INFECTION

prevention and control

SECOND EDITION

Elaine C. Dubay • Reba D. Grubb

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To all who have helped through knowledge or patient care
to improve the practice of infection prevention and control
in hospitals and related institutions.

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Reba Douglass Grubb

Preface

Many diseases probably existed millions of years before man inhabited the earth. With the progress of civilization, *man's* contact with *man* has been the prime factor in the spread of disease. From his earliest days he has tried a variety of methods, often cruel and not always successful, to prevent, cure, and control disease. As man has learned to cure a particular disease or to correct one problem by surgery, he has sometimes unintentionally created another. It was true that all too often the operation was a success but the patient died of a secondary infection. Man's greatest steps forward in battling infection have come with the administration of direct patient care and control of the patient's environment.

The sign of Apollo, which citizens of ancient Greece placed on their doors, gave little protection against the diseases that came from the filth in which they lived and the contaminated water that they drank. Protection became a reality only when they cleaned up their environment and their water supply.

Today, the processes of pasteurization, sterilization, and purification do their share to prevent and control infection. The daily routine measures of prevention and control taken by the general public are generally effective when consistently used, but they are not enough in hospitals and other health facilities. Infection is a problem in this environment as it is nowhere else. The ill, the newborn, and the geriatric are more susceptible to infection because they have less resistance. The same germs that may be harmless or of minor consequence to a well-functioning person may cause serious setbacks and even death in the patient with low resistance. In the mid-1800's the risk of postoperative infection in the hospital was so great that Sir James Simpson, the discoverer of chloroform, observed that the man lying on the operating table in one of the surgical hospitals was exposed to a greater risk of death than was the English soldier on the field at Waterloo. Dr. Charles Bell, a distinguished nineteenth century Edinburgh surgeon, went so far as to call the hospital "the house of death." He believed that a physician gave his patients a better chance of recovery by hurrying them out of the hospital to a fresher, cleaner environment.

Health facilities will probably never be completely free of infection because they exist to administer to the ill. Disease and infection are ever present, and for this reason every effort must be made to keep the institutional environment as germ-free as possible. In no other way can the patients who must temporarily live in this environment or the staff administering to their needs be protected from the spread of infection.

Prevention and control of the spread of infection demand a relentless battle and constant attention. Primitive man was not far amiss in his belief that illness was caused by the entrance of evil spirits or devils into a person's body, since disease germs can be "devils" in their actions. They are prepared to take advantage of every opportunity to perform their deadly work.

In this text, the discussion of the battle against infection in the institutional environment is divided into two areas: prevention and control. There is, as there should be, some overlapping of these areas. The division is somewhat arbitrarily made in an effort to point out and deal with the problem of infection in every facet of the organization.

Prevention as defined in this book has two goals: first, it aims at protecting the uninfected patient from any disease or infection; second, it tries to forestall in the patient any increase in preexisting infection of a noncommunicable nature.

Control as defined in this book has the following goals: to check the spread of a preexisting communicable or infectious disease to other patients, visitors, or personnel; to limit the disease so that it does not become more serious in the patient already infected with a communicable disease; and to keep the highly susceptible patient with no present disease from becoming infected.

The goal of prevention and control is reached through specific and general policies and procedures. A *policy* is practical wisdom—any governing principle, plan, or course of action. A *procedure* is the action taken or the manner of accomplishing this course of action; it is the step, or steps, taken to proceed. The elements of policies and procedures are interrelated and must work together.

Policies and procedures for prevention and control of disease and infection are not an innovation. Early examples, although strange to us, were apparently logical to those who determined and used them. Although sometimes extreme and ineffective, they were at least efforts at prevention and control and showed that the need for such measures existed.

During the plague of the early eighteenth century, the policy of prevention was to remove the patient, who was considered to be the source of infection, to a field where he would either recover or die. Those who cared for the patient were then isolated for 10 days after the patient either died or recovered.

The people of that time believed that the foul air caused spread of the plague. Physicians courageous enough to care for the sick protected themselves as best they could with gowns, masks, and gloves. They were attired in helmets, long robes, and heavy gauntlets. Their faces were protected with large glasses and a respirator, resembling a long beak, filled with aromatic herbs.

Protective garb dating from 1721. Redrawn from a plate of the frontispiece from *Relation de la peste de Marseilles, Plague of Marseilles,* 1721.

The aftermath of the San Francisco earthquake in 1906 was a chaos of death, injury, disease, and destruction. The fear of a typhoid epidemic was very real with the dead and dying lining the streets. Food, water, and shelter were scarce, and most available supplies were contaminated. Strict ordinances (or policies) were enforced by the military. The procedure was extreme and unbending; anyone disobeying the rules was shot.

Today, health facilities, regardless of the size and structure, are less extreme in their approach to enforcing policies of prevention and control. Instead of fear and punishment they have established a good, strong system of knowledge through education. These programs of infection control and prevention are further reinforced through written up-to-date policies and procedures that are made available to every staff member of the health care facility.

We believe that this emphasis on education will keep the threat of disease at a minimum. Strict adherence to these policies and procedures is a must for all personnel, medical staff, students, and visitors. Only when we have full cooperation can the prevention and control of infection be achieved. The title of the surveillance person varies with the individual hospital. Such titles as nurse epidemiologist, surveillance officer, and infection control: specialist, practitioner, nurse clinician, or coordinator are presently being used. For clarity in the book we are using the title of infection control coordinator to identify the surveillance person.

It is not possible for the text to be all-inclusive on the subject of infection prevention and control; rather the text is intended as a guide to provide the reader with an overview of the various aspects of the subject. The section on education should prove helpful to the infection control coordinator and to those who are responsible for orienting new persons to the hospital or for

implementing programs for the continuing education of experienced personnel. The information on meeting the emotional needs of the isolation patient should prove especially valuable to those who work directly with this special patient.

We hope that the suggested readings included will help readers continue to update their information and stimulate them to seek out current, supportive medical reference books and journals.

We are indebted to many friends and colleagues who have contributed helpful comments, criticisms, and suggestions.

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Contents

CHAPTER ONE

Microorganisms and infection

Although health care professionals possess a background in the study of microorganisms and their relation to human disease, a brief review of the most familiar microorganisms should prove helpful in the development of an infection prevention and control program.

That man cannot live in a sterile environment for a long period of time without severe consequences was discovered over a century ago by Louis Pasteur (1822-1895) and his colleagues. The years between 1882 and 1910 have been described as the golden age of microbiology. It was during this period that most of the pathogenic organisms were identified, making it possible to prevent and control many infections and diseases.

Microbiology is a science that studies the nature, morphology, physiology, composition, and reproduction of microscopic living things. Within its scope are the subspecialties of bacteriology (bacteria), virology (viruses), mycology (fungi), protozoology (protozoa), parasitology (parasites), and immunology (serology).

BACTERIA

In this review emphasis is being placed on bacteria, since these organisms are the major contributors to infection and disease as they relate to the health facility environment.

Optimum conditions

Bacteria, like any living organism, need certain conditions for growth, reproduction, and maintenance of life. Several factors influence the well-being of bacteria.

1. *Growth cycle* (Fig. 1-1). Bacteria have a growth cycle, just as mankind has stages of life. A tube of fresh liquid medium, with an inoculum of x number of organisms, provides proper conditions for growth through several phases of the cycle.
   a. The *lag phase* represents a period of adaptability to the new environment so that new growth can be initiated.

□ Contributed by Mary L. Fried.

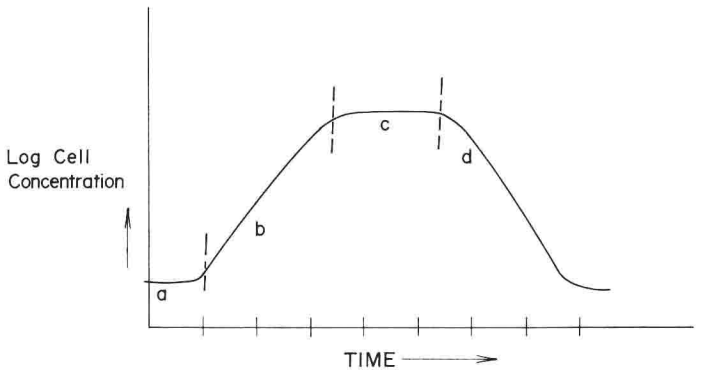

Fig. 1-1. Phases of bacterial growth cycle.

b. In the *exponential phase* new cell material is being produced, and the multiplication of new cells occurs at an exponential rate until the nutrients become exhausted or metabolic substances that inhibit growth are produced.
c. In the *stationary phase* there is a reduction of growth to a point where a minimum number of cells are produced and a corresponding number of cells begin to die, so that the overall number of cells remain constant.
d. During the *death phase* nutrients are exhausted and toxic metabolic waste products have accumulated; therefore growth declines. Cells die at an increasing rate until only a few cells remain viable.

The time of the cycle depends on the organism; some organisms undergo a complete growth cycle in a matter of hours, whereas others may need several days.

2. *Temperature.* For each bacterial species there is a temperature at which the organism grows best. The largest group of bacteria are termed mesophiles (moderate temperature lovers). They include organisms that live in or attack the human body; their best growth occurs between 20° and 43° C. The psychrophilic (cold-loving) organisms grow best at temperatures below 15° C. Thermophiles (heat-loving organisms) grow at temperatures of 45° C. and over. For most pathogenic bacteria the optimal temperature is 35° to 37° C. Since organisms have the ability to grow in a wide range of temperatures, they may be found in any environment.

3. *pH.* pH is a concentration symbol that indicates the acidity or alkalinity of a solution. Most pathogenic organisms grow best in a solution with a neutral pH of 7. Few organisms grow in an acid pH under 5 or in an alkaline pH above 8.