PREFACE

Acquired immunodeficiency syndrome (AIDS) was first identified as a distinct new disease syndrome in 1981 in the United States. In 1983 the human immunodeficiency virus (HIV) was identified as the causative agent for AIDS. There are several rather unusual aspects of HIV and AIDS which make this new disease different from previous diseases. For example, the mean time from HIV infection to AIDS is approximately 10 years, which is much longer than the infectious periods of less than 10 days for measles, mumps and chicken pox. Moreover, because HIV infected individuals do not recover, they continue to be infectious throughout their lives. Modeling approaches have been useful in analyzing previous infectious diseases, so it is natural to use models to study the epidemiology of HIV/AIDS.

This monograph describes the results of a project to use mathematical modeling and computer simulations to analyze HIV transmission dynamics and AIDS in various risk groups in the United States (U.S.). This research project started in 1987 and has been supported by contract 200–87–0515 from the Division of HIV/AIDS, Center for Infectious Diseases, Centers for Disease Control (CDC), Atlanta, Georgia. Although some results have been described in journal articles (Hethcote, 1987; Hethcote, 1989; Hethcote, Van Ark and Longini, 1991; Hethcote, Van Ark and Karon, 1991; Hethcote and Van Ark, 1992), many results in this monograph have not appeared before or have only appeared in reports to CDC. Our modeling approach to HIV/AIDS has been similar to the approach to gonorrhea (Hethcote and Yorke, 1984); namely, to use simple models to answer specific questions and to emphasize conceptual understanding through reconstruction of the HIV epidemics. A detailed discussion of the purposes and limitations of epidemiological modeling is given in Section 1.6.

The epidemiology of HIV/AIDS and general aspects of modeling HIV/AIDS are described in Chapter 1. The model formulated in Chapters 2 and 3 is analyzed mathematically in Chapter 4 and applied to the population of homosexual/bisexual men in San Francisco in Chapters 5 and 6. This group has been chosen as the first population to be analyzed because there is more information available on HIV/AIDS in these homosexual men than for any other group in the world. This model is expanded in Chapter 7 to encompass the five major risk groups in the U.S. It is shown in Chapter 8 that the HIV epidemics in homosexual men and intravenous drug users (IVDUs) are not crucially linked by homosexual IVDUs so that they can be modeled as separate epidemics. Chapter 9 considers relationships between AIDS incidence data in related risk groups and racial/ethnic groups in the Northeast region of the U.S. and its subregions. In Chapter 10 the modeling approach is used to compare HIV and AIDS in the five major risk groups in 15 subregions of the U.S. and then the similarities and differences revealed by these comparisons are discussed.

Because some injections (e.g., steroids) are not intravenous, the term *intravenous drug user* or IVDU has been changed in some recent publications to *injecting drug user* or IDU. Moreover, the term *homosexual/bisexual men* has recently often been replaced by *men who have sex with men.* Since much of the work presented here was done before the terminology changed, we have

not converted to the new terms. If the reader prefers the new terminology, then the reader can mentally convert the old terms to the new terms throughout this manuscript.

As described in Section 1.4, AIDS is a worldwide problem, so it would be desirable to extend the modeling approach used here to other continents and countries. Some aspects of the model developed here would be useful for other countries, but other aspects would not. In the U.S. the dominant modes of transmission are through homosexual contact and needle–sharing between IVDUs. In many other parts of the world the dominant mode of transmission is through heterosexual contact. Here we have focused on HIV/AIDS in the U.S. since better AIDS incidence data is available in the U.S. than in most other countries.

We hope that the mathematical modeling and computer simulations of HIV/AIDS in this monograph will be useful to epidemiologists, scientists, mathematicians and students who are interested in the epidemiology of HIV/AIDS or in how modeling can contribute to the understanding of disease transmission in populations. Modeling has become a widely used tool in epidemiology. One indication of the increased importance of epidemiological modeling is the workshop, "A National Effort to Model AIDS Epidemiology", held at Leesburg, Virginia on July 25–28, 1988, which was sponsored by the Office of Science and Technology Policy, Executive Office of the President of the U.S. (OSTP, 1988).

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