

Title: Epidemiology of Dengue Hemorrhagic Fever

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Objectives

To determine the factors which influence the occurrence and spread of dengue hemorrhagic fever in Southeast Asia.

Description

A second epidemic of dengue hemorrhagic fever occurred on the island of Koh Samui in the Gulf of Thailand off the coast of Surat Thani province in 1967. The epidemic was investigated in detail in a manner similar to the previous study carried out on the island in 1966. The studies were designed to determine the epidemiologic patterns and to compare such patterns and serologic observations with data obtained during the previous studies. Extensive efforts were carried out to obtain information concerning the vectors of dengue viruses on the island.

A study was carried out in cooperation with the Institut Pasteur, Saigon, Republic of Vietnam, and the US Army Medical Research Team, Vietnam, to determine the relative importance of Aedes aegypti and Aedes albopictus as vectors of dengue viruses in the Saigon area. Mosquito collections were carried out by personnel of the Institut Pasteur, Saigon and frozen pools of mosquitoes were shipped to Bangkok for isolation and identification of viruses.

Data on hospitalized hemorrhagic fever cases in Bangkok and Thonburi hospitals were collected by monthly visits to each hospital by public health nurses in the same manner as have been used since 1962. Reports of hemorrhagic fever occurring outside of Bangkok were obtained from hospitals and from Department of Health records.

Results

The 1967 Dengue Hemorrhagic Fever Epidemic on Koh Samui

In late 1965, dengue hemorrhagic fever was first reported on the island of Koh Samui. In 1966 dengue hemorrhagic fever occurred in epidemic form; studies of the 1966 epidemic were presented in the previous annual report prepared 15 April 1967. The present report encompasses observations made during the 1967 dengue epidemic season in the same population.

Beginning in July 1967 when cases resembling hemorrhagic fever began to appear for treatment, all cases of febrile illness seen at the two medical clinics (one private and one governmental) were considered for inclusion in the study. As in the 1966 epidemic, clinical records of each case were the basis for inclusion into one of four clinical categories: shock syndrome (SS) hemorrhagic fever (HF) dengue fever (DF) and undifferentiated fever (UF) using the criteria previously described. Cases such as pharyngitis, pneumonia, etc., which could not be so categorized were excluded from further consideration.

Acute and convalescent sera were collected as previously. All paired sera were examined for hem-agglutination-inhibiting (HI) antibody against 4 dengue antigens. In most cases complement-fixing (CF) and/or plaque-reduction neutralizing (PRNT) antibodies were also assayed. Serologic response was classified into "primary", "secondary", "dengue not elsewhere classifiable" and "not dengue". In addition, two other categories were recognized. A response consisting of an HI titer of <20 in the acute specimen and >640 in the convalescent sera and a similar pattern in PRNT antibody with high PRNT titers to three or four dengue serotypes was considered as a "probable secondary". The combination of fixed HI titers (640 or greater) and fixed CF titers was considered as evidence of "possible dengue".

Sera from selected cases obtained 10 to 20 days after onset were subjected to sucrose density gradient ultracentrifugation; absence of dengue HI antibody activity in the 19S globulin (IgM) fraction was taken as evidence of a "secondary" response.

For comparison with the age-specific antibody prevalence data obtained for the village of Ang Thong in 1966, single serum specimens were obtained from 367 residents (ages 6 mos-55 years) of two villages in tambol Na Muang on the south end of the island. Presence of dengue HI antibody at a titer of 1:20 or greater was considered evidence of past infection.

From 25 August to 10 September, all households in the village of Lamai were visited daily to estimate the number of dengue infections occurring for which medical care was not sought and which would otherwise have been missed. Acute and convalescent sera were obtained from each child seen during this survey with an oral temperature of 101°F or greater for serologic diagnosis and attempted viral recovery.

Entomological collections for adult female Aedes aegypti and Aedes albopictus were carried out in and around residences of cases admitted to the study as soon as possible after notification of the case. Collections were made during the day for a minimum of 4 hours per location, using both resting and biting collection techniques. Some houses were collected from on several successive days.

Mosquitoes from these collections were anesthetized with CO₂, identified, and pooled by species, date, and site of collection. Pools contained a maximum of 10 mosquitoes. Pooled mosquitoes were frozen and shipped on dry ice to Bangkok for virus recovery attempts.

Virus recovery from mosquito pools, and from acute serum was carried out using the direct and delayed plaque technique in LLC-MK₂ cell culture.

Between 5 August and 13 December 1967, a total of 114 cases of febrile illness seen at one of the two medical clinics on the island were admitted to the study. Adequate serum specimens were available from 101 of these patients.

Table 1 presents representative serologic responses to dengue virus infection classified as primary, secondary and probable secondary—with results of assay for 19S antibody by sucrose density gradient ultracentrifugation. The HI and PRNT responses of cases 24 and 31 are typical of responses observed to initial infection, with low antibody titers in the convalescent specimen and a high degree of specificity. Over 50% of the detectable dengue HI antibody activity was found in the 19S globulin fractions of the convalescent sera in these two cases. Cases 18 and 29 typify a "secondary" response with low antibody titers in the acute specimen, and broadly reacting high titers in the convalescent specimen. No dengue antibody activity was detected in the 19S globulin fractions. Cases 34 and M-13 have high-titer broadly reacting convalescent sera, but no detectable antibody in the acute specimen. The antibody activity in the convalescent sera was confined to the 7S region of the gradient with no detectable 19S antibody present.

Table 1. Typical serologic responses of patients with dengue infections. Three types of responses are presented.

Case No.	Day of Illness	HI Antibody ^{1/}				N Antibody ^{2/}				19 S Antibody ^{3/}
		D-1	D-2	D-3	D-4	D-1	D-2	D-3	D-4	
24	3 ^{4/}	0	0	0	0	0	0	0	0	pos
		0	0	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0	
31	2 ^{4/} 13	20	20	40	160	20	20	40	160	pos
18	3 12	0 1280	0 2560	0 2560	0 20480	0 > 640	40 > 640	0 100	10 > 640	neg
29	2 16	0 5120	20 2560	0 5120	20 5120	0 > 640	10 > 640	0 > 640	0 > 640	neg
34	2 ^{4/} 13	0 1280	0 5120	0 10240	0 10240	0 > 640	0 > 640	0 > 640	0 > 640	neg
M-13	2 ^{4/} 12	0 2560	0 10240	0 20480	0 5120	0 > 640	0 > 640	0 > 640	0 > 640	neg

^{1/} Reciprocal of HI antibody titer vs 4 units of indicated antigen 0 = <20

^{2/} Reciprocal of 50% plaque reduction titer vs indicated viruses 0 = <10

^{3/} Anti-dengue 19S HI antibody

^{4/} Dengue-4 virus isolated from serum

Table 2 presents the distribution of the 101 cases by clinical syndrome and classification of serologic response. There were 5 patients with SS, 10 with HF, and 86 with DF or UF syndromes. For all practical purposes, these last two clinical categories can be considered as one.

Table 2. Distribution of 101 suspected dengue cases by clinical syndrome and serologic response to dengue.

Clinical Syndrome ^{1/}	Serologic Response to Dengue ^{1/}					Totals
	Primary	Secondary	Dengue N.E.C. ^{2/}	Possible Dengue ^{3/}	Not Dengue	
SS	0	4 ^{4/}	1	0	0	5
HF	0	4	2	4	0	10
DF	8	15	3	4	22	52
UF	3	17 ^{4/}	1	2	11	34
Totals	11	40	7	10	33	101

^{1/} See text for definitions.

^{2/} Rise in HI or CF titer but not classifiable as to primary or secondary.

^{3/} HI and CF titers high but no rise demonstrated.

^{4/} Including 1 case of probable secondary response (see text).

Fifty-eight cases were diagnosed as due to dengue on serologic grounds. Dengue virus was recovered from seven of these. Eleven of the 58 patients showed a primary serologic response; 40 a secondary-type response (including two with probable secondary response.). The remaining seven had rises in dengue HI antibody but the response was not clearly differentiable into primary or secondary, usually due to delay in obtaining the acute serum. Of these 58 dengue cases, 5 had SS, 6 had HF and 48 had DF or UF, clinically. No cases classified as SS or HF showed a primary type antibody response.

An additional 10 cases were classified as possible dengue. These had fixed HI titers of 1:160 or greater, and either fixed CF titers or insufficient serum to complete CF tests. By clinical syndrome these were 4 HF and 6 DF/UF.

Figure 1 presents the temporal distribution of the 68 cases of dengue and possible dengue, by week of onset. The first case occurred on 12 July; the last on 30 November.

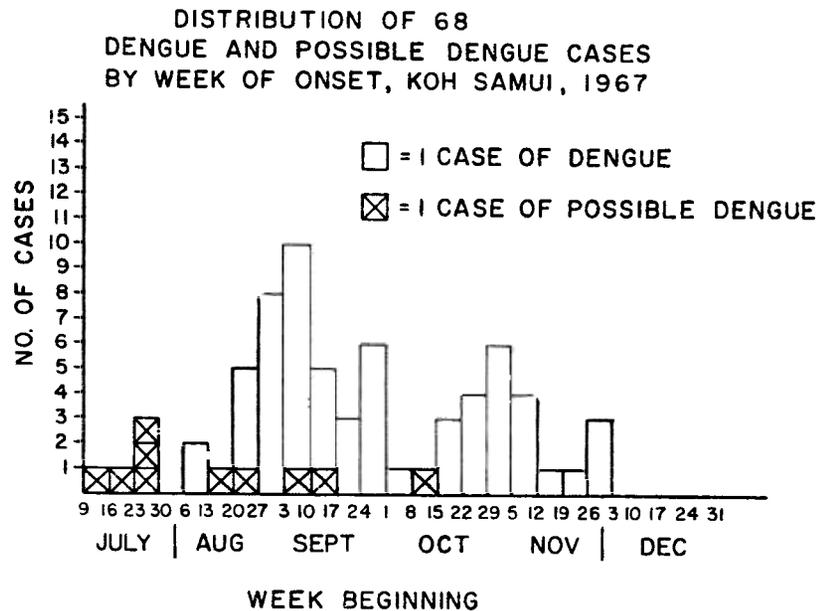


Figure 1.

Figure 2 presents the age distribution of the 68 dengue and possible dengue cases. The youngest patient was a 5 month-old boy with undifferentiated fever and a primary type serologic response. The oldest patient, a woman 36 years old, had a five day history of fever, with purpura and petechiae on physical examination. Her serologic response was diagnostic for dengue. The delay between onset and date of acute specimen did not permit clear differentiation of her response into primary or secondary type. The 22 year old patient indicated, a male, had a similar clinical syndrome; his serologic response, high fixed HI titer and fixed CF titer, was classified "possible dengue".

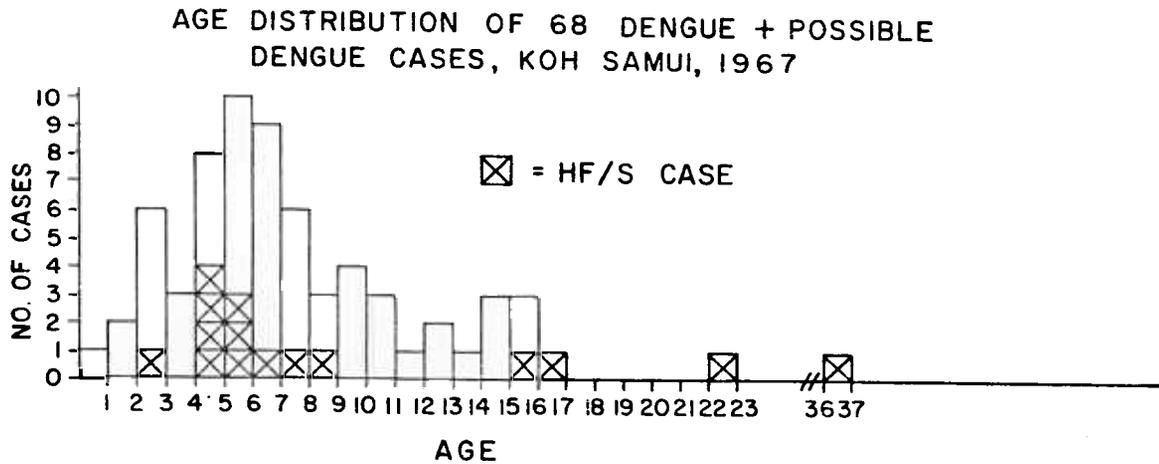


Figure 2.

Figure 3 presents the geographic distribution of the 68 dengue and possible dengue cases, with earliest date of onset recorded for each affected village. Cases were first reported on the southeast coast, then on the northwest coast of the island. The village of Lamai with 23 cases, had reported 5 cases in 1966. Mae Nam, which had 32 cases in 1966, had only 1 in 1967.

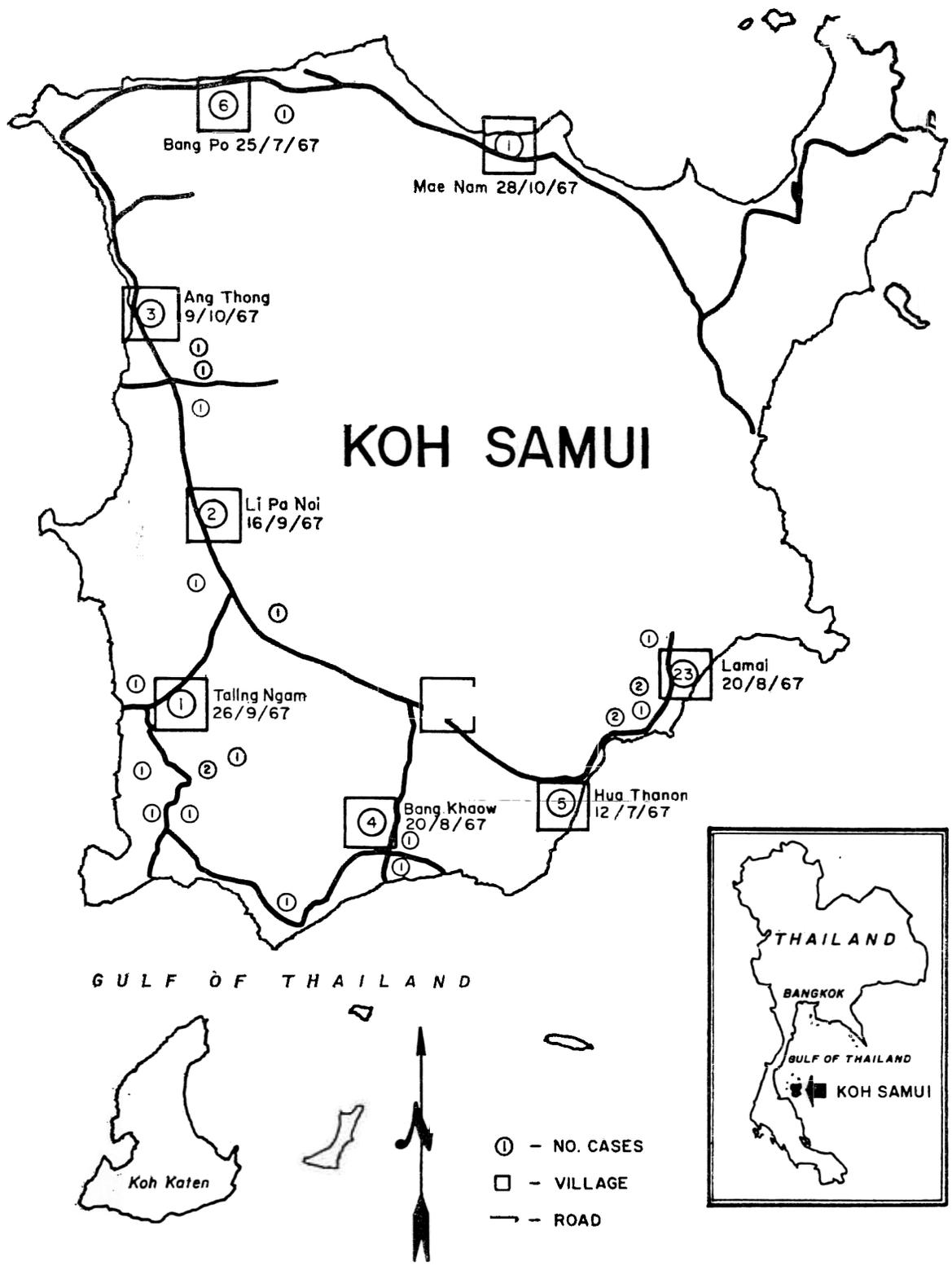


Figure 3. Map of Koh Samui showing location, numbers of cases and date of onset of first case in each village.

Dengue viruses were recovered from seven of the 58 dengue patients. All patients from whom dengue virus was recovered had DF or UF syndrome: by serologic response 2 were primary and the remainder secondary dengue infections.

The survey for possible missed cases in La Mai revealed 25 cases of undifferentiated fever of which 17 were serologically diagnosed as dengue. Four of the 17 had primary type antibody response, 8 had secondary and 5 were positive but not classifiable, due to delay between onset and initial serum specimen. Dengue viruses were recovered from the acute serum of 3 of these children.

Age-specific dengue HI antibody prevalence was derived from a sample of 367 residents of two villages in Na Muang. The sample represented about 10% of the population of that tambol (township). The sample size and sampling ratio varied by age group as seen in Table 3. The sexes are equally represented up to age 15. Thereafter females predominate. The age specific prevalence ratios are graphically portrayed in figure 4.

Table 3. Dengue HI antibody survey in Na Muang 1967.

Age Group	Population (est. 1967)	Sample Size	Antibody Prevalence %
0-4 Yrs	711	65	35
5-9 "	537	146	83
10-14 "	405	67	88
15-19 "	368	25	88
20+ "	1662	64	100
Totals	3683	367	79

Figure 5 summarizes the collections of A. aegypti and A. albopictus made in the course of this investigation, by time of collection species and virus isolation results. Dengue viruses were recovered from 19 of 147 pools of A. aegypti and from 10 of 897 A. albopictus pools. The areas where virus-positive mosquito pools were collected are given in table 4. Note that in nine instances virus was recovered from two or more pools and in two areas virus was recovered from both species. Most of these collections were made in and around houses of suspected cases. Table 5 summarizes the mosquito virus recovery results by final etiologic diagnosis of the index case. A few collections, labelled "no case" were made in houses adjacent to the residence of suspected cases. Of 411 pools collected in or around homes of dengue or possible dengue cases 25 (6.1%) yielded dengue virus. Only 2 virus strains were recovered from 430 pools collected in homes where the index case had a non-dengue caused illness, or where there was no index case. In these instances the virus was recovered from A. albopictus taken outdoors. Mosquito collections in houses where the index case was undiagnosable yielded virus at an intermediate rate.

AGE SPECIFIC PREVALENCE OF DENGUE HI ANTIBODY
 IN 367 RESIDENTS AGE 6MOS - 55 YRS, KOH SAMUI, 1967

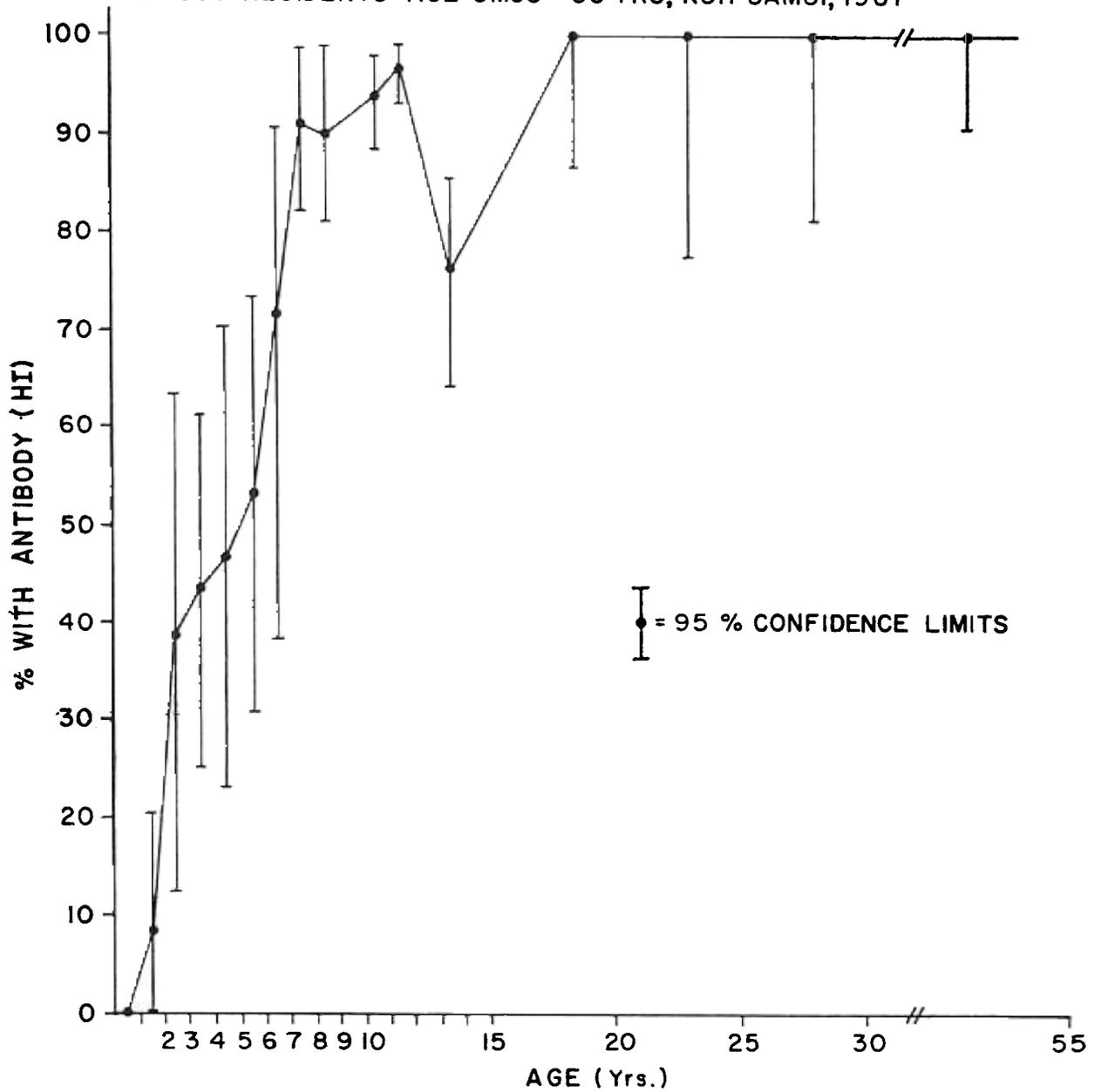


Figure 4.

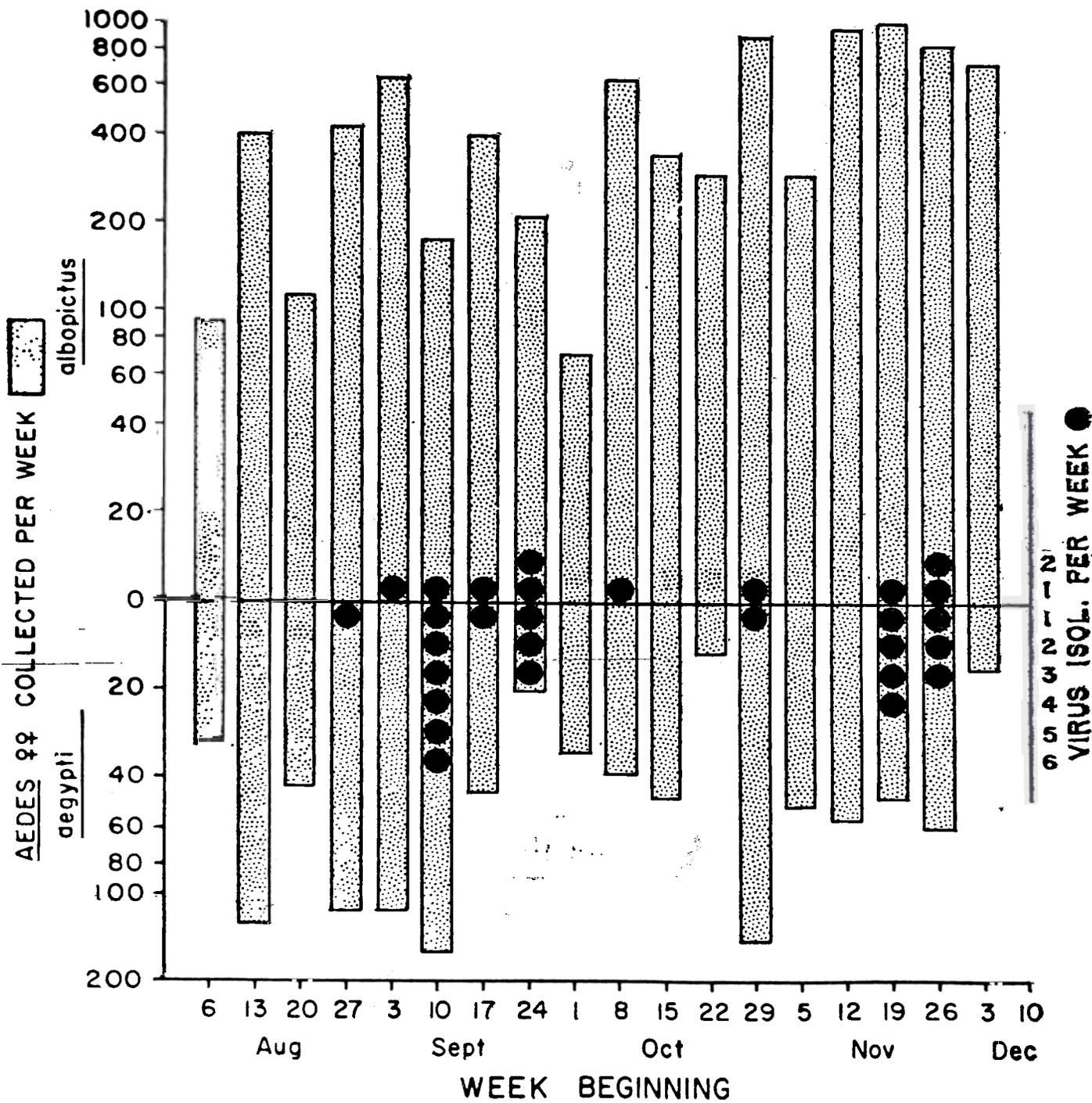


Figure 5. Collections of Aedes mosquitoes for virus isolation, Koh Samui 1967.

Table 4. Recovery of dengue-4 viruses from Aedes mosquitoes collected on Koh Samui, 1967.

Date	Place	Number of pools with virus	
		<u>aegypti</u>	<u>albopictus</u>
30 Aug	Lamai, Maret	1	
7 Sept	Lamai, Maret		1
11 "	Lamai, Maret*	2	
12 "	Lamai, Maret		
13 "	Lamai, Maret	1	
16 "	Bangkao, Na Muang*	3	
17 "	Huatanon, Maret	1	
21 "	Ban Trok Phara, Lipanoi		
25 "	Huatanon, Maret	1	
26 "	Bangkao, Na Muang*	2	
27 "	Lamai, Maret*		2
10 Oct	Lamai, Maret		1
4 Nov	Taling Ngarm*	1	
20 "	Taling Ngarm*	3	
24 "	Ang Thong*	1	1
28 "	Taling Ngarm*	1	1
1 Dec	Taling Ngarm		1
2 "	Taling Ngarm*	2	
	Total		10

Positive pools from in or near the same house

Table 5. Virus recovery from Aedes aegypti and Aedes albopictus, by diagnosis of index case.

Final Etiologic Diagnosis of Index Case ^{1/}	<u>Mosquito Species</u>		Total
	<u>aegypti</u>	<u>albopictus</u>	
Dengue	17/65 ^{2/}	8/333	25/398 } (16.1%)
Possible Dengue	0/3	0/10	
Incomplete	2/19	0/184	2/203 (1.0%)
Not Dengue (No Case)	0/43	2/316	2/359 } (0.5%)
	0/17	0/54	
Total	19/147 (13.0%)	10/897 (1.1%)	29/1044

^{1/} See text for definition.

^{2/} No. pools from which dengue virus was recovered/no. pools collected.

A total of 39 strains of dengue virus were recovered, 10 from human sera and 29 from mosquito pools. All 39 strains were dengue type 4.

The 1967 dengue hemorrhagic fever epidemic on Koh Samui was less extensive than the 1966 epidemic. In both years the epidemic curve was biphasic. Cases began in July, approximately 1 month after the onset of the rainy season. The second peak in the distribution may be related to an increase in rainfall in September, although records are not sufficiently accurate to permit clear definition of this point.

The age distributions in both years were similar. Three patients over age 15 were seen in 1967. One of these, a 36 year old female with HF had an antibody response which could be considered secondary except that the interval between onset and the acute specimen was over 4 days, thus precluding accurate definition of the serologic response.

Cumulating the experiences of 1966 and 1967, certain features are apparent. The age range of the 20 shock cases was from 3—15 years with a median of 6 years. As has been true in Bangkok epidemics most severely ill patients were between 3 and 8 years of age.

No consistent pattern of geographical spread, based upon dates of onset of clinical cases, could be detected in either epidemic. The area around the village of Mae Nam, which had a high clinical dengue attack rate in 1966 was virtually spared in 1967 although the dengue serotypes present were not the same in the two epidemics. This suggests that a degree of protection against cross—challenge may last at least one year. However, this may represent the effect of increased awareness of mosquitoes and preventive measures on the part of the population of that area, changes resulting from the 1966 experience.

The survey for febrile illnesses in La Mai indicated that most dengue caused illness was not being referred for medical care, but that few if any severe illnesses (SS or HF syndrome) were being missed by the investigators.

Age-specific dengue antibody prevalence data from the rural area of Na Muang, compared to that derived from an earlier survey in the more urban area of Ang Thong, indicates that the dengue experience of the two populations surveyed has been similar. This suggests that the dengue experience of the entire island population has been comparable, and that the assumptions on which generalization was made from the Ang Thong sample to the island population as a whole were valid. In both the 1966 (Ang Thong) and 1967 (Na Muang) survey samples prevalence increased fairly regularly with age, but a sharp drop was noted, in the 10 year age group in Ang Thong and in the 11-16 year age group in Na Muang. This antibody prevalence pattern suggests that the cohorts under age 10 have been at higher risk of dengue infection than were the other cohorts, at the same age. Thus it appears that the rate of dengue virus transmission on the island had increased significantly during the previous 10 years.

The observations made during the 1967 epidemic again appear consistent with the "second infection" hypothesis of dengue shock syndrome and no data was obtained which was at variance with the conclusions concerning pathogenesis of disease due to dengue virus infection drawn from the previous years experience.

A single serotype, dengue-4, appeared to be responsible for the 1967 epidemic in contrast to the previous year when types 1, 2 and 3 were recovered. Apparently transmission of the previously prevalent dengue serotypes could not be maintained in this relatively small isolated population and the 1967 epidemic resulted from the introduction of dengue-4 virus to the island.

Evidence for transmission of dengue-4 virus by both A. aegypti and A. albopictus was obtained and it is apparent that both species were acting as important vectors during the course of the epidemic. This is the first record of natural infection of A. albopictus with dengue-4 virus.

A. albopictus as well as A. aegypti infected with dengue—4 virus were found throughout the course of the epidemic and infected mosquitoes of both species were found in proximity to patients with dengue hemorrhagic fever.

Vectors of Dengue Viruses in Vietnam

Observations by investigators at the Institut Pasteur, Saigon have shown that epidemic dengue hemorrhagic fever has occurred yearly in Saigon and nearby provinces since 1963. Aedes aegypti is considered to be the major vector of dengue viruses in Saigon on the basis of its high prevalence and by

inference from its known vector status in similar areas. Recent observations by Dr. Do Van Quy at Institut Pasteur, Saigon indicate that Aedes albopictus is also present in Saigon and adjacent areas. The vector status of A. albopictus in the Saigon region is unknown.

Between 15 May and 15 December 1967 a study was undertaken to determine the dengue virus infection rates of A. aegypti and A. albopictus in the Saigon area. Areas of suspected high prevalence of mosquito infection were located by finding the residences of patients with hemorrhagic fever admitted to Nhi Dong Hospital, Saigon. The diagnosis of hemorrhagic fever in such index cases was based solely on clinical observations.

Indoor resting collections were made in the homes of the hemorrhagic fever patients and in nearby houses. Outdoor biting collections were attempted in nearby areas. Additional outdoor biting collections were made in Saigon such as cemeteries and parks where A. albopictus populations were relatively high. Mosquitoes were separated by species at time of collection and all mosquitoes of the same species collected on a given date in the same neighborhood were pooled and held in cages. Indoor and outdoor collections were kept separately, Mosquitoes were held alive for 24 hours and then anesthetized by chilling. The species identification of the mosquitoes was confirmed and pools of 25 mosquitoes each were frozen and stored at -70°C until tested.

Mosquito pools were triturated in M-199 containing 20% heat inactivated fetal bovine serum at pH 7.8 using 2 ml of diluent for 25 mosquitoes. Isolation attempts were carried out by the direct and delayed plaque method in LLC-MK₂ cell culture. In addition, all suspensions were inoculated intracerebrally and intraperitoneally into 1-2 day old suckling mice. Mice were observed for signs of illness and tested for resistance to intracerebral challenge with mouse adapted dengue-2 virus. Viral agents recovered were identified by plaque reduction neutralization tests against specific reference monkey antiserum. Virus infection rates in mosquitoes were calculated by the method of Chiang and Reeves.

Thirty dengue viruses were recovered from a total of 46,394 A. aegypti in 1875 pools for an overall infection rate of 0.64/1000. No viruses were recovered from 7,807 A. albopictus. The weekly collections and virus isolation results are given in table 6.

Of the 30 dengue virus strains, dengue-2 was most commonly recovered, 23 strains having been isolated. Three strains each of dengue-1 and dengue-4 were recovered, and a single strain of dengue-3 was recovered.

Very high infection rates in A. aegypti were apparent in some locations. Three dengue-2 strains were isolated from 175 A. aegypti in 7 pools collected on 7 June in Bien Hoa. Collections made on the following day in the same area, yielded three strains from 125 mosquitoes in 5 pools.

Six dengue-2 strains came from the Bien Hoa area and two dengue-1 strains came from Tu Thua in Long An province. The remaining 22 virus strains were recovered from collections made in the metropolitan Saigon area including such widely separated sections as Na Be, Go Vap, Phu Nhuan, Ton Son Nhut, and Cholon.

The high infection rates found in A. aegypti reflect the highly selective method of mosquito collection i. e. in homes of hemorrhagic fever victims and adjacent buildings. The failure to find infected A. albopictus does indicate that A. albopictus is of much less importance than A. aegypti as a dengue vector in Saigon. However the failure to find infected A. albopictus under these conditions does not rule out the possibility that it may be a vector in Saigon. The A. albopictus collected with few exceptions did not come from areas where cases of hemorrhagic fever had been found. Outdoor biting collections near homes of hemorrhagic fever cases generally yielded few mosquitoes. Over 95% of the A. albopictus collected were found in parks, cemeteries, and gardens at some distances from homes of the index hemorrhagic fever cases.

During the period in which this study was done the incidence of hemorrhagic fever in Saigon was quite low with only 130 cases reported from Saigon Hospitals. The demonstration of the presence of 4 dengue serotypes in the Saigon area during a year of relatively low incidence of clinical illness due to dengue is of interest. It may indicate that all 4 dengue serotypes are continuously being transmitted in the metropolitan Saigon area.

Table 6. *Aedes* mosquito collections from Saigon area and dengue virus isolations by week, 15 May-17 Dec 1967

Week Beginning	<u>Mosquito Collections</u>				<u>Virus Isolations*</u>			
	<u><i>Aedes aegypti</i></u>		<u><i>Aedes albopictus</i></u>		<u>D.</u>	<u>D.2</u>	<u>D.3</u>	<u>D.4</u>
	<u>No. Mosq.</u>	<u>No. Pools</u>	<u>No. Mosq.</u>	<u>No. Pools</u>				
14 May	650	26	275	11				
21 "	1950	78	275	11				
28 "	1700	68	125	5				
4 June	1325	53	125	5	2	6		
11 "	1550	62	50	2				
18 "	1346	55	388	17				
25 "	2187	88	343	15				
2 July	2452	100	512	21		2		
9 "	3011	124	145	7		1		1
16 "	1574	65	275	11				
23 "	1615	67	166	7		2		
30 "	1522	63	267	12				
6 Aug	1731	74	425	17		2		
13 "	1600	64	259	11		4		
20 "	1668	69	321	13				1
27 "	1680	69	451	20				
3 Sept	2019	83	154	6		3		
10 "	2455	98	281	11				1
17 "	2264	90	93	4				
24 "	581	23	50	2				
1 Oct	—	—	—	—				
8 "	470	19	380	16		2		
15 "	1881	75	146	6				
22 "	1040	42	226	11				
29 "	600	24	277	11				
5 Nov	1250	51	370	16				
12 "	1344	57	390	16				
19 "	1508	62	225	9				
20 "	1346	43	245	11				
3 Dec	1339	53	278	11				
10 "	736	30	250	9				
Totals	<u>46394</u>	<u>1875</u>	<u>7807</u>	<u>324</u>	<u>3</u>	<u>23</u>	<u>1</u>	<u>3</u>

* All virus isolations from *A. aegypti*

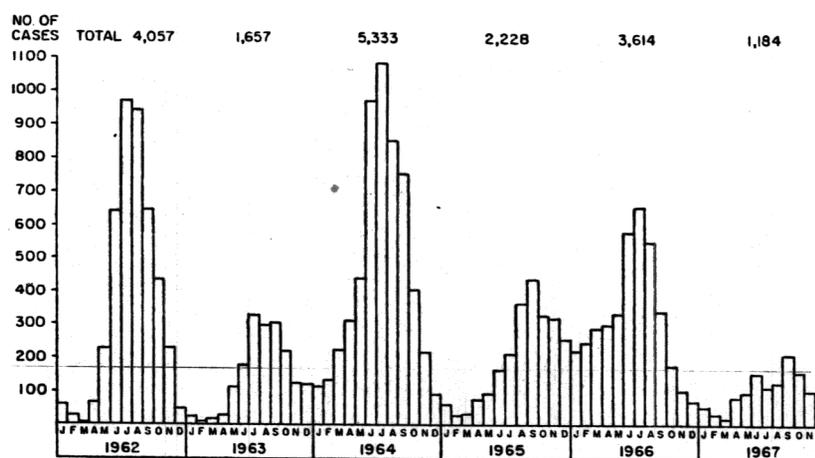
Simultaneous comparison of isolation methods permits the conclusion that the direct and delayed plaque method in LLC—MK₂ cell culture is more sensitive for recovery of dengue viruses from mosquitoes than intracerebral inoculation of suckling mice with challenge of surviving mice at first and third passages. Of the 30 dengue strains isolated, 24 were recovered in both systems and 6 (one dengue—1, three dengue—2, one dengue—3, and one dengue—4) were isolated only in cell culture, the mice being negative. A single, as yet unidentified agent, was isolated only in mice.

Dengue Hemorrhagic Fever in Bangkok

As has been done since 1962 each of the 17 major hospitals in the Bangkok—Thonburi municipalities was visited monthly by a public health nurse. Data on admissions for, and deaths due to, hemorrhagic fever during the preceding month were obtained. Clinical records were summarized for selected cases in one hospital.

During 1967, the 17 hospitals surveyed reported 1184 cases of hemorrhagic fever admitted, with 44 deaths. The indicated case fatality rate, 3.7% is essentially the same as in the two preceding years.

The distribution of admissions for hemorrhagic fever by month of admission (figure 6) shows a broad flat "peak" as appeared in 1963 and 1965. Cases were at a minimum during the dry months of February and March.



CASES OF THAI HEMORRHAGIC FEVER ADMITTED TO BANGKOK AND THONBURI HOSPITALS,
1962 — 1967

Figure 6.

The age distribution of admissions (figure 7) is slightly different from those of the two preceding years, in that relatively more admissions were recorded in the under one year age group. The 1184 cases included 617 males and 567 females. Fatalities were 22 for each sex.

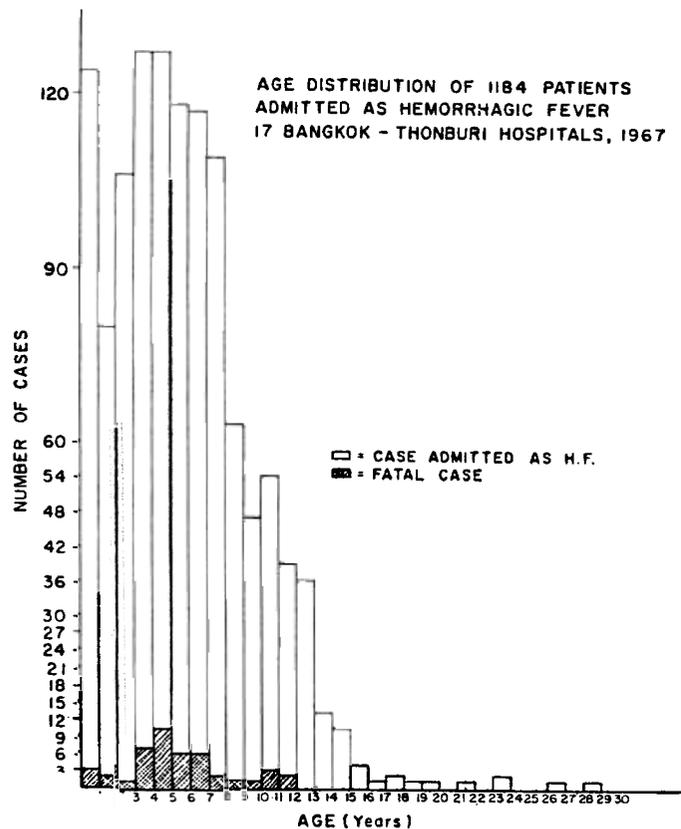


Figure 7.

Several indications were found that these statistics and those of previous years are best considered approximations only. Of the 1184 admissions, 145 listed home addresses from twenty three provinces other than Bangkok and Thonburi. Case fatality ratios varied from 0.5% to 7.2% in the five hospitals which reported over 100 HF admissions for the year. These data are based on admission diagnosis, and do not necessarily reflect final diagnosis. At one hospital, a recheck of records indicated that 25% of admissions for HF have a final diagnosis of other than HF. At this hospital, of 16 deaths ascribed to HF, records indicate 2 had encephalitis, 1 myocarditis and 1 purulent meningitis. The margin of error may be higher in the other hospitals surveyed.

Inaccuracies in the data notwithstanding, there were fewer cases of hemorrhagic fever in Bangkok during 1967 than in any previous year since 1961.

Summary

Epidemiologic studies were carried out during a dengue hemorrhagic fever epidemic on Koh Samui in 1967. Dengue-4 virus was shown to be the etiologic agent and dengue shock syndrome cases were again shown to be associated with second dengue infection. Aedes albopictus and Aedes aegypti were found infected with dengue-4 virus.

Virus recovery attempts from Aedes aegypti mosquitoes captured in Saigon resulted in isolation of strains of all four dengue serotypes. No viruses were recovered from Aedes albopictus captured during the same period.

Dengue hemorrhagic fever in Bangkok continues to be a major health hazard to the pediatric population. Numbers of cases reported during 1967 were the lowest reported in five years.