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Effect of a dengue clinical case management course on physician practices in Puerto Rico

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Abstract

Background—Prior to 2010, the clinical management of dengue in Puerto Rico was shown to be inconsistent with World Health Organization guidelines. A four-hour classroom-style course on dengue clinical management was developed in 2009 and mandated in 2010 for Puerto Rico medical licensure. Fifty physicians were trained as 'master trainers' and gave this course to 7,638 physicians. This study evaluated the effect of the course on the clinical management of hospitalized dengue patients.

Methods—Pre- and post-course test responses from participants were analyzed. Changes in physician practices were assessed by reviewing the medical records of 430 adult and 1075 pediatric dengue patients at the 12 hospitals in Puerto Rico that reported the most cases during 2008–2009 (pre-intervention) and 2011(post-intervention). Mixed-effects logistic regression was used to compare key indicators of dengue management. Key informant interviews of hospital medical directors and department chiefs were conducted to understand reasons for, or barriers to, changes in practice.

Findings—Physician test scores increased from 48% correct to 72% after taking the course. Medical record review showed that the percentage of adult patients who did not receive corticosteroids increased from 30% to 68% (OR 5.9, 95% CI 3.7–9.5) and from 91% to 96% in pediatric patients (OR 2.7, 95% CI 1.5–4.9). Usage of isotonic intravenous saline solutions during the critical period increased from 57% to 90% in adult patients (OR 6.2, 95% CI 1.9–20.4) and from 25% to 44% in pediatric patients (OR 3.4, 95% CI 2.2–5.3). Key informant interviewees attributed improvements in practice to the course and identified additional barriers to further change.

Interpretation—The management of hospitalized dengue patients improved significantly following implementation of a classroom-style physician training course taught by master trainers. An online version of the course was launched in 2014 to expand its reach and sustainability.

The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Background

Over the last few decades, the incidence and severity of dengue in the Americas has substantially increased[1]. Puerto Rico has not escaped this regional trend. An epidemic in 2007 with high rates of hospitalization and severe disease[2] was followed in 2010 by Puerto Rico's largest documented dengue epidemic[3]. Review of fatal cases in the 2007 outbreak revealed a number of concerns regarding the clinical management of severe dengue[4], including substantial deviations from World Health Organization (WHO) treatment guidelines[5-7]. Adoption of these management practices has been credited with improved patient outcomes in various countries including Thailand[8, 9], Vietnam[10, 11], and Nicaragua[12]. Clinical management concerns in Puerto Rico included failure to recognize dengue, warning signs for severe disease, or early signs of shock; infrequent patient monitoring; administration of intravenous non-isotonic saline solutions; and widespread use of corticosteroids despite evidence against their use[13-15]. Some of these issues were also identified in a review of fatal dengue cases from 1992–1996[16] and were further investigated by an assessment of physicians' clinical knowledge and practices in 2007–2008[17]. During the latter assessment, 40% of respondents reported using corticosteroids regularly to treat dengue, and the majority were not familiar with appropriate intravenous fluid usage or indications for platelet or blood transfusion.

In response to these identified gaps in knowledge and practices, the Centers for Disease Control and Prevention Dengue Branch (CDC-DB) developed a 4-hour classroom course for physicians on dengue clinical management that was implemented in late 2009 through 2010. Few studies have attempted to document the effectiveness of physician education in improving dengue clinical management; those that did typically did not evaluate changes in clinical practice[8-10]. In addition, evidence for the effectiveness of continuing medical education (CME) is generally limited, especially when given in single-event, classroom settings[18-20]; CME has been shown to be more effective in changing physician knowledge than in changing actual physician practice[21]. The objective of our study was to determine if changes occurred in the clinical management of hospitalized dengue patients following implementation of the CDC-DB course.

Methods

The Course

Using findings from the 2007 review of fatal dengue cases and the 2007–2008 physician survey, CDC-DB in 2009 developed a dengue clinical management course and pilot tested it among several hundred clinicians in Puerto Rico. The course was then revised to include the newly released 2009 WHO dengue guidelines and several interactive case studies. Course participants were provided with electronic and hard copy materials, as well as clinical management pocket guides for quick reference.

CDC-DB trained 50 Puerto Rican physicians identified as recognized leaders in dengue clinical care to be 'master trainers' to teach the course. Master trainers were paid a nominal stipend and received regular feedback concerning their teaching performance. Each classroom presentation was taught by two master trainers, typically an outpatient physician

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and a hospitalist. All course materials were in English, but master trainers often taught in Spanish, employing the bilingual approach common to medical education in Puerto Rico. Master trainers were often consulted by physicians they trained and frequently provided feedback to CDC-DB.

The Intervention

In December 2009, the Puerto Rico Secretary of Health mandated completion of the CDC-DB course for all physicians as a requirement for medical licensure, including renewal, beginning in 2013. However, a large dengue epidemic in 2010 resulted in the declaration of a public health emergency, and in August the Secretary of Health amended the previous mandate to require all primary care, emergency, and hospitalist physicians to complete the course by November 2010.

The Evaluation

Evaluation of the CME intervention consisted of pre- and post-course assessments, a medical record review, and key informant interviews of medical directors and chiefs of staff.

Pre- and post-course assessments—Before and after each course session, participants completed a 15-question multiple-choice test covering various aspects of dengue clinical management. To preserve confidentiality, the pre-test was not linked by name to the post-test. Comparison of mean pre- and post-test scores was made by computing 95% confidence intervals for the difference of proportions and performing the standard chi-squared test.

Medical records review—Changes in physicians' clinical practices were assessed by reviewing all dengue inpatient medical records from the 12 hospitals with the most laboratory-confirmed dengue inpatients reported to the island-wide Puerto Rico Department of Health/CDC-DB passive dengue surveillance system[3] in 2008–2009 (pre-intervention group) and 2011 (post-intervention group); 11 of the hospitals were located in the San Juan metropolitan area. These pre- and post-intervention periods did not overlap with the intervention period (2010) or with dengue epidemic years, when the quality of medical care might vary widely depending on patient load.

Record reviews were conducted using an abstraction form that captured patient age, sex, municipality of residence, hospital name, and length of stay. Abstracted clinical information included presence of clinically significant bleeding, vital signs and frequency of monitoring, corticosteroid use, platelet and red blood cell transfusions, colloid use, intravenous fluid orders, and hematocrit and platelet count results. During January–March 2012, data abstractors reviewed records and entered data into Epi Info™ 7. Data were regularly checked for outliers and missing data and were corrected by referencing the original medical record. ICD-9 discharge codes were obtained from hospital databases.

We compared *a priori* selected key indicators of dengue clinical management previously identified as concerns in Puerto Rico[4,17]. Primary outcome measures were defined as the proportion of patients who were not given corticosteroids, prophylactic platelet transfusions,

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and non-isotonic intravenous saline solutions throughout hospitalization or during the critical phase of dengue (defined as 48 hours after last documented temperature ≥38°C; patients without documented fever during hospitalization were excluded from this analysis). Secondary outcome measures were defined as the level of monitoring (e.g., measuring of fluid intake and output, frequency of hematocrit and vital signs monitoring), red blood cell transfusions for patients with clinically significant bleeding, avoidance of ibuprofen, and ICD-9 discharge diagnoses of dengue. Although the pre-intervention group (2008–2009) fell under the 1997 WHO guidelines and the post-intervention group (2011) fell under the 2009 WHO guidelines, the recommendations for the selected indicators did not differ[5, 6].

Individual physicians' practices were not compared because multiple physicians usually cared for each patient; therefore, data were analyzed at the hospital level. Data were stratified by age–adult (age ≥20 years) versus pediatric (age <20 years)—because these patients were treated in different wards and hospitals, usually by different physicians. Analysis was performed in R statistical software (www.r-project.org, ver. 2.15.3). We used a mixed-effects logistic regression, incorporating hospital as strata, and used likelihood ratio tests to compare different models. Models were fit using the "lme4" package[22] and the "survival" package[23]. Odds ratios (OR) and 95% confidence intervals (CI) are reported and multiple comparisons were used when applicable, using the "multcomp" package[24].

Key informant interviews of medical directors and department chiefs—To understand the reasons for or against adoption of the practices taught in the course, medical directors and 3–6 department chiefs from each of the 12 study hospitals were interviewed in May–July 2013. Seven predetermined topics were discussed using results from the medical records review. Participating department chiefs varied by hospital but included pediatrics, internal medicine, family medicine, emergency medicine, critical care, obstetrics and gynecology, infectious disease, hematology, and nursing. Interviews were conducted with medical directors using a standard list of questions, followed separately by group interviews with department chiefs using the same set of questions. The interviews were conducted in Spanish and English depending on the preference of the participants and audio recorded for quality assurance after obtaining verbal consent.

Ethical approval

The study protocol was reviewed by the CDC Human Research Protection Office and determined to be exempt from IRB review requirements.

Results

Of the approximately 9,000 Puerto Rican physicians who fell under the 2010 mandate, 7,638 (85%) took the CME course (Fig. 1). The number of sessions conducted, as well as the number of physicians trained, increased in August and September following the Secretary of Health's revised mandate due to the ongoing dengue epidemic. Most (56%) physicians trained were generalists, meaning that they had no further post-graduate training beyond an internship year.

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Analysis of pre- and post-course tests revealed that on average, physicians' knowledge scores increased 24 percentage points from 48% to 72% (Table 1). Key questions such as whether corticosteroid usage in dengue patients is indicated showed average increases from 64% to 95%.

Of 1508 inpatients whose records were reviewed, 53% were male and 71% were under 20 years of age. The median age overall was 20 years (range: 0–88); median ages were 11 years for pediatric patients and 42 years for adults. Most hospitals admitted both pediatric and adult patients, but not all had enough dengue patients to study in both age groups. As a result, in four hospitals both adult and pediatric charts were reviewed, while in two hospitals only adults charts were reviewed and in six hospitals only pediatric charts were reviewed.

Primary outcomes in the pre- and post-intervention period are presented in Table 2. Physicians treated adult and pediatric dengue patients significantly differently prior to implementation of the course; most notably, adults more frequently received corticosteroids (70% vs. 9%) and isotonic saline (49% vs. 9%). Practices across the 12 hospitals improved significantly for both adult and pediatric patients, but changes were more pronounced when stratified by hospital. For example, adult and pediatric patients from one hospital (C) had large increases in the percentage of patients not receiving steroids (Fig. 2a). We explored whether a patient's minimum platelet count was associated with steroid receipt but found no significant association before or after the course in either adult or pediatric patients (p-value = 0.21).

Secondary outcomes showed smaller improvements (Table 3). Stratification by hospital revealed improvements at individual hospitals not evident in the overall results. For example, adult patients from two hospitals (C and D) showed statistically significant improvements in monitoring (i.e., ordering of intake and output measurements on admission), even though there was no significant improvement overall among adult patients (p-value = 0.75, Fig. 2b).

Twelve medical directors and 64 department chiefs participated in the key informant interviews. Table 4 summarizes the seven clinical management areas that were explored in depth. All interviewees noted changes in dengue management in their hospitals and attributed these changes to the training course. The main changes cited were decreased use of steroids, faster identification of dengue patients, increased awareness of dengue warning signs, decreased emphasis on platelet count as a measure of disease severity, more aggressive fluid resuscitation, and increased awareness of the need for hematocrit monitoring.

In most cases, structural or institutional barriers to change were identified. Some of the interviewees thought that certain practices should be contingent on disease severity, arguing, for example, that non-isotonic saline for maintenance fluids and once daily hematocrits might suffice for less severe patients. The continued, albeit reduced, administration of steroids and prophylactic platelet transfusions was frequently attributed to consultations with hematology specialists. With some practices, such as avoiding prophylactic platelet transfusions and administering only isotonic saline, several of those interviewed either were not aware of or did not understand the reason for the recommended practice.

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In discussing how to improve clinical management of dengue patients further, nearly all interviewees suggested that a standard protocol or standing orders would aid both physicians and nurses. Participants also desired that dengue management be taught to medical students and nursing staff. Uncertainty of dengue diagnosis was frequently cited as a barrier to good management, and almost all of the interviews mentioned a need for a rapid dengue diagnostic test.

Discussion

Our data indicate that clinical management training resulted not only in increased physician knowledge, but more importantly, in better management of dengue patients in Puerto Rico. Only one previous study has sought to directly assess the impact of dengue case management training on clinical practices, but it included other concurrent interventions such as standardized hospital protocols, making it impossible to measure the effect of training alone[12].

There were significant changes in most primary outcome measures, the most dramatic being the decreased use of corticosteroids in adults. In children, steroid use was already uncommon, but in the single hospital where steroids had been routinely administered to children, their use ceased after the course. Simplicity of the educational message—avoid steroids—as well as ease of implementation may have contributed to widespread uptake across all hospitals. Use of isotonic saline solutions during the critical phase increased from 57% to 90% in adults and from 25% to 44% in children. Isotonic saline use was likely lower in children because pediatricians routinely use half normal saline with dextrose for maintenance fluids; however this practice might change given new evidence suggesting that isotonic fluids are safer than hypotonic fluids in hospitalized children[25].

Among secondary outcome measures, changes were inconsistent. Monitoring of fluid intake and output was ordered more often among pediatric patients, as were vital signs. This did not occur among adult patients, but adults experienced significant increases in frequency of hematocrit monitoring, while children did not. As revealed by the key informant interviews, changes in monitoring are influenced by hospital protocols, nursing staff, and resource availability rather than solely by physician preference, which could account for this inconsistency. Finally, patients more frequently received dengue discharge ICD-9 codes, possibly reflecting increased clinician awareness of the disease and diagnostic acumen.

A key finding was that practices differed between adult and pediatric patients. The clearest examples were with steroids and isotonic saline use, as previously noted. This trend was so pronounced that children from different hospitals were treated more similarly than children and adults in the same hospital. This indicates the need for specific educational messages directed to physicians caring for adults or children.

This study highlighted some of the challenges facing physicians who care for dengue patients. The intensive monitoring that is recommended for hospitalized dengue patients can be difficult to implement, especially during an epidemic, and might require additional nursing staff or training. Hematocrit monitoring can be challenging if laboratory turnaround

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time is slow; alternatives include performing microhematocrit testing in inpatient wards or new technologies such as non-invasive hematocrit monitoring using pulse oximetry-like equipment[26]. In the future, better markers of significant vascular leakage or impending shock could decrease the amount of monitoring needed[27,28]. Finally, the availability of a sensitive and specific rapid dengue diagnostic test would aid physicians in being more confident that a given patient should be managed as a dengue patient[29].

There were several limitations to the study. This was a retrospective study based upon medical record review with historical comparison groups rather than randomized or contemporaneous control groups. Only laboratory-confirmed dengue patients were included, so patients who had dengue but did not have a diagnostic test performed were excluded. Only hospitalized patients were included, so this study cannot be generalized to outpatient settings. In addition, this study did not prove that the improved physician practices observed in 2011 were due exclusively to the course. For example, the 2010 epidemic alone might have increased physicians' familiarity with dengue and improved skills in patient management. However, no other physician education programs were conducted during the study period and physician practices had remained similar for many years despite several large epidemics[4,16]. Further, the course's effect on dengue morbidity or mortality cannot be assessed because of the cyclical nature of dengue and variations in dengue severity between years and individuals. Finally, we were not able to match pre- and post-test surveys to the participants, but the results we presented were expected to be conservative in a statistical sense.

Despite these limitations, we conclude that the CDC-DB course was effective in changing physician practices for dengue management. Several factors distinguish this course from most other physician CME interventions[20]. Virtually all physicians in Puerto Rico who see dengue patients took the course during August–October 2010, so physicians could see the recommended practices being performed by their colleagues. Respected local opinion leaders were used as master trainers to transmit the information and were available as resources to their colleagues after the training. Distribution of pocket guides for dengue management helped ensure that the course exerted ongoing impact on physicians' practices. Finally, the course was given during the 2010 dengue epidemic, meaning that doctors understood the importance of the material and likely saw patients soon after taking the course, leading to early reinforcement of course material.

Review of course evaluation forms revealed that many physicians appreciated its content and importance, with several noting that it was the first time anyone had taught them dengue clinical management. Physicians' primary complaint was that four hours was too long; however, there was also a desire for more patient cases and time for discussion. Many participants requested an online version of the course that could be taken at their leisure.

The findings from this evaluation have led to changes in dengue educational materials for physicians, namely a revision of the dengue pocket guide (available at www.cdc.gov/dengue/clinicallab under clinical management tools) and development of an online version of the course (www.cdc.gov/dengue/training) to ensure the sustainability of the course and facilitate physicians' access to the information. Additionally, the evaluation generated

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substantial interest in developing standing orders for hospitalized dengue patients which could serve as a checklist and reinforce best clinical practices.

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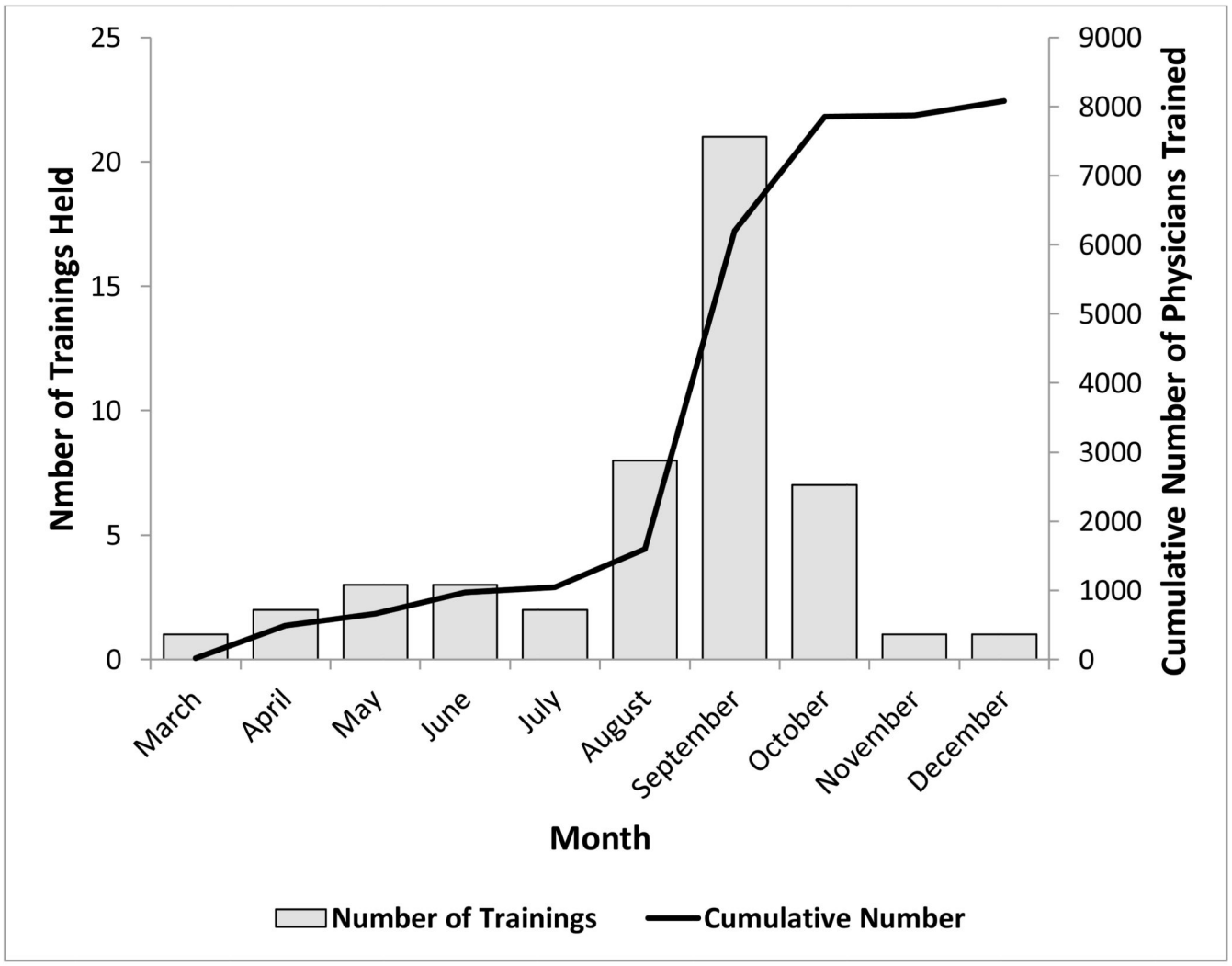

Figure 1. Number of training sessions and cumulative number of physicians trained, Puerto Rico, March-December, 2010

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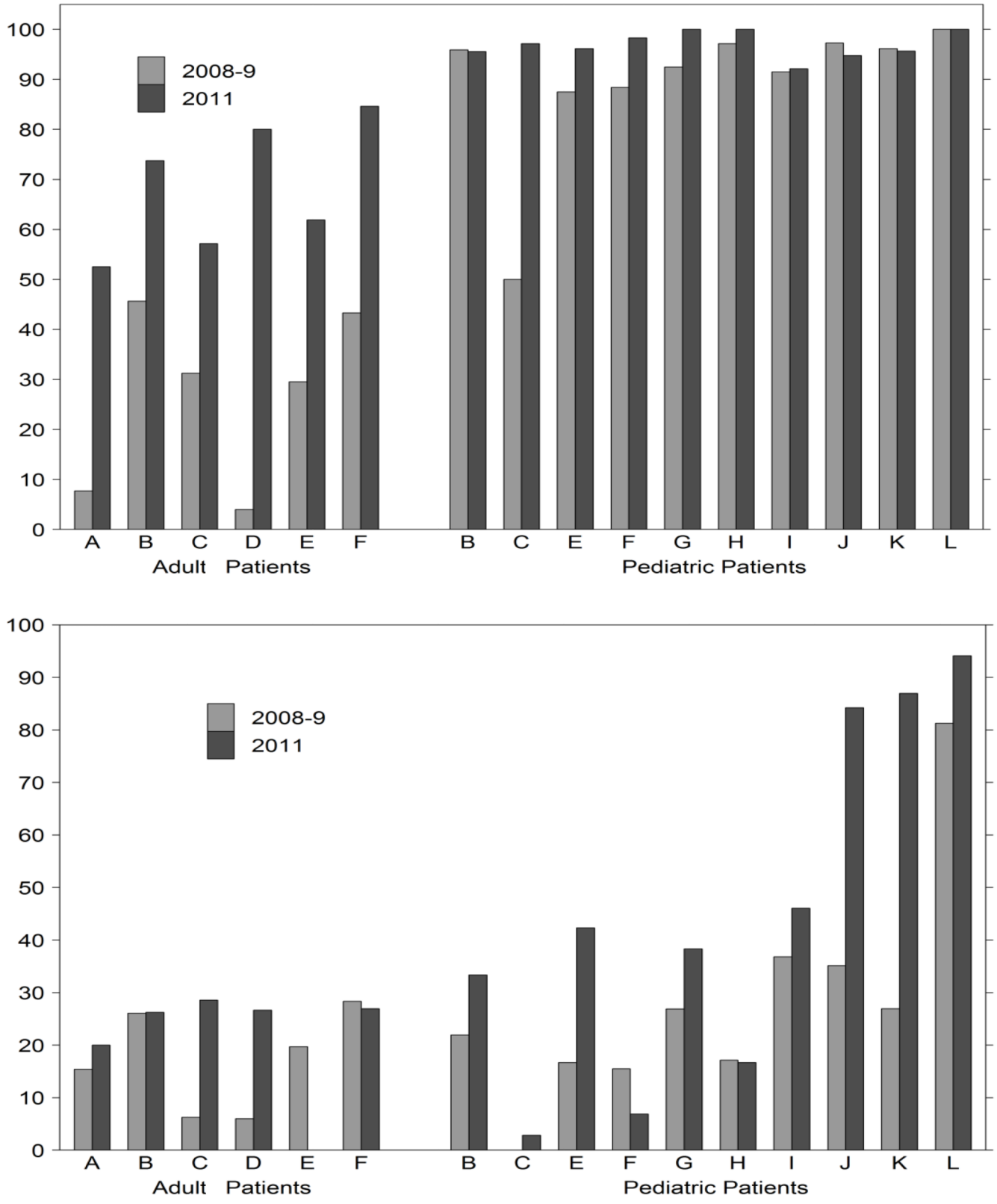

Figure 2.

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A) Proportion of patients who did not receive steroids before and after training course, by hospital and age group

B) Proportion of patients with fluid intake and output measurements ordered before and after training course, by hospital and age group

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Table 1

Pre- and post-course test results of physician knowledge of dengue management

	% correct (pre)	% correct (post)	% Change in score (95% CI)[†]
Steroids	64	95	32 (28–36)
Isotonic fluids	68	85	18 (13–22)
Early shock	5	24	19 (16–23)
Warning signs	13	30	16 (12–21)
All 15 questions	48	72	24 (23–25)

[†]All changes in percent between pre- and post-tests are statistically significant.

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Table 2

Primary outcomes in dengue case management before and after the training course

Primary Outcome[†]	2008–2009 % (total n)	2011 % (total n)	OR (95% CI)
Did not receive steroids			
Adult	30 (253)	68 (177)	5.9 (3.7–9.5)[*]
Pediatric	91 (603)	96 (472)	2.7 (1.5–4.9)[*]
Received only isotonic saline during critical period [‡]			
Adult	57 (56)	90 (42)	6.2 (1.9–20.4)[*]
Pediatric	25 (226)	44 (230)	3.4 (2.2–5.3)[*]
Received only isotonic saline during hospitalization			
Adult	49 (253)	69 (177)	2.3 (1.5–3.6)[*]
Pediatric	9 (603)	16 (472)	2.2 (1.5–3.3)[*]
Did not receive prophylactic platelet transfusions			
Adult	88 (249)	90 (173)	1.0 (0.5–2.0)
Pediatric	96 (588)	97 (466)	1.2 (0.6–2.5)

[†] Adult and pediatric patients differed significantly for all primary outcomes, in both 2008–2009 and 2011.

[*] Outcome differed significantly between 2008–2009 and 2011.

[‡] Total n is much lower for this outcome because not all patients had a critical period during admission.

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Table 3

Secondary outcomes in dengue case management before and after the training course

Secondary Outcome	2008–9 % (total n)	2011 % (total n)	OR (95% CI)
Fluid intake and output monitoring ordered			
Adult	19 (253)	22 (177)	1.1 (0.7–1.8)
Pediatric	26 (603)	39 (472)	2.0 (1.5–2.6) *
Vital signs ordered for at least every 4 hours †			
Adult	19 (253)	21 (177)	1.2 (0.7-2.0)
Pediatric	47 (603)	53 (472)	1.6 (1.2-2.0) *
>1 hematocrit drawn per day †			
Adult	71 (253)	74 (177)	1.9 (1.2–3.1) *
Pediatric	85 (603)	85 (472)	1.0 (0.7–1.5)
>1 hematocrit drawn per day during critical period			
Adult	34 (119)	37 (79)	1.4 (0.7-2.8)
Pediatric	37 (394)	44 (329)	1.3 (0.9-1.8)
Received blood transfusion for significant bleeding			
Adult	25 (4)	25 (4)	‡
Pediatric	13 (15)	33 (6)	‡
Did not receive ibuprofen			
Adult	99 (253)	100 (177)	‡
Pediatric	99.8 (603)	100 (472)	‡
Discharge diagnosis was dengue †			
Adult	45 (256)	56 (178)	1.1 (0.7-1.7)
Pediatric	80 (601)	84 (475)	1.3 (0.9-1.8)

† Adult and pediatric patients differed significantly for this outcome, in both 2008–2009 and 2011.

* Outcome differed significantly between 2008–2009 and 2011.

‡ Insufficient data for calculation.

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Table 4

Summary of clinical management areas covered in key informant interviews

Clinical Management Area	Barriers to Improvement
Use of steroids	• Hematologists are often consulted in cases of severe thrombocytopenia and frequently give steroids due to concern about conditions such as idiopathic thrombocytopenic purpura. • This is something that physicians have always done, and anecdotally, patients appear to improve after steroid use.
Prophylactic platelet transfusions	• There is a general lack of understanding of why this is not a recommended practice. • These are given when hematologists are consulted—a generalist will not do this without a consultation.
Choice of saline solution	• Many physicians, especially pediatricians, are not aware of recommendation for normal saline as maintenance fluid in dengue. Some said that they do not use normal saline for fear of sodium overload. Others said if they were not sure that the patient had dengue, they use their usual (non-isotonic) fluid. • Choice of saline solution may depend on the severity of the patient–in a less severe dengue patient, doctors may feel comfortable using non-isotonic saline. • In some hospitals, pre-mixed bags of isotonic saline with dextrose are not readily available, which is particularly important for pediatric patients.
Hematocrit monitoring	• Doctors are unable to get a fast turnaround time for hematocrit result, decreasing its utility. • This is considered less important for non-severe patients.
Intake and output monitoring	• Except for in intensive care units (ICUs) where this is performed automatically, doctors do not order this because they believe that nurses or parents will not cooperate (e.g. parents throw away diapers before they can be weighed).
Vital signs monitoring	• Hospital practices vary, but vital signs are generally monitored every eight hours in inpatient wards, and it is hard for busy nurses to do them more frequently. • In some hospitals, and especially in ICUs, physicians do not have to order vital signs monitoring, but they are still done per protocol, which decreases the incentive for physicians to write an order for frequent vital signs monitoring.
ICD-9 discharge diagnosis of dengue	• Doctors fear that they will not be paid by insurers without a dengue confirmatory test, so they use other diagnoses like dehydration or thrombocytopenia. • Some doctors do not feel comfortable writing a dengue diagnosis without lab confirmation.