

1 **Title Page**

2 **Knowledge, attitudes, and practices regarding dengue infection among public sector healthcare**
3 **providers in Machala, Ecuador**

4

5 **Authors:**

6 Andrew S. Handel¹, Efraín Beltrán Ayala^{2, 3}, Mercy J. Borbor-Cordova⁴, Abigail G. Fessler⁵, Julia L.

7 Finkelstein⁵, Roberto Xavier Robalino Espinoza³, Sadie J. Ryan⁶, Anna M. Stewart Ibarra^{7*}

8

9 Affiliations:

10 ¹ Department of Pediatrics, Stony Brook Children's Hospital, Stony Brook, NY

11 ² Universidad Técnica de Machala, Ecuador

12 ³ Ministerio de Salud Publica, Machala, El Oro, Ecuador

13 ⁴ Escuela Superior Politécnica del Litoral, Guayaquil, Guayas, Ecuador

14 ⁵ Division of Nutritional Sciences, Cornell University, Ithaca, NY

15 ⁶ Department of Geography, University of Florida, Gainesville, FL, USA

16 ⁷ Center for Global Health and Translational Science, State University of New York Upstate Medical

17 University, Syracuse, New York, USA

18 *Corresponding author

19 Email addresses:

20 ASH: Andrew.Handel@stonybrookmedicine.edu

21 EBA: felizbeltran57@hotmail.com

22 MJBC: meborbor@espol.edu.ec

23 AGF: ag.fessler@gmail.com

24 JLF: jfinkelstein@cornell.edu

25 RXRE: roberto.robalino@hotmail.com

26 SJR: sjryan@ufl.edu

27 AMSI: stewarta@upstate.edu

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29

30 **Abstract**

31 **Background:** Dengue fever is a rapidly emerging infection throughout the tropics and subtropics with
32 extensive public health burden. Adequate training of healthcare providers is crucial to reducing infection
33 incidence through patient education and collaboration with public health authorities. We examined how
34 public sector healthcare providers in a dengue-endemic region of Ecuador view and manage dengue
35 infections, with a focus on the 2009 World Health Organization (WHO) Dengue Guidelines.

36

37 **Methods:** A 37-item questionnaire of dengue knowledge, attitudes, and practices was developed and
38 administered to dengue healthcare providers in Machala, Ecuador. Survey focus areas included:
39 “Demographics,” “Infection and Prevention of Dengue,” “Dengue Diagnosis and the WHO Dengue
40 Guide,” “Laboratory Testing,” “Treatment of Dengue,” and “Opinions Regarding Dengue.”

41

42 **Results:** A total of 76 healthcare providers participated in this study, of which 82% were medical doctors
43 and 14% were nurses. Fifty-eight percent of healthcare professionals practiced in ambulatory clinics and
44 34% worked in a hospital. Eighty-nine percent of respondents were familiar with the 2009 WHO Dengue
45 Guidelines, and, within that group, 97% reported that the WHO Dengue Guide was helpful in dengue
46 diagnosis and clinical management. Knowledge gaps identified included *Aedes aegypti* mosquito feeding
47 habits and dengue epidemiology. Individuals with greater dengue-related knowledge were more likely to
48 consider dengue a major health problem. Only 22% of respondents correctly reported that patients with
49 comorbidities and dengue without warning signs require hospital admission, and 25% of providers
50 reported never admitting patients with dengue to the hospital. Twenty percent of providers reported rarely
51 ($\leq 25\%$ of cases) obtaining laboratory confirmation of dengue infection. Providers reported patient
52 presumptive self-medication as an ongoing problem. Thirty-one percent of healthcare providers reported
53 inadequate access to resources needed to diagnose and treat dengue.

54

55 **Conclusion:** Participants demonstrated a high level of knowledge of dengue symptoms and treatment, but
56 additional training regarding prevention, diagnosis, and admission criteria is needed. Interventions should
57 not only focus on increasing knowledge, but also encourage review of the WHO Dengue Guidelines,
58 avoidance of presumptive self-medication, and recognition of dengue as a major health problem. This
59 study provided an assessment tool that effectively captured healthcare providers' knowledge and
60 identified critical gaps in practice.

61

62 **Keywords:** dengue fever, KAP survey, Ecuador, medical practitioners

63

64 **Background**

65 Dengue virus infection is a major cause of morbidity, mortality, and economic hardship in the tropics and
66 subtropics [1,2]. Infection occurs when one of four dengue virus serotypes (DENV 1-4) are transmitted to
67 humans by *Aedes* sp. (primarily *Aedes aegypti*) mosquitoes [1]. Dengue infection may cause fever,
68 headache, abdominal pain, rash, muscle aches, and bone pain (hence ‘break-bone fever’). Infection with
69 additional dengue serotypes increases the risk of hemorrhagic disease, resulting in severe mucosal and
70 gastrointestinal bleeding, hypovolemia, and potentially death [1]. It is crucial that healthcare professionals
71 are able to accurately diagnose, monitor, treat, and hospitalize patients infected with dengue fever.

72
73 Latin America has seen a surge of dengue infections since the 1980s, increasing the need for physicians
74 skilled in managing dengue. From 2010 to 2014, an average of 1.5 million cases per year were reported in
75 the Americas [3], although total case estimates are higher due to underreporting [2]. Díaz-Quijano et al.
76 [4] estimated that dengue-related mortality rates have tripled every decade in Latin America since dengue
77 became endemic in the 1980s. The economic burden of dengue fever is also tremendous: the estimated
78 median cost of dengue treatment in the Americas is US\$472 per ambulatory case (72.9% of cases) and
79 US\$1,227 per hospitalized case [5]. The total economic impact of dengue in the Americas was estimated
80 at US\$2.1 billion per year (2000-2007 estimate; range US\$1-4 billion) [5], underscoring the significant
81 economic burden of dengue fever infection and the need to improve interventions.

82
83 Understanding how clinicians manage suspected cases of dengue is crucial to improving patient
84 outcomes. In 2009, the World Health Organization (WHO) revised its classification system of dengue
85 severity [6]. The central aim of the new scheme is to improve clinical outcomes by identifying patients at
86 highest risk of mortality who may require therapeutic interventions. However, acceptance and
87 incorporation of these recommendations has varied considerably since publication, with ongoing debate
88 regarding the utility of each classification scheme [7,8]. Recent investigations of the WHO Dengue
89 Guidelines are promising. Prasad et al. [9] compared the sensitivity of the 2009 and 1997 WHO

90 guidelines in identifying the severity of dengue infection among 56 patients who tested positive for
91 dengue infection in northern India. The study found that, when compared to the ‘gold standard’ of actual
92 level of medical intervention provided (i.e. outpatient versus inpatient treatment), the 2009 WHO
93 classification system had 98.0% sensitivity, compared to 24.8% sensitivity using the 1997 system. In an
94 analysis of 1,962 cases reviewed from 18 countries, Barniol et al. [10] found that 13.7% of cases could
95 not be classified using the 1997 WHO classification system, compared to 1.6% using the 2009 WHO
96 classification system. As the debate over dengue classification continues, it is critical to understand how
97 clinicians interpret and apply the guidelines in clinical practice.

98

99 Previous research has focused on how community members view dengue infections; however, there have
100 been few attempts to date to better understand the perspectives of clinicians. These studies have been
101 conducted mainly in Asia [9, 11, 12, 13, 19, 20], with a single study performed in Puerto Rico [21]; to our
102 knowledge, no studies to date have been conducted in Central or South America. Results have varied
103 considerably across these studies. In a study of Sri Lankan practitioners [11], Kularatne et al. report
104 significant disagreement among physicians over the utility of treating dengue with steroids, antibiotics,
105 and platelet transfusions. Lee et al. [12] noted that clinical practice varied significantly by practice setting,
106 as physicians practicing in private practice were more likely to refer patients with dengue to the hospital
107 and to utilize dengue PCR testing (vs. serology), compared to physicians practicing at public clinics.
108 Thaver et al. [13] conducted a knowledge-based assessment in Pakistan and found that practitioners had a
109 stronger understanding of dengue pathophysiology than clinical diagnosis and treatment. Together, these
110 studies provide evidence that clinical practice varies by region and over time, making it crucial to
111 understand local, current practices for dengue management when identifying areas of potential
112 improvement.

113

114 As the epidemiology of dengue has evolved over the past century, so have healthcare systems’ strategies
115 to reduce infection rates. Healthcare providers who interact directly with patients have an important role

116 in both treating and preventing the spread of dengue. This study was conducted to assess the knowledge,
117 attitudes, and practices regarding dengue infection among healthcare providers in a dengue-endemic city
118 in Ecuador. We also assessed familiarity with the [2010 Pan American Health Organization's \(PAHO\)](#)
119 [Spanish translation \[14\] of the 2009 WHO Dengue Guidelines](#), and how these guidelines influenced their
120 clinical practice, providing important information to help guide future interventions.

121

122 **Methods**

123

124 **Study Site and Study Population**

125 We conducted a study of the knowledge, attitudes, and practices associated with dengue infection among
126 healthcare providers practicing in Machala, Ecuador, from December, 2013 through December, 2014.

127 Machala is an urban coastal city located in El Oro Province, Ecuador (3.2667°S, 79.9667°W, altitude 6m,
128 population 245,972), and has been well-described as hyper-endemic for dengue fever (DENV 1-4)

129 [154,165]. Over a five year period (2010 to 2014), 72,060 cases of dengue were reported in Ecuador, with
130 an annual average of 14,412 cases [176]. This study is part of an ongoing collaboration with the Ministry
131 of Health to strengthen dengue surveillance capacities, with the aim of studying public sector healthcare
132 providers; private physicians were therefore not included in our study. The Ecuadorian Ministry of Health
133 previously collaborated with the Pan American Health Organization (PAHO) to translate the 2009 WHO
134 Dengue Guidelines into a 2010 Spanish version of the guidelines [147], which was distributed throughout
135 Machala and serves as a focal point of our study.

136

137 Physicians and nurses were recruited as the study population because they serve as the frontline
138 healthcare workers for diagnosis and treatment of dengue and other febrile illnesses. Healthcare providers
139 in Machala include primary care providers working in local healthcare clinics (Centros de Salud) and
140 tertiary care providers practicing in public and private hospitals, including emergency care physicians,
141 hospitalists, and subspecialists. The public health system requires that individuals visit a single assigned

142 Centro de Salud prior to referral to hospital subspecialists. These clinics provide care free of charge.
143 Private clinics were not included in this study. It is common for Ecuadorians to view hospital care as
144 superior to ambulatory clinics, leading some patients to seek primary care in the Emergency Department.

145

146 **Participant Recruitment**

147 Two methods of recruitment were utilized in this study. Participants from the public health sector were
148 recruited at dengue management training conferences in Machala, with survey distribution prior to the
149 educational session. These trainings were conducted in collaboration with and sponsored by the
150 Ecuadorian Ministry of Health and the Global Emerging Infections Surveillance and Response System
151 (GEIS, a division of the United States Armed Forces Health Surveillance Center), with the goal of
152 improving recognition of dengue infection and awareness of the World Health Organization’s Clinical
153 Manual of Dengue. These individuals were recruited for the training sessions as they play key roles in
154 dengue management. The second form of recruitment involved visits to the Ministry of Health public
155 health clinics and to the Teófilo Dávila Hospital, the reference hospital for the province of El Oro.

156

157 **Questionnaire Development**

158 We developed a 37-item questionnaire, with the goal of evaluating the knowledge, attitudes, and practices
159 associated with dengue infection among healthcare providers. Information regarding dengue infection was
160 based on the World Health Organization’s Clinical Manual of Dengue, with a subset of questions on local
161 dengue epidemiology based on peer-reviewed sources [3, 13, 154]. The questionnaire comprised of the
162 following sections: “Demographics,” “Infection and Prevention of Dengue,” “Dengue Diagnosis and the
163 WHO Guide,” “Laboratory Testing,” “Treatment of Dengue,” and “Opinions Regarding Dengue” (See
164 Appendices A1 for English and A2 for Spanish versions of the survey instrument). The survey was
165 piloted through face-to-face interviews with physicians in Machala prior to conducting the full study.

166

167 **Data Analysis**

168 Survey responses were analyzed using R (Version 3.1.2). Descriptive statistics (e.g. means, medians,
169 frequency distributions) were calculated. A Cumulative Knowledge Score (CKS) was calculated as an
170 aggregate of all knowledge-based questions (See questions in Tables 2, 3). Correct answers received one
171 point and incorrect answers received zero points, for a maximum possible score of 14 points. Questions
172 requiring participants to select multiple correct answer choices were given one point per correct answer
173 selected. A Clinical Scenario Score (CSS) was similarly developed from three clinical questions, with a
174 maximum score of three points (See Table 3). These same clinical questions were included in the CKS.
175 Bivariate Pearson Correlations (r) were conducted to assess whether the CSS and CKS were associated
176 with awareness and/or support of WHO clinical guidelines, prior training, years of experience or number
177 of patients treated, and region of medical practice. We also examined whether dengue risk perceptions
178 were associated with support for the WHO dengue guidelines, and the proportion of patients referred for
179 dengue laboratory testing or hospital admission. The questions were grouped by dependent variable, and a
180 Bonferroni correction was used for multiple comparisons. The alpha level was set at 0.05 (i.e., values of
181 $p < 0.05$ were considered statistically significant).

182
183 Closed-ended questions using a Likert scale and open-ended questions were used to assess doctor and
184 patient perceptions of dengue (See Tables 5-7). The frequencies of these themes were tabulated, and for
185 each theme, and the average scores from the Likert scale were used to identify themes that associated with
186 greater risk perceptions.

187

188 **Results/Discussion**

189

190 In this study, several common themes emerged; healthcare providers reported:

- 191 1. High use and awareness of the 2009 WHO Dengue Management Guidelines.
- 192 2. High level of knowledge regarding dengue signs and symptoms, but demonstrated significant
193 knowledge gaps regarding dengue epidemiology and prevention.

- 194 3. Limited knowledge of WHO-recommended criteria for dengue hospital admission, and under-
195 utilization of confirmatory laboratory tests.
- 196 4. High level of concern regarding the burden of dengue in Machala; and a lack of training and basic
197 tools needed to adequately diagnose and manage dengue infections.
- 198 5. High levels of presumptive self-medication and delay in seeking medical attention among patients
199 with dengue fever.

200
201 This study assessed the knowledge, attitudes and practices of local healthcare providers in dengue
202 management. This study was restricted to one group of healthcare practitioners in Machala at one point in
203 time, and accordingly, the small sample size of available providers within Machala may limit
204 generalizability of findings. Additionally, data collected were self-reported, limiting our ability to assess
205 healthcare practices and causal inference. However, this study captures useful information from a
206 community with a high burden of dengue, and this assessment framework can inform dengue
207 management in other settings.

208

209 **I. Demographics**

210 A total of 76 healthcare providers involved in dengue care and treatment in Machala, Ecuador,
211 participated in the study. Demographic information is presented in Table 1. Surveys were administered to
212 participants during visits to their offices or at training events, resulting in a 100% response rate. Forty-one
213 percent of participants were male and 59% were female. Ages ranged from under 30 years old to less than
214 70 years old, with a median age group of 41 to 50 years old and a median of 10 to 14 years of healthcare
215 experience. Participants consisted of physicians (82%), nurses (14%), and other healthcare professionals
216 (4%). There are 93 physicians working in the public health sector in Machala including 63 doctors at 17
217 public health clinics, 15 in the central hospital, and 15 in the social security hospital, giving an inclusion
218 rate of 67% of all potential physician subjects in the city. Healthcare providers worked primarily in public
219 health clinics (58%) and the Teófilo Dávila Hospital (34%).

220

221 **II. Healthcare Provider Views of Dengue Burden**

222 As seen in Table [25](#), healthcare providers in Machala were concerned with dengue infections, with 89%
223 of participants agreeing that it is a “major problem for my patient population”. Of those in agreement, the
224 majority reported that dengue is a significant threat because the virus is endemic to the region and has the
225 potential to cause high morbidity. One participant reported that dengue may cause “the deterioration of
226 the [individual], family and community health”. The majority of respondents (78%) also agreed with the
227 statement, “My patients feel that dengue infection is a major problem for their health,” with 34% citing
228 health complications and mortality as the major concerns in the general population. Seventeen percent of
229 participants suggested that public health measures within the city, including disease prevention efforts,
230 local infrastructure, and education were inadequate for controlling disease transmission. A small subset
231 (6%) of providers reported that dengue is not a major problem because the region already has effective
232 prevention and treatment interventions in place. A similar proportion of providers also felt that a dengue
233 diagnosis creates an unnecessary sense of fear among patients.

234

235 **III. Providers’ Views of the Community Response to Dengue and Self-Medication**

236 The majority (76%) of healthcare providers perceived that patients exhibiting symptoms of dengue would
237 seek attention at a healthcare facility. An equal proportion also reported that patients are aware of the
238 steps needed to prevent dengue infection (See Tables [2-45-7](#) for physician attitudes toward dengue); of
239 those who agreed with this statement, 30% suggested that public health awareness campaigns were
240 successful. For example, one participant reported, “due to constant [educational] campaigns, [patients]
241 know to seek out medical help before they develop alarms signs”.

242

243 Seventeen percent of providers reported that upon symptom onset, many patients “turn to self-medication
244 and do not seek out professional help”. Previous studies have reported that communities in the urban
245 periphery, and particularly men, report self-medicating to treat dengue [18]. This tendency to self-

246 medicate can result in greater dengue morbidity and mortality due to lack of clinical management, and has
247 the potential to increase community susceptibility to other diseases by promoting bacterial resistance to
248 over-prescribed antibiotics.

249

250 **IV. Clinical Scenario Scores and Cumulative Knowledge Scores**

251 The Cumulative Knowledge Score analysis results are presented in Tables [5 and 6](#)~~2 and 3~~ (Table [6](#)~~3~~
252 consists of the Clinical Scenario subset of questions). The mean Cumulative Knowledge Score was 10.5
253 of 14 possible points (SD \pm 1.73). Using a Bonferroni correction, the statistical significance level for CKS
254 was determined to be $p < 0.01$. The Cumulative Knowledge Score correlated positively with: 1) reporting
255 familiarity with the WHO Dengue Guide ($r = 0.427$, $p < 0.01$), 2) agreeing with the statement “I believe that
256 dengue is a major problem for my patient population” ($r = 0.433$, $p < 0.01$), and 3) agreeing to the statement
257 “My patients feel that dengue infection is a major problem for their health” ($r = 0.282$, $p < 0.01$). Notably,
258 having previous dengue training was not significantly correlated with the CKS ($p = 0.225$). These
259 associations provide evidence of the interrelatedness of a practitioner’s knowledge, patient care, and
260 concern for dengue infection. Clinician education must not only focus on basic knowledge, but also
261 emphasize dengue’s burden on individual health and communities.

262

263 The Clinical Scenario Score analysis results are presented in Table [6](#)~~3~~. The mean Clinical Scenario Score
264 was 2.1 of 3 potential points (Table [6](#)~~3~~). Using a Bonferroni correction, the statistical significance level
265 for CSS was determined to be $p < 0.0125$. A higher CSS was correlated with the following responses: 1)
266 reporting familiarity with WHO Dengue Guidelines ($r = 0.326$, $p < 0.01$), 2) agreeing with the statement “I
267 believe that dengue is a major problem for my patient” ($r = 0.37$, $p < 0.01$), 3) agreeing with the statement “I
268 am fully trained to manage a patient with an infection of dengue without warning signs,” ($r = 0.383$,
269 $p < 0.01$), and 4) agreeing with the statement “In my experience, a community member who has dengue
270 symptoms will seek medical attention” ($r = 0.453$, $p < 0.01$). Higher CSS was also associated with reporting
271 that the WHO Guidelines are helpful, although this was not statistically significant after a Bonferroni

272 correction was applied ($r=0.245$, $p<0.05$). These findings emphasize the importance of practitioner ‘buy-
273 in’ of dengue’s detrimental impact, as clinical knowledge and concern for dengue infections are strongly
274 associated. Of note, the clinical scenarios comprised a small component (3 of 14 points) of the above-
275 mentioned Cumulative Knowledge Score.

276

277 **V. Providing Patients with Accurate Dengue Prevention and Treatment Guidance**

278 Although study participants demonstrated a high level of understanding of dengue infection signs,
279 symptoms, and treatment, we identified specific gaps in knowledge of dengue prevention and
280 epidemiology. A total of 29% of participants incorrectly selected “take paracetamol” as a method for
281 preventing dengue infection (Table 52). Although it is possible that some participants misinterpreted this
282 question as asking which medications may help manage dengue, the survey clearly asked how dengue
283 may be *prevented*, indicating a misconception of prevention strategies. In addition, 25% incorrectly
284 selected “night time” as the most likely feeding time for *Aedes* mosquitoes. Similar findings have been
285 documented elsewhere: Huang et al. [19] found that only 14.4% of Taiwanese providers correctly
286 identified *Aedes* mosquito feeding habits, compared to 82.8% who correctly identified *Anopheles*
287 mosquito feeding habits. When participants were asked which dengue virus serotypes are found in
288 Ecuador, only 38% correctly answered all four serotypes (DENV 1-4). Ho [20] also found limited
289 knowledge of dengue epidemiology among healthcare providers in Taiwan, with only 47.7% correctly
290 responding that dengue is endemic in that country. These misunderstandings may lead healthcare
291 providers to give patients incorrect, clinically significant advice. It is critical to target specific local
292 misconceptions of dengue prevention and transmission through training of medical professionals, in order
293 to reduce the burden of dengue.

294

295 **VI. Confusion Regarding Hospital Admission Criteria**

296 Clinicians indicated confusion when developing appropriate dengue treatment plans for their patients.
297 When healthcare professionals were asked which groups of patients with dengue require hospital

298 admission, only 22% correctly stated that patients with “dengue without warning signs but with
299 comorbidities” require hospital admission (Table 52). The 2009 WHO Dengue Guidelines provide
300 specific recommendations for appropriate clinical observation based on a patient’s risk of significant
301 morbidity [7]. These guidelines state that any patient with a comorbidity (e.g. diabetes mellitus, obesity,
302 risk of hemorrhage such as peptic ulcer disease) should be admitted to a hospital during a dengue
303 infection, regardless of the severity of infection. Additionally, only 45% of participants correctly
304 responded to all three clinical scenarios (Table 63), demonstrating knowledge gaps of patient admission
305 criteria.

306
307 Hospital admission rates for dengue infection vary considerably between regions globally. For example,
308 Tomashek et al. [21] found that only 31% of Puerto Rican medical providers used hospital admission
309 criteria consistent with the 1997 WHO Dengue Guidelines. Conversely, Lee et al. [12] reported that one-
310 third of providers in Singapore “always” or “often” admitted patients with suspected dengue, regardless
311 of infection severity. Globally, it is estimated that less than 5% of patients infected with dengue will
312 develop severe disease [22], and WHO recommends that patients who do not meet criteria for
313 hospitalization have frequent office follow-up [7]. This is particularly important in resource-limited
314 settings. Patients with comorbidities who are not admitted to hospitals may have worse clinical outcomes,
315 underscoring the need for close monitoring of this patient population.

316

317 **VII. Diagnostic Testing: Under-Utilization and Inadequate Resources**

318 Study participants indicated suboptimal use of confirmatory diagnostic laboratory tests when dengue
319 infection was suspected (Table-74). As appropriate in a region with many acute febrile illnesses with
320 similar clinical presentations as dengue, 61% of healthcare providers reported referring all patients with
321 suspected dengue infection for laboratory test confirmation. However, 20% of participants reported
322 referring patients for confirmatory laboratory tests 25% of the time or less. As these patients may actually
323 be infected with other febrile illnesses such as leptospirosis, malaria, or chikungunya, laboratory

324 confirmation is crucial for differential diagnosis and to inform appropriate medical interventions. It is
325 important to note that 14% of providers reported inadequate access to diagnostic testing for dengue (Table
326 [74](#)). Additionally, providers who agreed with the statement “I am fully trained to manage a patient with
327 an infection of dengue without warning signs” referred a higher percentage of their patients for laboratory
328 testing ($r=0.345$, $p<0.01$), compared to those who disagreed with this statement. This may signal one of
329 two possibilities: clinical confidence is increased with better access to diagnostic testing, or providers
330 who report greater confidence in their clinical training refer more patients for confirmatory laboratory
331 tests. Access to dengue diagnostic testing remains a key issue in this context.

332
333 Healthcare providers were asked about availability and access to a variety of resources for dengue
334 diagnosis and treatment. A total of 31% of providers reported having inadequate resources (See Table [74](#)
335 for specific resources). There were no significant correlations between reported lack of resources for
336 dengue diagnosis and treatment and insufficient training, Cumulative Knowledge Scores, treatments used,
337 or other items from this survey. Identifying the impact of resource deficiencies is difficult to assess from
338 the data collected, as no discernible differences in knowledge, attitudes, or practices were identified in
339 this study. Further investigation of availability and access to resources for dengue diagnosis and
340 treatment, and how they influence daily clinical practice is needed.

341

342 **VIII. Awareness and Implementation of the WHO Dengue Guidelines**

343 Awareness of the 2009 WHO Dengue Guidelines was high, with 89% of participants reporting previous
344 knowledge of the guidelines. Of these respondents, 97% reported that these guidelines were helpful. This
345 finding is in contrast to Kularatne’s study of Sri Lankan practitioners [13], in which only 45% of
346 practitioners reported using the WHO Dengue Guidelines. However, Kularatne’s study was conducted
347 prior to the current version of the WHO Dengue Guidelines, and may be more related to local medical
348 practices and training.

349

350 **IX. Impact of Practice Setting**

351 In this study, there were no significant differences in reported knowledge, attitudes, and practice, between
352 healthcare providers practicing in a hospital versus ambulatory settings, including familiarity with the
353 2009 WHO Dengue Guidelines, reporting that these guidelines were helpful, or overall dengue
354 knowledge ($p>0.05$). Previous studies have indicated that practice settings can influence clinical
355 management of dengue fever. Ho et al. [20] found that healthcare providers practicing at Taiwanese
356 medical centers (i.e. medical school-affiliated hospitals at the highest accreditation level) had significantly
357 different levels of knowledge, compared to providers at non-medical centers. In order for dengue
358 interventions to be most effective in hyper-endemic regions, healthcare providers of all types and at all
359 settings must receive adequate training and guidance, and differences in knowledge, attitudes, and
360 practice by setting should continue to be assessed.

361

362 **Conclusion**

363 Findings from this study provide important insights into medical practitioner knowledge, attitudes, and
364 practices associated with dengue fever in a resource-limited endemic region. These findings highlight
365 several strategies to improve diagnosis and clinical management of dengue infections in this region. A
366 strong healthcare policy begins with accurate information, which can best be obtained and disseminated
367 through close collaboration between the public, primary healthcare providers, health educators, and the
368 public health sector.

- 369 • Healthcare providers should receive continuous education about dengue prevention, transmission,
370 and high-risk patient populations.
- 371 • Providers' needs should be assessed in future studies, as nearly one-third of participants reported
372 inadequate access to crucial healthcare resources.
- 373 • Health providers should educate their patient population about the harms of self-diagnosis and
374 presumptive self-medication.

375 • Findings demonstrated that those providers who showed the greatest concern of dengue infections
376 were also the most knowledgeable and provided clinical care that more closely aligned with
377 WHO recommendations. Future interventions should therefore provide core dengue information
378 while emphasizing dengue’s impact on health and development.

379 • Periodic reassessment of the local knowledge, attitudes, and clinical practices will be instrumental
380 to reduce the burden of dengue fever and improve clinical management in high-burden settings.

381

382 **Declarations:** None

383 **List of abbreviations:** World Health Organization (WHO), Pan American Health Organization (PAHO),
384 Clinical Scenario Score (CSS), Cumulative Knowledge Score (CKS)

385

386 **Ethics Approval and Consent to Participate:**

387 The investigation protocol was reviewed and approved by the Institutional Review Boards (IRB) of the
388 State University of New York (SUNY) Upstate Medical University in Syracuse, New York, and the
389 Ecuadorian Ministry of Health. The study was certified as exempt by the IRBs (as all participants were
390 over the age of 18 and no personal identifying information was collected), and no informed consent was
391 required during the administration of the questionnaire.

392

393 **Consent for Publication:** N/A

394

395 **Availability of data materials:** Survey instruments in English and Spanish are included as supplements.

396 Raw survey data available upon request.

397

398 **Competing Interests:**

399 The authors declare that they have no competing interests with the research.

400

401 **Funding:** The IDSA Medical Scholars Program provided a stipend to ASH to support this study.

402

403 **Authors' Contributions:**

404 ASH was involved in study design, creation of the questionnaire, data collection, statistical analysis,
405 interpretation of results, and coordinating and drafting the manuscript. EBA was involved in study design,
406 creation of the questionnaire, and data collection. MJBC was involved in study design, creation of the
407 questionnaire, and interpretation of results. AGF participated in statistical analysis and interpretation of
408 results. JLF participated in interpretation of results and review of the manuscript draft. RXRE was
409 involved in study design, creation of the questionnaire, and data collection. SJR was involved in study
410 design, creation of the questionnaire, interpretation of results, and review of the manuscript. AMSI
411 conceived of the study, and was involved in study design, creation of the questionnaire, data collection,
412 statistical analysis, interpretation of results, and coordinating and drafting the manuscript.

413

414 **Authors' Information:** Andrew S. Handel: Department of Pediatrics, Stony Brook Children's Hospital,
415 Stony Brook, NY, email: Andrew.Handel@stonybrookmedicine.edu; Efraín Beltrán Ayala: Universidad
416 Técnica de Machala, Ecuador, email: felizbeltran57@hotmail.com; Mercy J. Borbor-Cordova: Escuela
417 Superior Politécnica del Litoral, Guayaquil, Guayas, Ecuador, email: meborbor@espol.edu.ec; Abigail G.
418 Fessler: Division of Nutritional Sciences, Cornell University, Ithaca, NY, email: ag.fessler@gmail.com;
419 Julia L. Finkelstein: Division of Nutritional Sciences, Cornell University, Ithaca, NY, email:
420 jfinkelstein@cornell.edu; Roberto Xavier Robalino Espinoza: Ministerio de Salud Pública, Machala, El
421 Oro, Ecuador, email: roberto.robalino@hotmail.com; Sadie J. Ryan: Department of Geography,
422 University of Florida, Gainesville, FL, USA, email: sjryan@ufl.edu; Anna M. Stewart Ibarra: Center for
423 Global Health and Translational Science, State University of New York Upstate Medical University,
424 Syracuse, New York, USA, email: stewart@upstate.edu.

425

426 **Acknowledgments:** Thank you to the healthcare providers of Machala for their participation and to
427 SNEM Machala, MSP Ecuador, and the Center for Global Health and Translational Science at SUNY
428 Upstate Medical University for their support.
429

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Table 1. Characteristics of Study Participants (n=76)		
Category	Response Selected	n (%)
Gender	Male	31 (41%)
	Female	45 (59%)
Age (years)	<30	24 (32%)
	31-40	10 (14%)
	41-50	17 (23%)
	51-60	17 (23%)
	61-70	6 (8%)
	>70	0 (0%)
Medical Role	Doctor	62 (82%)
	Nurse	11 (14%)
	Other	3 (4%)
Years of Medical Experience	<1	6 (8%)
	1-4	26 (34%)
	5-9	5 (7%)
	10-14	7 (9%)
	15-19	10 (13%)
	>19	22 (29%)
Practice Setting (n=74)	Community Health Center (Subcentro de Salud)	43 (58%)
	Hospital	25 (34%)
	Diagnostic Laboratory	2 (3%)
	Other	4 (5%)

513

514 *Note: Percentages may not equal 100% due to rounding

515

Table 25. Physician responses to the statement “I think that dengue is a major problem for my patient population” (n=71)

Categorical responses	Open-ended responses
Agree or Strongly Agree (n = 63, 89%)	The region is an endemic zone
	Dengue has a high morbidity
	There is a lack of preventative measures
	Patients self-medicate
	There exists poor infrastructure
	Dengue poses a high risk to others
	There is a lack of education about dengue
	There is a lack of social consciousness regarding dengue
Neutral (n = 4, 6%)	There is adequate education about dengue
Disagree or Strongly Disagree (n = 4, 6%)	Good preventative measures are in place
	Good medical attention is available

516

Table 36. Physician responses to the statement “My patients feel that dengue infection is a major problem for their health” (n=68)

Categorical responses	Open-ended responses
Agree or Strongly Agree (n = 53, 78%)	Dengue has a high morbidity
	Dengue is considered an alarming diagnosis
	Dengue decreases economic productivity
	Dengue is difficult to detect
	The environment is conducive to disease transmission
	Dengue poses a high risk to others
Neutral (n = 7, 10%)	Adequate medical attention is available
Disagree or Strongly Disagree (n = 8, 12%)	Patients believe self-medication is adequate
	There is a lack of education about dengue

517

Table 47. Physician responses to the statement “In my experience, a member of the community who exhibits dengue symptoms will seek medical attention” (n=71)

Categorical responses	Open-ended responses
Agree or Strongly Agree (n = 54, 76%)	Patients believe that dengue has a high morbidity if untreated
	Dengue symptoms are severe
	Patients want to prevent complications
	There is adequate education about dengue
	There is easy access to medical attention
Neutral (n = 7, 10%)	Some patients will seek attention while others self-medicate
Disagree or Strongly Disagree (n = 10, 14%)	Patients do not seek medical attention until complications develop
	Medical care is delayed by self-treatment

518

Table 52. Knowledge-Based Questions (n=76)

Note: One point given per question, unless otherwise specified		
Question	Correct Response	n (%) with correct response
1. How is dengue spread?	Aedes mosquito	75 (99%)
2. At what time of day are people most likely to be infected by dengue?	Any answer other than "Night"	57 (75%)
3. Which of the dengue serotypes have been found in Ecuador? - Note: 0.25 point given per correct answer, with a total of 1 point available	DENV 1-4 are all present DENV 1 DENV 2 DENV 3 DENV 4	 54 (71%) 54 (71%) 48 (63%) 34 (45%)
4. What advice do you give your patients to prevent dengue infection? - Note: Question is worth a total of 2 points - 0.25 point given per correct answer, with a maximum of 1 point. Column to the right indicates the n (%) of respondents receiving - 1 point given for not selecting "Take Paracetamol"	1. Frequently change the water in flower vases 2. Remove containers that accumulate clean water 3. Eliminate tanks or puddles with stagnant water 4. Keep drinking water containers (cisterns, tanks) tightly closed Did not select "Take Paracetamol"	66 (87%) 69 (91%) 55 (72%) 67 (88%) 54 (71%)
5. Which group of patients should be hospitalized? - Note: Each response is worth 1 point. Question is worth a total of 4 points - If the answer is correctly selected, the respondent gains 1 point - If the answer is correctly left blank, the respondent gains 1 point - Responses that are correct are marked here as (T) and if incorrect are marked as (F)	1. Dengue without warning signs (F) 2. Dengue without warning signs but with comorbidities (T) 3. Dengue with warning signs (T) 4. Severe dengue (T) Percent answering all 4 correctly	76 (100%) 17 (22%) 59 (78%) 58 (76%) 15 (20%)

<p>6. According to the WHO's 2010 Clinical Management of Dengue guidebook, what signs and symptoms can be used to identify an infection of dengue without alarm signs?</p> <p>- Note: Question is worth 1 point - Each response is worth 1/19 point, which is given for either correctly selecting a true response or correctly leaving a false response blank</p>	<p>Correct Responses</p> <p>Headache Muscle pain Retro-orbital pain Positive tourniquet test Fever/subjective warmth Petechial rash Vomit</p> <p>Incorrect</p> <p>Ascites Constipation Diarrhea Dyspnea Dysuria Chest pain Edema Icterus Lymphadenitis Nasal secretions Persistent cough Thrombocytopenia</p>	<p>n (%) selecting response</p> <p>59 (78%) 60 (79%) 62 (82%) 45 (59%) 64 (84%) 33 (43%) 25 (33%)</p> <p>1 (1%) 5 (7%) 10 (13%) 3 (4%) 2 (3%) 1 (1%) 2 (3%) 1 (1%) 3 (4%) 11 (14%) 3 (4%) 15 (22%)</p>
<p>7. Select any the treatments you could use in a patient suspected to have dengue</p> <p>- Note: Question is worth 1 point - 0.5 points given for hydration (either oral and/or IV) and 0.5 points given for paracetamol. Recipient is given 0 points if anti-bacterial or anti-viral medication is selected</p>	<p>Oral Hydration IV Hydration Paracetamol Anti-bacterial Anti-viral Any of the following (listed individually in survey): Aspirin, NSAIDs / Steroids / Immunosuppressants (methotrexate, cyclosporine, etc.) / Opioids / Platelets / Plasma / Whole blood transfusion</p>	<p>70 (92%) 12 (16%) 71 (93%) 1 (1%) 1 (1%) 0 (0%)</p>

Table 63. Clinical Knowledge Questions

Note: Each question is worth 1 point. (T) if placed next to the correct response

Question	Response Selected	n (%)
<p>1. An 8-year old male patient presents to your office with a 4 day history of fever, nausea, vomiting three times per day, and joint aches. He is accompanied by his mother, who reports that he has been less active over the past few days and seems to be getting more uncomfortable. You note the following abnormalities on physical exam: The patient has bleeding of the oral mucosa, a palpable mass on the right side 2 cm below the ribs, and winces when you palpate his abdomen. You do not observe fluid in the abdomen or difficulty breathing. Based on current WHO guidelines, this patient is best classified as:</p>	(n=73)	
	Dengue fever	0 (0%)
	Dengue hemorrhagic fever	5 (7%)
	Dengue shock syndrome	0 (0%)
	Dengue without warning signs	2 (3%)
	Dengue with warning signs (T)	61 (84%)
Severe dengue	5 (7%)	
<p>2. A 5-year-old girl patient presents to your office with a few days of fever and a distended, painful abdomen. Her mother states that she has been less active over the past three days. It is currently February and you have seen six patients in the past three weeks with dengue infections. The best course of action in managing this patient is to:</p>	(n=73)	
	Order dengue lab tests, tell the patient to get rest at home, and ask the patient to return to your office in 24 hours	10 (14%)
	Order dengue lab tests and admit the patient to the hospital for 24 hours of observation (T)	54 (74%)
	Order dengue lab tests and admit the patient to the Intensive Care Unit for close monitoring and access to emergency care	9 (12%)
<p>3. A 27-year-old male patient presents to your office in February with two days of fever and complaints of muscle aches. He notes that he has had three episodes of non-bloody vomiting in the past two days. The patient notes that his younger sister has similar symptoms. You recall hearing numerous reports of dengue infection during the last month. The best course of action in managing this patient is to:</p>	(n =71)	
	Order dengue lab tests, tell the patient to get rest at home, and ask the patient to return to your office in 24 hours (T)	52 (73%)
	Order dengue lab tests and admit the patient to the hospital for 24 hours of observation	19 (27%)
	Order dengue lab tests and admit the patient to the ICU for close monitoring and access to emergency care	0 (0%)

Table 74. Practice-Based Questions**Note:** Percentages given do not include respondents who did not answer the question

Question	Response Selected	n (%)
Approximately how many patients do you see per week?	0	3 (5%)
	1-49	6 (10%)
	50-99	28 (47%)
	100-149	16 (27%)
	>150	7 (12%)
Are you familiar with the WHO's 2010 Clinical Management of Dengue guidelines?	Yes	67 (89%)
	No	8 (11%)
Do you feel that the WHO's Dengue guidelines help in managing dengue?	Yes	64 (97%)
	No	2 (3%)
Of those patients who you suspect have dengue fever, approximately what percentage do you refer to a lab for diagnostic testing?	0% of patients	1 (1%)
	10% of patients	10 (15%)
	25% of patients	3 (4%)
	50% of patients	8 (12%)
	75% of patients	5 (7%)
	100% of patients	40 (61%)
Do your patients ever use a private lab without a referral?	Yes	31 (47%)
	No	35 (53%)
Approximately what percentage of patients with dengue fever do you refer to the hospital for additional medical treatment?	0	14 (26%)
	<10%	31 (57%)
	25%	1 (2%)
	50%	6 (11%)
	75%	1 (2%)
	100%	1 (2%)
Do you feel you have adequate resources to treat your patients when they have dengue?	Yes	48 (69%)
	No	22 (31%)
If you said 'No' to the previous question, what are you lacking? - Note: Percentages given as n/22, based on above question * Subjects may select multiple options	Sufficient training	7 (32%)
	Medication needed to treat	9 (41%)
	Instruments needed to treat	8 (36%)
	Access to lab tools	10 (45%)