JOURNAL OF CLINICAL MICROBIOLOGY, Dec. 1995, p. 3133–3137 Vol. 33, No. 12
0095-1137/95/$04.00+0


# Meningococcal Carriage, Alcohol Consumption, and Campus Bar Patronage in a Serogroup C Meningococcal Disease Outbreak

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Received 19 May 1995/Returned for modification 1 August 1995/Accepted 11 September 1995

**Community outbreaks of serogroup C invasive meningococcal disease are increasing in North America (L. H. Harrison, JAMA 273:419–421, 1995; L. A. Jackson, A. Schuchat, M. W. Reeves, and J. D. Wenger, JAMA 273:382–389, 1995; C. M. Whalen, J. C. Hockin, A. Ryan, and F. Ashton, JAMA 273:390–394). In a recent 15-month university outbreak, disease was linked to patronage of a specific campus-area bar, suggesting that aspects of a campus bar environment might promote meningococcal transmission (P. B. Imrey, L. A. Jackson, P. H. Ludwinski, et al., Am. J. Epidemiol., in press). To investigate this hypothesis, oropharyngeal carriage results from samples taken from 867 university health service clients and 85 campus-area bar employees during the last 3 months of the outbreak were analyzed to determine factors correlated with carriage of any strain of *Neisseria meningitidis*. Results were validated with data from samples from 344 health center clients and 211 campus bar employees taken 8 months after the last outbreak case. Recent alcohol consumption (adjusted prevalence odds ratio = 3.8 for >15 versus 0 drinks in last week [*P* = 0.0012]) and campus bar patronage (adjusted odds ratio = 1.9 for any versus no patronage in last 2 weeks [*P* = 0.0122]) showed separate effects in both univariate and multiple logistic regression analyses of data from the 1992 health center clients. Prevalence of meningococcal carriage among 1992 campus bar workers was 3.8 times that among health center clients; this prevalence ratio was roughly 2.5 after adjustment for alcohol consumption and bar patronage. Recent antibiotic usage was protective (prevalence odds ratio = 0.3) among health center clients and bar workers. These findings were generally supported by the validation samples. If alcohol consumption and other aspects of the campus bar environment facilitate transmission of and/or colonization by *N. meningitidis*, then the introduction of a highly pathogenic substrain into the campus bar environment may provide an unusual opportunity for invasive meningococcal disease within a campus community.**

Invasive meningococcal disease (IMD) in older children and adults generally follows transmission of the organism by an asymptomatic carrier of *Neisseria meningitidis* (3). However, IMD is a rare product of meningococcal transmission, requiring the coincidence of a pathogenic strain, a susceptible host, and unknown facilitative conditions. Thus, even quite substantial fluctuations in the prevalence of pharyngeal meningococcal carriage, undifferentiated by substrain, have not proven reliable in predicting either outbreaks or trends in endemic rates of IMD (18, 23). Nevertheless, to the extent that common mechanisms promote transmission of all *N. meningitidis* strains to both patients and carriers, reduction of meningococcal carriage may potentially limit the transmission of outbreak strains and secondarily reduce IMD. Hence, considerable effort has been devoted to the identification of factors associated with prevalence and, less frequently, incidence of meningococcal carriage. Various sociodemographic characteristics, genetic factors, environmental conditions, and personal behaviors which facilitate droplet transmission, as well as agents which may irritate the pharyngeal epithelium, have been considered.

In the United States and Canada, outbreaks of serogroup C IMD are occurring with increasing frequency (12, 14, 22). Our investigation of one recent cluster of nine cases of serogroup C IMD, by a case-control study and carriage surveys accompanied by multilocus enzyme electrophoresis, implicated a specific bar as a likely locus of transmission of the primary outbreak strain (13). This strain, isolated from seven of nine patients, was closely related to the 1991–1992 Canadian outbreak strain. An eighth patient yielded a distinguishable but also closely related strain, while no isolate was obtained from the remaining patient, who had received antibiotics prior to diagnosis. The unfortunate establishment was one among many taverns which are located near a large residential university campus and serve primarily student patrons. All patients in this cluster were undergraduates residing on that campus, with the exception of a student at a community college 3 mi (ca. 5 km) distant. Exposure to campus-area bars, considered as a group, was also a risk factor for disease. We hypothesized that factors in the campus bar environment might generally promote transmission of *N. meningitidis*. Below, we test this hypothesis using oropharyngeal carriage data obtained

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from 1,211 swabs from clients of the university's student health center and 296 swabs from campus-area bar workers during and after the outbreak. Alcohol consumption, cigarette smoking, antibiotic use, and other variables were considered both separately and in conjunction with campus bar patronage in a multifactor model to control for confounding.

## MATERIALS AND METHODS

**Setting.** The outbreak, described elsewhere in more detail (13), occurred from February 1991 through April 1992 at a residential university campus of approximately 26,000 undergraduate and 10,000 graduate students in an urban community of 100,000 in the midwestern United States. There were five male and four female patients between 18 and 22 years of age. Sixteen thousand university students were immunized with quadrivalent meningococcal vaccine from late February to March 1992, after eight cases had occurred. Vaccination of entering students has continued since. The final patient, in late April 1992, was apparently immunologically unresponsive to the vaccine.

**Student health center carriage studies.** Oropharyngeal carriage of *N. meningitidis* was evaluated at the university student health center in February 1992 prior to initiation of the immunization program, in early May 1992 just after the last case, and in January 1993. Students presenting at acute care, medical, gynecology, preventive medicine, and urgent care clinics were asked to participate. Volunteers completed a questionnaire on age, gender, ethnic group, year in school, cigarette usage, alcohol usage in past week, use of antibiotics currently or during the past month, prior receipt of rifampin or meningococcal vaccine, and reason for clinic visit. Participants were also asked to circle, from a list of eight campus-area bars and six restaurants, those they had patronized in the previous 2 weeks. (One of the restaurants also functioned as a bar during evenings.)

**Campus bar carriage studies.** Between mid-March and mid-May 1992, oropharyngeal carriage was evaluated among employees of five of the campus-area bars listed in the health center questionnaire. Volunteers were queried similarly to health center clients and were also asked about duration of employment, primary job, and usual shifts at each bar or restaurant where they worked. Workers at these and six other bars were subsequently surveyed in January 1993.

**Laboratory methods.** Health center carriage samples in February 1992 and January 1993 were collected and processed by staff on site, while public health district personnel collected and processed those from bar workers and patrons. To check comparability of results, roughly 30% of the May 1992 samples from health center subjects were collected and processed by the public health district personnel who conducted the bar surveys.

Health center personnel immediately delivered samples to a laboratory within the building, where they were plated onto Thayer-Martin medium and stored at 37°C in a 5% $CO_2$ incubator. Plates were initially examined after overnight incubation but were incubated for at least 48 h. Detectable growth was tested by Gram stain and oxidase. For specimens compatible with a *Neisseria* species, carbohydrate utilization was evaluated by the quadFERM+ system (Analytab Products, Plainview, N.Y.). Samples collected by public health department personnel were immediately plated onto Martin-Lewis agar and stored in Ziploc bags at ambient temperature after addition of $CO_2$ tablets. Upon reaching the public health laboratory, usually within 2 h, plates were incubated for 2 days at 37°C, and detectable growth was tested by Gram stain and oxidase.

Isolates compatible with *N. meningitidis* were transferred to chocolate agar slants, incubated for 24 to 48 h, and shipped overnight to the Centers for Disease Control and Prevention, where isolates confirmed as *N. meningitidis* were serogrouped by slide agglutination. Because of a shortage of reagents, 1993 isolates were tested only to identify serogroup C strains.

**Statistical analysis.** Multiple logistic regression was used to develop a multifactor model to examine associations with carriage in 1992 health center clients simultaneously, with the effect of each variable being controlled for other predictors. The 1993 health center survey was held as a validation sample. Possible predictors were screened individually by Cochran-Mantel-Haenszel (CMH) methods after joint stratification by month of survey and recent antibiotic usage. Statistically significant variables from the CMH analyses were candidates for inclusion in the logistic model, some after categorization was simplified. Seasonal trends were controlled by retaining month of sampling as a main effect in all models considered. Variables which were statistically significant when controlling for all other candidate predictors, as well as when controlling only for sampling month, were used to form an initial model (4). Automated variable selection algorithms (8, 17) were then used to suggest the choice of other candidate predictors, with modifications made as appropriate on the basis of substantive considerations, observed relationships among candidate predictors, and indicators of model fit. The selected model was validated by predicting carriage prevalence in subgroups of the 1993 health center sample and by results of independently applying a model of identical form to the 1993.

Analogous approaches were used to analyze data from bar workers separately for 1992 and 1993 surveys. Bar worker carriage prevalence was also indirectly adjusted by using health center client prevalence data. Standardized carriage prevalence ratios were obtained from 1992 health center carriage prevalence by two approaches: (i) employing observed prevalences in joint age, sex, ethnic group, antibiotic use, and alcohol use subgroups and (ii) employing predicted prevalences from the health center multiple logistic model.

## RESULTS

**Student health center carriage studies.** Samples from 86 (9.9%) of 876 students surveyued at the health center in 1992, cultured positive for *N. meningitidis*; 65% of isolates were nongroupable, 21% were serogroup B, and 2 to 4% were each of serogroups C, W135, Y, and Z. Overall carriage prevalence was 11.1% in February and 9.0% in May ($P = 0.30$ for change), although the proportion of nongroupable isolates increased from 44% in February to 86% in May ($P = 0.0001$). This change was apparently unrelated to the immunization campaign, as the percentage decline in carriage of groupable strains was virtually identical for those serogroups not covered (81% decline) and those covered (77% decline) by the tetravalent vaccine.

Carriage among those under 23 years of age tripled carriage among those 30 and over, carriage among whites tripled that among nonwhites, and carriage among males was 75% higher than that among females. Carriage was halved among recent antibiotic users. Clients attending primarily to receive allergy shots or assistance with either gynecological problems or birth control (henceforth designated type I clients) were carriers half as often as others (henceforth designated type II clients). Carriage was five times more common in those reporting 21 or more alcoholic drinks in the past week than in those reporting none, with a dose-response effect evident, and carriage was doubled for those who had patronized any listed bars within the past 2 weeks. Meningococcal immunization, past use of rifampin, and cigarette smoking were not statistically significantly associated with carriage. Table 1 gives estimates of prevalence ratios, with associated $P$ values, for the seven categorized variables retained as candidate predictors for multiple logistic modeling.

Alcohol consumption and antibiotic usage within the past month satisfied the criteria for inclusion, with survey month to control secular trend, in the initial logistic regression model. Automated variable selection methods chose client type (I versus II) and ethnic group (white versus nonwhite) as additional useful predictors; however, ethnic group lacked a plausible biologic interpretation but was strongly correlated with recent bar exposure. Further, the observed association of carriage with bar exposure was strong among both nonwhites and whites, while the association of carriage with ethnicity was not apparent once bar exposure was controlled. Replacement of ethnic group by bar exposure raised model likelihood and improved model fit by all other measures. The best combination of parsimony and explanatory power was achieved by a model which included, with survey month, only recent alcohol consumption, recent bar exposure, and an increment for type II clients who had not recently used antibiotics. No indications of effect modifiers or a nonlinear trend in alcohol consumption were found, nor did any individual bar achieve statistical significance when substituted for general bar exposure.

Table 2 gives fitted odds ratios, 95% confidence intervals, and Wald $P$ values for each variable, with statistics for overall model significance and fit. The model estimates that carriage odds among the group reporting heaviest drinking in the previous week almost quadrupled odds among reported abstainers, while recent patrons of a listed bar had twice the carriage odds of others; that type II clients without recent antibiotic coverage had almost triple the carriage odds of other visitors to the health center; and that clients with these three risk factors had more than 21 times the carriage odds of those with none.

TABLE 1. Meningococcal carriage prevalence ratios, confidence limits, and $P$ values among health center clients, February and May 1992

| Factor | Prevalence ratio[a] | 95% Confidence interval | $P$[b] |
|---|---|---|---|
| Age[c] | | | 0.013 |
| 24–29 vs ≥30 | 1.60 | 0.36–7.14 | |
| ≤23 vs ≥30 | 3.10 | 0.88–10.87 | |
| Alcohol in last week[d] | | | <0.00001 |
| 1–6 | 2.70 | 1.62–4.50 | |
| 7–15 | 3.29 | 1.78–6.10 | |
| >15 | 4.81 | 2.31–10.00 | |
| No antibiotic in past month[e] | 2.13 | 1.16–4.00 | 0.015 |
| Bar visit in past 2 wk[f] | 2.25 | 1.49–3.41 | 0.0001 |
| Gender (male vs female)[g] | 1.73 | 1.14–2.62 | 0.010 |
| Ethnic group (white vs nonwhite)[h] | 2.81 | 1.45–5.43 | 0.002 |
| Type II vs type I client[i] | 1.85 | 1.11–3.10 | 0.019 |

[a] Mantel-Haenszel method, with joint stratification by sampling month (February or May) and antibiotic use during past month.

[b] From CMH statistic using rank scores for the age categorization and for drinks in past week.

[c] Categorized from age in years into 17 to 23, 24 to 29, and 30+, with respective crude carriage prevalences of 75 of 685 (10.9%), 7 of 111 (6.3%), and 2 of 52 (3.8%); 19 subjects were not used in this analysis because of missing data on age or antibiotic usage. The association of carriage with age in years was also statistically significant ($P = 0.022$).

[d] Data are ranges of numbers of drinks compared to a baseline category of 0 drinks. Crude carriage prevalences for the categories none, 1 to 6, 7 to 15, and more than 15 drinks in last week were 18 of 387 (4.7%), 41 of 323 (12.7%), 16 of 102 (15.7%), and 8 of 35 (22.9%), respectively; 20 subjects were not used in this analysis because of missing data on antibiotic or alcohol usage. The four alcohol categories were simplified from nondrinker, drinker but not in past 7 days, or 1 to 3, 4 to 6, 7 to 10, 11 to 15, 16 to 20, or more than 20 drinks in past 7 days, with one drink defined as 2 oz (ca. 60 ml) of liquor, 5 oz of wine, or 12 oz of beer. This original categorization was also statistically significantly related to carriage ($P < 0.00001$ from the CMH statistic using rank scores).

[e] Reported statistics from stratification only by month of survey (February or May). Crude carriage prevalences were 10 of 190 (5.3%) in those reporting antibiotic use within the past month and 76 of 669 (11.4%) for other subjects; eight subjects were not used in this analysis because of missing data on antibiotic usage. Categories were simplified from current use, no current use but used in past month, or not used in past month. The 3-category variable was also statistically significantly related to carriage ($P = 0.012$ from the CMH statistic using rank scores, stratifying by month of survey).

[f] Reported visit in past 2 weeks to any of eight listed campus area bars. Crude carriage prevalences were 58 of 410 (14.1%) for bar visitors versus 28 of 449 (6.2%) for nonvisitors; eight subjects were not used in this analysis because of missing data on antibiotic usage.

[g] Crude carriage prevalences were 45 of 352 (12.8%) for males and 34 of 469 (7.2%) for females. Forty-one subjects were not used in this analysis because of missing data on antibiotic usage or gender.

[h] Crude carriage prevalence was 78 of 669 (11.7%) from white subjects and 8 of 190 (4.2%) from nonwhite (black, Asian, Pacific Islander, or Native American) subjects. Eight subjects were excluded from this analysis because of missing data on antibiotic usage.

[i] Crude carriage prevalence among type I visitors, who came for allergy shots, birth control, or gynecologic concerns, was 15 of 237 (6.3%) compared with 71 of 622 (11.4%) for type II clients, that is, those who came for all other reasons. Eight subjects were excluded from this analysis because of missing data on antibiotic usage.

Carriage prevalence among 343 health center clients in 1993 was 12.2%. Table 3 shows observed carriage counts and their predicted values based on the 1992 model for subgroups of these students. Overall, 41.0 carriers were predicted and 42 were observed, and the fit is adequate. When parameters of the 1992 model were reestimated using the 1993 data, the estimated odds ratios of 1.46 for each increment in alcohol consumption, 1.63 for type II clients without antibiotic coverage, and 5.47 for recent bar patronage were statistically compatible (5% level) with the respective 1992 estimates of 1.56, 2.88, and 1.94. The likelihood ratio chi-square substantiated model significance (27.61 with 3 *df*, $P = 0.0001$), while the Hosmer-Lemeshow chi-square for goodness of fit (5.58 with 8 *df*, $P = 0.69$) and other fit indicators were satisfactory. The 1993 estimated odds ratio of 5.47 ($P = 0.0009$) for campus bar patronage confirms and indeed exceeds the estimated effect seen in 1992. Table 3 reflects this in the 1992-based model's overprediction of 1993 carriers in those not reporting recent bar patronage (10.3 expected versus 5 observed).

Adjusted for health center clinic, carriage results obtained in May 1992 by the public health district were virtually identical to those obtained by the health center (Mantel-Haenszel $P = 0.91$).

**Campus bar carriage studies.** The 85 bar workers studied in 1992 ranged from 19 to 28 years of age, with 68 (80%) between 20 and 22. Seventy-four (88%) were students, 56 (66%) were male, all but 1 drank alcohol, and 32 (38%) carried meningococci (69% nongroupable, 19% serogroup B, and 12% serogroup C). Table 4 summarizes the comparison of results from these workers with carriage among health center clients. Carriage among bar workers was significantly higher among those who had not recently used antibiotics (estimated odds ratio = 3.40, $P = 0.045$), but no statistically significant associations with place of employment, age, sex, ethnic group, year in school, days or shifts worked, weekly hours worked, job responsibilities, previous meningococcal vaccination or rifampin prophylaxis, cigarette smoking, or level of recent alcohol consumption were found. The standardized carriage ratios for these employees were 2.8 and 2.3 by adjustment methods i and ii, respectively, indicating observed prevalence roughly 2.5 times that expected on the basis of health center client experience. January 1993 carriage was 28% among 211 workers at 11 bars, statistically compatible with although somewhat lower than that among bar workers in 1992 ($P = 0.10$). The 1993 standardized carriage ratios for bar workers were 2.1 and 1.6,

TABLE 2. Point and interval estimates for odds ratios and Wald $P$ values from final model for meningococcal carriage in 1992 health service clients[a]

| Factor | Estimated OR[b] | 95% Confidence interval for OR | Wald $P$ |
|---|---|---|---|
| Mo (February vs May) | 1.08 | 0.93–1.26 | 0.3196 |
| Alcohol intake in last week[c] | | | 0.0012 |
| 1–6 | 1.56 | 1.19–2.03 | |
| 7–15 | 2.42 | 1.42–4.14 | |
| >15 | 3.77 | 1.69–8.42 | |
| Type II[d] *without antibiotic* | 2.88 | 1.71–4.85 | 0.0001 |
| Bar patronage in last 2 wk[e] | 1.94 | 1.15–3.25 | 0.0122 |

[a] The likelihood ratio model chi-square for the four covariates is 44.09 with 4 *df* ($P = 0.0001$), and that for the three nonblocking factors is 43.03 with 3 *df* ($P = 0.0001$). The Hosmer-Lemeshow lack-of-fit statistic is 9.72 with 9 *df* ($P = 0.37$). The model excludes 8 of 867 subjects with missing data on one or more variables.

[b] OR, odds ratio.

[c] Data are ranges of numbers of drinks compared to a baseline category of 0 drinks. The model treats the four categories of alcohol consumption as equally spaced.

[d] Includes all who came for reasons other than allergy shots or gynecologic and/or birth control issues.

[e] Yes if visit to any of eight specified campus-area bars; no otherwise.

TABLE 3. Characterization of January 1993 health center clients by recent alcohol intake, campus bar patronage, and antibiotic usage-client type, with observed and predicted numbers carrying meningococci from multiple logistic modeling of 1992 surveys[a]

| No. of clients | Bar patronage last 2 wk | Alcohol intake in last wk (no. of drinks) | Type II client without antibiotic | No. of 1993 carriers observed | No. of carriers predicted by 1992 model |
|---|---|---|---|---|---|
| 39 | No | 0 | No | 0 | 1.1 |
| 53 | No | 0 | Yes | 3 | 4.1 |
| 28 | No | 1–6 | No | 0 | 1.2 |
| 25 | No | 1–6 | Yes | 2 | 2.9 |
| 2 | No | 7–15 | No | 0 | 0.1 |
| 5 | No | 7–15 | Yes | 0 | 0.8 |
| 0 | No | >15 | No | 0 | 0.0 |
| 0 | No | >15 | Yes | 0 | 0.0 |
| 14 | Yes | 0 | No | 3 | 0.7 |
| 29 | Yes | 0 | Yes | 4 | 4.1 |
| 44 | Yes | 1–6 | No | 5 | 3.6 |
| 55 | Yes | 1–6 | Yes | 11 | 11.1 |
| 19 | Yes | 7–15 | No | 5 | 2.3 |
| 24 | Yes | 7–15 | Yes | 6 | 6.8 |
| 3 | Yes | >15 | No | 1 | 0.6 |
| 4 | Yes | >15 | Yes | 2 | 1.5 |

[a] See footnote to Table 2.

indicating a persistent substantial excess above other students and even recent bar visitors with similar recent drinking and antibiotic histories. Other 1993 results for bar workers were similar to those for 1992 (recent antibiotic usage odds ratio = 3.01, $P = 0.030$).

## DISCUSSION

These data suggest that both alcohol consumption and additional factors common to campus bar environments enhances transmission of *N. meningitidis*. Evidence from both the stratified and multiple logistic analyses is strongly consistent with a dose-response effect of alcohol consumption on carriage prevalence. The data also suggest a dose-response effect of exposure to the campus bar environment. In early 1992, carriage was doubled among health center clients reporting recent bar patronage compared with that by others, and carriage was increased sixfold among bar workers. Although these differences are partly explainable by alcohol consumption and antibiotic use, a substantial association remains after adjustment for these and other relevant variables. For example, the multiple logistic model indicates that a health center client who drank alcohol and who had patronized a listed bar in the previous 2 weeks had almost twice the odds of carrying *N. meningitidis* as another student whose sample was taken in the same month, who had visited the health center for a similar reason, who had similar recent antibiotic exposure, who typically drank alcohol at a comparable level, but who had not recently patronized a listed bar (Table 2). A similar carriage gradient from nonpatrons to patrons to bar workers was again found in January 1993. The gradient supports a dose-response relationship under the reasonable assumptions that recent patrons of campus bars generally spend more time in that environment than others and that the exposure time of bar workers is greater still.

However, it is difficult to isolate specific environmental conditions promoting transmission in campus bars by epidemiologic means. Crowding, cigarette smoke, and alcohol would seem the most prominent candidates. Elevated carriage and disease have been linked to shared living accomodations and possibly crowding in studies evaluating spread in households and dormitories (7, 10, 15, 18, 21). Crowding in a campus bar environment is of shorter duration but often at much higher density than that observed in households and dormitories. Increased carriage has also been noted among public transportation workers (5), many of whom are periodically exposed to high-density crowding. In addition to the influence of crowding, some practices that facilitate transmission of oropharyngeal secretions, such as sharing of drinks, cigarettes, and utensils, may occur among a wider group of acquaintances in campus bars than in other venues outside the home.

Meningococcal carriage has been associated with cigarette smoking and/or passive smoke exposure in several recent studies (1, 2, 5, 19–21). We found no association of carriage with smoking in our data and did not query individuals on passive smoke exposure at home. However, active smoking was associated with disease in the outbreak which prompted this investigation (13).

An association of meningococcal carriage with alcohol use has not, to our knowledge, been previously reported, although heavy alcohol use has been tentatively suggested as a risk factor for IMD (9, 16), possibly through immune suppression (11). Alcohol also might facilitate attachment of *N. meningitidis* to the pharyngeal mucosa by an irritating and/or drying effect.

Biological effects of alcohol on meningococcal carriage (or IMD) may be difficult to distinguish epidemiologically from possible effects of behavioral correlates of alcohol consumption, including bar patronage. In our health center surveys, in which alcohol consumption was measured by using seven categories of reported drinking (0, 1 to 3, 4 to 6, 7 to 10, 11 to 15, 16 to 20, and ≥20 drinks) in the previous week and bar patronage was dichotomized by reported visits to any of a group of bars within the previous 2 weeks, both variables were independently statistically associated with increased carriage. However, if time spent in campus bars were closely correlated with reported drinking by bar patrons, the apparent alcohol effect would statistically incorporate an additional impact of the bar environment that escaped capture by the crude dichotomy representing campus bar patronage. This additional impact might be biologically unrelated to alcohol consumption. On the other hand, if bar patrons underreported alcohol intake more than nonpatrons, the apparent effect of bar exposure would include a statistical reflection of any real effect of alcohol. Finally, unmeasured behavioral or other factors such as

TABLE 4. Carriage of all meningococci by bar workers and health center clients in February 1992, May 1992, and January 1993

| Source, yr, and characteristic | No. surveyed | Carriage (%) |
|---|---|---|
| Bar workers | 296 | 30.7 |
| 1992, 5 bars | 85 | 37.6 |
| 1993, 11 bars[a] | 211 | 28.0 |
| Health center clients | 1211 | 10.6 |
| 1992 | | |
| Recent bar patrons[b] | 411 | 14.1 |
| Others | 456 | 6.1 |
| 1993 | | |
| Recent bar patrons[b] | 192 | 19.3 |
| Others | 152 | 3.3 |

[a] Including all bars sampled in 1992 ($n = 53$).
[b] Of listed bars, within past 2 weeks.

kissing and other intimate behaviors may be confounding the relationships we observe, though such unknown factors would have to be quite strongly associated with reported drinking, bar exposure, and carriage to fully account for the relationships found here (6). The most straightforward interpretation of our data is that alcohol consumption and the bar environment contribute separately and quite noticeably to carriage.

We failed to find associations of carriage with alcohol consumption or hours worked weekly by bar workers surveyed. These surveys had generally lower statistical power than the studies of health center clients because of both smaller sample sizes and the higher inherent level of variability stemming from generally increased carriage prevalence. The ability to evaluate effects of alcohol consumption was weakened by the virtual absence of nondrinkers among bar workers. Working hours may have been a poor reflection of total bar exposure time, the real independent variable of interest, which was unavailable, as we did not measure recreational bar exposure in this population.

If (i) meningococcal carriage is elevated in campus bar workers and patrons, (ii) crowding in campus bars leads to frequent physical transmission of droplets containing viable meningococci, and (iii) alcohol facilitates nasopharyngeal colonization by meningococci, then campus bars may routinely concentrate and spread *N. meningitidis*. Ordinarily this would be of little consequence, since carriage is endemic and rarely pathogenic. However, carriage of a highly pathogenic substrain by employees or regular patrons of a campus bar may provide an unusual opportunity for an extended outbreak of IMD within a campus community (13). For this reason, the roles of alcohol and crowded bars in dissemination of *N. meningitidis* warrant further investigation. Public health officials may wish to ascertain bar employment and recent bar exposure histories of college student victims of IMD.

## ACKNOWLEDGMENTS

We are grateful to Carl Langkop and Jim Martin for wise counsel and to R. W. Armstrong for both wise counsel and helpful administrative support.

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