be clear: If you haven't already tested for radon, do so now. If your indoor radon level exceeds the guidance level, remediate. If you have remediated, maintain your system properly and seek advice from local and state health officials as to how frequently retesting is warranted to ensure continued acceptable levels.

Gerald Nicholls, PhD, MS, MA
Environmental Safety, Health and Analytical Programs
New Jersey Department of Environmental Protection
Trenton, NJ

References

1. Shabecoff P. Radioactive gas in soil raises concern in three-state area. *New York Times.* May 19, 1985:1.
2. Samet JM. Radon and lung cancer. *J Natl Cancer Inst.* 1989;81:745–759.
3. Tanner AB. The source of radon in homes. In: Harley NH, ed. *Proceedings of the 24th Annual Meeting of the National Council on Radiation Protection and Measurements,* Radon 10, Washington, DC, March 30–31, 1988. Bethesda, Md: NCRPM; 1989:159–169.
4. New Jersey Department of Environmental Protection. *Statewide Scientific Study of Radon.* Trenton, NJ: New Jersey Dept of Environmental Protection; 1989.
5. Henschel DB, Scott AG. The EPA program to demonstrate mitigation measures for indoor radon: initial results. In: *Indoor Radon.* Pittsburgh, Pa: Air Pollution Control Association; 1986: 110–121.
6. US Environmental Protection Agency and US Dept of Health and Human Services. *A Citizen's Guide to Radon: What It Is and What to Do About It.* Washington, DC: US Environmental Protection Agency. EPA publication 86–004.
7. *Radon Reference Manual.* Washington, DC: US Environmental Protection Agency; 1987. EPA publication 520/1-87-20.
8. Nicholls GP, Deieso DA. New Jersey: involving the commercial sector. *Environment.* 1987; 29(2):34–37.
9. *Congressional Hearings on Radon and Indoor Air Pollution, Before the House of Representatives Subcommittee on Natural Resources, Agriculture and Environment, Committee on Science and Technology,* October 10, 1985 (EPA response to additional questions p 275).
10. Nicholls GP. Comparison of natural and man-made exposures to nuclear radiation in New Jersey. Paper presented at: American Nuclear Society Topical Conference: Radiological Effects on the Environment Due to Electricity Generation; July 19, 1988; New Brunswick, NJ.
11. Office of Radiation Control Program Directors. *Summary of State Radon Programs.* Washington, DC: US Environmental Protection Agency; 1987. EPA publication 520/I-87-19-1.
12. National Academy of Sciences, National Research Council. *Biological Effects of Ionizing Radiation, IV: Health Risks of Radon and Other Internally Deposited Alpha Emitters.* Washington, DC: National Academy Press; 1988.
13. Cohen BL. Relationship between exposure to radon and various types of cancer. *Health Physics.* 1993;65:529–531.
14. Cohen BL. A national survey of 222-Rn in US homes and correlating factors. *Health Physics.* 1986;51:175–183.
15. Cohen BL. Expected indoor radon levels in counties with very high and very low lung cancer rates. *Health Physics.* 1988;57:897–903.
16. Cole L. *Element of Risk: The Politics of Radon.* Washington, DC: AAAS Press; 1993.
17. Lubin JH, Samet JM, Weinberg C. Design issues in epidemiological studies of indoor exposure to radon and risk of lung cancer. *Health Physics.* 1990;59:807–817.
18. National Academy of Sciences, National Research Council. *Biological Effects of Ionizing Radiation, VI: Health Effects of Exposure to Radon.* Washington, DC: National Academy Press; 1998.
19. Alavanja MCR, Lubin JH, Mahaffey JA, Brownson RC. Residential radon exposure and risk of lung cancer in Missouri. *Am J Public Health.* 1999;89:1042–1048.
20. US Environmental Protection Agency. *A Citizen's Guide to Radon.* 2nd ed. Washington, DC: 1992. EPA publication 402-K92-001.

Elimination and Reintroduction of a Sexually Transmitted Disease: Lessons to Be Learned?

At a time when the reported incidence of most sexually transmitted diseases (STDs) in the United States is on the decline,[1] the annual incidence of reported primary and secondary syphilis is at its lowest level since World War II,[1] and the Centers for Disease Control and Prevention are initiating a campaign to eliminate syphilis from the United States,[2] the article by Williams et al.,[3] published in this issue of the journal, points to several rather disturbing patterns and trends and offers some important lessons.

The article by Williams et al.[3] is one of many that report on increases in unsafe sexual behaviors among men who have sex with men—a potentially alarming behavioral change. In San Francisco, Calif, the proportion of surveyed men who reported having had anal sex with men increased from 57.6% in 1994 to 61.2% in 1997. Among this group, the proportion reporting "always" using condoms declined from 69.6% in 1994 to 60.8% in 1997, and the proportion of men who reported having had multiple male sex partners and unprotected anal intercourse increased from 23.6% in 1994 to 33.3% in 1997.[4] Other researchers have documented similar increases in unsafe sexual behaviors among men who have sex with men, in response to perceived recent advances in therapeutic options.[5,6,7]

Aggregate increases in unsafe behavior among gay men may result from a number of factors, including the introduction of new cohorts of younger men into the sexually active population; the existence of gaps in the coverage of preventive interventions, particularly among ethnic minorities; and relapse into unsafe behaviors among those who had previously adopted safer practices. Available data support all 3 of these hypotheses: researchers have documented increases in unsafe sexual behavior among young gay men,[8,9] as well as disproportionately higher proportions of ethnic minorities among men who engage in risky homosexual behaviors[10,11] and reductions in safer sex practices because of the perception that AIDS is no longer as big a threat as it used to be[7] (R. Y. Barrow et al., unpublished data, 1999).

In several cities, including Seattle, Wash, increases in unsafe sexual behaviors among men who have sex with men have been associated with increased incidence and/or prevalence of one or more STDs, including HIV infections. In Chicago, Ill, comparisons of the demographics of primary and secondary syphilis cases reported in 1998 with those reported in 1997 revealed that in 1998, men who have sex with men emerged as an important factor for syphilis transmission, changing the epidemiology and demographics of primary and secondary syphilis in this city (C. A. Ciesielski, H. A. Beidinger, unpublished data, 1999). In San Francisco, the increases in unsafe sexual behaviors among men who have sex with men, described above, were accompanied by

Editor's Note. Please see related brief by Williams et al. (p 1093) in this issue.

increases in male rectal gonorrhea.[4] From 1994 through 1997 the incidence of rectal gonorrhea increased from 21 to 38 cases per 100 000 adult men; the increase was highest among men aged 25 to 34 years (from 41 to 83 cases per 100 000).[4] In Washington, DC, between 1993 and 1996 the annual number of clinic patients with gonorrhea increased by 93%, from 72 to 139 (R. Y. Barrow et al., unpublished data, 1999). This increase was associated with increases in unsafe sexual behaviors among men who have sex with men and with perceived decreased concern about acquiring HIV infection because of advances in antiretroviral therapy (R. Y. Barrow et al., unpublished data, 1999).

Interactions between STD and HIV epidemics have been well documented in the literature.[12] The overlap between gonorrhea infections and HIV infections observed in Washington, DC (R. Y. Barrow et al., unpublished data, 1999) and the overlap between syphilis and HIV infections observed in Seattle[3] are 2 recent examples of the interplay between STD and HIV epidemics in communities. Increases in unsafe sexual behaviors and non-HIV STDs among men who have sex with men raise concerns regarding future HIV trends in the United States. In the context of the high prevalence of unsafe behaviors, other STDs, and HIV, small increases in unsafe behaviors and other STDs may result in important increases in the incidence of HIV infection.[4]

The Reproductive Rate of Infection and Consequences of Interventions

The recent increases in unsafe sexual behaviors among men who have sex with men and the related increases in STD incidence highlight the importance of focusing on the long-term impact of risk reduction interventions. Recently, Kelly eloquently argued that ". . . one-shot face-to-face interventions, even when capably undertaken, are unlikely to be sufficient to help people durably sustain changes in behavior practices as strong and complex as sexuality and drug use," and that long-term maintenance of preventive behaviors necessitate support from peer group social norms, relationships, the environment, and public health policies.[13] Sustainability of desirable changes in individual behaviors may depend on sustained implementation of interventions at the level of the social structure.

In addition, many interventions lead to unintended and often unexpected consequences.[14,15] The increase in unsafe behaviors among gay men, in part in response to news regarding antiretroviral therapy[7] (R. Y. Barrow et al., unpublished data, 1999), is an example of such consequences. It is increasingly clear that the 3 components of the reproductive rate of infection—the probability of transmission, the probability of exposure between infected and susceptible individuals, and the duration of infection—are not independent of each other but, rather, highly interactive.[16] Changes in one of the components lead to changes in other components, perhaps because each of these components is subject to at least partial control by the individual. Thus, it is important to consider the impact, on both risk behaviors and health outcomes, of interventions targeting transmission probability, probability of exposure between infected and susceptible individuals, and duration of infection.

Phases of Epidemics and Sexual Networks

The study of elimination and reintroduction of primary and secondary syphilis in Seattle showed that characteristics of persons with primary and secondary syphilis varied across epidemic spread, elimination, and reintroduction periods.[3] There were significant differences between cases during the various epidemic phases with respect to age, sex, ethnicity, drug use, and involvement with commercial and anonymous sex. This finding has important implications for STD prevention programs, suggesting that the evolution of STD epidemics needs to be monitored closely and that intervention strategies need to be adjusted periodically in response to the evolving characteristics of epidemics.[16] Furthermore, Williams and colleagues report that during all 3 phases of the primary and secondary syphilis epidemic in Seattle, imported cases differed from locally acquired cases with respect to age, sex, ethnicity, and drug use behaviors.[3] Differences between imported and locally acquired cases, in conjunction with the increasing proportion of imported cases, highlight the importance of retargeting prevention efforts to changing subgroups of the population as epidemics evolve.

Examination of the specific subpopulations involved in the recent epidemics of primary and secondary syphilis reported from different areas across North America suggests that there are a number of different syphilis epidemics, evolving in different subgroups, each with their own distinct dynamics. Some of these epidemics have involved younger gay men; others have involved drug-using heterosexuals or ethnic minorities[3] (R. Y. Barrow et al., unpublished data, 1999; C. A. Ciesielski, H. A. Beidinger, unpublished data, 1999). These variations across local areas highlight the need to understand the local epidemiology and adjust intervention strategies accordingly.

The increasing proportion of imported cases with different characteristics, observed during later phases of epidemics, also have implications for expanding the geographic scope of STD prevention efforts, particularly during elimination phases of epidemics. Recent work being conducted in Manitoba, Canada, on sexual networks involved in the transmission of chlamydial and gonococcal infection[17,18] allows us to compare geographic approaches and sexual network approaches in preventing the spread of these sexually transmitted infections. Findings from these studies indicate that during later phases of STD epidemics, the majority of sexual networks involved in the epidemic are not restricted to one geographic area[17]; frequent contact between network members from a small group of northern reserves and individuals in the major southern population center of Winnipeg have formed bridges of transmission between these communities.[17] In an analysis of types of *Neisseria gonorrhoeae* and sexual networks, geography was found to be less sensitive than sexual networks as a marker for organism type, with 19% of individuals in the related networks having residences that differed from the predominant community.[18] These recent analyses of sexual networks suggest that, particularly during the introduction, elimination, and reintroduction phases of epidemics, when local transmission of pathogens involves relatively small numbers of people, it may be important to study the mobility patterns of the population and their sexual networks and to expect that the persons important to the spread of infection would have characteristics unlike those who spread infection during phases of epidemic and endemic spread.

Conclusions

As rates of many STDs decline and remain low in local areas in the United States, we have a unique opportunity to refine our understanding of the transmission dynamics of distinct STDs and the intervention strategies appropriate for their prevention. Recent interest in the role of sexual networks in STD transmission dynamics, as it evolves through distinct phases in the evolution of STD epidemics,[3,16–19] may be particularly helpful in defining phase-appropriate intervention strategies to be employed in STD prevention. As we enter an era in which one or more STDs may be eliminated in the United States and North America, the real challenge to

evidence-based prevention efforts will involve the establishment of the right balance between targeted and universal approaches, geographic and network-based techniques, and local and global strategies.

Sevgi Aral, PhD
Division of STD Prevention
Centers for Disease Control
and Prevention
Atlanta, Ga

References

1. Division of STD Prevention. *Sexually Transmitted Disease Surveillance, 1997*. Atlanta, Ga: Centers for Disease Control and Prevention; September 1998.
2. St. Louis ME, Wasserheit JN. Elimination of syphilis in the United States. *Science*. 1998; 281:353–354.
3. Williams LA, Klausner JD, Whittington WLH, Handsfield HH, Celum C, Holmes KK. Elimination and reintroduction of primary and secondary syphilis. *Am J Public Health*. 1999;89: 1093–1097.
4. Centers for Disease Control and Prevention. Increases in unsafe sex and rectal gonorrhea among men who have sex with men—San Francisco, California, 1994–1997. *MMWR Morb Mortal Wkly Rep*. 1999;48(3):45–48.
5. Dilley JW, Woods WJ, McFarland W. Are advances in treatment changing views about high-risk sex? *N Engl J Med*. 1997;337: 501–502.
6. Kalichman SC, Nachimson D, Cherry C, Williams E. AIDS treatment advances and behavioral prevention setbacks: preliminary assessment of reduced perceived threat of HIV-AIDS. *Health Psychol*. 1998;17:546–550.
7. Kelly JA, Hoffmann RG, Rompa D, Gray M. Protease inhibitor combination therapies and perceptions of gay men regarding AIDS severity and the need to maintain safer sex. *AIDS*. 1998;12(10):F91–F95.
8. Dean L, Meyer I. HIV prevalence and sexual behavior in a cohort of New York City gay men (aged 18–24). *J Acquir Immune Defic Syndr Hum Retrovirol*. 1995; 8:208–211.
9. Hays RB, Paul J, Ekstrand M, Kegeles SM, Stall R, Coates TJ. Actual versus perceived HIV status, sexual behaviors and predictors of unprotected sex among young gay and bisexual men who identify as HIV-negative, HIV-positive and untested. *AIDS*. 1997;11:1495–1502.
10. Carballo-Dieguez A, Dolezal C. HIV risk behaviors and obstacles to condom use among Puerto Rican men in New York City who have sex with men. *Am J Public Health*. 1996;86:1619–1622.
11. Peterson JL, Coates TJ, Catania JA, Middleton L, Hilliard B, Hearst N. High-risk sexual behavior and condom use among gay and bisexual African-American men. *Am J Public Health*. 1992;82:1490–1494.
12. Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sex Transm Infect*. 1999;75:3–17.
13. Kelly JA. Community-level interventions are needed to prevent new HIV infections [editorial]. *Am J Public Health*. 1999;89:299–301.
14. Aral SO, Peterman TA. Measuring outcomes of behavioural interventions for STD/HIV Prevention. *Int J STD AIDS*. 1996;7(suppl 2):S30–S38.
15. Aral SO, Peterman TA. Do we know the effectiveness of behavioral interventions? *Lancet*. 1998;351(suppl 3):33–36.
16. Wasserheit JN, Aral SO. The dynamic topology of sexually transmitted disease epidemics: implications for STD prevention strategies. *J Infect Dis*. 1996;174(suppl 2):S201–S213.
17. Jolly AM, Matusko P, Wylie J. Sexual contact networks and chlamydia transmission in Manitoba, Canada. Paper presented at: Sunbelt XIX: International Sunbelt Social Network Conference; February 18–21, 1999; Charleston, SC.
18. Wylie J, MacLean I, Brunham R, Craig C, Jolly AM. Gonorrhea types and sexual networks in Manitoba, Canada. Paper presented at: Sunbelt XIX: International Sunbelt Social Network Conference; February 18–21, 1999; Charleston, SC.
19. Potterat JJ, Zimmerman-Rogers H, Muth SQ, et al. Chlamydial transmission: concurrency, reproduction number and the epidemic trajectory. *Am J Epidemiol*. In press.