Circadian Rhythm and Environmental Determinants of Blood Pressure Regulation in Normal and Hypertensive Conditions

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INTRODUCTION

Modern medicine emphasizes the concept of homeostasis, constancy of the intern milieu. Accordingly, it is assumed that biological functions and processes are relatively stable during the 24 h and other time periods and that the exacerbation of disease and risk of severe clinical events are of equal probability each hour of the day and night, day of month, and month of year. Also, it is taken for granted that the kinetics and effects of medications are independent of the time of day when they are ingested, inhaled, injected, or infused. The concept of homeostasis as proposed by Claude Bernard in France in the 19th century and elaborated upon by Walter Cannon in the United States early in the 20th century was deduced from studies performed primarily during the daytime. In their eras, the assessment of biological parameters repeatedly at more than a single time of day was not generally feasible. The laboratory techniques of yesteryear necessitated the withdrawal of very large volumes of blood to determine the concentration of hormones and other constituents. Moreover, instrumentation enabling around-the-clock measurement of physiologic variables had not yet been invented. Today, modern laboratory methods require sometimes minute amounts of blood, and ambulatory devices facilitate the monitoring of a variety of variables, such as activity, body temperature, blood pressure, heart rate, and brain activity, continuously throughout the 24 h. The findings of investigations employing this technology invariably reveal that biological functions and processes are anything but constant. Rather, they document a prominent genetically based time structure consisting of rhythms with periods as short as a second or less to as long as a year (1–3). The majority of practitioners and even academic investigators know very little about biological rhythms. This chapter first discusses the fundamental properties of biological rhythms and biological timekeeping. It provides an in-depth discussion of the role of circadian (24-h) rhythms in blood pressure (BP) regulation and day–night patterns in common cardiovascular (CV) diseases.

MEDICAL CHRONOBIOLOGY: BASIC CONCEPTS AND PRINCIPLES

A biological rhythm is a self-sustaining oscillation that is defined by a set of specific attributes—period, amplitude, and phasing. The period is the duration of time required to complete a single repetition of the rhythm. If the period is close or equal to 24 h, it is termed a circadian rhythm. Ultradian rhythms have periods shorter than 20 h, and infradian rhythms have periods greater than 28 h. The temporal patterns of electrical impulses of the brain and heart are illustrative examples of rhythms of very short period, and menstrual and seasonal patterns are familiar examples of rhythms with long periods.