

## EPIDEMIOLOGY OF ACUTE HEPATITIS IN THE STANN CREEK DISTRICT OF BELIZE, CENTRAL AMERICA

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**Abstract.** Hepatitis is common in the Stann Creek District of southern Belize. To determine the etiologies, incidence, and potential risk factors for acute jaundice, we conducted active surveillance for cases. Cases of jaundice diagnosed by a physician within the previous 6 weeks were enrolled. Evaluation included a questionnaire and laboratory tests for hepatitis A, B, C, D, and E, a blood film for malaria, and a serologic test for syphilis. Etiologies of jaundice among 62 evaluable patients included acute hepatitis A, 6 (9.7%), acute hepatitis B, 49 (79.0%), hepatitis non-A–E, 2 (3.2%), and malaria, 5 (8.1%). There were no cases of acute hepatitis E. One patient each with antibody to hepatitis C and D were detected. The annualized incidence of hepatitis A was 0.26 per 1,000. All cases of hepatitis A were in children 4–16 years of age. The annualized incidence of hepatitis B, 2.17 per 1,000, was highest in adults aged 15–44 years (4.4 per 1,000) and was higher in men (36 cases; 3.09 per 1,000) than women (13 cases; 1.19 per 1,000). Four (31%) of the women with hepatitis B were pregnant. The annualized incidence was significantly higher in Mestizo (6.18 per 1,000) and Maya (6.79 per 1,000) than Garifuna (0.38 per 1,000) or Creole (0.36 per 1,000). Persons with hepatitis B were significantly more likely to be born outside of Belize (82%), had been in Belize < 5 years (73%), and lived and worked in rural areas (96%) than was the general population. Of those  $\geq$  14 years of age with hepatitis B, only 36% were married. Few persons admitted to transfusions, tattoos, IV drug use, multiple sexual partners, visiting prostitutes, or sexually transmitted diseases. Only 1 of 49 had a reactive test for syphilis. Six patients were hospitalized (including 3 with acute hepatitis B and one with hepatitis A), and none to our knowledge died. Acute hepatitis B is the most common cause of viral hepatitis in the Stann Creek District, but the modes of transmission remain obscure. Infants, women attending prenatal clinics, and new workers are potential targets for immunization with hepatitis B vaccine.

### INTRODUCTION

Acute hepatitis is common in many areas of the world and results in chronic morbidity in some persons infected with hepatitis B or C. In Latin America, hepatitis caused by hepatitis A,<sup>1</sup> B,<sup>2,3</sup> D,<sup>4–8</sup> and E<sup>9,10</sup> have been reported to cause both endemic and epidemic cases of jaundice.

Belize, Central America, is a small (8,867 square miles) English-speaking country slightly smaller than Vermont. Country-wide studies among the Belize Defense Force,<sup>11</sup> health care workers,<sup>12</sup> and pregnant women<sup>13</sup> have all indicated that persons from the Stann Creek District in southern Belize have a higher prevalence of antibody to hepatitis B compared with persons from other districts. These studies also indicate that persons of Garifuna and Creole ethnicity have a higher prevalence than Mayan, East Indian, and German ethnic groups.

Observations of acute jaundice in the Stann Creek District have suggested that many cases occur among agricultural workers, most of whom are recent immigrants from other Central American countries. Furthermore, acute jaundice has been observed in pregnant women. A 1991 survey of agricultural workers and their families indicated about 70% had been exposed to hepatitis B, exposure to hepatitis A was almost universal, and evidence of exposure to hepatitis E was detected in 5–8%.<sup>14</sup> In that study, 47 patients reported a history of hepatitis within the previous 6 months, but an etiology was confirmed in only 28%.

Because of continued reports of jaundice in the Stann Creek District, we initiated active surveillance of cases of jaundice in the district in order to determine the etiologies, the incidence, and potential risk factors for jaundice in this

area. We also studied family members of cases to determine the prevalence of exposure to hepatitis viruses in these persons. Results of this study are essential to the development of prevention strategies.

### METHODS

The Human Use Research Committees at the Uniformed Services University of the Health Sciences and the Belize Ministry of Health approved the study.

**Case findings.** The study was conducted from January 15, 1994, through May 10, 1995. Though the study was conducted over 16 months, it was suspended for one month because of increased criminal activity on the Southern Highway. Therefore, the actual time of the study was 15 months. Cases were sought through the three practicing physicians at the Stann Creek District Hospital in Dangriga, the district capital (Figure 1), located in the northern part of the district, and a solo practitioner in Independence in the southern part of the district. These were the only practicing physicians in the district at the time. Surveillance was also conducted through public health nurses who provide prenatal care and childhood immunizations at the Health Center in Dangriga and during weekly mobile clinics to villages throughout the district.

A team from the Belize-United States Epidemiology Research Center (ERC) in Belize City conducted active surveillance. This team traveled to the Stann Creek District every 6 weeks to obtain names and addresses of patients with jaundice from the physicians and nurses. The team conducted follow-up of patients enrolled by three physicians in Dangriga as well as public health nurses. On each trip, team

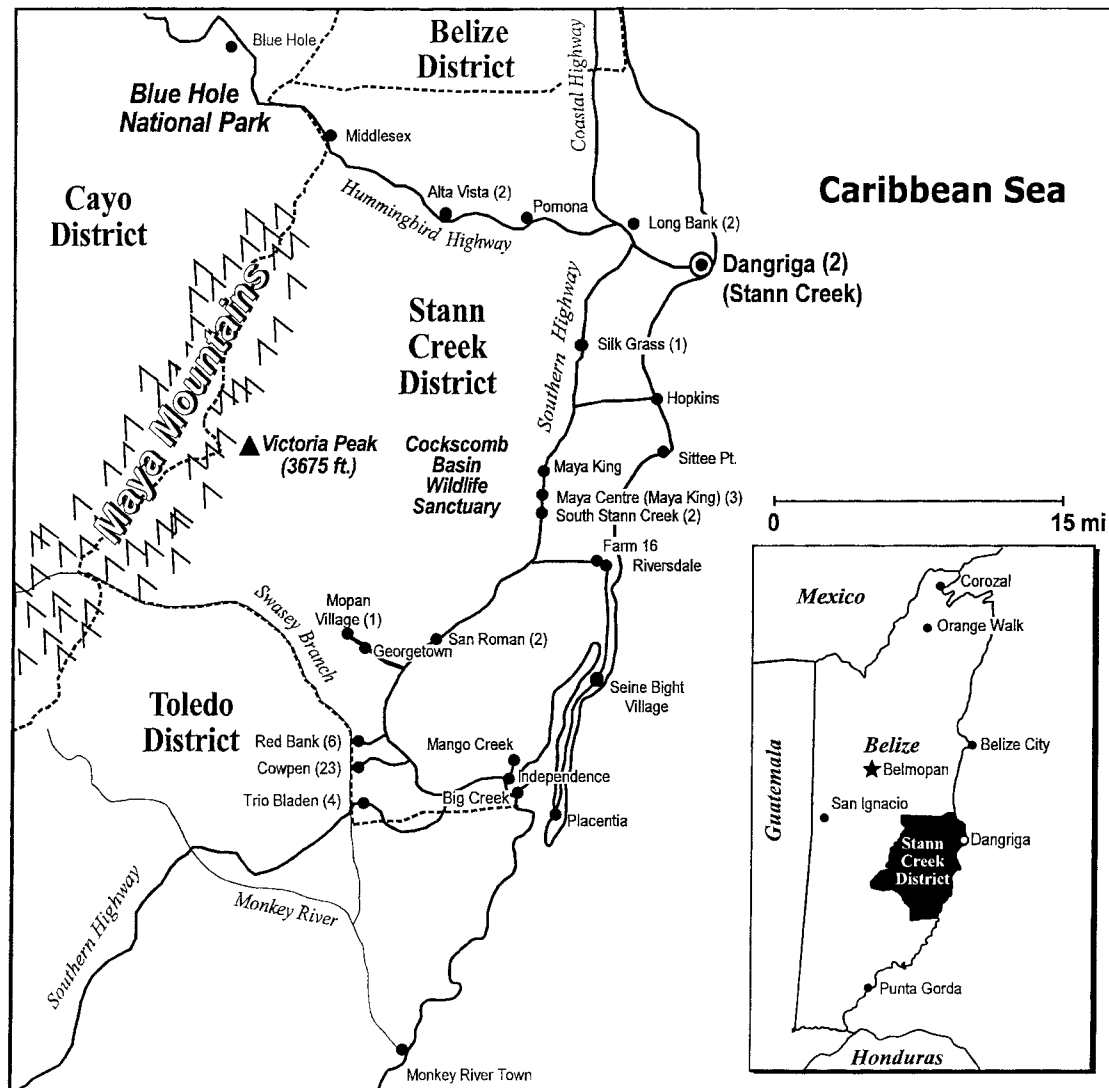


FIGURE 1. Map of the Stann Creek District of Belize. Numbers to the side of locations indicate number of cases of acute hepatitis B (one case location unknown).

members enrolled new patients at various villages along the southern highway—at citrus farms in the northern part and at packing sheds where bananas were being processed in the southern part of the district. Inquiry was made about any workers or family members with jaundice. Each trip required three days. In this way, we made every effort to cover the district uniformly in search of new cases.

Cases were defined clinically as persons presenting with jaundice who had been diagnosed by a health care worker within the previous 6 weeks. These cases were invited to participate in the study. After written informed consent, a questionnaire was administered to obtain personal data, a history of the present illness, and past medical history including previous episodes of jaundice, family history of jaundice, history of sexually transmitted disease, and alcohol intake. A brief physical exam was conducted, concentrating on the sclera, skin, and abdomen. A 7 ml sample of blood was obtained for serological and biochemical studies and a 3 ml sample for hematological studies. A urine sample was also requested. Family members or household contacts were

also asked to donate a 7-ml blood sample after written informed consent.

Blood and urine specimens obtained at the hospital in Dangriga were shipped by air to the ERC in Belize City. Specimens obtained by the ERC field-team were transported under frozen packs back to Belize City at the end of each field trip.

**Laboratory studies.** For cases of acute jaundice, the following laboratory exams were performed: a complete blood count with differential, a thick smear for malaria, alanine amino transferase (ALT), aspartate amino transferase (AST), total and direct bilirubin, and a rapid plasma reagin (RPR) test for syphilis. Enzyme immunoassays (EIA) for IgM antibody to hepatitis A virus (anti-HAV), IgM antibody to the hepatitis B core antigen (anti-HBc), and hepatitis B surface antigen (HBsAg) (Abbott Laboratories, North Chicago, IL) were performed. If the tests for IgM anti-HAV and IgM anti-HBc were non-reactive, exams for total anti-HAV and anti-HBc were performed. Hepatitis E was diagnosed using an ELISA test for IgM and IgG antibodies to hepatitis E, which

employs as antigen a 56 KD recombinant protein expressed in insect cells from the second (capsid) open reading frame (ORF-2) of the HEV genome.<sup>15,16</sup> Antibody to hepatitis C was detected using a second-generation test for anti-HCV (HCV EIA 2.0, Abbott) and a strip immunoblot assay (RIBA HCV 3.0 SIA, Chiron, Emeryville, CA). HCV RNA was detected with the Roche Amplicor. Antibody to hepatitis D was detected using the Abbott Anti-Delta EIA. To evaluate contacts of cases, tests for total anti-HAV, anti-HBc, and anti-HCV and anti-HEV were performed. Hepatitis B surface antigen and anti-HDV were sought in those with anti-HBc.

Patients were excluded from analysis if the ALT or AST were not elevated at least 1.5 times normal, if a questionnaire or serum specimen were not available, or if serological or biochemical tests were not performed. Acute hepatitis A, B, or E was diagnosed when IgM antibody to the respective viruses was detected. Hepatitis C was diagnosed if anti-HCV was detected. Non-A-E hepatitis was diagnosed if liver enzymes were elevated, but criteria for hepatitis A, B, C, D, or E were not met. Malaria was diagnosed as the probable cause of jaundice if malaria parasites were detected on the blood film and no viral etiology was discovered.

Reports of laboratory tests were returned to the patient with a personal explanation of the results. Reports of patients with malaria or a reactive test for syphilis were given to the malaria control officials or public health officials, respectively, for treatment and follow-up.

**Statistics.** The rates of infection were calculated by dividing number of cases by the number of persons reported in the 1991 Belize Census and adjusted by 12/15 to estimate the annual incidence since cases were collected over a 15-month period. Populations of villages and towns were obtained from the Vector Control Department survey of 1998–1999 kindly provided by Dr. Peter Allen. Chi-square was used to compare discreet values. Proportions of demographic and housing data from the census were compared with those reported by cases. Confidence intervals were calculated for incidence rates. When the lower confidence interval was a negative number, the value of 0 was used.

## RESULTS

A total of 86 persons with clinical jaundice were enrolled in the study. A total of 24 patients were excluded from analysis for the following reasons: no questionnaire ( $n = 5$ ), no serum specimen ( $n = 9$ ), serologic or biochemical tests not performed ( $n = 3$ ), or biochemical studies did not confirm liver inflammation ( $n = 7$ ). Overall, these 24 were similar in age, gender, ethnicity, place of birth, and location of residence in Belize compared with those who were included. Of the 13 serum specimens submitted, 5 had anti-HBc, including 2 with IgM-anti-HBc, all 13 had anti-HAV (none had IgM-anti-HAV), one had anti-HCV, and none had anti-HEV. The proportion of cases enrolled at the Dangriga Hospital Out-Patient Department was higher among those excluded (11 of 20, 55%; 4 unknown) compared with included cases (24 of 62, 39%;  $P = 0.37$ ). This reflects the difficulty of completing questionnaires, collecting specimens, and transferring both to the research unit in Belize City by air

or bus, compared with collection by the research team. There were 62 evaluable patients.

Among these 62 patients, an infectious etiology was determined in 60 (96.8%). Hepatitis B was the most common cause of acute hepatitis and was the etiology of 49 (79.0%) of the cases. Hepatitis A was the second most common cause of jaundice and was implicated in only 6 (9.7%) cases. Two (3.2%) patients had mild elevations of ALT, but no specific viral etiology was identified. Both cases had serologic evidence of previous hepatitis A and B, but neither had HBsAg, antibodies to hepatitis C or E, nor was hepatitis C RNA detected. One of these cases was ascribed to alcoholic hepatitis and the other to jaundice of pregnancy (cholestatic jaundice). Malaria was the presumed cause of jaundice in 5 (8.1%) patients (*Plasmodium falciparum*,  $n = 3$ , and *Plasmodium vivax*,  $n = 2$ ). One of the patients with acute hepatitis B also had *P. vivax* malaria.

IgG antibody to hepatitis E was present in 10 (16%) of the 61 cases tested, but none had IgM anti-HEV. Antibody to hepatitis C was detected by EIA in only one of 60 patients tested (indeterminate by RIBA-2 and negative for HCV RNA), a man with acute hepatitis B. Anti-delta antibody was detected in one of the 49 patients with acute hepatitis B, a 14 year-old Mayan farmer. Based on a population of 18,085 persons in the Stann Creek District (1991 census), the annualized incidence of icteric hepatitis A was 0.26 per 1,000, while the incidence of hepatitis B was eight times as great, 2.17 per 1,000.

Hepatitis A was observed only among children aged 4–16 years. Of the six cases, four were Mestizo, one Garifuna, and one of unknown ethnicity. Four patients were female and two were male. Four were born in Belize and two in Guatemala. Three of these children had evidence of hepatitis B (total anti-HBc without IgM) and two had HBsAg, indicating continued infection with hepatitis B. Neither of these two had anti-delta antibody. None had IgG antibody to hepatitis E. All were from rural areas. Only one, a 14 year-old boy, was hospitalized. All recovered.

The distribution of the 49 cases of hepatitis B indicates young adult males were most often affected (Table 1). Eighty-two percent of cases of hepatitis B were 15–44 years of age with the highest incidence rate in those 35 to 44 years. Males comprised 73% of the cases with an incidence rate ratio of 2.6 compared with females. Ninety percent of cases of hepatitis B were observed among Mestizo and Mayan ethnic groups who had incidence rates approximately 16 times higher than Creole and Garifuna ethnic groups.

Most of the cases occurred in persons born outside Belize (Table 2). According to the 1991 census data, 3,299 (18.2%) of the Stann Creek District population were foreign-born compared with 40 of 49 (82%) of the cases ( $P < 0.001$ ). Significant differences exist between the distribution of duration of time in Belize for cases among immigrants compared with the immigrants interviewed in the census ( $P < 0.001$ ). Most (73%) of the cases of hepatitis B occurred in persons who had been in Belize  $< 5$  years. Those who had been in Belize  $< 1$  year had the highest estimated incidence, 22.9 per 1,000. Forty-seven cases (96%) lived in rural areas compared with 64% of the district population ( $P < 0.001$ ). One of the two cases from the urban areas made frequent trips to provide health care in rural areas.

TABLE 1  
Incidence of acute hepatitis B by age, gender and ethnicity

Age (yr)	Cases/population	Incidence per 1,000	Annualized incidence per 1,000* (95% confidence intervals)
0-4	0/2,926	N/A	N/A
5-14	4/5,197	0.77	0.62 (0.01, 1.22)
15-24	15/3,349	4.48	3.58 (1.77, 5.39)
25-34	15/2,471	6.07	4.85 (2.41, 7.31)
35-44	10/1,449	6.90	5.52 (2.11, 8.93)
45-54	2/914	2.19	1.75 (0, 4.17)
≥55	3/1,780	1.69	1.35 (0, 2.87)
All ages	49/18,085		2.17 (1.56, 2.77)
<b>Gender</b>			
Males	36/9,334	3.86	3.09 (2.07, 4.09)
Females	13/8,751	1.49	1.19 (0.54, 1.83)
<b>Ethnicity</b>			
Creole	2/4,389	0.46	0.36 (0, 0.87)
Garifuna	3/6,323	0.47	0.38 (0, 0.81)
Mestizo	32/4,142	7.73	6.18 (4.94, 8.31)
Mayan	12/1,412	8.50	6.79 (2.97, 10.63)
East Indian	0/665	N/A	N/A

\* Number of cases divided by population  $\times 12/15 \times 1,000$ . N/A = not applicable.

Among the 45 persons with acute hepatitis B who were  $\geq 14$  years of age, 18 (40%) were single, 20% common law marriage, 36% married, and 4% separated. Comparisons with census data are not appropriate since census data records 64.9% of those  $\geq 14$  years as single, but does not include the common-law marriage category, which could be classified as either single or married. A significantly higher proportion of patients reported only one person in the household and a lower proportion reported  $\geq$  five in a household compared with the census population. For example, 30.6% of patients reported a one-person household compared with 15.5% of the general population, 18.3% versus 14.1% reported two, 14.2% versus 12.4% reported three, 10.2% versus 12.2% reported four, and 26.5% versus 45.8% reported  $\geq$  five persons per household.

Most of the cases were among lower socioeconomic groups. Compared with the general population of Stann

Creek District, fewer patients had electricity (22% versus 48%;  $P < 0.001$ ), flush toilets (6% versus 23%;  $P = 0.006$ ), or piped water in their homes (23% versus 37%;  $P = 0.04$ ). Many patients had rodents (51%) and animals (23%) in or around their homes. All 49 patients with acute hepatitis B had serologic evidence of previous hepatitis A, while 9 (19%) of 48 tested had IgG antibody to hepatitis E.

The majority, 41 (84%) of the cases came from the southern half of Stann Creek District (south of Victoria Peak) which is roughly the boundary for the citrus region to the north, and the banana region to the south. Most of the cases came from communities that were primarily Mestizo or Mayan. The largest number of Mestizo cases came from the community of Cowpen ( $n = 21$ ; annual incidence of 32.74 per 1,000), while the largest number of cases among the Mayans were from the neighboring community of Red Bank ( $n = 6$ , annualized incidence of 6.86 per 1,000) (Figure 1). Only three cases, including one of the public health nurses who saw many of the patients, came from Garifuna communities (Dangriga annualized incidence 0.25 per 1,000 and Silk Grass, 3.31 per 1,000). Other locations had intermediate annualized incidence rates: Long Bank, 6.40; Alta Vista 6.96; Maya Center, 13.04; South Stann Creek, 2.94; Farm 16, 2.29; Mopan Village, 2.13; San Ramon, 5.93; and Trio Bladen, 7.73.

Known risk factors for hepatitis B were reported infrequently, though a substantial number declined to answer certain questions (Table 3). Indicators of sexual transmission, such as a history of multiple sexual partners, history of previous sexually transmitted disease, or a reactive syphilis serology were all uncommon. A history of hepatitis in other family members was present in 21%, and 13% of the patients reported previous episodes of jaundice. No one reported use of illicit intravenous drugs and only one person recalled injections of medications in the previous 6 months.

Of the 62 cases of jaundice, six required hospital care including 4 (19%) of 21 females and 2 (5%) of 41 males ( $P = 0.19$ ). Three patients with hepatitis B were hospitalized as was one patient with acute hepatitis A, one pregnant

TABLE 2  
Annualized incidence rates by place of birth, duration in Belize, and location in Belize of patients with acute hepatitis B compared with April 1991 Census data for Stann Creek District

Place of birth	Study population	Census data	Annualized incidence/1,000 (95% confidence intervals)
Belize	9 (18%)	14,786 (81.8%)	0.49 (0.16, 0.80)
El Salvador	6 (12%)	483 (2.7%)	9.94 (2.03, 17.84)
Guatemala	17 (35%)	1,490 (8.2%)	9.13 (4.81, 13.44)
Honduras	16 (33%)	924 (5.1%)	13.85 (7.12, 20.58)
Unknown/Other	1 (2%)	402 (2.2%)	1.99 (0, 5.88)
Total	49 (100%)	18,085 (100%)	2.17 (1.56, 2.77)
<b>Duration in Belize of 40 patients born in other counties (yr)</b>			
<1	9/40 (23%)	314 (9.5%)	22.92 (8.17, 37.69)
1-2	9/40 (23%)	792 (24%)	9.09 (3.1, 14.00)
3-4	9/40 (23%)	443 (13.5%)	16.25 (5.74, 26.76)
$\geq 5$	10/40 (25%)	1,654 (50.1%)	4.84 (1.85, 7.83)
Unknown	3/40 (7%)	96 (2.9%)	25.00 (0, 52.84)
Total foreign born	40 (100%)	3,299 (100%)	9.70 (6.71, 12.69)
<b>Location in Belize</b>			
Urban (Dangriga)	2/49 (4%)	6,435 (36%)	0.25 (0, 0.59)
Rural (rest of district)	47/49 (96%)	11,650 (64%)	3.23 (2.31, 4.15)

TABLE 3  
Potential risk factors for hepatitis B

Risk factor	No. re- porting/ no. re- sponding	Percent report- ing
Blood transfusions	2/47	4
Tattoos	3/44	7
History of intravenous drug use	0/46	0
Hepatitis in the past	6/47	13
Hepatitis in family members	8/38	21
≥ Two sexual partners in lifetime	2/36	6
History of sexually transmitted disease	2/41	5
Reactive RPR*	1/49	2
Surgical/dental procedure (previous 6 months)	1/48	2
Injectable medications† (previous 6 months)	1/42	2
Travel out of Belize (previous 6 months)	3/48	6

\* RPR = rapid plasma reagin.

† Oral medications known to cause jaundice reported by patients included (number of patients): erythromycin (10); sulfa-containing medications (0); alpha methyl dopa (0); chloroquine and/or proguanil (3), verapamil (1), vitamins 5, none (21), and no response, 7.

woman with non-A-E hepatitis, and one woman with *P. falciparum* malaria. Among the 13 females with acute hepatitis B, four (31%) were pregnant at the time of hepatitis B, but none required hospitalization. There were no known deaths.

The 62 patients or their parents named 151 household contacts (see distribution of number in household above). Serum samples were obtained from 60 contacts of cases. Antibody to hepatitis A was found in 50 of 60 (83%) and anti-HBc in 38 (63%). Of these 38, 6 (16%) had HBsAg but none had anti-delta antibody. Among the 52 contacts of patients with acute hepatitis B, 31 (60%) had antibody to hepatitis B core antigen (6 had HBsAg) compared with 7 of 8 (88%) contacts of patients without acute hepatitis B. Anti-HCV was detected by EIA in 2 contacts. Both were negative by RIBA-2 and HCV RNA. One of these, a 50 year-old female, was married to the 59 year-old man with acute hepatitis B mentioned earlier in whom anti-HCV was detected by EIA. Anti-HEV was found in 4 of 60 (7%).

#### DISCUSSION

This study documented the incidence and etiology of acute jaundice in the Stann Creek District of Belize. Hepatitis A virus infection was the most common cause of jaundice in children, but hepatitis B virus was the most common cause of jaundice in adults. Malaria sometimes presented as a cause of mild jaundice in this area of Belize. None of the cases was caused by hepatitis C or E. In contrast to a previous study, an infectious etiology was established in 97% of documented hepatitis cases.

Hepatitis A virus infection appears to be almost universal in this area of Belize. Only a few children who escape early childhood infection are infected in later childhood and become jaundiced. Overall, hepatitis A accounted for only about 10% of cases of jaundice. Improved sanitation and vaccination will be required to decrease the incidence of hepatitis A.

Hepatitis B virus infection was commonly observed in recent immigrants from Spanish-speaking countries who worked on the banana farms of southern Stann Creek District. Males who were 15–44 years of age were most often affected. The majority of workers had been in Belize less

than five years. Mayans who lived near and often worked on the banana plantations also had a high incidence of hepatitis B. Women had a lower incidence, but almost one-third of the female patients were pregnant. Women with jaundice were hospitalized more often than men.

The incidence rate for hepatitis B in this study was exceedingly high. Intensive surveillance for hepatitis B in four U. S. counties between 1981 and 1988 indicated an average incidence of 13.2 cases per 100,000.<sup>17</sup> The incidence of 217 per 100,000 in Stann Creek District is more than 8 times as high. The true incidence of infection<sup>18</sup> is doubtless much higher based on the high prevalence of antibody to hepatitis B observed in family members in this study, school-aged children,<sup>19</sup> and farm workers.<sup>14</sup>

Differences in rates of hepatitis B among ethnic groups in Belize, as in the United States, have been noted.<sup>17,18</sup> Based on the prevalence of antibody to hepatitis B nationwide in Belize, which was highest in adult Garifuna and Creole ethnic groups,<sup>11–13</sup> one might predict the incidence of acute clinical hepatitis B is highest in these same groups. To the contrary, the incidence of jaundice from acute hepatitis B in Stann Creek District was highest among Mestizo and Mayans. New cases of hepatitis B are occurring despite the high prevalence (up to 70%) of anti-HBc in the Mayan and Mestizo populations.<sup>14,19</sup> Most cases of hepatitis B occur in workers who have recently come into the area.

The mode of transmission of hepatitis B in this area is not clear from these studies. Sexual transmission is not suggested as a major method because most persons denied multiple sexual partners or a history of sexually transmitted diseases (though some persons did not answer these questions). Only one patient had serologic evidence of syphilis. Syphilis has been associated with hepatitis B in pregnant women in Belize<sup>13</sup> and other studies.<sup>20,21</sup> Still, sexual transmission is likely a source of some transmission, just as in Taiwan<sup>22</sup> and the United States,<sup>17</sup> especially among young single men who live in temporary housing as they work. Though not reported by individual patients on the questionnaire, there were reports of commercial sex opportunities in the area.

Transmission within households is also probable. Serologic evidence of hepatitis B infection was documented among 60% of household contacts of cases with acute hepatitis B. Transmission of hepatitis B from children to adult family members and *vice versa* is well documented.<sup>23–27</sup> The 1991 household study indicated that about 70% of children in the study had antibody to hepatitis B core antigen.<sup>14</sup> A 1995 study of children in two schools in the banana plantation region at Cowpen and Red Bank indicated that 67% and 79%, respectively, had antibody to hepatitis B and 6–20% had hepatitis B surface antigen.<sup>19</sup> Among contacts of patients in the present study, the prevalence of antibody to hepatitis viruses mirrored that previously reported from southern Stann Creek District.

A third mode of transmission may relate to occupational exposure. A number of workers were observed to have breaks in the skin, which may be the source of HBsAg-contaminated serum. For example, workers had bacterial and fungal skin diseases from working in the hot, humid environment, often in gloves. Others had burns from lime or other chemicals. In addition, most workers used sharp knives to process the bananas and machetes to cut stocks of bananas

from banana trees. Large hands of bananas are cleaved from the stocks using a tool with a 4–6 inch curved blade. Hands of bananas are placed in large tanks of water and floated down a processing line where workers cut them into packing sizes. Multiple opportunities for blood exposure exist during banana processing. Outbreaks of hepatitis B have occurred in athletes who get cuts and scratches, then sit in tubs of water.<sup>28</sup> Other professionals who use knives, such as butchers<sup>29,30</sup> and health care professionals have an increased risk of hepatitis B.<sup>31,32</sup> Altercations resulting in blood exposure, another known method of hepatitis B transmission, are also common in these agricultural camps, especially on weekends.

Control of hepatitis B through immunization may offer the best means of prevention of acute disease and chronic sequelae, such as chronic hepatitis, cirrhosis, and hepatocellular carcinoma.<sup>33–35</sup> The prevalence study of children in the schools of the area<sup>19</sup> and the household survey<sup>14</sup> indicate that the majority of children are infected before entering school. Therefore, children should be immunized during infancy at the time of childhood immunizations.<sup>36</sup> Newly arrived workers constitute another group that might benefit from immunization. Since most infections occurred in new immigrants, workers could be offered hepatitis B vaccine upon arrival and at specified periods such as payday. Women presenting for prenatal care could be immunized against hepatitis B just as they are immunized for tetanus. This would decrease the morbidity of hepatitis B in pregnant women and prevent the passage of hepatitis B to their children. Therefore, at least three high-risk populations would be accessible for immunization and would benefit directly from immunization.

Malaria was also identified as a cause of jaundice in this study. A major increase in malaria was noted in Belize during the study period.<sup>37</sup> Homes in Belize typically do not have screens on the doors and windows and few people use mosquito nets. Historically, over 95% of malaria cases in Belize have been caused by *P. vivax*. However, in recent years, *P. falciparum*, which is more likely to cause jaundice, is becoming more common, as it is in areas of Honduras,<sup>38</sup> the origin of many workers in the banana-growing district. In Belize, 86% of the cases of *P. falciparum* malaria occurred in Stann Creek or Cayo District in 1995.<sup>37</sup> Better housing, mosquito control, personal protective measures, and chemoprophylaxis may decrease malaria as a cause of febrile illness and jaundice.

Hepatitis E was not a cause of acute jaundice in this study, although 10 cases and four of their contacts had IgG antibody to hepatitis E. Outbreaks of acute hepatitis E have occurred in southern Mexico,<sup>10</sup> and hepatitis E has caused illness in travelers returning from Mexico.<sup>9</sup> Exposure to rats and pigs in the housing areas may relate to this unexpected finding.<sup>39</sup> Hepatitis C was also unusual, with a prevalence of anti-HCV among cases of only 1.6% and among household contacts of 3.3%. This low prevalence is consistent with a previous study among the Belize Defense Force.<sup>11</sup> Though delta hepatitis was uncommon, the potential for co- or superinfection with hepatitis B exists.<sup>5–8</sup>

The study has several potential weaknesses. First, not all cases of hepatitis were enrolled. Many infections are subclinical. Others declined to make the 2–3 hour bus ride to

Dangriga and were missed by the mobile teams. Second, data from the April 1991 census used to calculate incidence might not accurately reflect the situation in 1994–1995. The population of Stann Creek District increased 21% from 1980 to 1991 with a 3% decrease in Dangriga (population 6,435) and a 54% increase in the rest (rural parts) of the district. Therefore, the population in 1994–1995 may be somewhat different from that in 1991. Another weakness of the study is that suitable comparison groups were not available. Not enough cases of hepatitis A or C were available to compare with hepatitis B cases. Comparison of demographic, housing, and utilities data from the census is useful, but may not compare directly with the locations in which cases were occurring. Histories of sexual activity or illegal drug use are difficult to obtain under the best of circumstances—which we did not have working cross-culturally in crowded homes, or packing sheds, or busy outpatient departments.

A case-control study may help determine the specific risk factors for hepatitis B transmission. However, the present study has clearly delineated the etiologies of acute jaundice. It has defined the populations at highest risk for hepatitis B in terms of age, gender, ethnicity, time in country, and location within the district. These facts, along with previous nationwide studies conducted among the Belize Defense Force, health care workers, pregnant women, and localized study of school-aged children in Stann Creek District provide an epidemiologic basis for disease prevention. Disease surveillance for effect of preventive measures should also be implemented.

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