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# Psychological Approach to the Cardiac Arrhythmias: A Focus on the Emotions

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## 1. Introduction

This chapter proposes a psychological approach to the cardiac arrhythmias. Initially, psychosocial risk factors highlighted in the specialized literature will be reviewed: socioeconomic status, social support, age, gender, type A behavior pattern, stress and depression. Following this, studies regarding the impact of negative emotions and positive emotions on cardiac rhythm will be reported, with emphasis on the investigation conducted during the Holter monitoring. Finally, prospects for future research will be outlined and the role of the psychologist in Cardiology will be discussed.

## 2. Psychosocial risk factors

Having the control and prevention of heart disease as their main goal, many researchers, both in Biomedicine and Psychology, have struggled to identify its predisposing elements. Risk factors can be initiators, promoters, potentiators or precipitators, according to the disease stage in which they operate. However, from the psychological point of view, the most interesting distinction is that which distinguishes them as modifiable (e.g. smoking and sedentary lifestyle), partially modifiable (e.g. menopause, and high waist-hip ratio) and non-modifiable (e.g. family history and age).

Today, it has been established that well known organic risk factors - such as hypertension, hypercholesterolemia, obesity and diabetes - explain only 40% of the occurrence of cardiac disease (Kubzansky & Kawachi, 2000). In fact, empirical studies have demonstrated the relationship between cardiovascular diseases and psychosocial factors, such as the accumulation of stress, the type A behavior pattern, hostility and depression. That is, the literature indicates that psychosocial factors act synergistically with biological factors, increasing the predisposition to cardiac events (Frasure-Smith & Lesperance, 1998, Rozanski et al., 1999).

Some of the most widely studied psychosocial factors will be addressed next.

### 2.1 Socioeconomic status

Low socioeconomic status is associated with an increase in unhealthy behavior and other harmful psychosocial factors, significantly contributing to an increase of risk in healthy

people, and with a worse prognosis in people with installed coronary artery disease (Rozanski et al., 1999). Linked to these conditions are the difficulties of: access to health services, adherence to prescribed care, nutritional diet composition and installation of an adequate sanitary network (Gallo & Mathews, 2003; Lotufo, 1996).

Some studies suggest that, on one hand, the lower levels of socio-economic status precede the development of depressive symptoms and disorders, and of anxiety. Conversely, it is believed the socioeconomic status tends to diminish in individuals with impaired physical or emotional health. Therefore, it is increasingly accepted that these factors interact in a dynamic and reciprocal way (Gallo & Mathews, 2003).

## 2.2 Social support

Population surveys have found relationships between coronary artery disease and simple indicators of social support, such as marital status and the habit of visiting friends (Frasure-Smith & Lesperance, 1998; Rozanski et al., 1999). The effects of the social support depend on both the nature of the receiver and the source of the support. Studies have shown that pessimistic individuals do not benefit from social support and that the support given by friends is more effective than that given by strangers. In general, people with a social support network or that feel less alone live longer and in a healthier way, regardless of gender, because the social support directly affects the physiological responses to stress (Glynn et al., 1999).

In postmortem studies with *cynomolgus* monkeys, it was found that females raised in isolation presented more coronary atherosclerosis than isolated males and than specimens raised in groups. The incidence of atherosclerosis in these females was four times higher than in females raised in social groups and is associated with the weakening of ovarian function, hypercholesterolemia and exaggerated heart rate responses (Rozanski et al., 1999). These results suggest that females are more susceptible to social isolation.

Berkman and Syme (1979, as cited in Eaker, 1998) found that the number of social ties is inversely related to total mortality among women. Regarding mortality from coronary diseases, it was observed that the only significantly related element was the absence of social groups or communities.

High levels of perceived social support confer a lower risk for future cardiac events (Rozanski et al., 1999). Berkman et al. (1992, as cited in Eaker, 1998) found data suggestive, although limited, that social support is related to increased post-myocardial infarction survival. Thus, the probability of the first myocardial infarction being fatal is higher among unmarried men than married ones (Glynn et al., 1999).

Social support facilitates the prognosis of coronary artery disease by predisposal to adherence to treatment and to modification of risk factors, as well as alleviating the emotional and physical responses to environmental stress (Frasure-Smith & Lesperance, 1998). In addition, social support prevents the engagement in risk behaviors such as smoking, consumption of fatty foods and excessive alcohol consumption. Social support reduces the arterial pressure levels and the cardiac response in the face of stressor stimuli in humans, with an inverse relationship between levels of adrenaline in the urine, the degree of social support and resting heart rate (Rozanski et al., 1999).

## 2.3 Age

Age remains one of the major risk factors for coronary diseases. Hypertension, the coronary artery diseases and cardiac insufficiency are common in the elderly, encouraging the

perception that there is a general decline in cardiovascular function associated with aging. Age causes specific changes in the cardiovascular system, such as prolonged duration of the contraction and relaxation and decreased chronotropic response to catecholamines (Schulman, 1981). Fleg and Kennedy (1982, as cited in Carvalho-Filho, 2000) found ventricular arrhythmias in 80% and supraventricular arrhythmias in 88% of a sample of individuals of both sexes, aged between 60 and 85 years. In the sample studied by Chandra et al. (1988, as cited in Carvalho-Filho, 2000), the prevalence was 93.2%, both for ventricular arrhythmias as well as supraventricular arrhythmias.

However, age is only a risk factor for coronary diseases when over 65 years, though not for idiopathic arrhythmias, as demonstrated in the study of Lane et al. (2005). These authors found that patients with idiopathic ventricular fibrillation were significantly younger ( $36.0 \pm 11.6$  years) than patients with coronary disease ( $57.1 \pm 8.1$  years).

It must be considered that in situations of stress, older individuals manifest less increase in cardiac reactivity than younger people. Despite perceiving them with the same intensity, older adults present less physiological reactivity to the emotions and worry less about inhibiting them. It is possible that the decrease in cardiac reactivity faced with emotions is due to physiological aging, similar to what happens in other biological systems, or that it is the result of changes in the emotional regulation skills, especially in relation to the internalization and externalization of the emotions (Labouvie-Vief et al., 2003). Uchino et al. (2005) found evidence of increased cardiac and vascular reactivity to stress in older individuals and that age predicts an increase in systolic arterial pressure related to stress.

Although physiological aging predisposes for the emergence of cardiac diseases, maturity with respect to the emotions and the changes in social relationships could act as protectors for events or other complications, since this preserved the cognitive resources. The importance of the nature of social relationships also changes as a result of age. Thus, the Alameda County Study found that marital status was more important among the participants under 60 years of age at the beginning of the study, whereas among the participants over 65 years of age, the bonds of friendship and with other family members were more significant to predict mortality (Stansfeld & Fuhrer, 2002).

## 2.4 Gender

Eaker (1998) suggests that psychosocial risk factors for cardiac disease are the same for both genders. However, the male gender appears as a risk factor because the research has focused on analyzing more men than women. Studies regarding prevalence indicate that the high mortality rates among women were due to the high incidence in this group and not a reflection of a differentiated service (Lotufo, 1996). In other words, hormonal factors, genetic inheritance, differences in cerebral structure and function, and psychosocial factors seem to be associated with the prevalence of coronary disease among women.

Among the psychosocial factors, the psychological style and mechanisms, the social and family role exercised by women, and social and professional changes are increasing highlighted (Perez et al., 2005). The climacteric stage, in turn, is related to various psychological symptoms and complaints, such as irritability, anxiety and depression, and these symptoms are exacerbated in women who have lost their social role and are unable to establish new existential goals (Favarato & Aldrighi, 2001).

Studies also show that the prognosis of coronary diseases is worse in women than in men. Data from the American Angioplasty Registry show that the success rate of myocardial revascularization and coronary angioplasty surgeries are similar, however, the

postoperative complications are greater in women. In general, women have a greater age, and a higher prevalence of diabetes mellitus, hypertension, angina and cardiac insufficiency (Lima & Nussmacher, 1996).

Frasure-Smith and Lesperance (1998) suggest that the association between cardiac diseases and depression is similar in men and women. However, the majority of research is performed on men, with a proportion of 2:1, even though the incidence of depression and anxiety is higher in women (Kubzansky & Kawachi, 2000; Perez, 2004). There are also few studies on the effect of hostility in women. The type A behavior pattern did not present an association with the incidence of coronary disease in women (Eaker, 1998). In contrast, Favarato and Aldrighi (2001) compared various aspects related to the quality of life during menopause and concluded that sadness, tearfulness, nervousness and dissatisfaction with life were more commonly reported by women with coronary pathologies than by the control group.

The gender differences in the incidence of coronary artery disease and atherosclerosis are attributed to the effects of estrogen. Pre-menopausal women, or those on hormone replacement therapy, have relative protection from coronary disease, ischemic stroke and atherosclerosis (Lima & Nussmacher, 1996). However, it must be remembered that the curve of incidence of these pathologies in women has a delay of approximately 10 years when compared to men. It is assumed, therefore, that atherosclerosis progresses for years and the clinical symptoms observed in the menopause began years before (Perez, 2004; Rozanski et al., 1999).

There are biological differences between men and women also in relation to platelet aggregation, a factor that predisposes to thrombus formation. *In vitro* studies found that aspirin, the most used drug to inhibit platelet aggregation in the clinical practice, inhibits this phenomenon in men but not in women (Lima & Nussmacher, 1996).

Menopause is also reflected in the incidence of depression, due to estrogens being related to serotonin metabolism, in that, their presence would have a similar effect to antidepressants, with respect to neurotransmission (Almeida & Fráguas Jr., 1996). Evidence suggests that psychosocial stress causes hypothalamic hypogonadism and these ovarian abnormalities reduce levels of estrogen, with manifestations ranging from subclinical luteal phase defects with regular menstrual intervals to irregular cycles of amenorrhea, hypercholesterolemia, and other neuroendocrine and behavioral indicators. Atherosclerosis is therefore accelerated, predisposing to coronary artery disease and possibly ischemic stroke (Rozanski et al., 1999).

The social roles of gender make the reactions different when faced with the same stimulus. Men and women may feel anger in the same proportions and for almost the same reasons. However, men more freely express their negative emotions, experiencing anger more frequently although they repress fear. They express emotions with higher levels of physiological activation. In contrast, women report a greater range of emotions and verbalize more intensely, repressing both the experience and the expression of anger, concern themselves more with the reactions of others. The suppression of anger determined by socialization, in women, causes the feeling or demonstration of this emotion to generate other negative emotions such as guilt, anxiety, shame and depression (Kubzansky & Kawachi, 2000; Lavoiea et al., 2001). This summation of emotions increases physiological reactivity, especially among adolescents and young women, a trend that decreases with age (Labouvie-Vief et al., 2003; Lavoiea et al., 2001).

The studies that have investigated marriage as a source of social support found that, among men, marriage is a protective factor and among women there is little or no relationship between marriage and health. Similarly, divorce or widowhood is more harmful to the health of men (Glynn et al., 1999).

### 2.5 Type A behavior pattern

The Type A behavior pattern (TABP) corresponds to a set of reactions of a person facing a situation that seems challenging (Laham, 2001). Friedman and Rosenman identified the TABP in the 1950s, and characterized it as a syndrome consisting of hostility, feelings of competition and exaggerated commitment to work (Rozanski et al., 1999). This behavioral pattern is seen to be more evident in the male gender, though easily identified in women when they have to perform competitive professional activities (Almeida & Fráguas Jr., 1996). Among the psychological aspects the following also stand out: hyperactivity, restlessness, rapidity, hurry, impatience, time urgency, hostility, competitiveness, low frustration tolerance, feeling of being under pressure, need to show competence, high sense of responsibility and inattention to symptoms of pain or fatigue. As fatigue is the earliest and most common symptom of an impending heart attack, the individual postpones seeking help by denying or ignoring it (Laham, 2001; Sirois & Burg, 2003).

Interpersonal relationships are problematic, with characteristics of dominance, tension and emotional aggressivity, anger, marital and professional problems, and social mobility and inconsistency (Laham, 2001; Sirois & Burg, 2003).

The physiological manifestations of the TABP are: a) higher cholesterol levels, even in young people; b) increased variability in arterial pressure; c) high levels of frequent and prolonged sympathetic stimulation; d) cardiovascular and biochemical changes harmful to the heart and blood vessels; e) intense discharge of catecholamines; f) greater progression of atherosclerosis; g) less decrease in platelet aggregation after ergometric testing; and h) greater acceleration of blood coagulation under stress (Laham, 2001).

The TABP is two times more related to the increase of coronary artery disease and five times more related to the recurrence of myocardial infarction (Rozanski et al., 1999).

Despite this evidence, several other studies have found no link between the TABP and the risk of coronary diseases (Rozanski et al., 1999). Studies with patients recovering from myocardial infarction suggest that the TABP has a protective effect and population studies have reported increases in the prevalence of the TABP simultaneous with decreases in the rates of coronary artery disease (Frasure-Smith & Lesperance, 1998).

### 2.6 Stress

Stress, through neurohormonal activation of the hypothalamic-pituitary-adrenal axis, has systemic effects that influence the processes of atherosclerosis and thrombogenesis, also suggesting associations between psychological stress and cardiac infarction in patients with idiopathic ventricular fibrillation. There is evidence that the more stressful events an individual experiences in a given period of time, the greater the possibility of an occurrence of cardiac events (Frasure-Smith & Lesperance, 1998; Lane et al., 2005).

The studies on the subject distinguish three modalities of stress: chronic, subacute and acute. Chronic stress may be associated with decreased vagal tone, which in itself is an established risk factor for cardiac mortality (Lane et al., 2005). The type of chronic stress most studied in relation to coronary artery disease is that associated with work. Work activities with high demands and low pay are recognized as predictors of cardiac events, relating to greater progressions of carotid atherosclerosis and increasing by four times the risk of death (Rozanski et al., 1999).

Subacute stress lasts for some months. Acute stress, in turn, is the type most investigated recently by means of longitudinal studies (Lucini et al., 2005; Rozanski et al., 1999). Epidemiological studies show an increase in cardiac events in situations of public calamity

such as earthquakes or war. Thus, during the 1994 earthquake in Los Angeles, rates of mortality due to coronary artery disease increased from an average of 4.6 in the previous week to 24 on the day of the earthquake (Burg et al., 2004; Lampert et al., 2002; Rozanski et al., 1999). During the Korean War autopsies were carried out on soldiers whose average age was 22 years and coronary lesions were found in 77% of the cases analyzed (Giannotti, 2002).

The hypothesis that stress causes myocardial ischemia, increased blood pressure or electrophysiological changes can be investigated in the laboratory by means of exposure to controllable stressors, such as mental arithmetic and verbal fluency tests (Rozanski et al., 1999). Approximately half of the patients with symptomatic coronary artery disease present left ventricular dysfunction when subjected to mental stress tests (Jain et al., 2001). James et al. (2000) found that psychological stress caused by cognitive tests resulted in electrophysiological responses in patients with coronary stenosis, but not in patients with normal coronary arteries.

The mental stress tests caused sympathetic activation, increased cardiac rate and arterial pressure and reduced left ventricular ejection fraction, however did not produce change in the parasympathetic tone (Jain et al., 2001). Even when the cardiac rate increases are small, the increases in arterial pressure are substantial when compared to those resulting from physical exercise (Rozanski et al., 1999). Previous studies had demonstrated that ischemia induced by mental stress is associated with the greatest risk, when compared with ischemia induced by exercise (Blumenthal et al., 2005). The increase of the adrenalin serum levels seems to relate psychological stress to platelet aggregation (Kubzansky & Kawachi, 2000).

Patients who present myocardial ischemia when subjected to physical stress tend to also present it when subjected to mental stress in laboratory tests. However, myocardial ischemia produced by mental stress is not usually perceptible to the conventional electrocardiogram and is clinically silent, usually occurring with low heart rate elevations compared with physical exercise (Rozanski et al., 1999).

The frequency and magnitude of ischemia induced by mental stress vary according to the type of stressor. When the stressor has a greater emotional load, or is personally relevant, such as the task of reporting personal errors or remembering episodes of anger, it results in greater increases in the frequency and magnitude of abnormalities of the left ventricular wall than those caused by non-specific mental stressors, such as mental arithmetic. It was also found that mental stress causes increased coronary vasoconstriction and that the coronary microcirculation does not dilate sufficiently (Rozanski et al., 1999).

Lampert et al. (2002) investigated the occurrence of arrhythmias in situations of daily life. Some activities showed potential association with the occurrence of arrhythmias, such as driving, discussing and receiving bad news. Physical activity was associated with the period preceding the arrhythmia and there was no interaction between physical activity and emotions.

Negative emotions and stress are interconnected, because in determining whether an event is stressful, one must know the interpretation of this event for the individual and its significance (Kubzansky & Kawachi, 2000). The emotional and psychological involvement of the participant is an important component of the mental stress tests. However, studies that use cognitive tests as mental stressors found inconsistent results which were difficult to replicate. Jain et al. (2001) believe that this is due to the attenuation of the responses caused by familiarization, conditioning or adaptation of the participant to the repetition of the tests. Recent experimental findings suggests that sympathetic overstimulation resulting from stress can increase the concentration of protein kinase C in the central cerebral structures,

such as the prefrontal lobe, leading to a deregulation of the thinking, mood or behavior (Lucini et al., 2005).

### **2.6.1 Tako-Tsubo syndrome or broken-heart syndrome**

Since the 1990s, the so-called Tako-Tsubo syndrome has been reported in the literature. It is also known as ventricular apical ballooning syndrome, transitional broken heart syndrome and stress cardiomyopathy. Its pathophysiology is still not sufficiently understood, and the syndrome is characterized by chest pain and clinical, electrocardiographic and echocardiographic changes that mimic an acute myocardial infarction. It is different of the latter condition in that the coronary arteries do not show obstructions and there is significant recovery of the ventricle. In general, the syndrome affects women after menopause age, between 60 and 75 years old, although cases in children have also been reported (Finn et al., 2005; Lemos et al. 2008; Merli et al., 2006).

It persists for a few weeks and its onset can be precipitated by intense emotional stress such as death or illness of a family member, distressing events, arguments with relatives or friends, traffic accidents, financial losses, termination of employment and change of residence. There is also an increased incidence after natural disasters, such as the 2004 earthquakes in Japan. Other psychosocial impacts of major events, such as wars and sport matches, are frequently associated. Approximately 1-2% of cases of hospitalization because of signs of acute myocardial infarction account for this syndrome (Núñez Gil et al., 2009).

### **2.7 Depression**

Depression is strongly associated with the neurohormonal imbalance related to the pathogenesis of the cardiac diseases and is considered both a primary and secondary risk factor (Frasure-Smith & Lesperance, 1998; Pinton et al., 2006). It includes feelings of sadness, loneliness, hopelessness, guilt and shame, and has well-defined diagnostic criteria. It occurs frequently associated with some type of loss, characterized by a behavioral inhibition, with decreased mobilization of the physiological resources (Kubzansky & Kawachi, 2000; Rozanski et al., 1999). Depression is twice as common among women (Lavoie et al., 2001), among single people and those without close friends (Almeida & Fráguas Jr., 1996; Perez et al., 2005).

Even with all the evidence associating depression to the cardiac diseases, cardiologists still have difficulties in making this association, because the somatic symptoms of fatigue, lack of energy, loss or increase in appetite and sleep disturbances are common and can be confused with symptoms of the cardiopathy (Perez et al., 2005).

Not only is depression as a diagnostic entity related to disease. The presence of depressive symptoms is also related to the occurrence of cardiac events (Rozanski et al., 1999) and increases the risk of mortality by between two and four times (Pinton et al., 2006). Depressive symptoms are significantly associated with psychological factors such as hopelessness, despondency, apathy, intolerance to frustration and cognitive distortions (Perez et al., 2005; Shnek et al., 2001; Sirois & Burg, 2003). Several studies have suggested that depression is associated with decreased survival in the short and long term in survivors of myocardial infarction (Pitzalis et al., 2001).

The prevalence of depression is approximately three times higher in patients with coronary disease than in the general population (Rozanski et al. 1999; Sirois & Burg, 2003). It is estimated that the prevalence of clinically significant depressive disorders in cardiac

patients is around 14% to 27%. Psychiatric evaluations showed that 16% of the patients studied by Lane et al. (2005) presented moderate or severe depression in the three months preceding the cardiac episodes.

Depression predicts the occurrence of myocardial infarction, angina, angioplasty and/or myocardial revascularization surgery, as well as presenting itself as an independent risk factor for mortality, with the same prognosis as left ventricular dysfunction and history of previous myocardial infarction (Sirois & Burg, 2003). Longitudinal studies have found between 1.5 and 2.0 times higher risk for coronary events in people diagnosed with depression or with self-reported depressive symptoms (Kubzansky & Kawachi, 2000).

### **3. Emotions and their effects on cardiac rhythm**

#### **3.1 Negative emotions and positive emotions**

The conceptual and theoretical description of the emotions has been the subject of much debate. However, most experts agree that the emotions comprise affective, cognitive, behavioral and neurobiological components which sustain the adaptive behavior (Gallo & Mathews, 2003; Kubzansky & Kawachi, 2000). Emotions are perceived as internal phenomena that cause external manifestations or signs, being organic or behavioral. Emotional experiences must be distinguished from emotional disorders, which are psychiatric disorders that encompass diverse symptoms, behavior and cognitive and affective processes, occurring infrequently when compared with the emotional experiences (Gallo & Mathews, 2003).

The emotions can be grouped into the positive and negative, however, the specialists still disagree about whether these groups are two poles of the same dimension, or form distinct dimensions (Gallo & Mathews, 2003). Richman et al. (2005) identified four families of positive emotions: joy, interest, contentment and love. Shaver et al. (1987, as cited in Hupka et al., 1999) defined six categories of emotions subordinate to the general classification of negative and positive emotions: anger, fear, sadness, joy, love and surprise. Within these categories, they distributed the emotional lexicons of the English language in several subcategories: affection, lust, longing, cheerfulness, zest, contentment, pride, optimism, enthrallment, relief, amazement, irritation, exasperation, rage, disgust, envy, torment, suffering, sadness, disappointment, shame, neglect, sympathy, horror and nervousness.

Emotions rarely occur in isolation and there is great variability of expression. Thus, in response to stimuli with the same emotional load, some individuals are more responsive than others and this tendency has been termed emotional reactivity (Carels et al., 1999). The hyperactivity of the sympathetic nervous system leading to exaggerated responses of cardiac rate and arterial pressure in situations of engagement, dispute or aversiveness is called, by some authors, cardiovascular reactivity (Rozanski et al., 1999).

The literature suggests that when the style of regulation is more expressive and externalized, physiological reactivity is lower (Labouvie-Vief et al., 2003). Specialists also suggest that emotional reactivity that deviates from the norm in both directions is related to a risk of hypertension and probably also to arrhythmia (Carels et al., 1999; Kubzansky & Kawachi, 2000).

Several measures and criteria have been used in studies regarding emotions, including clinical diagnoses of pathologies such as, for example, the definition of depression and anxiety (Kubzansky & Kawachi 2000). The majority of studies on emotions use self-reports, although this tends toward inaccuracy, because it involves remembering and reconstructing.

Some adopt methods of inducing emotions in the laboratory, but the generalization of the results cannot be determined (Thomas & Diener, 1990). Longitudinal studies separate the participants into “exposed” and “unexposed” to the risk factor and relate the two groups to the emergence of the target pathology, however, there is no way to determine if a person was exposed or not to a particular emotion (Kubzansky & Kawachi, 2000).

Even with so many limitations, associations have been found between emotions and disease. Emotions can influence the onset of specific diseases or may result from diseases, influencing their prognosis. The relationship between emotions and cardiovascular health is, therefore, bidirectional, with the cumulative effect over time (Kubzansky & Kawachi, 2000). Studies have shown that patients with ambulatory ischemia during routine activities are more likely to have experienced negative emotions in the hours prior to the ischemic episode. Individuals with high emotional reactivity are 2.5 times more likely to show myocardial ischemia in the quotidian, 3.0 times more likely to manifest it in the laboratory and almost 4.0 times more likely to manifest it on two occasions (Carels et al., 1999).

Emotions, especially the negative ones, alter cardiovascular reactivity and neuroendocrine functioning, affecting the autonomic nervous system and hypothalamic-pituitary-adrenal axis acting on the cardiovascular system. These changes cause hypercholesterolemia, elevation of the level of catecholamines in the plasma and urine, impaired platelet functioning favoring platelet aggregation, thrombosis and rupture of existing plaques, impairment in vagal control functioning, increased cardiac rate, alterations in the electrical stability of the heart and reduction of cardiac variability, with a negative impact on the prognosis for coronary disease (Kubzansky & Kawachi, 2000; Perez et al., 2005; Richman et al., 2005; Sirois & Burg, 2003). Excessive or chronic emotional activation increases the levels of adrenalin and noradrenalin, increasing the quantity of free fatty acids, the arterial pressure, the cardiac rate and total peripheral resistance (Kubzansky & Kawachi, 2000).

Sudden death of cardiac origin has been associated with intense and prolonged emotions (Lampert et al., 2002). Furthermore, intense transient emotional states can cause the detachment of atherosclerotic plaques, initiating acute cardiac events, such as sudden death (Kubzansky & Kawachi, 2000).

There is still no consistent evidence of this association in relation to cardiac arrhythmias (Lampert et al., 2002), even knowing that “negative emotions such as anxiety and depression can affect the electrical stability of the heart by altering the autonomic regulation (specifically, reducing the cardiac rate variability)” (Kubzansky & Kawachi, 2000, p. 330) and that behavioral factors cause excessive sympathetic activation, triggering arrhythmias (Rozanski et al., 1999).

The arrhythmias of behavioral origin are caused by the sum of three conditions: a) myocardial electrical instability, usually due to previous coronary disease, b) an acute triggering event, often related to mental stress, and c) a chronic intense psychological state, which often include depression and hopelessness (Rozanski et al., 1999).

There is evidence that different emotions are related to different patterns of cardiac response. Studies show that anger increases the cardiac rate by between 5.0 and 9.0 beats per minute (bpm), fear increases it by between 5.5 and 8.0 bpm, sadness by between 4.0 and 7.0 bpm and joy by between 2.0 to 3.0 bpm (Labouvie-Vief et al., 2003). A study conducted with resident physicians showed an increase of unsustainable atrial and ventricular ectopic arrhythmias due to the stress of receiving an emergency call (Burg et al., 2004; Lampert et al., 2002).

### 3.1.1 Anger and hostility

Evidence for the association between anger and cardiac disease is still limited, however, suggestive. Studies show that high levels of anger precede the cardiac diseases, while others suggest that both the suppression and expression of anger have cardiac consequences (Kubzansky & Kawachi, 2000).

Anger is an emotional experience that ranges from an irritation or mild annoyance to a full fury (Sirois & Burg, 2003). It occurs in response to events perceived as unfair and accompanies physiological activation, leading to aggressive behavior, being strongly interlinked with hostility (Kubzansky & Kawachi, 2000). Anger, its expression, and hostility may influence the incidence of recurrent depression among women (Lavoiea et al., 2001).

The manifestation of anger and hostility, while stable personality traits, are associated with increased ischemia (Burg et al., 2004). An anger-trait is defined as the disposition to perceive situations as annoying or frustrating and the tendency to respond to these situations with higher frequencies of anger (Spielberger, 1998, as cited in Richman et al., 2005).

Stimuli that generate responses of anger are more likely to provoke abnormalities in the cardiac rhythm (Rozanski et al., 1999), conferring risk for cardiac diseases through the persistence of exaggerated cardiovascular reactivity (Lavoiea et al., 2001). The emotions of anger and anxiety can precipitate arrhythmias due to increased sympathetic activity. It is therefore possible that anger and anxiety, present in a chronic form, increase the risk of arrhythmias due to the influence on the sympathetic-parasympathetic equilibrium (Burg et al., 2004). Not only the expression of anger, but also its inhibition and the inability to discuss feelings of anger are related to cardiac diseases (Kubzansky & Kawachi, 2000).

Anger not only contributes to the development of atherogenesis and to cardiac disease but also triggers acute coronary events (Chang et al., 2002; Kubzansky & Kawachi, 2000). Both anger and physical exercise can cause non-fatal myocardial infarctions and/or transient ischemia (Lampert et al., 2002), however, in the two hours subsequent to episodes of anger, the relative risk of myocardial infarction increases by more than two times (Rozanski et al. 1999; Sirois & Burg, 2003). In the study by Lampert et al. (2002) anger episodes of moderate intensity were reported preceding 15% of the cardiac events studied.

The phenomenon of arrhythmias triggered by anger can be observed both in patients with recurrent episodes as well as those with single episodes, however, the study of the association between anger and cardiac arrhythmias is difficult because in a study it is virtually impossible to select participants with different tendencies (Lampert et al., 2002).

### 3.1.2 Anxiety

Anxiety is characterized by the perception of the inability to predict, control or obtain results in circumstances evaluated as threatening and covers physiological responses (Carels et al. 1999; Kubzansky & Kawachi, 2000). Patients who presented ventricular arrhythmias associated with emotions obtained scores above the average of the general population in anxiety tests (Burg et al., 2004).

Anxiety has been shown to be related to the occurrence of cardiac events by affecting the autonomic cardiac control, which could increase the risk of fatal ventricular arrhythmias (Sirois & Burg, 2003) and reduce the R-R variability (Rozanski et al., 1999). In addition, acute states of anxiety may lead to hyperventilation, which in turn triggers coronary vasospasm (Kubzansky & Kawachi, 2000).

Initially it was not possible to relate anxiety with cardiac diseases (Kubzansky & Kawachi, 2000). However, more recent studies, which used self-reporting, have suggested that the mere presence of symptoms may be a risk factor, without the need to meet the diagnostic criteria for anxiety. The experience of moderate intensity anxiety can trigger potentially fatal arrhythmias in patients with ischemic cardiac disease. Patients with higher scores in Spielberger's anxiety tests also reported anxiety in the 15 minutes prior to an ischemic event (Burg et al., 2004). Similarly, Denollet and Brutsaert (1998, cited in Sirois & Burg, 2003) found that individuals with high scores in the State-Trait Anxiety Inventory and in the social inhibition scale of the Heart Patients Psychological Questionnaire suffered more cardiac events during the eight years of follow-up, regardless of ventricular function impairment.

Large-scale surveys were conducted to better demonstrate the relationship between anxiety and cardiac events. The Determinants of Myocardial Infarction Onset Study observed an increased relative risk of myocardial infarction in the two hours following an episode of anxiety. Both the Normative Aging Study and the Framingham Heart Study associated symptoms of anxiety with an increased risk of fatal coronary heart diseases (Kubzansky & Kawachi, 2000).

However, the studies that relate anxiety and autonomic control of the heart do not have consistent results, probably due to the different measures used and because anxiety is often associated with depression (Pitzalis et al., 2001).

Few studies have examined the prognostic significance of anxiety in patients diagnosed with cardiac disease.

### 3.1.3 Positive emotions

The studies regarding emotions has flourished in recent years, however research into positive emotions has not kept pace. Possibly, due to the difficulties in conceptualization and definition and because the positive emotions seem to be more diffuses. In fact, taxonomies of basic emotions only identify one positive emotion for every three or four negative emotions. Thus, there is little consensus about what can be considered a positive emotion. Another factor that certainly complicates the study of positive emotions is to realize that for specific negative emotions there are specific facial expressions and that this does not occur with the positive emotions, which share the facial expression of the smile between them. Furthermore, different autonomic responses were demonstrated related to negative emotions, however, the same was not verified in situations of positive emotion (Fredrickson, 1998).

A form of positive emotion that has received certain attention is curiosity, a term used to describe hypothetical mechanisms that serve to guide or attract an organism in the direction of new stimuli (Swan & Carmelli, 1996). Curiosity is defined as an affective state or trait that appears closely related to interest, being related to wanting to investigate, learn and incorporate new experiences. Thus, Richman et al. (2005) followed, for two years, a population composed of 4,027 men aged between 55 and 69 years to verify the relationship between hope, curiosity and hypertension, diabetes mellitus and respiratory infections. For each unit increase in curiosity test scores, the researchers perceived a 57% decrease in the risk of developing hypertension. This decrease was 40% for the scores of the hope tests in the first year of follow-up. In the second year of follow-up, patients with higher scores in the hope tests had a 48% reduction.

Positive emotions may have the potential to reduce the effects of stress on the cardiovascular system even faced with inevitable negative life events. Concepts such as optimism and positive attitude can cause negative events to be viewed with the confidence that the future holds something positive and better. The internally generated, positive emotional state seems to modify the adverse effects of prolonged exposure to negative emotions (Danner et al., 2001; Richman et al., 2005).

### **3.2 The Holter Examination: An investigation regarding activities and emotions**

Autonomic dysregulation in the context of stress has been investigated both in animals and in laboratory conditions, however, few studies have been conducted in everyday situations, probably due to the difficulty of making accurate measurements in the midst of multiple environmental factors and because of the perceptual variability between subjects (Lucini et al., 2005). It is important to consider that, under experimental conditions, the occurrence is restricted of emotions still little known. Therefore, recognition of the influence of other emotions in the arrhythmogenesis is also restricted. Thus, the study of emotional changes that occur in the quotidian of people with ambulatory electrocardiographic monitoring can better clarify important research questions. Additionally, from the standpoint of diagnostic evaluation, this feature is relatively simple and accessible.

In view of these scientific and clinical interests, a study was conducted with the following objectives: a) to identify emotions simultaneous to arrhythmias at different times of the day; b) to verify that the same activity can be presented simultaneously to arrhythmias at different times of day; c) to verify the occurrence of similar arrhythmias in individuals with similar emotional reports; d) to identify aspects of daily experience that occur simultaneously to arrhythmias, e) to verify whether people that conduct similar activities present similar arrhythmias and f) to describe and analyze the association between emotions and activities reported during the 24-hour Holter Examination (Sánchez, 2007; Bonomo & Araujo, 2009).

A total of 13 men and 17 women participated in the investigation, aged between 48 and 69 years, with complete high school education as the minimum level of schooling, who did not use antiarrhythmic medication, antipsychotics or beta blockers and had the ability to communicate orally and in writing. The data obtained during the examination were first transferred to a memory card, coupled to the Holter device. As usual, after receiving guidance on how to proceed within the 24 hour period, the return was scheduled for the following day with a view to removing the device at the same time. The recorded electrocardiographic information were processed by computer, generating a Tabular Report.

In the Daily Report, in addition to recording the activities performed during period of the examination, the participants were asked to record the concomitant emotions. If different emotions occurred during the same activity, they should register this emotional change, its intensity and the time. After removal of the device and evaluation by a cardiologist, they were interviewed by the psychologist researcher using a previously prepared script. These reports were audio recorded and later transcribed. The Daily Report data were paired, hour by hour, with the Tabular Report data. Those periods which, even after completion of the interview, remained without comment, were registered as "without report".

Initially, the data found in the Daily Reports and Tabular Reports were analyzed by means of descriptive statistics, using the arithmetic mean of the reports. It is worth explaining that

the analysis was focused on the waking period, with reports being excluded where patients said they were asleep, since there are limitations for the participant to record this experience. The daily activities and the emotional reports were organized into categories and subcategories. Subsequently, the software Alceste - *Analyse de Lexèmes Concurrents dans les Énoncés Simples d'un Texte* - was used for content analysis of the interviews.

### 3.2.1 Distribution of the ventricular and supraventricular arrhythmias

The women presented more arrhythmias, both ventricular (mean = 121.82) and supraventricular (mean = 265.59). The men presented a mean of 68.15 ventricular arrhythmias and 67.69 supraventricular arrhythmias. That is, the women presented more than twice the number of supraventricular than ventricular arrhythmias, however, these arrhythmias were distributed differently throughout the examination period (Bonomo & Araujo, 2009).

### 3.2.2 Distribution of arrhythmias by activity category

The activities were organized into three categories: a) physical activity, b) mental activity and c) travelling. Figure 1 shows that, among the women, the physical activities were more associated with ventricular arrhythmias and less with supraventricular arrhythmias. In the men, the exact opposite occurred. It can also be seen that in both men and women the mental activities were associated more with supraventricular arrhythmias than with ventricular arrhythmias. Regarding travelling, the association with supraventricular arrhythmias was higher in the female group.

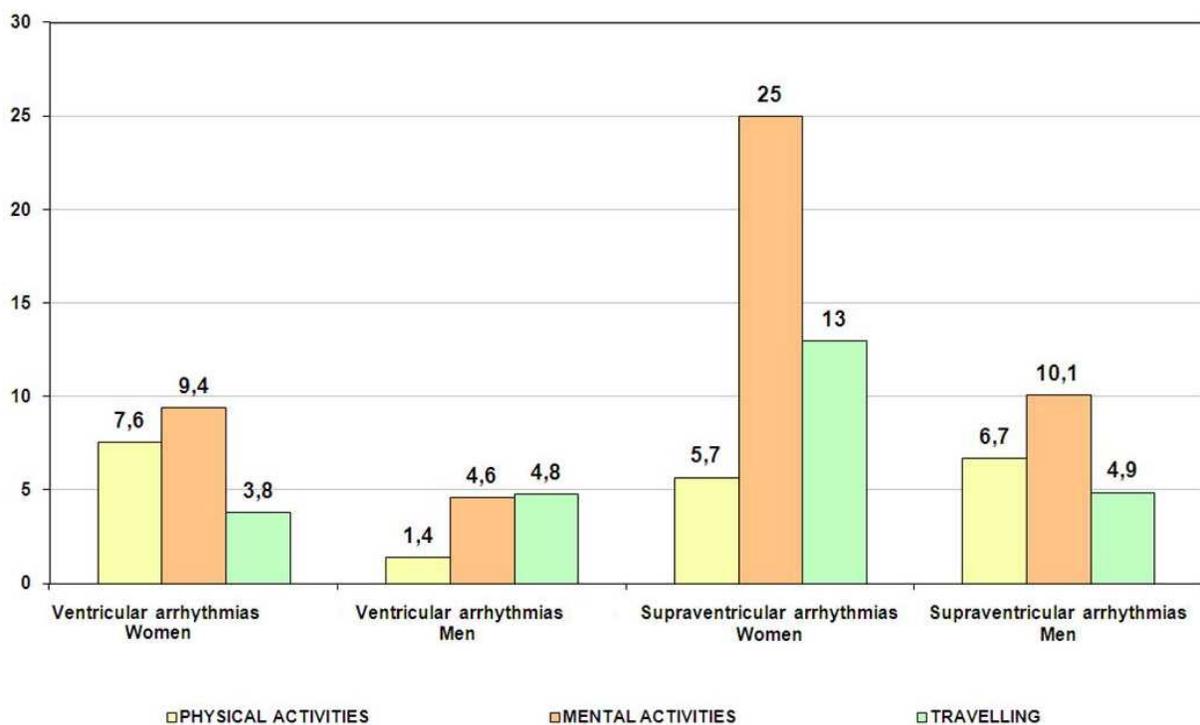


Fig. 1. Distribution of the mean of the reports of ventricular and supraventricular arrhythmias by category of activity.

### 3.2.3 Distribution of arrhythmias by emotion category

It was verified that only the reports of worry and sadness were similar between the two groups. Joy was the emotion that obtained the highest difference in the means of the reports, being more perceived by the women (see Table 1).

Categories	Subcategories	WOMEN		MEN	
		Total	%	Total	%
Positive	Blessed	5	3.1%	1	0.7%
	Joy	27	17.0%	3	2.2%
	Satisfaction	8	5.0%	-	-
	Security	-	-	3	2.2%
Neutral	Tranquility	68	42.8%	81	60.5%
Negative	Anxiety	14	8.8%	9	6.7%
	Worry	16	10.1%	17	12.7%
	Anger	9	5.7%	12	9.0%
	Surprise	1	0.6%	-	-
	Sadness	11	6.9%	8	6.0%
	Total	159	100%	134	100%

Table 1. Categories and subcategories of emotions reported by the participants

### 3.2.4 Emotions simultaneous to ventricular arrhythmias

The subcategory feeling blessed was the most frequently associated with ventricular arrhythmias in both genders (Figure 2). In the women, worry was related more with ventricular arrhythmias than anxiety and in the men this relationship was exactly the inverse. Anger was shown to be related to ventricular arrhythmias in the men but not in the women.

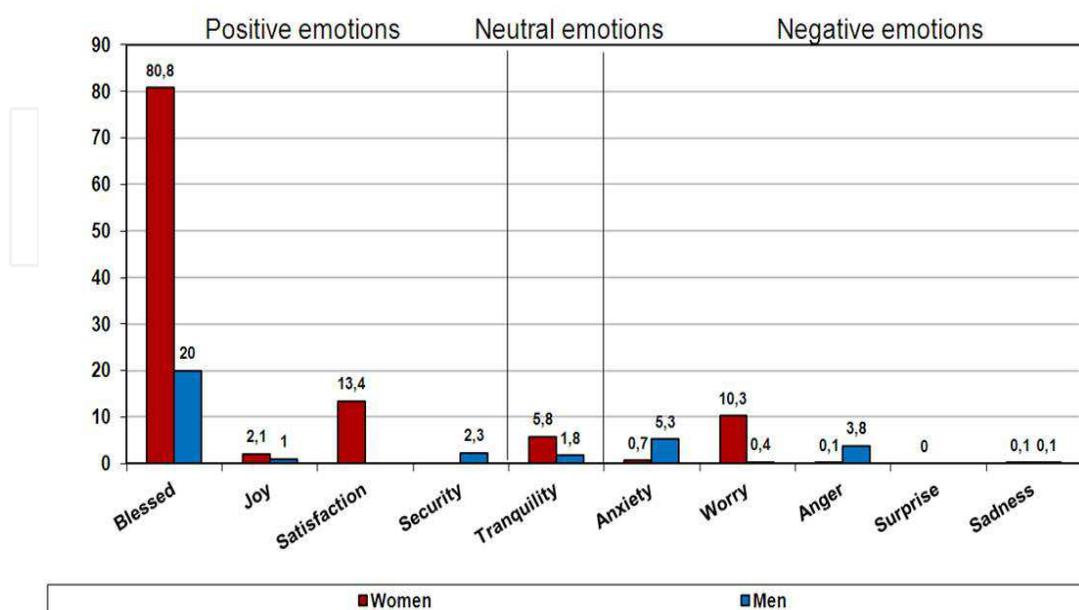


Fig. 2. Mean of ventricular arrhythmias in each subcategory of emotions reported.

Sadness was not simultaneous with ventricular arrhythmias in either gender. In the situations accompanied by reports of tranquility, ventricular arrhythmias were recorded more frequently in the women than in the men, possibly due to the activities that the women were performing.

### 3.2.5 Emotions simultaneous to supraventricular arrhythmias

Almost all the emotions that were recorded by both genders appeared simultaneously more frequently among women (see Figure 3).

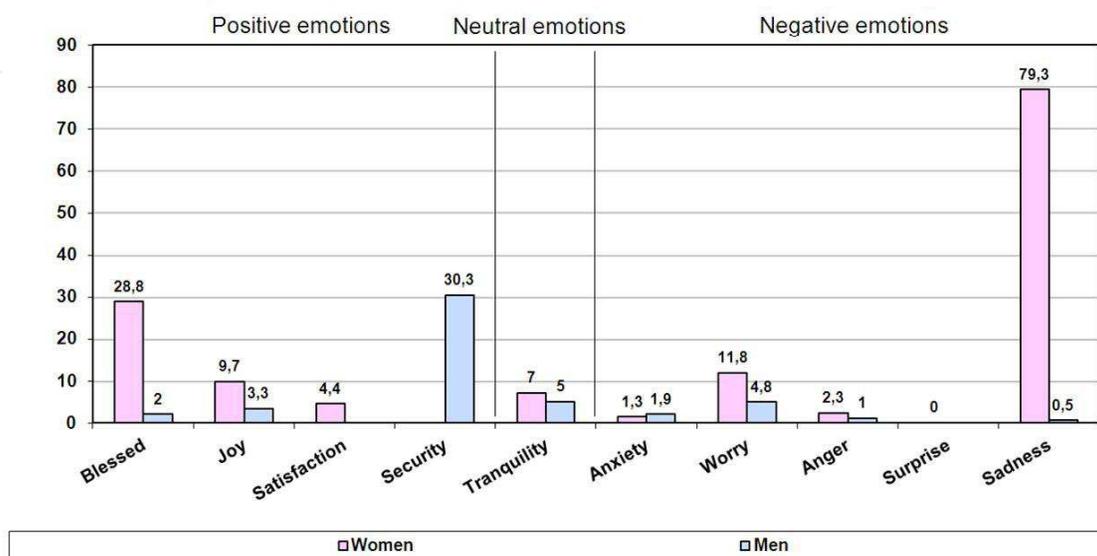


Fig. 3. Mean of supraventricular arrhythmias in each subcategory of emotions reported.

In summary, the majority of the emotions reported by the participants were presented more simultaneously to supraventricular than to ventricular arrhythmias. Both for men and women, the mean of the reports of sorrow concomitant to ventricular arrhythmias were very low. Anger differed from all the other emotions, it was simultaneous to more ventricular arrhythmias in the men and to supraventricular arrhythmias in the women. Surprise was the least identified category. This may reflect the difficulty in conceptualizing it, which indicates the need for more studies.

The analysis of the interviews also revealed the need for recognition of the efforts performed on behalf of the family members. When this recognition was not perceived by the participants, frustration occurred. It is worth mentioning that the majority attributed their organic disorders to external factors, having difficulty linking them clearly to their behavior or emotions. The men and women reported similar emotions in different social situations. The women said they were happy in situations of interaction with the family and the men when they were with friends. In fact, the men reported less interaction with the family, which in most cases, was limited to discussion of problems with the wife.

This study showed that the 24-hour Holter examination enables the identification of the simultaneity between emotions, daily life and cardiac arrhythmias.

## 4. Conclusions

It is considered that if knowledge about the participation of the emotions in arrhythmogenesis is continually improved, it will be possible to generate support for

psychological guidance based more on, and tailored to, the daily routine of the patients. For example, meditation, which reduces the frequency of premature ventricular contractions (Giannotti-Hallage, 1990), could be recommended at times of circadian peak.

In summary, disease prevention and health promotion depends on knowledge regarding the psychosocial determinants of risk behaviors and of the psychosocial processes that affect the triggering and experience of the chronic diseases. Therefore, to comprehend how the emotional factors trigger the functional imbalance of the heart may contribute to the planning of more effective therapeutic strategies. Certainly, the contribution of Applied Psychology to the area of Cardiology is increasingly promising concerning innovations for the work of the professionals of various categories integrated in interdisciplinary teamwork.

## 5. Acknowledgments

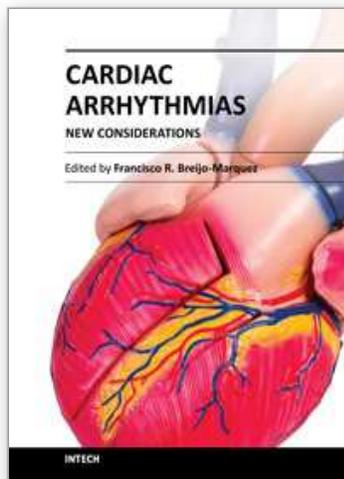
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## **Cardiac Arrhythmias - New Considerations**

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The most intimate mechanisms of cardiac arrhythmias are still quite unknown to scientists. Genetic studies on ionic alterations, the electrocardiographic features of cardiac rhythm and an arsenal of diagnostic tests have done more in the last five years than in all the history of cardiology. Similarly, therapy to prevent or cure such diseases is growing rapidly day by day. In this book the reader will be able to see with brighter light some of these intimate mechanisms of production, as well as cutting-edge therapies to date. Genetic studies, electrophysiological and electrocardiographic features, ion channel alterations, heart diseases still unknown, and even the relationship between the psychic sphere and the heart have been exposed in this book. It deserves to be read!

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