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CLINICAL REVIEW

Diurnal and twenty-four hour patterning of human diseases: Cardiac, vascular, and respiratory diseases, conditions, and syndromes

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SUMMARY

Various medical conditions, disorders, and syndromes exhibit predictable-in-time diurnal and 24 h patterning in the signs, symptoms, and grave nonfatal and fatal events, e.g., respiratory ones of viral and allergic rhinorrhea, reversible (asthma) and non-reversible (bronchitis and emphysema) chronic obstructive pulmonary disease, cystic fibrosis, high altitude pulmonary edema, and decompression sickness; cardiac ones of atrial premature beats and tachycardia, paroxysmal atrial fibrillation, 3rd degree atrial-ventricular block, paroxysmal supraventricular tachycardia, ventricular premature beats, ventricular tachyarrhythmia, symptomatic and non-symptomatic angina pectoris, Prinzmetal vasospastic variant angina, acute (non-fatal and fatal) incidents of myocardial infarction, sudden cardiac arrest, in-bed sudden death syndrome of type-1 diabetes, acute cardiogenic pulmonary edema, and heart failure; vascular and circulatory system ones of hypertension, acute orthostatic postprandial, micturition, and defecation hypotension/syncope, intermittent claudication, venous insufficiency, standing occupation leg edema, arterial and venous branch occlusion of the eye, menopausal hot flash, sickle cell syndrome, abdominal, aortic, and thoracic dissections, pulmonary thromboembolism, and deep venous thrombosis, and cerebrovascular transient ischemic attack and hemorrhagic and ischemic stroke. Knowledge of these temporal patterns not only helps guide patient care but research of their underlying endogenous mechanisms, i.e., circadian and others, and external triggers plus informs the development and application of effective *chrono*preventive and *chrono*therapeutic strategies.

Introduction

The activity/rest circadian rhythm is fundamental to sleep medicine, with insomnia, parasomnias, obstructive apnea, and other such disorders manifested specifically during repose. Circadian rhythms, which are orchestrated by a central brain clock in coordination with peripheral clocks [1,2], are also highly relevant to other, if not all, medical specialties. Indeed, astute early medical practitioners were not only knowledgeable of diurnal and 24 h patterns in the symptom intensity of and death from various diseases but the need to properly time therapy to achieve optimal outcomes [3,4].

The subject of this and our companion paper [5] is diurnal and 24 h patterning in the symptom intensity of acute and chronic medical diseases, conditions, and syndromes, other than sleep disorders that are well reported in this and other sleep journals, and of grave nonfatal and fatal events. PubMed and other relevant databases were searched for publications in all languages, entering 'circadian rhythm in disease' and specific diseases or medical conditions paired with the terms 'circadian', 'diurnal', 'nocturnal', or 'time-of-day'. Additionally, books devoted to human and clinical chronobiology and publications of medical chronobiologists with known research interest in disease time patterns were reviewed. Only reports pertaining to non-hospital investigations are cited,

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[1] This article is dedicated to Dr. Erhard Haus, a close colleague and internationally renowned pioneer of medical chronobiology, who passed away prior to its completion.

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Abbreviations

AAD	acute artery dissection
ABPM	ambulatory blood pressure monitoring
ACLI	acute critical limb ischemia
ACPE	acute cardiogenic pulmonary edema
AMI	acute myocardial infarct
AH	acute hypotension
AHI	acute hypotension intolerance
AP	angina pectoris
AR	allergic rhinorrhea
ARO	arterial retinal occlusion
AV	atrioventricular
BP	blood pressure
CBVD	cerebrovascular disease
CCA	cardiogenic cardiac arrest
CF	cystic fibrosis
CHF	chronic heart failure
CME	cystoid macular edema
COVI	chronic occupational venous insufficiency
COPD	chronic obstructive pulmonary disease
CVD	cardiovascular disease
DBP	diastolic blood pressure
DCS	decompression sickness
DVT	deep vein thrombosis
GERD	gastroesophageal reflux
HAPE	high altitude pulmonary edema
HS	hemorrhagic stroke
IBSDS	in-bed sudden death syndrome
IC	intermittent claudication
ICU	intensive care unit
IHD	ischemic heart disease
IS	ischemic stroke
NA	nocturnal asthma
PA	Prinzmetal angina
PAF	paroxysmal atrial fibrillation
PSVT	paroxysmal supraventricular tachycardia
PT	pulmonary thromboembolism
PUD	peptic ulcer disease
SBP	systolic blood pressure
SCCD	sickle cell circulatory disorder
SCD	sudden cardiac death
SIDS	sudden infant death syndrome
TIA	transient ischemia attack
TTC	Takotsubo cardiomyopathy
VPB	ventricular premature beats
VRO	venous retinal occlusion
VTA	ventricular tachyarrhythmia
VR	viral rhinorrhea

since life-extending care plus abnormal light–dark environments and atypical sleep-wake routines of hospital wards are likely to alter or disrupt circadian time structure and give rise to non-representative findings. Our thorough, although not exhaustive, literature search uncovered a far greater number of publications (>500) and disease states/medical conditions (>100) than anticipated. In keeping with journal guidelines, only selected findings are reported in two complementary articles, this one addressing temporal patterns in cardiac, vascular, and respiratory diseases and the second other common and uncommon diseases [5].

A variety of methods has been utilized to assess temporal patterns of acute and chronic ailments. Cardiac arrhythmias were explored by around-the-clock electrocardiographic Holter monitoring and retrieval of time-stamped data from implanted cardioverter defibrillator devices, and investigation of day–night variation of systolic and diastolic blood pressure (SBP and DBP) was accomplished by 24 h ambulatory blood pressure monitoring (ABPM) studies. Research of intraday differences in respiratory and most other chronic diseases relied on retrospective recall of clock-time phenomena or prospective diary, self-rating, and self-measurement protocols to gather data during the diurnal wake span, but seldom overnight, one or more days. Research of day–night patterns in grave non-fatal and fatal events primarily relied on databases containing clock time of: telephone calls requesting emergency ambulance service, symptom onset of persons presenting to hospital emergency departments, incidents of enrollees in medical registry trials, and demise recorded on death certificates. Generally, results were reported per clock-hour interval as group means in symptom intensity studies and number of incidents in acute event ones. The clock time of most and least severe symptoms and highest and lowest frequency of grave events are communicated herein as group phenomena.

Cardiac arrhythmias

Findings of time-of-day investigations of certain cardiac arrhythmias are inconsistent, perhaps the consequence of confounding by co-morbid conditions, particularly neurologic ones that affect the autonomic nervous system, and unknown timings of alcohol, caffeine, and illicit (e.g., cocaine) and prescribed (e.g., sympathomimetic, calcium channel blocker, etc.) drug intake.

Atrial arrhythmias

Benign cardiac arrhythmia syndromes are much less researched than serious ones; however, several Holter investigations report atrial premature beats and tachycardia manifest more frequently during diurnal activity than nighttime sleep [6]. A large case study of new-onset paroxysmal atrial fibrillation (PAF) reveals group bimodal 24 h variation, with morning and nighttime peaks, apparently representative of two different patient subtypes defined, respectively, by adrenergic vs. vagotonic, possibly age-dependent, triggering mechanisms [6–8].

Atrioventricular (AV) arrhythmias

AV nodal reentrant or AV reciprocating paroxysmal supraventricular tachycardia (PSVT), both in medicated and unmedicated diurnally active individuals, are most frequent in the afternoon ~16:00 h and least so during nighttime sleep [9–11].

Symptomatic 3rd degree AV heart block, a cardiac disorder whereby electrical conduction through the AV node is interrupted, results in complete dissociation of atrial and ventricular activity. Its manifestation based on patient recall of distinguishing symptoms, i.e., chest pain, palpitations, labored/rapid breathing, dizziness, syncope, excessive sweating, fatigue, and nausea, is most frequent between 06:00 and 12:00 h [12], when sudden cardiac death (SCD) and cardiogenic cardiac arrest (CCA) occur in greatest number [13,14].

Ventricular arrhythmias

Significant and reproducible temporal patterning of ventricular premature beats (VPB) is common in ischemic heart disease (IHD),