-identified and the final classification of cases as DHF, on clinical grounds only (without laboratory testing for dengue). Table 5 shows the distribution when laboratory positivity was added as a requirement for classifying DHF. In both

Table 4. Comparison of computer identification and hospital record review for detecting DHF cases in Puerto Rico, 1990-1991, without requirement of laboratory positivity.

Computer-identified DHF - hospital record review

DHF	Yes	No	Total
Yes	29	4	33
No	73	111	184
	102	115	217

Chi-square (Yates) = 24.20, $p < 0.01$

Sensitivity = $\frac{29}{102} = 0.284$ Specificity = $\frac{111}{115} = 0.965$

95% Confidence Interval (CI)=0.197-0.372 95% CI=0.932-0.999

PVP* = $\frac{29}{33} = 0.879$ PVN† = $\frac{111}{184} = 0.603$

95% CI=0.767-0.990 95% CI=0.533-0.674

*PVP - Predictive value of a positive test
†PVN - Predictive value of a negative test

Table 5. Comparison of computer identification and hospital record review for detecting DHF cases in Puerto Rico, 1990-1991, with requirement of laboratory positivity.

Computer-identified DHF and laboratory -positive	DHF - record review and laboratory-positive		
	Yes	No	Total
Yes	18	2	20
No	39	158	197
	57	160	217

Chi-square (Yates) = 42.65, $p < 0.01$

Sensitivity = $\frac{18}{57}$ = 0.316 Specificity = $\frac{158}{160}$ = 0.988

95% Confidence Interval (CI)=0.195-0.436 95% CI=0.970-1.000

PVP* = $\frac{18}{20}$ = 0.900 PVN† = $\frac{158}{197}$ = 0.802

95% CI=0.768-1.000 95% CI=0.746-0.858

*PVP - Predictive value of a positive test
†PVN - Predictive value of a negative test

analyses, there was an association between the computer-identified and the final classification as DHF ($p < 0.01$). The accuracy of classification on clinical grounds alone (140 of 217, or 64.5%, 95% confidence interval [CI] 58.2-70.9%) was increased by adding laboratory testing to the clinical diagnosis (176 of 217, or 81.1%, 95% CI 75.9-86.3%), but there was similarly low sensitivity (28.4% and 31.6%), and high specificity (96.5% and 98.8%).

Discussion

Surveillance data clearly depend on the method for disease reporting. As expected for a change from sentinel to population-based methods, the identification of potential cases of DHF based on ICN reports produced an index of dengue severity that is consistent with the known local activity of dengue, and markedly increased the number of reports received (294 in 1989 vs. 67 the previous year). Still, because important tests for ascertaining dengue severity were frequently not performed in hospitals (and some hospitals do not participate in the voluntary reporting), many DHF cases could not be identified. For example, the near universal neglect of the tourniquet test means that grade I DHF is almost never recognized in Puerto Rico. For the same reasons, none of the surveillance systems we used to capture DHF/DSS cases (DCI, ICN or even hospital record review) is 100% comprehensive. The data differences among the ICN form and the hospital record reflect the attention that ICNs give to intravenous and urinary catheters, and their practice of interviewing the patient using our report form, but also the time of completion of the different forms. Prompt dengue case reports (close to the time of diagnosis or hospital admission) cannot be 100% complete in their description of the course of the clinical illness.

Capture-recapture calculations based on the number of patients reported as hospitalized in the DCI forms and those notified by ICNs from 1991 to 1995 estimated that the true number of hospitalizations was 2.30 times the number reported in DCI forms (25). We therefore conclude that the true DHF incidence in Puerto Rico is at least six times (2.30 from the capture recapture study x 2.85 from the hospital record review) what the surveillance system measures. In comparison to surveillance systems for other severe diseases, a DHF case-to-report ratio of 6:1 is larger than the recently reported ratios of 2:1 to 1:1 for hospitalized measles patients, meningococcal disease, tuberculosis, and HIV-related deaths in different studies in the United States and Puerto Rico (26-28). Those surveillance systems are supported by specifically-assigned state and federal resources. In contrast, DHF surveillance in Puerto Rico is a very economic system, since no funds are assigned to the network. Surveillance is achieved by a collaboration of the public and private sectors, and has survived because it is beneficial to all participants and imposes no major responsibilities outside routine duties. The system could nevertheless be improved by the use of a DCI form with symptoms listed in a way that the reporting individual would realize when all four criteria for DHF have been fulfilled, if the appropriate items have been marked. This would alert the care-giver to the patient's risk of severe illness, and might improve patient care. Full data for surveillance could only be expected in convalescent-phase samples. Another improvement would be the use of a less restrictive definition for DHF for use in conjunction with dengue laboratory tests.

An important determinant for the low sensitivity and high specificity of the surveillance system is the WHO clinical definition for DHF. Because the 1986 version required a positive tourniquet test, its application would not have allowed the inclusion of 52 (91.2%) of the 57 DHF cases identified by hospital record review. Even our version (any hemorrhagic sign, plus the other three criteria) proved so restrictive that the additior of laboratory positivity to the criteria did not increase the specificity of case detection (Tables 4 and 5). A standard case definition for DHF is indispensable to track the incidence of this emerging disease in Latin America, as has also been shown

for cholera (29-30). On the other hand, the capability of surveillance systems for detecting severe dengue must be evaluated, and local indicators of severity must be devised if the clinical data available are not sufficient to use the WHO definition.

DHF surveillance data in Puerto Rico, even with the limitations described in this analysis, provide abundant information, reliable for monitoring disease trends, and useful for guiding more detailed clinical and epidemiologic studies (24,31-32). These effective methods for surveillance may serve to inform the medical community promptly about the characteristics of other diseases and to acquire more accurate information on incidence trends for emerging infections.

Resumen

La vigilancia epidemiológica para enfermedades emergentes depende de cuatro factores críticos: método de notificación, definición de caso, diagnóstico de laboratorio, y conocimiento de la enfermedad entre los profesionales de la atención médica. El sistema de vigilancia de dengue hemorrágico (DH) en Puerto Rico recoge datos clínicos de tres fuentes: formularios de investigación de caso de dengue (ICD) enviados con las muestras diagnósticas, informes clínicos de enfermeras de control de infecciones (ECI), y expedientes hospitalarios. El reclutamiento de las ECI produjo un gran aumento en las notificaciones (67 a 294). Los expedientes hospitalarios de casos de posible DH demostraron que pruebas para verificar el diagnóstico (por ejemplo, sangre en la excreta, albúmina sérica) frecuentemente no se llevaban a cabo. Los informes de ICD y ECI subestimaron la severidad de los casos. Tras la revisión de expedientes hospitalarios, la razón de casos totales de DH a casos detectados por la vigilancia fue aproximadamente 3:1, usando criterios clínicos o mediante estos combinados con diagnóstico de laboratorio de dengue. Un factor determinante en la baja sensibilidad (28.4%) y alta especificidad (96.5%) del sistema de vigilancia fue la definición clínica de DH de la Organización Mundial de la Salud. A pesar de esas limitaciones, la vigilancia de DH en Puerto Rico provee información abundante y confiable para determinar las tendencias de la enfermedad. Estos métodos pueden aplicarse a otras situaciones para definir las características e incidencia de infecciones emergentes.

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