Am. J. Trop. Med. Hyg., 87(3), 2012, pp. 554–558
doi:10.4269/ajtmh.2012.12-0101

High Household Economic Burden Caused by Hospitalization of Patients with Severe Dengue Fever Cases in Can Tho Province, Vietnam

Pham Thi Tam, Nguyen Tan Dat, Le Minh Huu, Xuan Cuc Pham Thi, Hoang Minh Duc, Tran Cong Tu, Simon Kutcher, Peter A. Ryan, and Brian H. Kay*

Can Tho University of Medicine and Pharmacy, Can Tho City, Vietnam; National Institute of Hygiene and Epidemiology, Hanoi, Vietnam; Australian Foundation for Peoples of Asia and the Pacific Ltd., Ho Chi Minh City, Vietnam; Queensland Institute of Medical Research, Brisbane, Queensland, Australia

Abstract. During 2006–2007, a cohort of 144 confirmed dengue cases in Can Tho Province, Vietnam were compared with a matching set of 144 households that had no dengue cases. Approximately 6–9 months after sickness, there were no significant differences in terms of knowledge of the etiology of dengue, mosquito breeding habitats, and prevention measures in respondents from both sets of households. There was also no difference in the abundance of *Aedes aegypti* (Linn.) adults but the average numbers of late instar and pupal *Ae. aegypti* per household were greater in the negative control houses. Thus, the risk seemed to be no higher in case households, although it is conceivable that changes may have occurred in either group over the intervening period. The average cost for a dengue patient was 2,798,000 Vietnamese Dong (VND) (US$167.77), 2,154,000 VND for direct costs, and 644,000 VND for indirect costs. There was a 22% difference in cost for those with and without health insurance. In terms of impact on family economies, 47.2% had to borrow money for treatment, and after 6 months, 71.7% had not begun or had only managed part repayments. Approximately 72.9% indicated that the cost of supporting a dengue patient had impacted on the family economy, with the loss averaging 36% of the annual income in the lowest economic quartile.

INTRODUCTION

It is generally regarded that there is a paucity of data on the burden of dengue. Such knowledge is essential to cost-benefit analyses to guide decision making by government and by industry. In April 2008, a group of experts[1] conducted a systematic literature review that returned 43 publications outlining primary data. Nevertheless, the conclusion from this group was that health economics research specific to dengue was still urgently needed to inform decision making on various control options, including vaccination. Burden of disease estimates from the World Health Organization[2] indicated an estimated 36 million cases of dengue annually, with 2 million cases of dengue hemorrhagic fever (DHF), and this may equate to 670,000 disability-adjusted life years annually. However, these estimates may be based on underestimates of the duration and disability scores used to describe the illness.[3,4]

Apart from differences in methods, Hanna[3] correctly highlighted the challenges of improved diagnostics and diagnostic coverage to accurately enumerate the actual number of confirmed cases, but also to translate these into official national notification data. In Vietnam, for example, only 5–10% of cases are serologically confirmed and this is common in developing countries. In four sites in southern Vietnam, the average incidence from 2004–2006 was reported as 441/100,000 for children ≤ 14 years of age, and 98/100,000 for persons ≥ 15 years of age.[5] The reported incidence compared with that from a cohort study led to underreporting of 1.2 times for dengue shock syndrome, 5.4 times for DHF, and 15.7 for classical dengue.

This report details the direct and indirect costs of a cohort of 144 persons serologically confirmed as having dengue and hospitalized during June 2006–October 2007 in Can Tho Hospital and Can Tho Children's Hospital in southern Vietnam. Previously, both average direct and indirect costs of those visiting and/or admitted to Children's Hospital #1 in Ho Chi Minh City[6] was estimated at US$61.36, but this cost increased to US$126.80 with severity of disease.[6] In neighboring Thailand[7–9] and Cambodia,[9–11] the economic and societal impact is high, and losses per family may exceed family incomes, which could result in the sale of consumables and assets, and or borrowing to meet out-of-pocket expenses. This change may result in unsettled debts and the selling of family land.[10]

Our second objective was to ascertain whether there were any differences in knowledge and behavior of these 144 households with cases, in comparison to those without cases, to compare risk. To measure behavior outcomes, we hypothesized that case households would have greater numbers of immature and adult *Aedes aegypti* than those where dengue infection was not reported.

METHODS

Study areas. Can Tho City (10°2′N, 105°47′E), 169 km south of Ho Chi Minh City, is the largest city in the Mekong delta region. The city is a center of education, science, culture, and business. The city and surrounding areas have separate administrations, equivalent to provincial status, and its nine districts have an area of 1,389 km^2, mainly for rice production. The area has a population of 1,121,000 according to the 2004 census. It has a tropical monsoon climate with a wet season extending from May through November, and the average annual rainfall is 1,635 mm.

Study design. The protocol for this study was reviewed and approved by the Ethics Committee, Can Tho University of Medicine and Pharmacy. Household addresses of 144 DHF patients hospitalized in Can Tho Hospital and Can Tho Children's Hospital during June 2006–October 2007 were located from hospital records. They resided in eight of nine districts of Can Tho and in Chau Thanh in neighboring Hau Giang Province. All had positive serologic results by IgM antigen capture enzyme-linked immunosorbent assay using an in-house test developed by the Institute Pasteur (Ho Chi Minh City, Vietnam).

*Address correspondence to Brian H. Kay, Queensland Institute of Medical Research, Post Office Royal Brisbane Hospital, Brisbane 4029, Queensland, Australia. E-mail: brian.kay@qimr.edu.au

With the assistance of the hospital staff, former patients were contacted and asked if they were willing to participate 6–9 months after their convalescence. The purpose of the study was explained to those taking part and their consent was indicated by a completed questionnaire and survey form. Negative houses (n = 144) were selected as controls for the entomologic study and a knowledge, attitude, and practice study by being ≤ 200 meter from a positive household, being of similar style (based on size and materials used), and having children of similar age.

A questionnaire was devised to interview adult patients directly or in the case of children, assisted by family members. The structure of questionnaire includes three main parts: 1) demographic information of households, income, education level, and occupation; 2) knowledge of dengue and mosquitoes, and prevention measures; and 3) the social and economic impact of DHF cases. In addition, focus group discussions were held to amplify discussion about social and economic impact of hospitalization because of severe dengue, and also to obtain ideas about prevention.

Investigators from the Can Tho University of Medicine and Pharmacy were selected on the basis of having good interviewing skills for the questionnaire and or having entomologic training for household surveys. Team members were trained about the clinical and diagnostic issues relating to dengue at the Institute Pasteur (Ho Chi Minh City) and briefed on study objectives, economic impact, principles of interviewing, and using questionnaire codes, which were finalized by interviewing practice and group discussion with eight persons. Investigators were divided into small groups; each group included three members, including two investigators and one local collaborator. For each household, one investigator administered the questionnaire, whereas the other two members did the container and indoor sampling.

Paired entomologic surveys were done from April–June 2007 (n = 144) and from September–December 2007 (n = 144). For each of 10 container categories, the two groups had similar numbers of wet containers and positivity, but numbers of late instars and pupae were higher in the first survey. All water-bearing containers were surveyed for immature culicids and cyclopoid copepods by using a 20 × 20 × 20 mm net of fine gauze. Adult mosquitoes were captured resting indoors during standard 15-minute collections by using an aspirator.

Entomologic risk factors were compared between case and control households by using a Mann-Whitney rank sum test and a chi-square test. The factors were households positive for larvae, households positive for pupae, containers positive for larvae and for pupae, and numbers of III–IV instars and pupae expressed as a density index per household, and adult *Ae. aegypti* were expressed as a density index per household. Prevalence of *Mesocyclops* was expressed as percentage positive in containers of capacities > 50 liters.

RESULTS

Sampled population. There were no significant differences between the age categories ($P = 0.9$), sex ($P = 0.9$), education level ($P = 0.6$), and occupations ($P = 0.3$) of the 288 matched persons, 144 with dengue and 144 with no dengue case in the household. Most (82.6%) cases were in children of either sex < 15 years of age Table 1.

Table 1

Characteristics of 144 persons with dengue evaluated at Can Tho Province hospitals, Vietnam, 2006–2007

Characteristic	No.	%
Age, years		
≤ 5	31	21.5
6–10	35	24.3
10–15	53	36.8
> 15	25	17.4
Sex		
M	71	49.3
F	73	50.7
Education		
Pre-school	31	21.5
Elementary	54	37.5
Secondary	44	30.6
High school	11	7.6
Higher education school	4	2.8
Occupation		
Children < 6 years old	31	21.5
Pupil	96	66.7
Officer	4	2.8
Hired labor	5	3.5
Housewife	5	3.4
Other	3	2.1

Knowledge of dengue, its vectors, and prevention. Approximately 97.9% of those whom had recovered from dengue (n = 144) could list at least one symptom, compared with 78.5% of those who had not been infected ($P < 0.001$). Almost all (97.2%) respondents cited dengue as a serious or deadly disease (Table 2).

With respect to knowledge of the dengue mosquito, there were no significant differences between those who contracted dengue and those who did not: 77.8% and 82.0%, respectively, knew it was transmitted by a mosquito, 37.5% and 43.8% knew it was the striped mosquito, and 25.0% and 21.5% knew it was diurnal (Table 3). There were no significant differences in knowledge of breeding habitat: water jars ($P = 0.5$), flower vases and ant traps ($P = 0.6$), coconut shells ($P = 0.08$), tires ($P = 0.9$), and discarded materials ($P = 0.1$). There were no differences between the two groups with respect to prevention of breeding by using a lid ($P = 0.5$), changing stored water ($P = 0.7$), inverting containers ($P = 0.7$), using fish ($P = 0.1$), adding oil or salt to ant traps ($P = 0.9$), or with respect to use of various adulticides. There were also no significant differences with respect to claimed application of the above practices, and ≥ 37.4% of residents reported application of some form of larval control.

Dengue case and control houses had similar numbers of wet containers and positive containers per house. Likewise, the proportion of houses positive for larvae were similar in both case (46.5%) and control (58.3%) houses ($\chi^2 = 3.56$, degrees of freedom [df] = 1, $P = 0.06$). The proportion of houses positive for pupae were similar in both case (25.0%) and control (31.3%) houses ($\chi^2 = 1.09$, df = 1, $P = 0.29$). The proportions of containers positive for larvae at case (31.1%) and control houses (36.6%) were not significantly different ($\chi^2 = 3.21$, df = 1, $P = 0.073$). However, pupal positivity was significantly greater ($\chi^2 = 4.19$, df = 1, $P = 0.041$) in containers at control houses (17.0%) compared with case houses (12.2%).

In surveys 1 and 2, respectively, the numbers of larvae at control houses (mean ± SD = 115.2 ± 266.7, and 54.2 ± 91.1) were greater in both seasons than those at case houses

TABLE 2
Knowledge of dengue disease in Can Tho Province residents with and without dengue in the household, Vietnam, 2006–2007

Dengue symptom	Persons with cases, n = 144, no. (%)	Controls, n = 44, no. (%)	Total, n = 288, no. (%)	*P*
Mentioned ≥ 1 symptom	141 (97.9)	113 (78.5)	254 (88.2)	0.001
Muscular pain	7 (4.9)	4 (2.9)	11 (3.8)	0.5
High uninterrupted fever	134 (93.1)	102 (70.8)	236 (81.9)	0.000
Nose bleeding	9 (6.3)	5 (3.5)	14 (4.9)	0.3
Skin hemorrhage	38 (26.4)	52 (36.1)	90 (31.3)	0.07
Abdominal pain	18 (12.5)	13 (9.0)	31 (10.8)	0.3
Nausea, vomiting	45 (31.3)	15 (10.4)	60 (20.8)	0.000
Black stools	4 (2.8)	1 (0.7)	5 (1.7)	0.2
Lethargy or irritability	13 (9.0)	4 (2.8)	17 (5.9)	0.02
Cold extremities	23 (16.0)	7 (4.9)	30 (10.5)	0.002
Weak pulse	1 (0.7)	0	1 (0.4)	0.3

(70.5 ± 138.9,and 28.5 ± 67.2) but were not significantly different. Also, no significant differences were found with pupae (13.4 ± 33.5 and 8.7 ± 25.9) and (9.2 ± 27.9 and 5.9 ± 24.6). Partly because of the higher rates of positivity in control houses, total numbers of III-IV instars were 71% higher in control houses (12,378) than in case houses (7,256), and pupal numbers were 46% higher in control houses (1,608) than in case houses (1,101). However, adult density indices (0.73 and 0.74) were similar. *Mesocyclops* were present in 6.7 and 3.7% of big containers in case and control households.

Social and economic impact. Ninety-one % of persons with dengue (Table 4) sought treatment before admission to a hospital, mainly from private health clinics (48.9%) or from communal health centers (29.0%). After admission, 18.1% of patients sought treatment from pharmacies (46.2%) and from private clinics (38.5%). The mean ± SD for total treatment time was 9.7 ± 4.3 days, comprising before admission 2.5 ± 1.4 days, during admission 6.0 ± 1.7 days, and post- admission 1.2 ± 3.6 days. The range was 4–39 days.

The average cost (Table 5) for a case (n = 144) of dengue in a Can Tho household was mean ± SD 2,798,000 ± 2,364,000 Vietnamese Dong (VND) (US$167.77 ± 141.74 at January 2007 rates), of which 76% involved direct costs for treatment, medicine, and for food and transport to and from the hospital. Indirect costs comprised 24% in terms of lost productivity. The direct costs for treatment and hospital services were reduced by 22% for 43.8% who used health insurance cards, but 13.8% of those with insurance did not use their cards.

Almost half of the 144 families had to borrow to afford treatment and ancillary costs associated with a dengue case that required hospitalization (Table 6). Money was borrowed from various sources but mainly from family (up to 51%) or friends (up to 29%) and some borrowing was from employers, banks, or the government, or mortgaging or selling items (up to 6% for each of the last five categories). Approximately six months after convalescence, only 26.5% had repaid their debt in full, 39.7% had repaid some, and 33.8% had been unable to make any repayments.

Economic impact was examined as direct and indirect costs in relation to mean family income, which was divided into quartiles. The average loss of those in the lowest economic group with an annual income of 7,768,000 VND (US$465.76) lost 36%, the second group with mean income of 16,160,000 VND (US$968.94) lost 17%, and costs represented 12% of mean annual income of 25,674,000 VND (US$1539.41) to the third quartile, but this expenditure represented only 4% to the highest income group (57,038,225 VND,

TABLE 3
Knowledge of the *Aedes aegypti* mosquito and dengue transmission in 288 residents in Can Tho Province, Vietnam, 2006–2007

Knowledge of *Aedes aegypti* mosquito	Persons with cases, no. (%)	Controls, no. (%)	Total, no. (%)	*P*
What transmits dengue?				
Don't know	32 (22.2)	26 (18.1)	58 (20.1)	0.6
Mosquito	112 (77.8)	118 (82.0)	230 (79.9)	
Mosquito species?				
Don't know	67 (46.5)	57 (39.5)	124 (43.0)	0.4
Aedes	0 (0)	1 (0.7)	1 (0.4)	
Striped	54 (37.5)	63 (43.8)	117 (40.6)	
Others	23 (15.9)	23 (15.9)	46 (15.9)	
Mosquito biting time?				
Don't know	58 (40.3)	48 (33.3)	106 (36.8)	0.06
Day	36 (25.0)	31 (21.5)	67 (23.3)	
Night	21 (18.8)	14 (11.9)	35 (15.2)	
Day and night	26 (18.1)	45 (31.3)	71 (24.7)	
Twilight	3 (2.1)	6 (4.2)	9 (3.1)	

TABLE 4
Treatment for 144 patients with dengue before and after admission at a provincial hospital, Can Tho Province, Vietnam, 2006–2007

Features	No.	%
Treatment before admission to hospital		
Yes	131	91.0
No	13	9.0
Places of treatment before admission to hospital		
Buying drugs from pharmacies	9	6.9
Private clinic	64	48.9
Commune health center	38	29.0
District hospital	13	9.9
Other	7	5.1
Treatment after admission to hospital		
Yes	26	18.1
No	118	81.9
Places of treatment after admission to hospital (n = 26)		
Buying drugs from pharmacies	12	46.2
Private clinic	10	38.5
Commune health center	2	7.7
Other	2	7.7
Used health insurance cards		
Yes	63	43.8
Did not use	20	13.8
Did not have insurance		

TABLE 5

Direct and indirect cost (in 1,000 Vietnamese Dong) of dengue to patients with and without health insurance, Can Tho Province, Vietnam, 2006–2007*

Cost	No.	Mean	SD	Minimum	Maximum
Direct*					
Total	144	2,154	1,757	75	10,000
With insurance	83	1,673			
Without insurance	61	2,811			
For medicine and hospital service					
Total	144	1,288	1,372	75	6,700
With insurance	83	816			
Without insurance	61	1,932			
For food and transport					
Total	144	866	817	0	4,900
With insurance	83	857			
Without insurance	61	879			
Indirect (household income lost)					
Total	144	644	1,058	0	11,000
With insurance	83	528			
Without insurance	61	792			
Total (direct and indirect)					
Total	144	2,798	2,364	75	20,150
With insurance	83	2,201			
Without insurance	61	3,603			

*Significant difference between two means of with and without insurance card ($P < 0.001$).

US$3419.96). The range of total costs was 75,000–20,150,000 VND (US$4.50–1,208.18).

DISCUSSION

The average direct and indirect cost of a dengue infection requiring hospital admission in Can Tho Province was US$167.77 (range = US$4.50–1,208.18). This cost was considerably more than reported for Ho Chi Minh City, which averaged US$61.36 (range = of US$5.34–280.57).[6] We did not scale costs against severity but would expect that more prolonged and complicated treatments, and longer visitation periods, would result in higher cost as in this previous study. Those with insurance received a rebate between 12% and 25% depending on the services provided. Thus, it would seem that an average 22% rebate was not always sufficient to avoid hardship.

In Thailand, the total costs of one case in 1994 dollars was estimated as 37–57% of the monthly family income, at US$108.82 and US$161.49 in Bangkok and US$102.82 and US$138.02 in Suphan Buri Province for children and adults, respectively.[7] In 2001 in Kamphaeng Phet Province, US$61 per case represented more than the monthly family income.[8]

TABLE 6

Response and impact of a dengue case on family economies 6–9 months after hospitalization, Can Tho Province, Vietnam, 2006–2007

Responses	No.	%
Borrowed money		
Yes	68	47.2
No	76	52.8
Repaid their debt (n = 68)		
Repaid in full	18	26.5
Repaid some	27	39.7
No repayments	23	33.8
Economic impact		
Negligible (< 5% of family income)	39	27.1
Light (< 25%)	46	31.9
Medium (> 25–50%)	52	36.1
High (> 50%)	7	4.9

This latter study emphasized that the cost of dengue is of the same order as other diseases given priority in Southeast Asia, namely the tropical cluster (mainly schistosomiasis, leishmaniasis, and lymphatic filariasis), malaria, meningitis, and hepatitis.

In Banteay Meanchey[10] and Kampong Cham,[11] Cambodia, the high socioeconomic and societal impact seemed comparable to those from Can Tho. Direct and indirect costs varied from US$8 to US$103 (2001–2002 dollars) and from US$36 to US$75 (2006–2008 dollars), respectively. Health insurance rebates were not high enough to reduce societal burden, and in Banteay Meachey at least, 63% were forced to borrow from similar sources as at Can Tho. After six months in Can Tho, more than two-thirds of those who borrowed had been unable to retire their debt; in Banteay Meanchey, this figure was 62%. Unlike the study in Cambodia,[10] we did not enquire about the terms of the loan or of interest rates but it is obvious that the impact of dengue infection was highest in those who were poor.

The mean ± SD period of disability in the Can Tho cohort was 9.7 ± 4.3 days (range = 4–39 days. Before admission, 91% sought assistance mainly from private clinics and communal health centers for an average of 2.5 days. After admission to hospital for an average of 6 days, 18.1% of patients still purchased from pharmacies and private clinics but most relied on hospital treatment. This finding might indicate the level of family concern about the potential severity of dengue infection.

When we examined knowledge and risk factors, 80–96% of case and control households knew at least one dengue symptom and 95–97% knew it to be a serious or deadly disease. However approximately 6–9 months after infection, the entomologic indices for adult female *Ae. aegypti* in case households were similar to those where no dengue had occurred. However, numbers of late instars and pupae were lower. We cannot be certain that a case within a household did not stimulate at least some temporary activity but, overall, nominated preventive behaviors (37%) were similar for case and control households. Because our study design necessitated the questioning persons approximately 6–9 months after a dengue event to measure long-term effect, some respondents might have had recall bias. It is also possible, but unlikely, that entomologic indices in case houses may have changed relative to control houses.

Given the high impact of dengue cases, and the high level of knowledge about the habitat and behavior of *Ae. aegypti*, our data suggest that few households took long-term preventive action, or more specifically any action that would effectively control the vector. However, community responsiveness is multifaceted and complex,[12] and knowledge of the disease and vector may not be enough to stimulate a broad response.

Of locally promoted preventive measures, the use of covers or lids has been shown to be ineffective,[13] and frequent water changing in storage jars, or upturning jars, is impractical in a poor society, which relies on water capture and storage for survival.[14,15] The options of household spraying, coils, and gels would be affordable by the wealthy, and sleeping under a mosquito net is more appropriately directed against nocturnal vectors. Thus, use of fish as one practical suggestion had been adopted only by 23% of case and control households. No one had adopted *Mesocyclops* use, although they were present in 3.7–6.7% of big containers, and they had been promoted as part of the National Dengue Control Plan since 1998. This prevalence is common throughout Vietnam because

of water transfer practices and flooding,[16,17] but their uptake as a mosquito control tool is dependent on active health promotion.

This study demonstrates that in a cohort of 144 residents of Can Tho Province in the Mekong delta region, the socioeconomic impact of one case of dengue in a household can be as high as 36% of annual income, and this can result in family hardship. Economic impact was greatest in lower income families. Our study also demonstrates that it is likely that infection may be a random event because our risk indicators suggest little difference in those households with and without dengue infection. However, both groups could have been infected at a common high-risk site, e.g., school or market.

Finally, although most households with and without dengue experience were reasonably knowledgeable about how it occurred and what to do about it, the range of options presented by health authorities was in need of reconsideration. Use of fish is well understood but although the impact of community-based *Mesocyclops* has spread from northern to southern Vietnam,[16,18] it requires promotion in Can Tho. On the basis of a prospective cost study during 2006–2007 in four sites in southern Vietnam,[19] the cost in managing 290,000–460,000 cases in southern Vietnam was reported as averaging US$26 million per year. Based on our cohort, which might be representative of rural and provincial communities outside Ho Chi Minh City, this figure may be as high as US$48.4–76.8 million. Given the sustainability and low costs of < US$1 per person per year reported for community-based *Mesocyclops* programs,[20] it would seem that this approach (where applicable) would be a good investment.

Received February 14, 2012. Accepted for publication May 15, 2012.

Acknowledgments: We thank the Board of Leaders of Can Tho Hospital and the Children's Hospital for facilitating access to the list of in-patients; the Board of Leaders of the Can Tho University of Medicine and Pharmacy for creating favorable conditions for us to conduct this study; the Pasteur Institute in Ho Chi Minh City, the National Institute of Hygiene and Epidemiology in Ha Noi, and the Ministry of Health for support.

Financial support: This study was supported through an AusAID Vietnam Australia Non-Government Organization Cooperative Agreement grant, which was administered by the Australian Foundation for Peoples of Asia and Pacific, Limited.

Disclosure: None of the authors have any conflicts of interest.

Authors' addresses: Pham Thi Tam, Nguyen Tan Dat, and Xuan Cuc Pham Thi, School of Public Health, Can Tho University of Medicine and Pharmacy, Ninh Kieu, Can Tho City, Vietnam. Hoang Minh Duc and Tran Cong Tu, National Institute of Hygiene and Epidemiology, Hai Ba Trung, Hanoi, Vietnam. Simon Kutcher, Australian Foundation for Peoples of Asia and the Pacific Limited, currently Family Health International 360, Hanoi, Vietnam. Peter A. Ryan and Brian H. Kay, Queensland Institute of Medical Research, Herston, Queensland, Australia.

Reprint requests: Brian H. Kay, Queensland Institute of Medical Research, Post Office Royal Brisbane Hospital, Brisbane, Queensland 4029, Australia, E-mail: brian.kay@qimr.edu.au.

REFERENCES

1. Beatty ME, Beutels P, Meltzer MI, Shepard DS, Hombach J, Hutubessy R, Dessis D, Cordeville L, Dervaux B, Wichman O, Margolis HS, Kuritsky JN, 2011. Health economics of dengue: a systematic review and expert panel's assessment. *Am J Trop Med Hyg 84:* 473–488.
2. World Health Organization, 2008. *Update. The Global Burden of Disease*. Geneva: World Health Organization. Available at: http://www.who.int/healthinfo/global_burden_disease/GBD_report-2004update_full.pdf. Accessed July 26, 2011.
3. Hanna JN, 2010. *In Depth Examination of Important Issues for the Development and Introduction of Dengue Vaccines*. Pediatric Dengue Vaccine Initiative Occasional Paper no. 3. Seoul, South Korea: International Vaccine Institute.
4. Meltzer MI, Rigau-Perez JG, Clark GC, Reiter P, Gubler DJ, 1998. Using disability-adjusted life years to assess the economic impact of dengue in Puerto Rico: 1984–1994. *Am J Trop Med Hyg 59:* 265–271.
5. Coudeville L, Pollisard L, Chan QL, Nguyen TT, Vu HT, Luxemberger C, Nguyen KT, 2009. Annual Meeting of the American Society of Tropical Medicine and Hygiene. Abstract 391, 115.
6. Harving ML, Ronshalt FF, 2007. The economic impact of dengue hemorrhagic fever on family level in southern Vietnam. *Dan Med Bull 54:* 170–172.
7. Okanurak K, Sornmani S, Indaratna K, 1997. The cost of dengue fever in Thailand. *Southeast Asian J Trop Med Public Health 28:* 711–717.
8. Clark DV, Mammen MP Jr, Nisalak A, Puthimethee V, Endy TP, 2005. Economic impact of dengue fever/dengue hemorrhagic fever in Thailand at the family and population levels. *Am J Trop Med Hyg 72:* 786–791.
9. Suaya JA, Shepard DS, Siqueira JB, Martelli CT, Lum LC, Tan LH, Kongsin S, Jiatom S, Garrido F, Montoya R, Armien B, Huy R, Castillo L, Caram M, Sah BK, Sughayyar SR, Tyo KR, Halstead SR, 2009. Cost of dengue cases in eight countries in the Americas and Asia: a prospective study. *Am J Trop Med Hyg 80:* 846–855.
10. Van Damme W, Van Leemput L, Hardeman W, Meesen B, 2004. Out-of-pocket health expenditure and debt in poor households: evidence from Cambodia. *Trop Med Int Health 9:* 273–280.
11. Beaute J, Vong S, 2010. Cost and burden of dengue in Cambodia. *BMC Public Health 10:* 521–526.
12. Wagemakers A, Vaandrager L, Koelen MA, Saan H, Leeuwis C, 2010. Community health promotion: a framework to facilitate and evaluate supportive social environment and health. *Eval Program Plann 33:* 428–435.
13. Tran HP, 2011. *Relationships between Dengue Vector Abundance, Household Water Storage Practices and New Water Supply Infrastructure in Southern Vietnam*. PhD dissertation. School of Population Health, University of Queensland, Brisbane, Queensland, Australia.
14. Tran HP, Adams J, Jeffery JA, Nguyen TY, Vu SN, Kutcher SC, Kay BH, Ryan PA, 2010. Householder perspectives and preferences on water storage and use, with reference to dengue in the Mekong Delta, southern Vietnam. *Int Health 2:* 136–142.
15. Nguyen LA, Clements AC, Jeffery JAL, Nguyen YT, Vu SN, Vaughan G, Shinkfield R, Kutcher SC, Gatton ML, Kay BH, Ryan PA, 2011. Abundance and prevalence of dengue vector immatures and relationships with household water storage in rural areas in southern Vietnam. *Int Health 3:* 115–125.
16. Vu SN, Nguyen TY, Hoang MD, Tran CT, Vu TT, Nguyen HL, Le HS, Luu LL, Vu TQ, Ly HK, Huynh TT, Lam LZ, Kutcher SC, Aaskov JG, Jeffery JA, Ryan PA, Kay BH, 2012. Community-based control of *Aedes aegypti* using *Mesocyclops* in southern Vietnam. *Am J Trop Med Hyg 86:* 850–859.
17. Vu SN, Nguyen YT, Holynska M, Reid JW, Kay BH, 2000. National progress in dengue vector control in Vietnam; survey for *Mesocyclops* (Copepoda), *Micronecta* (Corixidae) and fish as biological control agents. *Am J Trop Med Hyg 62:* 5–10.
18. Kay BH, Vu SN, 2005. New strategy against *Aedes aegypti* in Vietnam. *Lancet 365:* 613–617.
19. Coudeville L, Pollisard L, Chan QL, Nguyen TT, Vu HT, Luxemburger C, Nguyen KT, 2008. *An Estimation of the Disease and the Economic Burden of Dengue in Southern Vietnam*. The Second International Conference on Dengue Haemorrhagic Fever, Phuket, Thailand. Abstract 391, 115.
20. Kay BH, Tran TT, Nguyen HL, Tran MQ, Vu SN, Phan VD, Nguyen TY, Hill PS, Vos T, Ryan PA, 2010. Sustainability and cost of community-based strategy against *Aedes aegypti* in northern and central Vietnam. *Am J Trop Med Hyg 82:* 822–830.