Hepatitis C Virus Infection in a Community in the Nile Delta: Risk Factors for Seropositivity

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The purpose of this study was to identify risk factors for hepatitis C virus (HCV) infection in a rural village in the Nile Delta with a high prevalence of antibodies to HCV (anti-HCV). One half of the village households were systematically selected, tested for anti-HCV, and interviewed: 973 of 3,999 (24.3%) subjects were anti-HCV–positive (reflecting prior HCV infection but not necessarily current liver disease), with nearly equal prevalence among males and females. Anti-HCV prevalence increased sharply with age among both males and females, from 9.3% in those 20 years of age and younger to >50% in those older than 35, suggesting a cohort effect with reduced transmission in recent years. Multivariate regression was used to estimate independent effects of risk factors on seropositivity. Among those over 20 years of age, the following risk factors were significantly associated with seropositivity: age ($P < .001$); male gender (odds ratio [OR] = 2.5, 95% CI = 1.3-4.7); marriage (OR = 4.1, 2.4-6.9); anti-schistosomiasis injection treatment (OR = 2.0, 1.3-2.9); blood transfusion (OR = 1.8, 1.1-2.9), invasive medical procedure (surgery, catheterization, endoscopy, and/or dialysis) (OR = 1.5, 1.1-1.9); receipt of injections from "informal" health care provider (OR = 1.3, 1.0-1.6); and cesarean section or abortion (OR = 1.4, 1.0-1.9). Exposures not significantly related to anti-HCV positivity in adults included: history of, or active infection with, *Schistosoma mansoni*, sutures or abscess drainage, goza smoking in a group, and shaving by community barbers. Among those 20 years old or younger, no risk factors were clearly associated with anti-HCV positivity; however, circumcision for boys by informal health care providers was marginally associated with anti-HCV (OR = 1.7, 1.0-3.0). Prevention programs focused primarily on culturally influenced risks in rural Egyptian communities are being implemented and evaluated. (Hepatology 2001;33: 248-253.)

Abbreviations: HCV, hepatitis C virus; anti-HCV, antibodies to HCV; OR, odds ratio.

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Previous studies of hepatitis C viral (HCV) infection in Egypt have shown a high prevalence of antibody to HCV (anti-HCV) among blood donors[1-4] and residents of rural areas endemic for schistosomiasis.[5] Anti-HCV was found in 12.1% of primary schoolchildren, 18.1% of residents of rural villages, and 22.1% of army recruits,[6] as well as in 31% of Egyptians applying to work abroad.[7,8] It is widely believed that parenteral exposure to the virus is the most important route for acquiring infection in Egypt.[7,9] We have recently reported data that suggest the very high prevalence of HCV infection in the adult population of rural areas of Egypt, particularly in men living in villages where schistosomiasis is endemic, is at least partially the result of extensive mass-control campaigns using parenteral tartar emetic conducted from the 1950s up until 1982.[10] Although the prevalence of infection among those too young to be exposed to these mass antischistosomiasis injection campaigns is lower than among the older population, infection in this younger cohort indicates that other modes of transmission have perpetuated the infection in the community. Uncertainty remains regarding the relative importance of various types of parenteral exposures and widely practiced community activities, *e.g.*, circumcisions, goza smoking in a group, or being shaved at a community barber.

To resolve this uncertainty, we conducted a large serologic survey in a rural Egyptian community. The purpose of this article is to report the observed associations of HCV infection with both the acknowledged parenteral exposures (*e.g.*, blood transfusions, injections, invasive hospital procedures, dental treatment) and widely practiced community activities that are usually not considered to be determinants of HCV transmission.

PATIENTS AND METHODS

Study Population. In 1997, one half of the households of a village in the Nile Delta, Aghour El Soughra, were systematically selected and interviewed with a structured questionnaire to identify potential exposures that might be related to HCV acquisition. Adults and children older than 10 years of age were interviewed themselves, with the head of the household providing information on children younger than 10 years of age. Informed consent was obtained from participants, or, in the case of minors, their parents. The Egyptian Ministry of Health and Population and the Institutional Review Board of the University of Maryland reviewed and approved all procedures and forms. Further details regarding the sampling design, response rate, and conduct of the survey are provided in a previous report.[11]

Questionnaires and Data Collected. Questionnaires were designed by a team of sociologists, epidemiologists, and clinicians familiar with modes of transmission of HCV and local customs. These assessed sociodemographic characteristics, present and past health conditions, and potential risk factors for exposure to HCV. The later included history of invasive medical procedures (*e.g.*, surgery, intrave-

nous or urinary catheterization, blood transfusions, endoscopy, renal dialysis) and dental procedures (*e.g.*, extractions, anesthesia, filling, gum treatment). Information on various community practices was also collected: history of injections, sharing hypodermic needles or syringes, particulars of circumcision, being shaved by a community barber, sharing razors and toothbrushes with family members, ear-piercing, tattooing, and group goza smoking (water-pipe with mouthpiece sharing in social setting).

Health care in rural Egyptian villages is provided by 2 different types of practitioners: 1) "formal" health care provider(s) are physicians or nurses who have received a formal education and often work in rural health units; and 2) "informal," or traditional, health care providers have learned their trade by practical experience working with older practitioners. This group includes midwives (dayas), barbers, and specialists who give injections and perform circumcisions and other minor surgical procedures. Data were obtained so that the risk of infection associated with health care given by these 2 groups could be analyzed separately. Adult females were asked questions about pregnancies and deliveries, whether the delivery was performed by a formal or informal health care provider, history of circumcision, cesarean section, and abortion.

Laboratory Testing. Study subjects were tested for anti-HCV using the Abbott HCV EIA 2.0 (Abbott Laboratories, Chicago, IL) according to the manufacturer's instructions. Schistosoma ova were microscopically counted in 50 g of stool by a modified Kato test. Details regarding the sample characteristics, response rates, anti-HCV prevalence, and laboratory and other procedures are published.[11]

Statistical Analysis. All exposures were tested for association with anti-HCV positivity in bivariate analysis, and those that were significant ($P < .05$) were adjusted for age to examine their effect independent of age. To perform this adjustment, we used separate logistic regression models controlling for age by including a dummy variable for those under 4 years of age, dummy variables for each 2-year age group for those from ages 4 to 40, and 5-year age groups for those over 40. The use of the dummy variables in these models averted the need to assume a linear relationship between the log-odds of seropositivity and age. In addition, to estimate the association between statistically significant exposures as well as other factors of interest and anti-HCV while controlling for other exposures, we fit several multivariable logistic regression models. In these larger models, age was controlled for as a continuous random variable. We chose to fit separate models for those below and above the age of 20 years, because some variables (*e.g.*, marriage, circumcision, pregnancies) were not relevant to both age groups, and because the seropositive children were more likely to represent more recent transmission. In all these models, to allow for correlation between members of the same household, we used the generalized estimating equations (GEE) approach[12] assuming an exchangeable correlation structure within households. The models were fit using SAS Proc Genmod.[13]

RESULTS

HCV Prevalence. Questionnaire and serology data were available from 3,999 study participants. Household data were missing for 6 individuals, and analysis is based on the remaining 3,993 subjects. The overall anti-HCV prevalence was 24.3%, and prevalence was nearly equal among males and females (24.9% and 23.8%, respectively; Table 1). Anti-HCV prevalence, however, was much higher among individuals older than 20 years of age, with the highest level, 56.7%, in those over 40. Among subjects older than 20, the small group with at least some university education had a lower prevalence than the remaining subjects.

Frequency of Exposures. All but 1 person in the village over the age of 20 reported a history of circumcision, and 98% were performed by informal health care providers (Table 2). Therefore, the impact of circumcision cannot be evaluated in this age group. Among those who were 20 years of age or younger, the large majority of males gave a history of circumcision, with 27% reporting it was performed by a formal health care provider. Among the females who were 20 years of age or younger, 40% reported not being circumcised.

TABLE 1. Anti-HCV Prevalence by Age, Gender, and Education

	N	Anti-HCV–Positive N (%)
Total	3,999	973 (24.3)
Age (yr)		
0-9	712	50 (7.0)
10-19	1,298	128 (9.9)
20-39	1,142	315 (27.6)
40+	847	480 (56.7)
Gender		
Females	2,172	518 (23.8)
Males	1,827	455 (24.9)
Education (for those >20 years)		
University attendance	67	12 (17.9)
School attendance	678	253 (37.3)
No school attendance	1,244	529 (42.5)

Most men over the age of 20 reported being shaved by a community barber. Also, one quarter reported smoking goza in a social group. Only a few in the community reported having tattoos or exposure to cautery (Table 2). Almost all of the participants reported having had injections for treating illness, and about one third of these reported that these were usually given by informal health care providers. With the exception of injection therapy for illness, the most common health care exposures that were potential risks for HCV infection were suturing, surgery, and the use of intravenous and urinary catheters (Table 3). Only 92 (2.3%) subjects received blood transfusions, and 23 (0.6%) had endoscopy. The large majority of women over the age of 20 had delivered a baby, usually attended by traditional midwives. Only 35% reported having had any invasive dental procedure, and almost all of these exposures were dental extractions (Table 3).

Seventeen percent gave a history of having had schistosomiasis (81% of whom were older than 20 years; Table 3). Of those tested for current schistosomiasis, 386 (12.4%) tested were positive. Only 183 (4.6%) gave a history of parenteral antischistosomal treatment, all but 1 being over 20 years old.

Associations Between Exposure History and Anti-HCV. Almost all community and hospital/clinic exposures were strongly associated with anti-HCV in bivariate analyses (data not shown). Because age is a strong confounder of these associations, we used logistic-regression models to estimate the association between each exposure and anti-HCV while controlling for age (Table 4). Males who reported being circumcised by informal health care providers had an estimated 1.8-fold higher odds of having anti-HCV compared with those who reported having been circumcised by formal providers ($P = .016$). Among females, circumcision by informal personnel was not significantly associated with anti-HCV ($P = .60$). However, only 45 females reported being circumcised by formal health care providers. Other community exposures, *e.g.*, group goza smoking, being shaved by a community barber, were not associated with increased risk of anti-HCV seropositivity.

Receiving injections from informal rather than formal health care providers was associated with 20% higher odds of seropositivity ($P = .046$; Table 5). A history of hospital ad-

TABLE 2. Number (%) With Exposure to Potential Community Risk Factors for HCV

	Total (n = 3,993)	Age ≤ 20 (n = 2,101)	Age > 20 (n = 1,892)
Circumcision			
Males			
None	62 (3.4)	62 (6.0)	0 (0)
By formal health care providers	300 (16.5)	280 (27.0)	20 (2.6)
By informal health care providers	1,456 (80.1)	701 (67.2)	755 (97.4)
Females			
None	422 (19.5)	421 (40.0)	1 (0.1)
By formal health care providers	45 (2.1)	36 (3.4)	9 (0.8)
By informal health care providers	1,701 (78.5)	600 (57.0)	1,101 (99.1)
Injection history			
Ever	3,749 (93.9)	2,000 (95.2)	1,749 (92.4)
Usually by informal health providers	1,207 (32.2)	446 (22.3)	761 (43.5)
Report sharing syringes	49 (1.2)	19 (0.9)	30 (1.6)
Shaving at community barber (males only)	757 (41.7)	99 (9.5)	658 (84.8)
Smoking goza in a group (males only)	194 (10.7)	2 (0.2)	192 (24.7)
Sharing razors within family	53 (2.9)	5 (0.5)	48 (6.2)
Ear piercing (females only)	2,138 (98.5)	1,030 (97.3)	1,108 (99.6)
Tattoo	13 (0.3)	1 (0.05)	12 (0.6)
Cautery	11 (0.3)	0	11 (0.6)

mission was associated with anti-HCV ($P < .001$), as were many of the invasive hospital procedures, *e.g.*, suturing, surgery, intravenous or urinary catheterization, blood transfusion. Women who had given birth ($P = .019$) or had cesarean section/abortions ($P = .04$) had significantly higher odds of seropositivity. Those women having babies delivered by traditional birth attendants had a somewhat higher risk of seropositivity than those whose babies were delivered by doctors or nurses (odds ratio = 1.4); however, this difference was not statistically significant ($P = .23$). None of the dental exposures was associated with anti-HCV after adjustment for age (Table 5). A history of schistosomiasis ($P = .04$) or parenteral treatment for schistosomiasis ($P < .001$) was associated with anti-HCV positivity (Table 5). However, active infection with *S. mansoni* was not more prevalent ($P = .47$) in those who had anti-HCV than in those who did not.

Multivariable Regression Results. Tables 6 and 7 show the results of fitting logistic-regression models to estimate the effect of each exposure while controlling for age, sex, marital status, education, and all other exposures in the model.

Among those over 20 years, age ($P < .001$), male gender ($P = .006$), and history of marriage ($P < .001$) were strongly associated with anti-HCV after controlling for all other variables in the logistic-regression model (Table 6). A history of having received injections from an informal health care provider increased the odds of being anti-HCV–positive by 30% ($P = .029$), and previous parenteral therapy for schistosomiasis was associated with 2-fold increased odds ($P < .001$) of

TABLE 3. Number (%) With Health Care–Related Risk Factors for HCV

	Total (n = 3,993)	Age ≤ 20 (n = 2,101)	Age > 20 (n = 1,892)
Hospital or clinic exposures			
Sutures	990 (24.8)	381 (18.1)	609 (32.3)
Surgery	673 (16.9)	153 (7.3)	520 (27.5)
IV catheter	415 (10.4)	68 (3.2)	347 (18.4)
Abscess drainage	334 (8.4)	113 (5.4)	221 (11.7)
Urinary catheter	106 (2.7)	8 (0.4)	98 (5.2)
Blood transfusion	92 (2.3)	20 (1.0)	72 (3.8)
Blood donation	81 (2.0)	2 (0.1)	79 (4.2)
Endoscopy	23 (0.6)	1 (0.5)	22 (1.2)
Obstetric exposures (female)			
Any delivery	1,030 (47.4)	39 (3.7)	991 (88.9)
Delivery with traditional birth attendants	954 (43.9)	29 (2.7)	925 (83.1)
Abortion	176 (8.1)	5 (0.5)	171 (15.4)
Dental treatments			
Any	1,394 (34.9)	219 (10.4)	1,175 (62.2)
Extractions	1,343 (33.7)	201 (9.6)	1,142 (60.5)
Gum treatment	112 (2.8)	19 (0.9)	93 (4.9)
Fillings	99 (2.5)	12 (0.6)	87 (4.6)
History of schistosomiasis	685 (17.2)	127 (6.0)	558 (29.6)
Parenteral treatment of schistosomiasis	183 (4.6)	1 (0.005)	182 (9.6)
S. mansoni eggs in stool*	386 (12.4)	138 (8.5)	248 (16.6)

NOTE. All risk factors based on self-report except *S. mansoni* eggs found in stool.

* No stool sample was available for 870 study subjects.

TABLE 4. Age-Adjusted Associations Between Community Exposures and Anti-HCV

	OR	95% CI	P
Circumcision			
Males			
By formal health care providers	1.0	Reference group	—
By informal health care providers	1.8	(1.1, 3.0)	.02
None	1.1	(0.3, 3.8)	.94
Females			
By formal health care providers	1.0	Reference group	
By informal health care providers	1.3	(0.5, 3.5)	.60
None	2.4	(0.7, 8.2)	.16
Shaving at community barber (males only)	0.8	(0.5, 1.3)	.37
Smoking goza in a group (males only)	0.9	(0.7, 1.4)	.76
Sharing razors within family	0.6	(0.3, 1.2)	.12
Ear piercing (females only)	1.3	(0.9, 4.6)	.70
Tattoo	0.9	(0.3, 3.0)	.85
Cautery	1.7	(0.4, 8.2)	.50

anti-HCV. After controlling for prior parenteral therapy, a history of schistosomiasis was not associated with higher odds of anti-HCV. Blood transfusions ($P = .028$), history of invasive hospital procedures ($P = .004$), and cesarean section or abortions ($P = .033$) were still significantly associated with anti-HCV after adjusting for all other exposures. After controlling for these procedures, a history of giving birth was no longer a significant predictor. Circumcision was not included in this model, because nearly all those older than 20 years of age were circumcised by traditional health care practitioners.

Among those 20 years of age or younger (Table 7), there was no exposure (other than age) that was significantly associated with anti-HCV. Among boys, a history of circumcision by informal health care providers was marginally associated with anti-HCV ($P = .055$).

TABLE 5. Age-Adjusted Associations Between Health Care Exposures and Anti-HCV

	OR	95% CI	P
Injections			
Usually by informal health care providers (versus usually by formal provider)	1.2	(1.0, 1.4)	.046
Shared syringes	1.2	(0.6, 1.7)	.55
Hospital or clinic exposures			
Admission	1.4	(1.1, 1.7)	.001
Sutures	1.2	(1.0, 1.4)	.08
Surgery	1.4	(1.1, 1.7)	.002
IV catheterization	1.5	(1.2, 1.9)	<.001
Abscess drainage	0.9	(0.7, 1.2)	.67
Urinary catheterization	1.8	(1.2, 2.7)	.001
Blood transfusion	1.7	(1.1, 2.7)	.02
Endoscopy	1.4	(0.6, 3.3)	.50
Blood donation	1.3	(0.8, 1.3)	.28
Obstetric exposures (female)			
Any delivery	1.6	(1.1, 2.4)	.02
Delivery by traditional birth attendant (versus formal health provider)	1.4	(0.8, 2.5)	.23
Cesarean section or abortion	1.4	(1.0, 2.0)	.04
Dental treatments			
Any	1.0	(0.9, 1.3)	.83
Extractions	1.0	(0.8, 1.2)	.84
Gum treatment	1.2	(0.8, 1.7)	.51
Fillings	1.3	(0.8, 2.0)	.31
History of schistosomiasis	1.2	(1.0, 1.5)	.04
Received parenteral antischistosomal therapy	1.8	(1.3, 2.4)	.001
S. mansoni eggs in stool	0.9	(0.7, 1.2)	.47

TABLE 6. Effect of Predictors on the Odds of Anti-HCV for Subjects Over 20 Years of Age Using the Multivariable Logistic-Regression Model

Variable	OR	95% CI	P
Age per year	1.0	1.0, 1.0	.001
Male	2.5	1.3, 4.7	.006
Ever married	4.1	2.4, 6.9	.001
Attended college vs. no school	0.5	0.2, 1.0	.057
Attended school (but no college) vs. no school	1.1	0.9, 1.4	.51
History of schistosomiasis	1.0	0.8, 1.3	.97
Injection treatment for schistosomiasis	2.0	1.3, 2.9	.001
Injections from informal health care providers	1.3	1.0, 1.6	.029
Sharing razors at home (men only)	0.5	0.3, 1.1	.086
Smoking goza (men only)	1.1	0.7, 1.5	.77
Surgery, endoscopy, IV or urinary catheterization, or renal dialysis	1.5	1.1, 1.9	.004
Sutures or abscess drainage	0.8	0.7, 1.1	.15
Giving birth attended by formal health personnel	0.7	0.3, 1.6	.42
Giving birth attended by traditional attendant	1.4	0.9, 2.4	.18
Donating blood	1.0	0.6, 1.7	.99
Cesarean section or abortion	1.4	1.0, 1.9	.033
Blood transfusion	1.8	1.1, 2.9	.028
Dental treatment	1.1	0.9, 1.3	.62
Shaved by a community barber	0.8	0.5, 1.3	.39

DISCUSSION

The large sample size (almost 4,000 inhabitants), with high prevalence of anti-HCV (1 in 4) allows assessment of many different potential exposures. This is particularly intriguing in a rural Egyptian village, because they have both the usual investigated health care exposures to parenterally transmitted infectious agents furnished by formal health care providers and community-acquired exposures, strongly influencing HCV transmission, such as health care furnished by informal, or traditional, health care providers.

Data obtained during a cross-sectional survey based on prevalent infection, such as we conducted, cannot easily distinguish historic from current risk factors for infection. Our data showed that age was highly associated with HCV infection and confounded the association of all other risk variables with infection. Thus, stratifying our subjects by age younger

TABLE 7. Effect of Predictors on the Odds of Anti-HCV for Subjects 20 Years of Age or Younger Using the Multivariable Logistic-Regression Model

Variable	OR	95% CI	P
Age per year	1.1	1.0, 1.1	.001
Male	0.7	0.4, 1.3	.26
Ever married	1.3	0.6, 2.6	.51
Circumcision (males) by informal health care provider	1.7	1.0, 3.1	.055
Circumcision (females) by informal health care provider	0.9	0.6, 1.6	.80
History of schistosomiasis	0.6	0.3, 1.3	.20
Injections from informal personnel	1.1	0.8, 1.5	.62
Surgery, endoscopy, IV or urinary catheterization, or renal dialysis	1.1	0.7, 1.7	.85
Sutures or abscess drainage	1.1	0.8, 1.5	.63
Blood transfusion	1.2	0.2, 5.7	.85
Dental treatment	1.1	0.8, 1.8	.53

than 20 and older than 20 provides a means, albeit imprecise, to assess more current risks as distinct from those that, however important in the past, may no longer play an important role in transmission of infection. Our data suggest that the risks for the younger inhabitants of the village are different and much less than those of older community members. By considering all these variables, using logistic-regression models, it is possible to provide insight about how HCV was, and is, being transmitted in Aghour El Soughra; furthermore, this information may be pertinent to the thousands of other similar rural communities in Egypt and other developing countries.

The most common invasive procedures were wound suturing, surgery, abscess drainage, and intravenous and urinary catheterization. Only 92 (2.3%) had received a blood transfusion, and 23 (0.6%) had been endoscoped. With the exception of suturing, abscess drainage, and endoscopy (for which the sample is small), all of above-mentioned invasive procedures were significantly associated with HCV infection when adjusted for age. Using logistic-regression models, having any of the invasive procedures or a blood transfusion remained significantly associated with anti-HCV in those older than 20, but not in the younger group. Others have defined these established parenteral risk factors for HCV among subjects in the United States,[14] Europe,[15,16] and elsewhere.[17-19] Most of the women in the village over the age of 20 had delivered babies, and the vast majority had at least 1 baby delivered by traditional birth attendants. Giving birth, having a cesarean section, and having an abortion were risks for anti-HCV in this age group. However, the risk of delivery attended by a traditional birth attendant did not reach statistical significance when compared with delivery by a doctor or nurse. Others have reported that surgical procedures such as abortion and/or uterine curettage were statistically significant risk factors for HCV infection.[20]

Thirty-five percent of the subjects reported that they have had dental treatments, with the most common procedure being extraction of teeth. We were unable to show that dental procedures increased the risk for HCV infection in this population. This contrasts with communities in southern Italy, where dental treatment was implicated in HCV transmission.[21]

In Egypt, an association of anti-HCV and a history of schistosomiasis was reported in adults and children with hepatosplenomegaly,[6,7] among blood donors,[5] and among patients with biopsy-proven cirrhosis.[22] Our results suggest that prior antischistosomal injection treatment is the major factor behind this association, and not a previous, or current, schistosomal infection *per se*. This was proposed earlier by Kamel et al.,[23] who could not find an association between anti-HCV positivity and the presence, and number, of *S. mansoni* ova in the stools, nor with ultrasound-defined schistosomal hepatic fibrosis in a rural community highly endemic for *S. mansoni*. The independent association of prior antischistosomal injection treatment and HCV infection on the individual level lends support to the recently published findings from ecologic data.[10]

Circumcision, one of the potential culturally influenced exposures to HCV in the community, occurred too frequently in either sex to be easily analyzed. All of the males over the age of 20 had been circumcised, and only 1 adult woman said that she was not circumcised. However, age-adjusted analysis demonstrated that males who were circumcised by informal health care providers were more likely ($P = .02$) to have been infected with HCV than those circumcised by physicians or nurses, whereas a similar relationship was not observed among the females. This may be because male circumcision is usually performed in groups during community ceremonies, while female circumcision is usually performed discretely and individually at home at an older age. The same tools may be used by the barber or some other informal male practitioner without adequate cleaning between consecutive boys' circumcisions. This would remain a relatively low risk for HCV transmission, because the infection rates among infants and young children are low, unless the same tools are used to perform wound sutures and abscess drainage on adults. However, even a low risk of infection would be important, because almost everyone in the village has the exposure.

Reports of receiving parenteral injections for medical purposes were ubiquitous. Often, these are given by informal health care providers, *e.g.*, injectionists, barbers, midwives, family members. Individuals rarely admitted to sharing syringes and needles with others, but it is not uncommon for some families to reuse needles and syringes among members of the same household (S. El-Katsha, S. Watts, manuscript in preparation). A history of receiving injections from informal health care providers was a significant risk factor for HCV infection both in the age-adjusted ($P = .046$) and in the logistic-regression ($P = .03$) models. Because this occurred very frequently (more often than we could document because of multiple occurrences and incomplete recall), it is probably a very important mode of transmission of HCV both now and in the past. Darwish et al.[5] previously noted an association of a history of receiving injections with anti-HCV among Egyptian blood donors. Similar to the role of shared use of syringes for administration of illicit drugs in Western countries,[15,24] the reuse of syringes for therapeutic reasons was shown to be responsible for high HCV prevalence in many different parts of the world.[21, 25-27]

Two common potential HCV exposures for males are shaving by a community barber and smoking tobacco with a water pipe. Men are often shaved in groups, usually using the same razor blade, which is mechanically cleaned between customers. During goza smoking, the water pipe is passed from one person to another. The mouthpiece may be wiped, but is not changed, between users. Theoretically, this could result in exposure to blood from individuals with gingivitis. Although both exposures were suspected to be risk factors for HCV transmission, neither being shaved by a community barber nor sharing a goza pipe were significantly associated with HCV either in the age-adjusted or logistic-regression models in this village.

Other less-common community exposures (*e.g.*, tattoo, earpiercing, cautery) were not risk factors for HCV in either model. Level of education was not associated with anti-HCV prevalence, except that the few community members who had attended college had a lower prevalence of anti-HCV than the many who did not attend school.

Interestingly, marriage was found to be a very strong risk for HCV in the logistic-regression model. This association of HCV in spouses could be the result of sexual transmission or to common exposures. Others have reported that spouses of patients with HCV have an increased risk for acquiring HCV, and this risk increases with age and is proportional to the

duration of marriage.[28-30] Although these authors assumed that the relationship between HCV infection and marriage provided evidence for sexual transmission of HCV, their data[30,31] suggest that this is somewhat rare. In addition to potential sexual transmission, married couples share many exposures that could be risks for HCV transmission, both for transmission from one to the other, as well as transmission from a common source. We are currently analyzing interfamilial transmission of HCV in the subjects from Aghour El Soughra, as well as from another sample of 6,000 subjects from a community in Upper Egypt,[32] to learn more about the determinants of HCV transmission in Egypt.

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REFERENCES

1. Darwish NM, Abbas MO, Abdelfattah FM, Darwish MA. Hepatitis C virus infection in blood donors in Egypt. J Egypt Public Health Assoc 1992;67: 223-236.
2. Kamel MA, Ghaffar YA, Wasef MA, Wright M, Clark LC, Miller FD. High HCV prevalence in Egyptian blood donors. Lancet 1992;340:427.
3. Hibbs RG, Corwin AL, Hassan NF, Kamel M, Darwish M, Edelman R, Constantine NT, et al. The epidemiology of antibody to hepatitis C in Egypt. J Infect Dis 1993;168:789-790.
4. Arthur RR, Hassan NF, Abdallah MY, el-Sharkawy MS, Saad MD, Hackbart BG, Imam IZ. Hepatitis C antibody prevalence in blood donors in different governorates in Egypt. Trans R Soc Trop Med Hyg 1997;91:271-274.
5. Darwish MA, Raouf TA, Rushdy P, Constantine NT, Rao MR, Edelman R. Risk factors associated with a high seroprevalence of hepatitis C virus infection in Egyptian blood donors. Am J Trop Med Hyg 1993;49:440-447.
6. Abdel-Wahab MF, Zakaria S, Kamel M, Abdel-Khaliq MK, Mabrouk MA, Salama H, Esmat G, et al. High seroprevalence of hepatitis C infection among risk groups in Egypt. Am J Trop Med Hyg 1994;51:563-567.
7. Mohamed MK, Hussein MH, Massoud AA, Sheir S, Aoun AA, Aboul Naser M. Study of the risk factors for viral hepatitis C infection among Egyptians applying for work abroad. J Egyptian Public Health Assoc 1996;71(1,2):78-111.
8. Mohamed MK, Rakhaa M, Soheir S, Saber M. Viral hepatitis C infection among Egyptians; the magnitude of the problem: epidemiological and laboratory approach. J Egyptian Public Health Assoc 1996;71(1,2):112-147.
9. Farghaly AG, Barakat RM. Prevalence, impact and risk factors of hepatitis C infection. J Egypt Public Health Assoc 1993;68(1-2):63-79.
10. Frank C, Mohamed MK, Strickland GT, Lavanchy D, Arthur RR, Magder LS, El Khoby T, et al. The role of parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt. Lancet 2000;355:887-891.
11. Abdel-Aziz F, Habib M, Mohamed MK, Abdel-Hamid M, Gamil F, Madkour S, Mikhail NN, et al. Hepatitis C virus infection in a community in the Nile Delta: population description and HCV prevalence. HEPATOLOGY 2000;32:111-115.
12. Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. Biometrics 1986;42(1):121-130.
13. PROC GENMOND, version 6.12. Cary, NC: SAS Institute, Inc.
14. Alter MJ. Epidemiology of hepatitis C. HEPATOLOGY 1997;26:62S-65S.
15. Trepo C, Pradat P. Hepatitis C virus infection in Western Europe. J Hepatol 1999;31:80-83.
16. Naoumov NV. Hepatitis C virus infection in Eastern Europe. J Hepatol 1999;31:84-87.
17. Sun CA, Chen HC, Lu CF, You SL, Mau YC, Ho MS, Lin SH, et al. Transmission of hepatitis C virus in Taiwan: prevalence and risk factors based on a nationwide survey. J Med Virol 1999;59:290-296.
18. Saxena R, Thakur V, Sood B, Guptan RC, Gururaja S, Sarin SK. Transfusion-associated hepatitis in a tertiary referral hospital in India. A prospective study. Vox Sang 1999;77(1):6-10.
19. Souto FJ, Fontes CJ, Martelli CM, Turchi MD, Martins RM, Andrade AL. Hepatitis C virus prevalence among an immigrant community to the southern Amazon, Brazil. Mem Inst Oswaldo Cruz 1999;94:719-723.
20. Brusaferro S, Barbone F, Andrian P, Brianti G, Ciccone L, Furlan A, Gnesutto D, et al. A study on the role of the family and other risk factors in HCV transmission. Eur J Epidemiol 1999;15:125-132.
21. Guadagnino V, Stroffolini T, Rapicetta M, Costantino A, Kondili LA, Menniti-Ippolito F, Caroleo B, et al. Prevalence, risk factors, and genotype distribution of hepatitis C virus infection in the general population: a community-based survey in southern Italy. HEPATOLOGY 1997;26:1006-1011.
22. Koshy A, al-Nakib B, al-Mufti S, Madda JP, Hira PR. Anti-HCV-positive cirrhosis associated with schistosomiasis. Am J Gastroenterol 1993;88: 1428-1431.
23. Kamel MA, Miller FD, el Masry AG, Zakaria S, Khattab M, Essmat G, et al. The epidemiology of Schistosoma mansoni, hepatitis B and hepatitis C infection in Egypt. Ann Trop Med Parasitol 1994;88:501-509.
24. Alter MJ. Hepatitis C virus infection in the United States. J Hepatol 1999;31(Suppl 1):88-91.
25. Chen TZ, Wu JC, Yen FS, Sheng WY, Hwang SJ, Huo TI, Lee SD. Injection with nondisposable needles as an important route for transmission of acute community-acquired hepatitis C virus infection in Taiwan. J Med Virol 1995;46:247-251.
26. Ho MS, Hsu CP, Yuh Y, King CC, Tsai JF, Mau YC, Hsu LC, et al. High rate of hepatitis C virus infection in an isolated community: persistent hyperendemicity or period-related phenomena? J Med Virol 1997;52: 370-376.
27. Li CP, Hwang SJ, Lu CL, Chan CY, Wu JC, Lee FY, Lee SD. Risk factor analysis of patients with chronic hepatitis C in Taiwan. Chung Hua I Hsueh Tsa Chih (Taipei) 1996;58:275-280.
28. Akahane Y, Kojima M, Sugai Y, Sakamoto M, Miyazaki Y, Tanaka T, Tsuda F, et al. Hepatitis C virus infection in spouses of patients with type C chronic liver disease. Ann Intern Med 1994;120:748-752.
29. Kao JH, Chen PJ, Yang PM, Lai MY, Sheu JC, Wang TH, Chen DS. Intrafamilial transmission of hepatitis C virus: the important role of infections between spouses. J Infect Dis 1992;166:900-903.
30. Goto M, Fujiyama S, Kawano S, Taura Y, Sato S, Sato T, Akahoshi A. Intrafamilial transmission of hepatitis C virus. J Gastroenterol Hepatol 1994;9(1):13-18.
31. Rooney G, Gilson RJ. Sexual transmission of hepatitis C virus infection. Sex Transm Infect 1998;74:399-404.
32. Nafeh MA, Medhat A, Shehata M, Mikhail NNH, Swifee Y, Abdel-Hamid M, Watts S, et al. Hepatitis C in a community in Upper Egypt: 1. Cross-sectional survey. American Journal of Tropical Medicine and Hygiene 2000;(in press).