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National Case-Control Study of Kaposi's Sarcoma and *Pneumocystis carinii* Pneumonia in Homosexual Men: Part 1, Epidemiologic Results

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To identify risk factors for the occurrence of Kaposi's sarcoma and *Pneumocystis carinii* pneumonia in homosexual men, we conducted a case-control study in New York City, San Francisco, Los Angeles, and Atlanta. Fifty patients (cases) (39 with Kaposi's sarcoma, 8 with pneumocystis pneumonia, and 3 with both) and 120 matched homosexual male controls (from sexually transmitted disease clinics and private medical practices) participated in the study. The variable most strongly associated with illness was a larger number of male sex partners per year (median, 61 for patients; 27 and 25 for clinic and private practice controls, respectively). Compared with controls, cases were also more likely to have been exposed to feces during sex, have had syphilis and non-B hepatitis, have been treated for enteric parasites, and have used various illicit substances. Certain aspects of a lifestyle shared by a subgroup of the male homosexual population are associated with an increased risk of Kaposi's sarcoma and pneumocystis pneumonia.

In June and July 1981, reports from California and New York City described the highly unusual occurrence of life-threatening opportunistic infections (particularly *Pneumocystis carinii* pneumonia), and a malignancy, Kaposi's sarcoma, in young, previously healthy, homosexual men (1, 2). Subsequent reports described the occurrence of the same illnesses in a smaller number of heterosexual men and women (3). Based on a national surveillance system, the Centers for Disease Control (CDC) concluded that the first cases in the "outbreak" of Kaposi's sarcoma and pneumocystis pneumonia had their onset in 1978, and that most cases had occurred since January 1981 (4). Underlying the occurrence of Kaposi's sarcoma and pneumocystis pneumonia was a type of acquired cellular immunodeficiency not previously described (5-8). This illness is now called "the acquired immune deficiency syndrome" (9).

In October 1981, CDC epidemiologists in collaboration with investigators in New York City, San Francisco, Los Angeles, and Atlanta began an exploratory case-control study to identify risk factors for the occurrence of Kaposi's sarcoma and pneumocystis pneumonia in previously healthy young persons. Because we sought detailed historical information on a broad range of topics, we limited our case selection to patients whom we could interview in person. Because we knew of only four living heterosexual patients when the study began, we limited our study to homosexual patients. We report the results of the study.

Methods

CASE DEFINITION AND SELECTION

Patients (cases) were homosexual men between the ages of 15 and 60 years, who had biopsy-proven Kaposi's sarcoma, pneumocystis pneumonia, or both. Persons with known predisposing risk factors for either disease, such as a malignancy other than Kaposi's sarcoma or prior treatment with immunosuppressive agents, were excluded from the study. Men were considered to be homosexual if they had had sexual intercourse with one or more men during the year before the onset of illness.

As part of CDC surveillance activities, a case file for Kaposi's sarcoma and pneumocystis pneumonia was established in June 1981 (4). By October 1981, CDC had received reports of 70 cases (50 with Kaposi's sarcoma, 14 with pneumocystis pneumonia, and 6 with both diseases) in New York City, San Fran-

▶ From the AIDS Activity, Center for Infectious Diseases, and the Epidemiology Program Office, Centers for Disease Control, Atlanta, Georgia; the New York City Department of Health, New York University Medical Center, Memorial Sloan-Kettering Cancer Center, New York, New York; the Department of Public Health, City and County of San Francisco, and the Department of Health Services, County of Los Angeles, California.

Table 1. Characteristics of 50 Homosexual Men with Kaposi's Sarcoma, Pneumocystis Pneumonia, or Both

	Patients (Cases)			
	Kaposi's Sarcoma ($n = 39$)	Pneumocystis Pneumonia ($n = 8$)	Both ($n = 3$)	Total ($n = 50$)
	← n →			
City of residence				
New York	28	6	1	35
San Francisco	7	1	1	9
Los Angeles	2	1	1	4
Atlanta	2	0	0	2
Race				
White	31	5	2	38
Black	6	1	0	7
Hispanic	2	2	1	5

cisco, Los Angeles, and Atlanta, that appeared to meet our case definition. Ten of the 70 could not be interviewed because they had died, 1; moved, 2; could not be found, 2; were too ill to be interviewed, 2; or refused to be interviewed, 3. Of the 60 cases who had interviews, 3 were excluded because they did not meet our study definition of homosexuality, and 7 were interviewed too late in the study for us to obtain controls. The remaining 50 cases (39 with Kaposi's sarcoma, 8 with pneumocystis pneumonia, and 3 with both) who met our case definition were matched with at least one control and, therefore, entered the study.

CONTROL DEFINITION AND SELECTION

Controls were homosexual men who had never had Kaposi's sarcoma or pneumocystis pneumonia and had not received immunosuppressive therapy in the preceding year. Cases and controls were matched by age (within 2 years for each control group except friend controls, who were matched to within 5 years), race, and metropolitan area of residence.

Obtaining a true random sample of homosexual men to serve as controls did not appear feasible. We therefore asked health departments, private clinics, and private physicians in each study site, as well as cases, to help us sample several different groups of homosexual men. We sought four matched controls per case, selected from the following groups.

Clinic controls: Two homosexual men were selected from either public sexually transmitted disease clinics or private clinics providing the same services for homosexual men at the four study sites. Selection of controls was done prospectively by identifying consecutive clinic attendees who could be matched with cases by the above criteria.

Private control: One homosexual man was selected from the practice of an internist or family physician at each of the four study sites. Selection was by a retrospective chart review using a list of random letters. All patients who could be matched with cases and did not have chronic illnesses (defined as illnesses of more than 1 month's duration) at the time of their most recent office visit were eligible for the control group.

Friend control: Each case was asked to identify a homosexual male friend who had never been his sexual partner.

We had varying success in obtaining controls for the 50 cases. Of the 150 controls sought from clinics or private practices, we obtained 120 (80%): 78 of 100 from clinics and 42 of 50 from private practices. All 50 cases had at least one control from either of these groups and 38 of the 50 cases (76%) had controls from both groups. When the cases for whom one or two controls were missing were compared with those for whom all three controls were obtained, there were no significant differences with respect to the matching variables of age, race, or city of residence. Therefore, there would be no bias in the comparison of cases and controls caused by missing controls.

Only 23 (46%) of the 50 cases identified friends who served as controls. Because of their small number, friend controls were subsequently excluded from the statistical analysis of risk factors, but were retained as a control group for laboratory studies.

INTERVIEWS

After giving written informed consent, cases and controls were interviewed in person by a CDC physician. The same physician interviewed both a patient and all of his matched controls. Questions asked of cases concerned the period before the onset of illness; questions for a particular case's controls were matched for the same period. Topics included sociodemographic characteristics, medical history, occupational and travel history, exposure to toxic substances, use of prescription and illicit drugs, use of inhalant sexual stimulants, sexual history, and

Table 2. Frequency of Selected Variables Among 50 Homosexual Patients with Kaposi's Sarcoma and *Pneumocystis carinii* Pneumonia and 120 Homosexual Controls

Variable	Patients (Cases) ($n = 50$)	Controls	
		Clinic ($n = 78$)	Private ($n = 42$)
Sociodemographic variables			
Median duration of education, *yrs*	16	16	16
Income over $20 000 in past year, %	36	37	38
Italian, Jewish, or Eastern European ancestry, %	38	22	26
Ever married, %	18	13	7
Previous illnesses, %			
Gonorrhea	86	73	74
Syphilis	68	36	36
Mononucleosis	14	17	7
Hepatitis B	14	14	21
Non-B hepatitis	48	30	33
Parasitic diarrhea	32	15	48
Prescription medication taken during past 10 years, %			
Drugs for enteric parasites*	44	19	50
Systemic corticosteroids	10	9	17
Use of illicit substances			
Median "street" drugs used†, *n*	6	4	4
Used nitrite inhalants, %	96	96	95
Used ethyl chloride, %	50	35	38
Sexual activity			
Median male sex partners per year, *n*	61	27	25
Median proportion of sex partners from bathhouses in past year, %	50	23	4
Median age at initiating regular sex with men, *yrs*	19	20	22
Mean feces exposure score‡	2.3	1.9	1.9
Mean sperm exposure and rectal trauma score§	2.1	2.0	2.2

* Includes metronidazole, iodoquinol, paromomycin, and quinacrine.

† Includes marijuana, cocaine, heroin, amphetamines, barbiturates, LSD, methaqualone, and phencyclidine.

‡ Based on participating in the following practices at least once in the past year: interviewee inserts his penis (1 point), tongue (1 point), or hand (1 point) into partner's rectum (maximum score = 3 points).

§ Based on participating in the following practices at least once in the past year: partner inserts his penis into interviewee's mouth (1 point), or inserts his penis (1 point) or hand (1 point) into interviewee's rectum (maximum score = 3 points).

family history. Interviews lasted about 60 to 90 minutes. At the time of the interview, cases and controls were also asked to donate specimens for laboratory testing. The results of this testing are the subject of a separate report (10).

STATISTICAL ANALYSIS

The purpose of the statistical analysis was to identify those variables potentially associated with risk of disease. The method used to conduct this exploratory analysis used the principal axes method of factor analysis for data reduction (11) and a stepwise selection procedure using a linear logistic regression equation for matched data (12, 13) (*see* Appendix).

Results

The distribution of the 50 study patients by diagnosis, city of residence, and race is shown in Table 1. Cases had a mean age ($\pm$SD) of 35.1$\pm$7.3 years (range, 21 to 53 years). Of the 150 controls who were sought, the 120 who were obtained did not differ significantly from the 50 cases with respect to the matching variables of age, race, and residence.

Cases and controls were compared with respect to selected interview variables (Table 2). Based on level of education and income, cases and controls were similar in socioeconomic status. Cases, however, were more likely than controls to have Italian, Jewish, or Eastern European ancestry and to have been married.

Histories of several infectious diseases, particularly sexually transmitted infections, were common for both cases and controls. However, compared with controls, cases were almost twice as likely to have reported a history of syphilis, and cases were also more likely to have a history of hepatitis other than hepatitis B. Histories of parasitic diarrhea and treatment for enteric parasites were more frequent for cases than clinic controls, but not private controls.

The use of various illicit substances was also relatively common for both cases and controls. However, cases were somewhat more likely than controls to have reported use of one of various "street" drugs. Almost all cases and controls reported use of nitrite inhalants for sexual stimulation, but the lifetime exposure to nitrites was greater for cases than controls. We estimated lifetime nitrite use by multiplying total months of use by average number of days of use per month. For cases, the median lifetime use was 336 days, compared with 168 days and 264 days for clinic and private controls, respectively. Cases were also more likely than controls to have reported inhaling ethyl chloride, but the lifetime use of ethyl chloride by all groups was much lower than that of nitrites.

Striking differences were observed between cases and controls in the numbers of their sexual partners. For the variable "number of male sex partners per year" (number of lifetime male partners divided by years of sexual activity before the onset of illness), the median number for cases was more than twice that for controls. A difference between cases and controls was also seen in the reported number of male sex partners in the 12 months before the onset of illness. Cases had a median of 68 such partners, compared with medians of 40 partners and 30 partners for clinic and private controls, respectively. Cases were more likely to have met sex partners in bathhouses and to have begun regular (at least once a month) homosexual intercourse at an earlier age than controls.

Table 3. Significant Variables Associated with Kaposi's Sarcoma and *Pneumocystis carinii* Pneumonia Among 50 Homosexual Men as Selected by Linear Logistic Regression Analysis

Variable	Rank in Selection*		
	Grouped Factor	Ungrouped Factor	Individual Variables
Sociodemographic factors			
Italian, Jewish, or Eastern European ancestry	3	3	2
Ever married	—	2	5
Previous illnesses			
Syphilis	2	—	2
Non-B hepatitis	2	—	5
Prescription medication taken in past 10 years			
Drugs for enteric parasites	3	—	2
Use of illicit substances ever			
Number of different "street" drugs used	4	4	—
Sexual activity			
Feces exposure score	3	—	4
Sperm exposure and rectal trauma score	3	3	—
Number of male sex partners per year	1	1	1
Proportion of sex partners from bathhouses in past year	1	3	—
Age at initiating regular sex with men	—	2	2

* Highest ranking variables are most strongly associated with illness. Dash indicates that variable was not selected.

Many of the individual variables were highly correlated with each other. For example, the variable "number of male sex partners per year" was significantly correlated with 10 of the 31 other variables, including meeting partners in bathhouses ($p < 0.0001$), history of syphilis ($p < 0.0001$), use of "street" drugs ($p < 0.02$), and use of nitrite inhalants ($p < 0.001$).

Table 3 shows the significant variables associated with Kaposi's sarcoma or pneumocystis pneumonia as selected by linear logistic regression analyses of grouped factors, ungrouped factors, and individual variables. To appear in the table, variables had to be important elements (that is, a factor coefficient greater than 0.2) of the grouped or ungrouped factors selected in the logistic regression analysis. (Factors selected by the forward and backward procedures were identical.) If the variable was an important element of one type of factor but not both, it appears in the table only if it was also selected in the supplementary analysis of individual variables. For each of the three selection procedures shown in the table, variables are ranked in order of selection (that is, a variable ranked "1" is most strongly associated with illness). An equal

Table 4. Frequency of Components of Variables Significantly Associated with Kaposi's Sarcoma and *Pneumocystis carinii* Pneumonia in 50 Homosexual Patients and 120 Homosexual Controls

Variable	Patients (Cases) ($n = 50$)	Controls	
		Clinic ($n = 79$)	Private Practice ($n = 42$)
	←	%	→
Ancestry			
Italian	20	9	7
Jewish	12	8	17
Eastern European	12	12	12
Medication for enteric parasites*			
Metronidazole	25	10	29
Iodoquinol	32	15	43
Paromomycin	12	5	36
Quinacrine	14	2	14
"Street" drugs†			
Marijuana	88	89	93
Cocaine	66	51	60
Heroin	10	8	5
Amphetamines	70	46	52
Barbiturates	32	22	26
LSD	64	44	45
Methaqualone	60	41	50
Phencyclidine	44	37	38
Exposure to feces during sex‡			
Inserted penis into partner's rectum	98	95	88
Inserted tongue into partner's rectum	78	64	62
Inserted hand into partner's rectum	52	33	38
Exposure to semen or rectal trauma during sex‡			
Partner's penis in interviewee's mouth	98	99	100
Partner's penis in interviewee's rectum	94	88	95
Partner's hand in interviewee's rectum	18	13	21

* Medication taken in the past 10 years.
† Street drugs ever used.
‡ Exposure at least once in past year.

ranking of several variables means that they had approximately equal importance. All the variables shown were positively correlated with illness.

The variables most strongly associated with Kaposi's sarcoma or pneumocystis pneumonia were those related to number of male sex partners and to meeting such partners in bathhouses. The variable "number of male sex partners per year" was an important element in the highest ranking grouped factor and ungrouped factor and was also the variable selected first in the analysis of individual variables. Also strongly associated with illness was the variable "proportion of sex partners from bathhouses." Although other variables shown in Table 3 were significantly associated with Kaposi's sarcoma and pneumocystis pneumonia, they were less important than variables that directly reflected sexual activity with large numbers of male partners.

Several of the variables significantly associated with Kaposi's sarcoma and pneumocystis pneumonia were combinations of responses to different questions. To aid in the interpretation of these variables, Table 4 shows frequency distributions for the component variables used in combination for the multivariate analysis. Differences between cases and controls regarding ancestry were mainly due to the higher frequency of Italian ancestry in cases. This difference was entirely the result of a difference between patients with Kaposi's sarcoma (26% Italian ancestry) and their matched controls (9% Italian ancestry). Although the variable concerning use of medication for enteric parasites was significant, no more than one third of the cases had used any one of the drugs in the previous 10 years, and the frequency of use by cases was lower than by private controls. Cases were more likely than controls to have used various "street" drugs at least once in their lives. However, no one drug was "ever used" much more often by cases than controls. The only drug used an average of more than once a month was marijuana. Median use of marijuana was eight times per month for cases and three times for persons in each control group.

Reported frequencies of participation in sexual practices associated with possible exposure to feces, semen, or rectal trauma are also listed in Table 4. Cases were more likely than controls to have reported inserting their tongue ("rimming") or hand ("fisting") into a partner's rectum at least once during the year before onset of illness. Because cases had had more sex partners per year than controls, their total number of anal exposures was also greater than for controls. The differences are small between cases and controls in the frequency of taking the receptive role in "fisting," oral, or rectal intercourse.

As previously noted, cases had greater exposure to nitrate inhalants than controls. A variable concerning lifetime exposure to inhaled nitrates was an important element of the grouped factor ranked fourth in the linear logistic regression analysis. This variable, however, was not an important element in any of the highly ranked ungrouped factors and was not significant in the analysis of individual variables.

We asked cases and controls if they obtained nitrites as ampules (pharmaceutical grade isoamyl nitrite), labeled bottles, or unlabeled bottles. Based on an analysis of 21 samples of labeled or unlabeled organonitrites collected in New York, San Francisco, and Atlanta in 1981, the last two sources of nitrite were found to contain either isoamyl or butyl nitrite (Liddle JA, Holler JS, and Hill RH, Centers for Disease Control. Unpublished data). Cases and controls were similar with respect to the proportion of their use of nitrites from each of these three sources. For cases, the mean proportion of nitrite use from ampules, labeled bottles, and unlabeled bottles was 23%, 38%, and 39%, respectively, compared with 22%, 43%, and 35% for controls.

The same analytic procedure used to compare all 50 cases with the 120 matched controls was used to compare the 39 cases who had only Kaposi's sarcoma to their 96 matched controls. The variable most strongly associated with Kaposi's sarcoma was "number of male sex partners per year." The other significant variables were also similar to those seen for all 50 cases, although there were small differences in the relative ranks of these variables.

Discussion

In this exploratory case-control study, the element of homosexual lifestyle most strongly associated with the occurrence of Kaposi's sarcoma and pneumocystis pneumonia was a history of sexual contact with large numbers of male partners. Bathhouse attendance, which facilitates meeting large numbers of partners, was also important. Other significant risk factors included a history of syphilis and hepatitis other than hepatitis B and the use of various illicit substances. A similar lifestyle has been described in several clinical and laboratory studies of Kaposi's sarcoma and pneumocystis pneumonia in homosexual men (5, 14-16) as well as in another case-control study of homosexual men with Kaposi's sarcoma (17).

Differences between cases and controls were seen, despite intentional selection of controls from homosexually active populations and possible misclassification of some controls. Regarding selection, we found large differences in sexual activity, despite the selection of two thirds of the controls from sexually transmitted disease clinics, a group expected to have many sexual partners. Regarding misclassification, when we began this study, we assumed that a homosexual man who did not have Kaposi's sarcoma or pneumocystis pneumonia would not have acquired immunodeficiency and, therefore, could be selected as a control. Subsequent reports have shown, however, that some apparently healthy homosexual men have abnormalities of cellular immunity (18-20). We confirmed the presence of such abnormalities, defined as diminished numbers of T-helper/inducer cells or abnormal mitogen or antigen responses in a lymphocyte transformation assay, in four of the 22 controls we studied (10). If these immunologic abnormalities represent another manifestation of the acquired immune deficiency syndrome, then some of the controls may have been misclassified and may have shared the risk factors for the syndrome with the cases. This possibility is currently being evaluated. However, the expected impact of these potential problems in control selection and classification would be to minimize differences between cases and controls rather than to create false differences.

Our study was largely a study of cases with Kaposi's sarcoma rather than those with pneumocystis pneumonia. This focus was a consequence of the small number of living homosexual men with pneumocystis pneumonia when the study started. Homosexual men with Kaposi's sarcoma and pneumocystis pneumonia have similar immunologic abnormalities, although those patients with pneumocystis pneumonia alone tend to be more severely immunosuppressed (6-8, 16). Three patients had both Kaposi's sarcoma and pneumocystis pneumonia at the start of our study, and two others who had Kaposi's sarcoma at the time of their interview were subsequently reported to have developed pneumocystis pneumonia. Until a larger number of cases with pneumocystis pneumonia can be studied and analyzed separately from those with Kaposi's sarcoma, the degree of similarity in risk factors for the two diseases cannot be fully established.

Although particular lifestyle risk factors were significantly associated with the occurrence of Kaposi's sarcoma and pneumocystis pneumonia among homosexual men in this study, a specific cause of this occurrence was not identified. Sexual activity itself may result in exposure to semen. Although inoculation of syngeneic and allogeneic spermatozoa into mice has been reported to cause immunosuppression (21), this phenomenon has not been described in humans. Histories of syphilis and non-B hepatitis were significantly associated with Kaposi's sarcoma and pneumocystis pneumonia, and laboratory studies also showed a higher prevalence of antibody to *Treponema pallidum* and hepatitis A virus in cases than controls (10). Nonetheless, these findings may simply be indicators of a sexually active lifestyle, which includes large numbers of sexual partners and fecal or anal-oral exposure, rather than causal clues. Similarly, the use of illicit substances was commoner for cases than for controls. However, no one substance seemed more important than any other. This pattern of substance abuse may be another indicator of the lifestyle shared by the patients.

We were not able to confirm the findings of Marmor and colleagues (17) who reported a strong association between amyl (but not butyl) nitrite exposure and the development of Kaposi's sarcoma in 20 homosexual men in New York City. In our study, nitrite exposure emerged as a relatively unimportant variable in the multivariate analysis. Further, during pretesting of our questionnaire we found that most of the cases and controls did not specifically know if they used amyl nitrite or butyl nitrite; rather, they described their nitrite use in terms of ampules and labeled or unlabeled bottles.

The occurrence of the acquired immune deficiency syndrome in heterosexual intravenous drug abusers (7, 22, 23) and hemophiliac patients (24) has suggested the possibility that the immunodeficiency may be caused by an infectious agent transmitted through blood or blood products. Intravenous drug use was uncommon for the homosexual cases we studied. However, rectal mucosal lesions, usually including punctate bleeding points, have been reported to occur in homosexual men with persistent hepatitis B virus infection (25). Hepatitis B surface antigen can be detected in specimens taken from the lesions and in feces. Thus, parenteral transmission of infectious agents carried in blood can occur during sexual activities involving anal exposure. If an infectious agent, carried in blood, is found to play a role in the development of acquired cellular immunodeficiency, then the large number of sex partners and anal exposures seen among patients with Kaposi's sarcoma and pneumocystis pneumonia in our study would have placed them at increased risk for exposure to such an agent. The hypothesis that a sexually transmitted infectious agent plays a causative role received support from the recent description of a "cluster" of sexually related homosexual patients with Kaposi's sarcoma and pneumocystis pneumonia in southern California (26).

The apparent association of Italian ancestry with Kaposi's sarcoma in our study is of interest because of the known association of Italian ancestry and "classic" Kaposi's sarcoma of elderly men (27). Friedman-Kien and associates (16) reported that both homosexual men with

Kaposi's sarcoma and heterosexual men with "classic" Kaposi's sarcoma in New York City have an increased frequency of the HLA-DR5 antigen compared with ethnically unmatched controls. Because this HLA type is relatively common among Italians (the gene frequency is 0.199; the phenotype frequency is 0.36) (28), matching for ethnicity would be valuable in future studies to explore the source of this association.

We conclude that the occurrence of Kaposi's sarcoma and pneumocystis pneumonia in the homosexual men we have studied is associated with certain aspects of their lifestyle. Although the number of sexual partners seems to be the most important risk factor, we cannot exclude the possibility that other highly correlated variables, such as illicit drug use, play some role in the development of these illnesses. The possible risk factors identified in this study should be examined in more detail in future studies. However, the meaning of epidemiologic risk factors for Kaposi's sarcoma and pneumocystis pneumonia may not become fully clear until laboratory investigations discover the cause of the underlying acquired immunodeficiency.

Appendix

To identify variables potentially associated with risk of diseases, the data of the 50 cases designated as having Kaposi's sarcoma, pneumocystis pneumonia, or both were compared with those from the 120 controls from clinics and private practices. In addition, the variables of the subset of 39 cases with Kaposi's sarcoma and those of their controls were analyzed separately; there were too few cases with pneumocystis pneumonia or both illnesses to be analyzed separately.

The limited number of cases necessitated reducing the 130 variables on the questionnaire to a smaller number of variables for analysis. By combining variables and eliminating variables with low dispersion (for example, if all cases and controls answered "no" to a question), 32 study variables were created. To reduce further the number of variables for analysis, we used factor analysis (principal axes method) (11). Each factor is a weighted combination of variables. For interpretation of a factor, those variables with weights (coefficients) having an absolute value of 0.2 or greater were defined to be the most important elements in the factor.

Two analytic approaches were used: grouped and ungrouped factor analysis. In the first approach, grouped factor analysis, the 32 variables were classified into four categories: sociodemographic, illness and therapy, use of illicit substances, and sexual behavior. For each category of variables, a set of significant factors was selected (that is, the variance of each factor selected was greater than one). This approach facilitates the interpretation of factors, but ignores the correlation structure between variables in different categories. In the second approach, we applied ungrouped factor analysis to the entire set of 32 variables. This approach considers the correlation structure among all 32 variables, but may produce factors that are difficult to interpret. Fourteen factors were obtained using grouped factor analysis and 12 were obtained using ungrouped factor analysis.

Subsequently, a forward stepwise selection procedure using a linear logistic regression equation for matched data (12, 13) was used to select those grouped and ungrouped factors that were important in the development of Kaposi's sarcoma or pneumocystis pneumonia. Grouped and ungrouped factors were analyzed separately. First, a separate linear logistic regression equation was fitted for each factor. From each equation, the value of maximized log likelihood, a measure of the strength of association between the factor and the probability of developing illness, was determined. Once the factor with the highest maximized log likelihood had been found, separate linear logistic regression equations were fitted to all pairs of this factor and each other factor. The equation with the largest value of maximized log likelihood was selected, so that the new factor in the equation had the second strongest effect on developing illness. Adding one factor at a time, the preceding procedure was repeated until the increase in maximized log likelihood was no longer significant at the 5% level (of $\frac{1}{2}$ chi square with one degree of freedom). The final equation contained all factors significantly associated with illness; the relative strength of association was determined by the order in which the factors were selected.

For the backward selection procedure, a linear logistic regression equation was fitted to the entire set of grouped or ungrouped factors and the value of the maximized log likelihood was calculated. Then, separate equations were fitted to sets containing all but one factor. The factor absent in the set with the smallest reduction in the value of maximized log likelihood (relative to the maximized log likelihood of the entire set) was determined to be the least significant factor. The procedure was then repeated until the removal of a factor produced a reduction in the value of the maximized log likelihood which was significant at the 5% level (of $\frac{1}{2}$ chi square with one degree of freedom). The resulting set contained all factors significantly associated with illness.

Subsequently, we applied the forward selection procedure to the set of 32 individual variables. However, because of the small sample size, this analysis of individual variables is viewed as supplementary to the analysis of factors. The small sample size also prevented the use of the backward selection procedure on individual variables.

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National Case-Control Study of Kaposi's Sarcoma and *Pneumocystis carinii* Pneumonia in Homosexual Men: Part 2, Laboratory Results

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The Centers for Disease Control conducted a case-control study to investigate an outbreak of Kaposi's sarcoma and *Pneumocystis carinii* pneumonia in homosexual men. The occurrence of these diseases was found to be associated with certain aspects of lifestyle, including a greater number of male sex partners per year, exposure to feces during sex, history of syphilis and non-B hepatitis, treatment for enteric parasites, and use of various illicit substances. Laboratory studies reflected both this lifestyle and the probable underlying cause of the Kaposi's sarcoma and *P. carinii* pneumonia — cellular immune deficiency. Patients were found to have lymphopenia, specifically a deficiency of the T-helper subpopulation, resulting in a reversal of the T-helper to T-suppressor ratio. Levels of IgG and IgA were increased. When compared with controls, patients were also found to have significantly higher titers of antibody to Epstein-Barr virus and cytomegalovirus, a higher prevalence of antibody to hepatitis A virus and *Treponema pallidum,* a lower prevalence of antibody to varicella zoster virus, and a higher frequency of isolation of cytomegalovirus.

AN OUTBREAK OF Kaposi's sarcoma and various opportunistic infections has recently been identified as affecting particularly homosexual men, abusers of intravenous drugs, Haitians, and, most recently, hemophiliacs in several American cities (1-4). To better characterize the syndrome and to identify possible risk factors for the immunosuppression, malignancy, and infection in these patients, the Centers for Disease Control (CDC) conducted a case-control study in New York City, San Francisco, Los Angeles, and Atlanta in October 1981. As described in the report by Jaffe and associates (5) on the epidemiologic results of this study, patients (cases) and controls were questioned on sociodemographic status, medical history, occupational and travel history, exposure to toxic substances, use of prescription and illicit drugs, use of inhalant sexual stimulants, sexual history, sexual practices, and family history. Of these variables, the one most strongly associated with illness was a greater number of male sex partners per year. Compared with controls, "cases" were also more likely to have been exposed to feces during sex, have had syphilis and non-B hepatitis, have been treated for enteric parasites, and have used various illicit substances. The investigators concluded that the occurrence of Kaposi's sarcoma and *Pneumocystis carinii* pneumonia in homosexual men was associated with certain aspects of lifestyle seen in a subgroup of the male homosexual population.

As part of this study, biologic specimens were obtained from patients and matched controls for laboratory examination to determine the character, relative frequency, and extent of immunosuppression, and the relative frequencies of past or current infection with several microorganisms known to have infected patients in the outbreak or

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