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Registration of biological parameters in burnout: ambulatory follow-up with wearable technology

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ABSTRACT

Background An increasing amount of people is faced with burnout symptoms along their career path. Burnout is a mental condition defined as a result of continuous and long-term stress exposure, particularly related to psychosocial factors off and at work. Although burnout is mainly considered a psychological condition, there are also plenty of physical elements. The consequences of burnout are potentially very serious economically since it can lead to deterioration in the quality of care or service that is provided by the staff. It appears to be a factor in job turnover, absenteeism, and low morale. The diagnostics of burnout are a difficult issue since it consists of a plethora of symptoms occurring together or otherwise. Moreover the matter turns even more complex since the separate symptoms are not at all specific for burnout.

Objective The goal of this explorative pilot study is to investigate whether a difference can be registered in heart rate, heart rhythm variability, sleeping pattern and skin conductance in patients with (imminent) burnout compared to a 'healthy' population by using wearable technology. Can we record the above parameters with the use of wearable technology in a patient-friendly and outpatient manner in order to identify particular somatic correlates of burnout? In other words, what are the possibilities of wearables as a spur to future research in burnout?

Methods In this pilot study patients aged 18 to 65 years visiting a Flemish general practitioner (GP) practice were offered the validated BMS-10 questionnaire if they showed complaints that were suggestive for burnout. If they acquired a score of 3,4 or higher, they were included in this pilot study. These patients were handed additional questionnaires for further differential diagnostics and they were asked to wear two wearable sensors, the Stingray® and Chill Band® during 1 week that monitor the heart rate, heart rhythm variability along with the skin temperature, skin conductance and physical activity. Besides this experimental group, the researchers also randomly selected a 'healthy' patient population as a control group in which the same parameters with the same wearables were registered during a same predefined period of 1 week.

Results In our pilot study, a total of 19 patients reported complaints suggestive of burnout when presenting them to the GP practice, of which 8 patients were subjected to the Stingray® and Chill Band® analysis. In addition, the researcher also selected 6 'healthy' control patients to be equally investigated with the Stingray® and Chillband®. The authors wanted to explore whether there are differences in biometric parameters such as heart rate, heart rate variability, galvanic skin response and skin temperature in patients diagnosed with burnout compared to a control group. The authors compared these different relevant parameters after taking into account the interpatient physiological variability, but no significant differences were detected between both groups.

Conclusion A system that can measure stress levels based on physiological signals will create interesting applications in real life situations. Ultimate goal is to design an easily wearable wireless system that can measure real time stress levels. This explorative pilot study set up a case-finding strategy in order to use a wearable sensor system to find physiological signals and features that show the most distinct reaction to mental stress in patients aged between 18-65 years old. Unfortunately, no significant differences in various biometric parameters could be detected between a burnout population and a control group. Patients experience both applied devices, the Stingray® and the Chill Band®, as very user-friendly and more homely. In the future the authors believe that further research with a more extensive sample size is required in order to explore this uncovered ground.

KEYWORDS Burnout, wearables, Stingray, Chillband, BMS-10, Maslach-Pines Burnout Inventory, 4DCL

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BACKGROUND

Mental stress is a huge problem in today's society: about half of work-related illnesses are directly or indirectly related to stress (1). The second most frequently occurring type of work-related health problems in the European population is 'stress, depression or anxiety'. These figures indicate that stress is a major financial and social problem in European society (2).

Partly by the economic crisis and subsequently by the structural changes in Belgian and European companies, the workload in our current society has been increasing continuously. Since workforces decrease and the amount of work remains the same, more and more work winds up with the remaining employees wherefore physical and mental demands are on the increase (3).

Several well-known causes, such as living up to higher demands, having fewer resources available, tackling deadlines rigidly, losing social networks, feeling as if you're being respected less, or feeling insecure about your professional future, can also account for this unfavourable development. Because of this growing load, in time some employees are confronted with the inability to continue to exercise their job in a highquality manner. In the long run, the ensuing stress, demotivation, overstrain and exhaustion can cause a crisis situation, which we call burnout or professional depletion (4).

For the past number of years, burnout and stress-induced complaints have been a persistent medical and social issue. Doctors and scientist are trying to comprehend the phenomenon of burnout better and are looking for the best possible treatment(s). Furthermore, the Belgian government attempts to map the complicated issue of burnout and supports diverse initiatives to prevent burnout or to enhance the diagnosis and treatment (5).

The written and spoken press covers the terms 'burnout' and 'professional fatigue' almost weekly. Indeed, it is a widespread condition with a significant social impact. Not only is burnout disastrous for the individual employee coping with it, but it also has a big negative impact on the entire organization in which this person is employed. Indeed, research shows that corporations, in which employees are affected by burnout, are exposed to more absenteeism and are more often confronted with employees looking for different employment (6).

These issues require a thorough knowledge of the various aspects of burnout and the development of effective solutions and/or treatments.

Definition

Burnout was first described in greater details by Herbert Freudenberger in the mid-1970's. His influential paper on "staff burn-out" set the stage for the introduction of the concept. As an unpaid psychiatrist in a treatment center for drug addicts, he observed that young and motivated volunteers experienced a gradual energy depletion and loss of motivation and commitment, which was accompanied by a wide array of other mental and physical symptoms. Freudenberger labeled this particular state of exhaustion "burnout" (7).

Independently, and about the same time, Christina Maslach – a social psychological researcher – studied the ways in which health care professionals cope with emotional arousal at work and observed that many of them were emotionally exhausted, had developed negative perceptions about their patients and experienced a crisis in their professional competence. She noticed that the term "burnout" was colloquially used by Californian poverty lawyers to describe the process of gradual exhaustion, cynicism and loss of commitment in their colleagues. Maslach and her co-workers decided to adopt this term as it was recognized by the interviewees in their study among human services professionals.

This simultaneous discovery of burnout marks the beginning of two different traditions that approach burnout from a practical and scientific point of view, respectively. After the introduction of the concept by Freudenberger and by Maslach and her colleagues, burnout soon became a very popular topic. The mass media eagerly picked up the burnout concept, and public interest in this topic grew enormously, making burnout a buzzword nowadays. The image of burnout as a popular term used by journalists and practitioners hampered the serious scientific study of this phenomenon (8).

In contrast to other medical diagnoses, there still is no widely accepted definition for burnout. Overexertion and burnout are also no existing diagnostic categories in neither DSM–V (Diagnostic and Statistical Manual of Mental Disorders 5th Edition) – the prestigious main used classification system for psychiatric disorders – nor in ICD-10 (International Classification of Diseases) of the WHO (World Health Organization) and this contributed to the disregard of this condition and the fact that there are dozens of existing definitions of burnout. The lack of an international accepted consensus on the subject of burnout contributes to the various circulating myths around burnout (9, 10).

In most early writings, burnout was "defined" by merely summing up the symptoms. Such "laundry lists" are problematic because they are inevitably selective and because they tend to ignore the

dynamic aspect of the syndrome. The definition used by diverse Belgian experts, reads as follows: "Burn-out is a persistent, negative, work-related state of mind in "normal" individuals that is primarily characterized by exhaustion, which is accompanied by distress, a sense of reduced effectiveness, decreased motivation, and the development of dysfunctional attitudes and behaviors at work. This psychological condition develops gradually but may remain unnoticed for a long time for the individual involved. It results from a misfit between intentions and reality at the job. Often burnout is self-perpetuating because of inadequate coping strategies that are associated with the syndrome." This definition of burnout specifies its general symptomatology, its preconditions, as well as the domain in which it occurs. More specifically, it narrows down more than 100 burnout symptoms to one core indicator (exhaustion) and four accompanying symptoms: (i) distress (affective, cognitive, physical and behavioural symptoms): (ii) a sense of reduced effectiveness; (iii) decreased motivation; and (iv) dysfunctional attitudes and behaviours at work (depersonalization). Furthermore, frustrated intentions and inadequate coping strategies play a role as preconditions in the development of burnout, and the burnout process is considered to be self-perpetuating despite the fact that it may not be recognized initially. Finally, the domain is specified: symptoms are work-related and burnout occurs in "normal" individuals who do not suffer from psychopathology (8).

Christina Maslach and Susan Jackson – the two American psychologists who associated their names to a renowned scaling system for burnout – define burnout as an emotional exhaustion arising from chronic tension and stress. An excess of stress at work, or in your private life, constitute the causal factor of burnout. Burnout is without a doubt the concluding phase of a long-lasting process of persistent stress against which the patient can't defend himself longer (11).

The correlates, causes and consequences of burnout

A high workload and high demands – especially for oneself – form the main source for the development of burnout, but these cannot explain everything though.

Demographic Characteristics

Burnout is observed more often among younger employees who have relatively little work experience than among those aged older than 30 or 40 years. The greater incidence of burnout among the younger and less experienced workers may be caused by "reality shock" or by an identity crisis caused by unsuccessful occupational socialization.

Initially, it was claimed that women report highger burnout levels than men. Gender is often confounded with occupational role and hierarchical position. For instance, compared to men, women occupy supervisory roles less often in organizations and therefore have less access to job-related rewards such as high income, social status and autonomy. When these confounding variables are taken into account, no significant gender differences in burnout are observed.

Burnout is associated with higher levels of education. This is quite remarkable since most stress-related problems seem more prevalent among workers with low status and poor education.

Finally, most studies show that singles have an increased risk of burning-out compared to those who are living with a partner. It is claimed that social support from the partner might alleviate stress.

Personality

Burnout is less common among those with a "hardy" personality, which is characterized by involvement in daily activities, having a sense of control over events, and openness to change.

By contrast, burnout is more common among those with an external locus of control who attribute events and achievements to powerful others or to chance compared to those with an internal locus, who ascribe events and achievements to their own ability, effort, or willingness to risk. Significant negative correlations of all three burnout dimensions have been found with self-esteem and self-appraisal of competence and personal worth.

Burnout appears to be particularly related to neuroticism, which is characterized by low levels of emotional stability, as well as anxiety, sadness, and irritability. Because neurotic people are emotionally unstable and prone to psychological distress, neuroticism may act as a vulnerability factor that predisposes professionals to experience burnout.

General Job Stressors

Workload and time pressure explain approximately 25-50% variance of burnout, especially of emotional exhaustion. Role conflict (i.e., conflicting demands at the job have to be met) and role ambiguity (i.e., no adequate information is available to do the job well) are highly correlated with burnout. Clear evidence exists for a positive relationship between lack of social support from supervisors and burnout. Finally, three factors that determine self-regulation of work activities are related to burnout: lack of feedback, poor participation in decision-making, and lack of

autonomy. More specifically we assume two underlying processes: (i) energy depletion is driven by high job demands (e.g., time pressure, emotional demands, shift work, cognitive demands) and is associated with exhaustion, and (ii) erosion of motivation is driven by lack of job resources (e.g., supervisor support, feedback, control, task variety, financial rewards) and is associated with disengagement (depersonalization).

Work-related attitudes

Although high and unrealistic expectations are related to burnout, this association is not as strong and unequivocal as might be expected. It has been claimed that everyone can experience stress, whereas burnout can only be experienced by those who entered their careers enthusiastically with high goals and expectations. When work is one of the main sources for a person's feeling of self-realisation, these individuals will show a major commitment and will perform under high pressure for a long period of time (7).

Pathofysiology of burnout

The way in which the individual copes with stress is considered crucial for the development of burnout. From psycho-neuro-immunological and psycho-neuro-endocrinological perspective, overexertion and burnout are considered to be the result of enduring stress that causes a chronic disruption of the neuro-hormonal system, which is the source of the entire spectrum of physical complaints and psychological dysfunctioning (12).

Initially, stress is a healthy body reaction. It is however the stress continuum in which stress evolves toward chronic stress and burnout that undermines physical and psychological functioning. Overexertion and burnout start out with stress that results from the discrepancy between resources (the individual's expectations and ideals), and demands (the harsh reality of everyday occupational life). Stressors are conditions or episodes that are perceived as threatening for the psychosocial equilibrium. A useful classification of stressors is: (i) obligations (recurring load at work, study, household, healthcare…), (ii) issues (unwelcome situations in various areas such as relationships, finance, work, career,…) and (iii) life events (more or less drastic changes in life that require 'processing' and/or adaptation of everyday life). Being confronted with one or more stressors, the individual in question somehow has to handle these stressors (coping) in order to maintain or restore the psychosocial stability. The individual may consciously observe this stress or it may remain unnoticed for a long time. A sensation of unpleasant tension (distress) arises when this person experiences particular difficulties to cope with the stressor(s) or to continue their normal activities. Thus far, this encompasses a fairly normal experience: every once in a while everyone has a busy time (obligations), everyone experiences problems or setbacks and everyone experiences radical changes (life events). However, when coping strategies fail to restore internal harmony and the individual doesn't know what to do anymore (demoralization), a loss of control develops and the person loses his grip on the situation. Then distress increases massively and the person in question has no other option than to drop out. The individual abandons the attempt to face the stressor(s), lets people down, reports sick and withdraws from social life. Then there is overexertion: a combination of distress, loss of control and social disfunctioning. In a situation of overexertion stress-related complaints can jointly determine the presentation of burnout. Therefore a process of somatization can be activated among sensitive individuals. Somatization implies that distress and associated physical complaints become a vicious circle due to preoccupation with these physical sensations. Gradually, the individual starts to feel emotionally strained, and begins to change his or her attitudes towards the job and the people he or she works with, finally resulting in burnout (13).

Symptoms and possible consequences of burnout

A key aspect of the burnout syndrome is increased feelings of emotional exhaustion. As their emotional resources are depleted, workers feel they are no longer able to give all of themselves at a psychological level. Another aspect is the development of negative, cynical attitudes and feelings about one's clients. A third aspect of the burnout syndrome is the tendency to evaluate oneself negatively, particularly with regard to one's work with clients. Workers feel unhappy about themselves and dissatisfied with their accomplishments on the job. Burnout can lead to deterioration in the quality of care or service that is provided by the staff. It appears to be a factor in job turnover, absenteeism, and low morale (14).

Initially when the clinical approach to burnout prevailed, more than 130 possible symptoms were identified. Typically, burnout is not restricted to symptoms at the individual level; in addition, interpersonal symptoms in relation to colleagues and recipients of one's care or services are observed (e.g., irritability, dehumanization, indifference) as well as symptoms that are related to organizational outcomes (e.g., job dissatisfaction, job turnover, low morale). The significance of burnout is particularly evident because of this multifaceted nature. However, a laundry-list approach is inappropriate to define the syndrome, because it denies that burnout is a process and confuses symptoms with precursors, correlates and consequences (7).

Essentially, overexertion and burnout are characterized by increasing grievances regarding the physical and psychological functioning: (i) physically (e.g. fatigue, sleep-disturbances, painful and strained muscles); (ii) cognitively (e.g. impaired concentration and memory, planning difficulties); (iii) affectively (e.g. irritability, tearing up quickly, depression, anxiety) and (iv) behavioural (e.g. impatience, haste, not stop working, more alcohol abuse, smoking…) (12). In Table 1 the most important symptoms/consequences of burnout are summarized.

Affective manifestations

Usually, a gloomy, tearful and depressed mood is observed among those who suffer from burnout. Although moods may change quickly, generally spirits are low, and a sad and dim mood prevails. The person's emotional resources are exhausted because too much energy has been used for too long a time. The second type of affective symptoms relates to aggression and anxiety. The burnt-out person's frustration tolerance is diminished, he or she is irritable, oversensitive, and behaves in a hostile and suspicious manner, not only towards recipients, but also towards colleagues and superiors (15).

Cognitive manifestations

First and foremost, burnt-out invididuals feel helpless, hopeless and powerless. Work has lost its meaning and after being unsuccessful in influencing one's work situation, the person now feels "trapped". A sense of failure is experienced as well as a feeling of insufficiency, impotence and poor job-related self-esteem. Moreover, particular cognitive skills such as memory and attention might be impaired and thinking becomes more rigid, schematic and detached.

One of the most characteristic symptoms of burnout at the interpersonal level is the decreased involvement with recipients. This negative attitude is particularly striking since initially the relationship with recipients has been characterized by involvement, empathy, concern and understanding. Cognitively, this is reflected by a cynical and dehumanizing perception of recipients characterized by negativism, pessimism, lessened empathy and stereotyping (15).

Behavioural manifestations

At the individual level, behavioural symptoms are mainly caused by the person's increased level of arousal. Typically the burnt-out professional's intrinsic motivation has vanished: enthusiasm, interest and idealism are lost. Contrarily, disillusionment, disappointment and resignation set in, and physical as well as mental withdrawal from others is observed.

At the organizational level, the most important manifestations of burnout are absenteeism, job turnover and impaired performance (15).

Cardiovascular and cerebrovascular manifestations

Several epidemiological studies regarding causes of stress – such as work or marital problems – have shown existing correlations between chronic stress and cardiovascular diseases (16).

In the INTERHEART-study the relationship between chronic stress and the incidence of acute myocardial infarction (AMI) was assessed in a sample of more than 25000 people. In this study they analyzed the influence of psychosocial stressors upon the risk of AMI. The prevalence of 4 stressors (stress on the job, stress at home, financial stress, recent difficult life events) is significantly higher in patients with AMI compared to people without AMI. Especially people, who experience chronic stress in the workplace, run more than twice the risk of AMI (17).

In the Whitehall II-studie, they observed a significantly higher risk of developing coronary disease in men who experience a true discordance between the extent of their efforts and the recognition they received as part of their job. The high-risk patients showed a competitive mindset and great commitment towards their job, while they received low level of acknowledgement of the hierarchy and while they were restricted in their career possibilities (18).

Using the results of 6 major prospective studies executed in a total of 118696 patients, a literature overview showed a significant correlation between experienced stress and coronary diseases (angina pectoris, infarction). A high level of stress correlates with an increase of 27% to be affected by coronary disease. A high stress level is considered as

Table 1. Symptoms and/or consequences of burnout

Physical	Cognitive and Affective	Behavioural
- Asthenia - Sleeping disorder - Lack of energy - Neurovegetative-functional complaints (palpitations, gastrointestinal symptoms, tightness...)	- Loss of control - Loss of motivation - Frustration/Irritability - Anxiety - Low self-esteem - Loss of idealism - Lack of concentration - Memory loss - Depressive mood	- Change of attitude (cynism, indifference, detachment) - Isolation - Lack of performance - Absenteeism - Agression

damaging as a rise in blood pressure with 2,7/1,4 mmHg or 5 extra sigarettes a day (19).

A meta-analysis comprising the data of 14 European studies, published between 1985 and 2008, showed that people with a demanding and stressful job carry a higher risk (24%) to be struck by a cerebrovascular accident (CVA) (20).

A recent study showed that overtime correlates with a higher risk of coronary diseases and CVA's. The authors analyzed the data of studies executed in the USA, Europe and Australia in more than 600000 people who had no coronary disease at the commencement of the study. They proved that working more than 55 hours per week, compared tot 35-40 hours per week, increased the risk of CVA with 33% and the risk of coronary disease with 13% (21).

Diagnosis of burnout

Throughout the different phases of the stress continuum, there are several alarm signals that can be picked up by the environment or the attentive general practitioner (GP). The alarm signals however are not specific and can also occur in numerous other conditions. The rapid detection of these alarm signals and the early launch of necessary interventions can breach and stop the stress continuum. Various validated questionnaires are available which can be very useful in the evaluation and diagnosis of professional fatigue (22).

The Maslach Burnout Inventory (MBI)

The Maslach Burnout Inventory (MBI) is the most widely used self-report questionnaire that consists of the three dimensions included in the definition of burnout. Emotional exhaustion refers to the depletion or draining of emotional resources caused by interpersonal demands. Depersonalization points to the development of negative, callous, indifferent, and cynical attitudes toward the recipients of one's care or services. Finally, lack of personal accomplishment is the tendency to evaluate one's work with one's recipients negatively. It is believed that the objectives are not achieved, which is accompanied by feelings of insufficiency and poor professional self-esteem. Generally speaking, the psychometric quality of the MBI is encouraging: the three scales are internally consistent, and the three-factor structure has been confirmed in various studies. Moreover, the cross-national validity of the MBI has been demonstrated across German, French and Dutch samples. Paradoxically, it is also the least specific scale that is related to measures of other concepts such as depression. There are no clinically valid cut-off points available for the MBI that allow differentiation between levels of burnout. The test authors divided the normative sample into three equally sized groups of 33,3%, assuming that the top, intermediate and bottom thirds of the samples would experience "high", "average" and "low" levels of burnout, respectively. Although they warn that this classification should not be used for diagnostic purposes, there is a strong temptation to do so, especially for practitioners. Only nation-specific and clinically validated cut-off points should be employed (11).

Later on, the BMS-10 questionnaire (Burnout Measure Short version) *(Appendix 1)* was developed in which different levels of physical, mental and emotional exhaustion are examined for each type of job.

Four Dimensional Complaint List (4DCL)

The general practitioner can use the 4DCL *(Appendix 2)* to separate psychosocial complaints from depressive and anxiety disorders, to quantify the severity of psychological suffering, to perceive somatization complaints and to monitor the course of the reported issues. The aim and added value of the 4DCL for clinical practice is to distinguish distress, depression, anxiety and somatization, which makes it very useful as a screening tool and to determine whether further diagnostics are necessary. To a certain extent distress symptoms can be distinguished from depression, anxiety and somatization. Practically the whole spectrum of psychological and psychosomatic complaints can be subdivided into these 4 dimensions.

The 4DCL questionnaire consists of 50 items to assess complaints during the past 7 days: 16 items for 'Distress', 6 items for 'Depression', 12 items for 'Anxiety' and 16 items for 'Somatization'. Distress is an aspecific measure for the severity of psychological suffering; somatization stands for the experience of physical stress-related complaints and the concerns this entails.

A higher distress-score (> 20) combined with relatively low scores for depression, anxiety and somatization is indicative for overexertion. The higher the distress score, the greater psychological suffering and social dysfunctioning. Patients with depression or anxiety disorders also show a high score for distress, but they equally show a high score for depression or anxiety respectively (23).

Burnout, job stress, and depression

Burnout has been equated with a myriad of terms; most of them are plagued by the same sort of definitional ambiguity. In particular, questions have been raised about the extent to which burnout can be distinguished from job stress, depression and chronic fatigue (24).

Burnout and Job Stress

Job stress is a generic term that refers to the temporary adaptation process at work that is

accompanied by mental and physical symptoms. By contrast, burnout can be considered as a final stage in a breakdown in adaptation that results from the long-term imbalance of demands and resources. In other words, burnout results from prolonged job stress. Moreover, burnout includes the development of dysfunctional attitudes and behaviors toward the recipients of one's care or services (depersonalization), one's job, and the organization one is working for. By contrast, job stress is not necessarily accompanied by such negative attitudes and behaviors. Finally, it has been claimed that anybody can experience stress, while burnout can only be experienced by those who entered their careers enthusiastically with high goals and who expect to derive a sense of significance from their work. Those without such expectations would experience job stress instead of burnout. Accordingly, burnout is a specific type of job stress that is characterized by its chronic and multifaceted nature. Moreover, it includes the development of negative attitudes, and it occurs among initially highly motivated individuals.

Burnout and Depression

Clearly, although burnout and depression are different phenomena, they also overlap to a certain extent characterized by similar dysphoric symptoms. Nevertheless, clinical practice suggests that the syndromes differ. Burnout tends, at least initially, to be job related and situation-specific rather than pervasive. Instead, a "real" depression generalizes across situations and other spheres of life as well. Depressive patients are generally overwhelmed by listlessness and lethargy and hold steadfastly to their ideas of guilt, whereas burnout victims present their complaints much more vigorously – they feel disappointed and aggrieved. Furthermore, burnout includes specific dysfunctional attitudes and behaviors that are not typically found in depression.

Burnout and Chronic Fatigue

The most prominent symptom of the chronic fatigue syndrome (CFS) is persistent unexplained fatigue, whereas other symptoms commonly reported include mild fever or chills, sore throats, painful lymph nodes, unexplained generalized muscle weakness, muscle discomfort, prolonged generalized fatigue after levels of exercise, generalized headaches, joint pain, neuropsychiatric complaints and sleep disturbances. Unlike burnout, CFS is pervasive, it can affect virtually all-major bodily systems: neurological, immunological, hormonal, gastrointestinal and musculoskeletal problems have been reported. Burnout symptoms are primarily psychological, although accompanying physical symptoms are not uncommon. Contrarily, CFS primarily includes physical symptoms, although accompanying psychological symptoms are observed as well. Furthermore, burnout is job related, whereas CFS is not restricted to a particular life sphere. Generally, burnout workers blame their jobs for the condition they are in, whereas for patients who suffer from CFS, the origin of their symptoms is unclear. Finally, while exhaustion is a common denominator of CFS and burnout, the development of negative dysfunctional attitudes and behaviours characterize the latter, but not the former (7).

Conclusion

Thus, it seams that burnout is a separate phenomenon that can be distinguished conceptually as well as empirically from job stress, depression and CFS. Nevertheless, emotional exhaustion shows some overlap with other concepts. The fact that depersonalization and reduced personal accomplishment are less substantively related to other three concepts implies that burnout is a unique, multidimensional, chronic stress reaction that goes beyond the experience of mere exhaustion (25).

Burnout is, more than depression, a multidimensional phenomenon, but is at the same time, unlike depression, restricted to the job setting.

Moreover, burnout is different from job stress in several ways; it refers more to a breakdown in adaptation as a result of prolonged job stress, it is characterized by a multidimensional symptomatology, particularly specific attitudes, and it seems partly the result of a high initial level of motivation.

Finally, unlike CFS, burnout is a multidimensional, work-related, and primarily mental syndrome, whereas CFS is generic and predominantly characterized by unexplained fatigue and additional physical symptoms (8).

Interventions

From the moment burnout was introduced in the early 1970s, there has been a vivid interest in interventions. Because individual characteristics as well as workplace characteristics are involved in the etiology of burnout, interventions may focus on the person or on the job. Although it is generally acknowledged that a combination of both approaches would be most effective, burnout interventions have been conducted predominantly on the individual level. However, a strictly individual approach to burnout creates the danger that a "blame the victim" situation is created.

Burnout has such a complex pathology, both through its medical, psychological and familial elements as its consequences (socially, personally, professionally, financially, economically), that teamwork is an absolute necessity for an adequate follow-up of this condition. Resumption of work after a long period of

absence has more chances of success if the patient is in follow-up as early as possible and he or she is being treated by a multidisciplinary team (GP, psychologist, sophrologist, psychiatrist, coach…). The return to work of a burnt-out patient has to be prepared carefully by all parties so that the patient has the necessary psychological protection when he or she resumes work (26).

The barrier-free access and the personal patient-doctor relationship make the GP the ideal health care professional to detect and diagnose burnout in an early stage. Patients appreciate the human approach and integral strategy of their GP. All too often, the patients call upon their GP with vague complaints such as palpitations, gastro-intestinal symptoms or impaired concentration so that the GP establishes the diagnosis of professional fatigue. Hence, burnout patients – after accepting their diagnosis and treatment – often value that their GP continues to play a coordinating role in the multidisciplinary handling of their condition (27).

Non-medicamentous treatments

Overall, overexertion shows a favourable clinical course. Based on current insights, the study group has reached a consensus, that as quickly as possible, at least within 2 weeks, following interventions have to be initiated: counseling, bringing perspective and an activating and structuring coaching by the company physician, GP or psychologist. The components of the treatment of overexterion are based on the principles of cognitive behavioural therapy, stess-inoculation therapy and a gradual activating and time-contingent approach (28).

Individual interventions

Individual approaches to prevent or reduce burnout include cognitive-behavioral techniques such as stress inoculation training, rational emotive therapy, cognitive restructuring and behavioral rehearsal. A cognitively oriented approach is relevant because burnout often involves “wrong” cognitions such as unrealistic expectations. In addition, relaxation techniques and didactic stress management are often used to reduce burnout. The latter involves the presentation of practical information about burnout and includes techniques such as self-monitoring.

In addition, other measures have been recommended to combat burnout, including time management, balancing work and private life, physical training, promoting a healthy diet, more realistic image of the job and increasing one’s social skills – particularly assertiveness.

In summary, it appears that individual burnout interventions work. However, it is rather difficult to draw general conclusions about the effectiveness of specific individual burnout intervention programmes because the evaluation studies use different methodologies, samples, procedures, time frames, measurement instruments and training methods. Nevertheless, one major conclusion emerges: at the least, the core symptom of burnout – emotional exhaustion – can be reduced by training professionals to use particular coping skills, most notably cognitive restructuring and relaxation techniques. Conversely, levels of personal accomplishment, and particularly depersonalization appear rather resistant to change. This fact is not very surprising since most techniques employed in burnout workshops focus on reducing arousal and not on changing attitudes (depersonalization) or on enhancing specific professional skills or resources (personal accomplishment).

Workplace interventions

Only occasionally, workplace interventions are explicitly carried out to reduce stress or burnout. Generally, other purposes are targeted such as increased productivity and efficiency, cost-effectiveness, smooth communication, or organizational flexibility. Nevertheless, there is an increasing awareness that preventing burnout is important because of the high direct and indirect costs associated with it. Workplace interventions to reduce burnout are more rare than individual approaches, and their effectiveness is seldom evaluated. Work redesign (i.e. job enlargement, job rotation and job enrichment) is mentioned as a major tool to decrease quantitative and qualitative workload. Since many burnout candidates feel “locked in” their careers, career development programs and career counseling are organizational approaches that can prevent burnout. Two-way communication between management and employees, adequate procedures for conflict management, and participative decision-making also have been proposed as antidotes to burnout. Moreover, is is suggested that social support from colleagues and superiors should be institutionalized in the form of regular consultations and team meetings. In addition, “time-outs” and sabbatical leaves have been suggested in order to enhance the recuperation from the daily stresses of the job.

Compared with individual interventions, the effects of workplace intervention programs to reduce burnout are somewhat disappointing. This is at least partly caused by methodological reasons because workplace programs are often participatory in nature so that a pretest posttest experimental design is not feasible, and effectiveness cannot be demonstrated (7).

Medicamentous treatments

In principle, there is neither room nor scientific foundation for medicinal treatment of overexertion

or burnout. Medication can be deployed temporarily (2 weeks) at most when alleviating grave symptoms is required such as sleep disturbances or functional physical complaints.

In GP practices it happens that over the first period of absenteeism caused by psychological complaints and serious sleep disturbances, benzodiazepines are being used temporarily to treat sleeping problems and stress-related complaints or symptomatic substances to control functional physical complaints such as pain or intestinal symptoms.

There is limited evidence for the effectiveness of alternative medicines to treat complaints fairly similar to overexertion or burnout. In one study, Ginkgo biloba has been found to be effective for neurasthenic complaints as well as Euphytosis en Ganoderma lucidem. However, the study group objects to the use of such medicines because of the risk of medicalization if the patient would ascribe an improvement to these substances instead of his/her own strength and actions (29).

It is advisable to continue to use the prescribed medication during the acute phase in order to minimize the number of disturbances in the patient's life and to enhance "a soft landing". If a psychotropic treatment is initiated (such as antidepressants), it cannot be terminated under the pretext of having to resume work shortly. The general recommendation is to maintain the treatment in the same dosage during 6 to 9 months after the symptoms have completely vanished (28).

Wearables in healthcare

Telemedicine has significantly broadened its scope the last few years. In the 90's, it was mainly used by healthcare providers, regardless time and location, for second opinion and patient consultation. Today it elaborates solutions for remote health monitoring to support prevention, early diagnosis, disease management, treatment and home rehabilitation. Remote health monitoring could lead to a significant reduction of total cost in healthcare by avoiding unnecessary hospitalisations and ensuring that those who need urgent care get it sooner. Latest developments in micro- and nanotechnologies as well as in information processing and wireless communication offer, today, the possibility for smart miniaturisation and non-invasive biomedical measurement as well as for wearable sensing, processing and communication. Although developing specific systems and applications to address specific user needs, the "smart health wearable" research and industrial community face a number of common critical issues, e.g. biomedical sensors, scenarios of use, data security and confidentiality, risk analysis, user interface, medical knowledge/decision support, dissemination, user acceptance and awareness, business models and exploitation. Beyond technology, which seems providing proof of concept, real future challenges such as clinical validation and impact assessment of the newly developed smart wearable applications, are ahead (30).

Chronic mental stress can cause health problems, which include for example hypertension, cardiovascular diseases, increased likelihood of infections and depression. If mental stress could be detected in an early stage, many stress related health problems could be prevented (31). Stress is known to activate the sympathetic nervous system (SNS). Much research has already been done on the detection of stress from physiological parameters that are influenced by the SNS. Examples are muscle activity, heart rate, heart rate variability, skin conductance and pupil diameter.

Other studies have shown that a combination of these physiological parameters facilitates differentiation between stressful situations and situations without stress (32).

The study of Wijsman et al. aimed at using a wearable sensor system to measure physiological signals and detect mental stress. Three different stress conditions were presented to a healthy subject group. During the procedure, ECG, respiration, skin conductance, and EMG of the trapezius muscles were recorded. In total, 19 physiological features were calculated from these signals. After normalization of the feature values and analysis of correlations among these features, a subset of 9 features was selected for further analysis. Principal component analysis reduced these 9 features to 7 principal components. Using these principal components and different classifiers, consistent classification accuracy between stress and non-stress conditions of almost 80% was found. This suggests that a promising feature subset was found for future development of a personalized stress monitor (33).

Stress is a huge problem in today's society. Being able to measure stress, therefore, may help to address this problem. A system that can measure stress levels based on physiological signals will create interesting applications in real life situations. Ultimate goal is to design an easily wearable wireless system that can measure real time stress levels. This study aimed at using a wearable sensor system to find the physiological signals and features that show the most distinct reaction to mental stress. Once these features are identified, it should be possible to construct a reliable stress measure out of these features.

METHODS

Sampling

In this observational pilot study, we included patients aged 18 to 65 years in one Flemish general practitioner (GP) office during a period of 6 consecutive months. When patients between these age groups came into the office for a consultation with complaints that were suggestive of burnout (exhaustion, lack of energy, sleep disturbances, anxiety, sense of failure, insomnia, concentration issues, stomach ache, headache, palpitations, lack of motivation, irritability, frustration…), they were offered to fill in the BMS-10 screening questionnaire (Maslach-Pines Burnout Measure Short Version) *(Appendix 1)* to objectify their complaints. Patients were also asked to fill in their name, date of birth, sex, weight and height. Patients who attained a BMS-10 score of 3,4 or more were considered positive for the diagnosis of burnout and were asked to fill in the BDCL (Burnout-Depression Complaint List) (*Appendix 3)* to detect underlying acute depression and the 4DCL-questionnaire (FourDimensional ComplaintList) *(Appendix 2)* to distinguish distress, depression, anxiety and somatization. If the latter two questionnaires dit not show an indication of possible other psychologic conditions, these subjects were provided with information about the goal, the following process and practical implications of the study. If they agreed to pursue, an informed consent was offered.

In this explorative pilot study, the researcher also randomly selected a control group. This is because it is practically impossible to completely eliminate all of the bias and outside influence that could alter the results of the experiment, but control groups can be used to focus on the variable you're trying to test. The subjects in the control group were offered the same questionnaires used in the experimental group to ensure no psychological issues were present. In summary the researchers made sure to include patients that showed no sign of any physical nor psychological conditions in order to pursue an optimal control group with an ideal health condition and comparable age and sex distribution as those of the experimental group.

Inclusion and exclusion criteria experimental group

To be included in the experimental group with burnout, patients had to be at least 18 years old and should not be older than 65 years. Secondly patients had to obtain a score of at least 3,4 for the BMS-10 screening questionnaire as this is considered an indication of burnout. The third criterion was that the additional two questionnaires, being the BDCL and 4DCL, were not to show any indication of moderate to severe underlying depression or other psychological conditions.

Following exclusion criteria were taken into account: terminal patients (defined by a life expectancy less than three months), a diagnosis of early-onset dementia (predefined diagnosis or Mini Mental State Examination < 21) and a medical history of cardial arrhythmias such as atrial fibrillation and extrasystoles. Pregnant women were also excluded from the study. We decided to exclude patients who were already taking antiarrhythmic medications, beta blocking agents and antidepressants. The final exclusion criterion for the experimental group was the inability to fill in the questionnaires because of either lack of intelligence or language skills.

Inclusion and exclusion criteria control group

To be included in the control group (i.e. group of patients with a low risk of having burnout), patients had to be aged 18 to 65 years. Secondly, patients should have achieved a score of not more than 3,4 on the BMS-10 questionnaire. A certain number of male and female patients were selected randomly to form a control group of 6 patients that matches the experimental group for age and sex.

The exclusion criteria for the control group were the same as for the high risk experimental group.

Home monitoring

Patients who met all predetermined inclusion criteria were offered to participate in the second part of this study. In this second part two devices called Stingray® and Chill Band® were attached to the patient by the author during a costless follow-up consultation shortly after the first acquaintance. Patients were allowed to take their regular medication. After 7 days the devices were detached by the patient himself and brought back to the GP's office. The patients were offered a questionnaire to inquire the user-friendliness of the devices and to determine if the patients experienced any side effects of the monitors *(Appendix 4)*.

The patient's weight, height, blood pressure and heart rate were measured and noted. An extensive anamnesis was taken including the patient's medical history, cardiovascular risk factors (smoking habits, alcohol consumption, hypertension, hypercholesterolemia, familial history) and medication use.

Stingray® device

During the first follow-up consultation, the Stingray® device was attached to the patient. Stingray® is a recently developed and an innovative body patch that measures Electrocardiogram (ECG) in 2 channels and Accelerometer (ACC) in 3 channels. The ECG patch measures up to 3 lead ECG signals, tissue-contact impedance and includes a 3D-accelerometer for physical activity monitoring. Below a figure (Figure 1) of patch and sensor node is represented. On the left the patch and sensor node are presented separately.

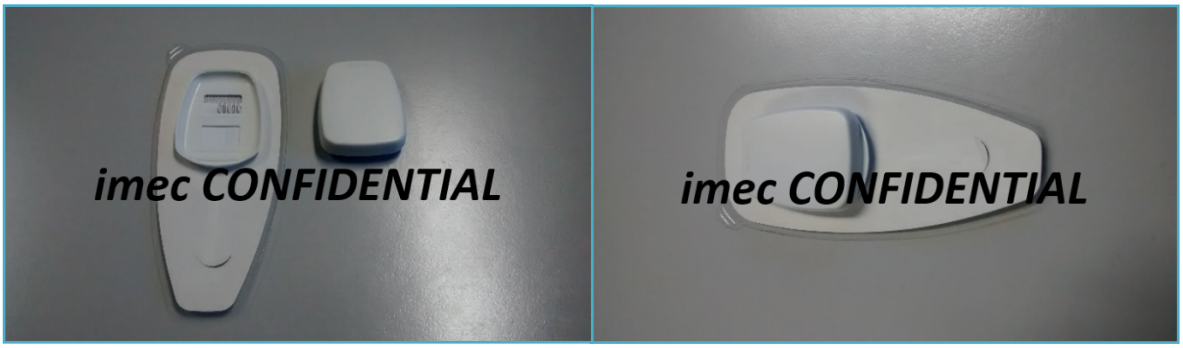


Figure 1: Stingray. Left: patch and sensor node. Right: sensor node and patch connected.

In this case the sensor is off. When the sensor is clicked in the patch it will switch on and the measurement starts (right figure). As long as the sensor is connected to the patch it will record.

When participants practice sports they are instructed to take off the patch (to avoid sweat in the sensor) and afterwards attach a new one.

This unique combination fuses power-efficient electronics and standardized communication, opening new perspectives for long-term monitoring in health, wellness and medical applications

Chillband® device

During the first follow-up consultation, the Chill Band® device was attached to the patient. Both the experimental population and control patients were asked to tap the device twice until a blue light lit up when they subjectively experienced any stress or nervousness, which would be noted as a stress event in the analysis of the Chill Band®.

The Minifornax or Chillband is a wearable wireless wristband that measures Galvanic Skin Response (GSR), Skin temperature (ST) and Acceleration (ACC) in 3 dimensions. Below a figure of the sensor is represented (Figure 2). The sensor switches on when the GSR electrodes are touched and cannot be switched off other than connecting it to a wall adaptor or computer (which the participants are not allowed to do). Therefore only the experimenter can switch off the sensor and this is usually only done the day after the experiment ends. Participants are allowed, but not obliged, to take off the sensor at night (Stingray® is worn 24/7). The sensor is not waterproof and therefore taken off during showering and sports. The Chill Band® has an unmatched low-power performance providing autonomies beyond one week of continuous monitoring.

Interpretation procedure

The interpretation of results was based on automatic software analysis of the Stingray® and Chill Band® developed by Imec and manual revision of the research team. These data include the mean heart rate (HR), heart rate variability (HRV), galvanic skin response (GSR), skin temperature (ST) and physical activity monitoring (ACC).

Data pre-processing and analytics were performed with Python using Jupyter Notebooks. The statistics were performed with the well-known SciPy Python Library.

Heart rate (variability)

Although stress has a psychological origin, it affects several physiological processes in the human body: increased muscle tension in the neck, change in concentration of several hormones and a change in heart rate (HR) and heart rate variability (HRV). The brain innervates the heart by means of stimuli via the Autonomic Nervous System (ANS), which is divided into sympathetic and parasympathetic branches. The sympathetic activity leads to an increase in HR (e.g. during sports exercise), while parasympathetic activity induces a lower HR (e.g. during sleep). The two circuits are constantly interacting and this interaction is reflected in HRV. HRV, therefore, provides a measure to express the activity of the ANS, and may consequently provide a measure for stress (1).

When a person is exposed to a stressor, the ANS is triggered: the parasympathetic nervous system is suppressed and the sympathetic nervous system is



Figure 2: Minifornax/Chillband.

activated. This results in the secretion of the hormones epinephrine and norepinephrine into the blood stream which leads to, for example, vasoconstriction of blood vessels, increased blood pressure, increased muscle tension and a change in heart rate (HR) and heart rate variability (HRV) (34).

When the stressor is no longer present, a negative feedback system stops cortisol production in the body, and a sympathovagal balance is established through homeostasis between the parasympathetic (vagal) and sympathetic system. Chronic stress, such as experienced in working situations, can lead to a chronic activation, overload and eventually exhaustion of the hormonal, cardiovascular, neural and muscular systems due to insufficient recovery and repair. Long-term consequences include, for example, an impairment of immune systems, delay of healing processes and musculoskeletal overload.

During the last few decades, researchers have used HRV to measure mental stress. HRV measures are calculated from the ECG signal by defining the distance between two consecutive R peaks. The variance in time between two consecutive R-peaks reflects the status of the ANS, since HRV is regulated by the sympathovagal balance. HRV in response to stress differs between individuals due to genetic composition, age and environment (35).

Taelman et al. explored measures of HR and HRV with an imposed stressful situation. The results suggest that HR and HRV change with a mental task or stressor. The short-term variability was less with a mental task than during rest. The longer-term variability did not differ significantly between the conditions, however. They also demonstrated that mean HR increased significantly from rest values with the additional load of a mental task (1).

HR and HRV recordings may have the potential; therefore, to measure stress levels and guide preventive measures to reduce stress related illnesses. With this study, we aim to investigate the interaction between HR, HRV and mental stress on group level and individual changes.

Galvanic Skin Response

One of the most sensitive markers for emotional arousal is galvanic skin response (GSR), also referred to as skin conductance (SC) or electro-dermal activity (EDA). GSR modulates the amount of sweat secretion from sweat glands. While sweat secretion plays a major role for thermoregulation and sensory discrimination, changes in skin conductance in hand and foot regions are also triggered quite impressively by emotional stimulation: the higher the arousal, the higher the skin conductance. It is noteworthy to mention that both positive ("happy" or "joyful") and negative ("threatening" or "saddening") stimuli can result in an increase in arousal – and in an increase in skin conductance.

Skin conductance is not under conscious control. Instead, it is modulated autonomously by sympathetic activity, which drives human behavior, cognitive and emotional states on a subconscious level. Skin conductance therefore offers direct insights into autonomous emotional regulation. It can be used as alternative to self-reflective test procedures, or – even better – as additional source of insight to validate verbal self-reports or interviews of a respondent (36).

Skin temperature

Acute stress triggers peripheral vasoconstriction, causing a rapid, short-term drop in skin temperature (ST) in homeotherms. Herborn et al. tested whether this response has the potential to quantify stress, by exhibiting proportionality with stressor intensity. They found that stressor intensity predicted the extent of initial skin cooling, and also the occurrence of a more delayed skin warming, providing two opportunities to quantify stress.

Beyond stress however, increased mental workload, pain and even positive experiences can trigger an acute drop in skin temperature. Whilst this ubiquity stems from shared, underlying hormonal changes in different emotional states, such that the skin temperature changes here may reflect arousal rather than stress specifically, in some species, variation in the responsiveness of different skin regions to positive versus negative stimuli suggests that comparison of temperature changes across skin regions may also reveal emotional valence. Moreover, pronounced changes in the distribution of heat around the body occur during thermoregulation. Consideration of the skin region selected and the emotional and physical context will clearly be important to understanding patterns of skin temperature change (37).

APPROVAL

This study was approved by the Medical Ethics Committee of the Catholic University Hospital Leuven (MP11662) *(Appendix 5)*. All patients gave informed consent to the investigations. No physical or emotional harm was done to participating patients and all data were processed and analyzed anonymously. There was no financial reward for those participating in this study.

RESULTS

A flow chart with the selection of patients for the experimental group is shown in (Figure 3). A total of 19 patients (3 men, 16 women) aged 18-65 years old reported complaints suggestive of burnout when presenting them to the GP practice during a period of 6 months.

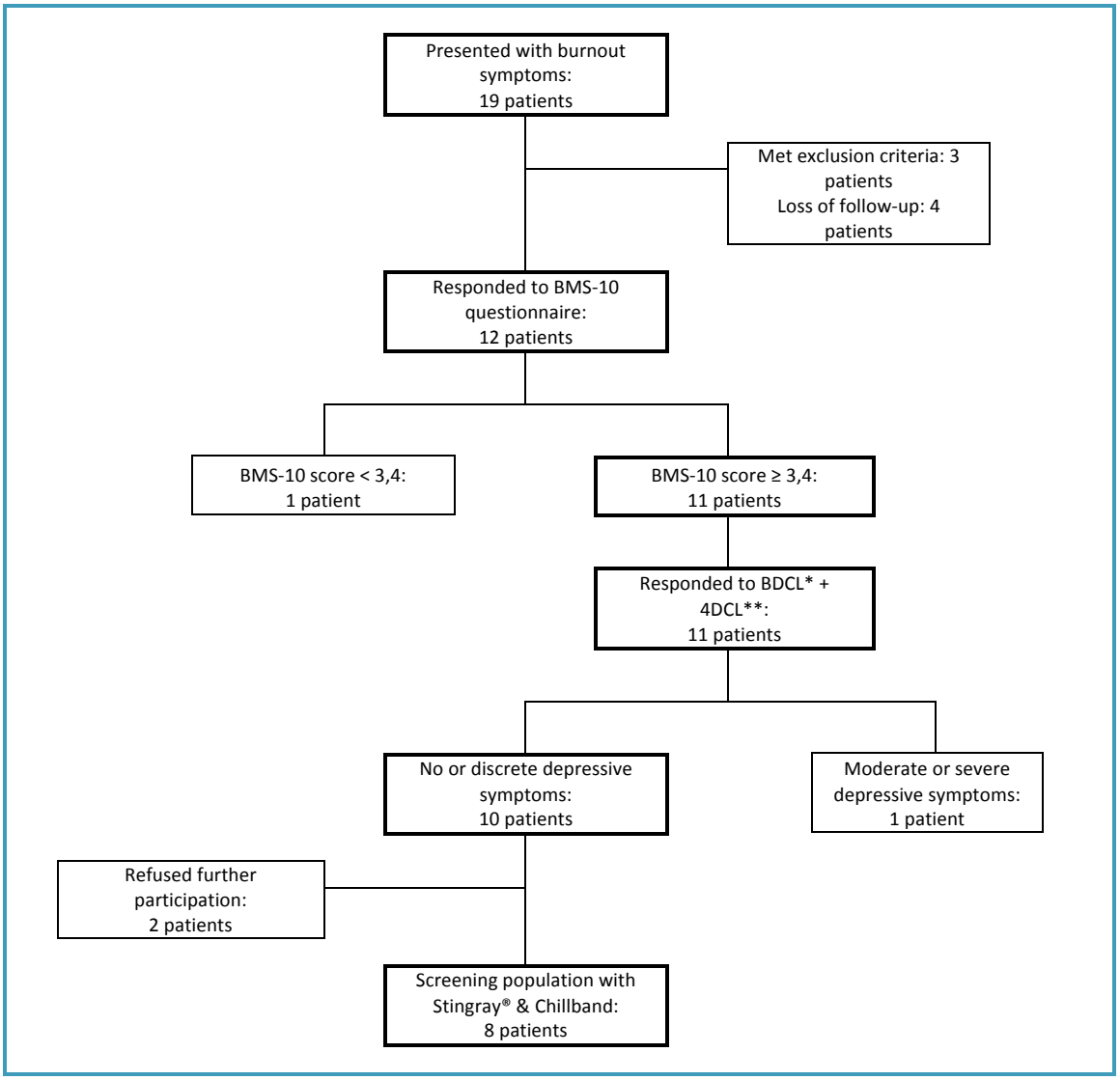


Figure 3: Flowchart of patient selection and inclusion

Of these 19 patients, 4 patients were lost during further follow up and 3 patients met the pre-set exclusion criteria, comprising 2 pregnant women and 1 male patient with a history of atrial fibrillation. The screening population therefore counted 12 patients that were subjected to the BMS-10 questionnaire.

From the 12 patients in the screening population, 11 patients attained a BMS-10 score of 3,4 or more, which was considered the cut-off value for inclusion in the burnout study population.

Patients, who achieved a score of 3,4 or more on the BMS-10 questionnaire, were equally offered to fill in the BDCL-questionnaire - to detect underlying depression - and the 4DCL-questionnaire, which allows us to distinguish distress, depression, anxiety and somatization. From those 11 patients, 10 patients attained a BDCL-score not exceeding 32 points, which correlates with no or mild depressive symptoms. Regarding the 4DCL, all 10 patients attained a score of 5 or less for depression and 6 or less for anxiety, which corresponds to no or mild depression or anxiety.

Between the 10 patients of the eligible population, 2 patients refused to take part in the further diagnostic evaluation with the Stingray® and Chill Band® because of various reasons (lack of time, holiday, fear of feeling even worse with the device, etc.). This resulted in a final experimental group of 8 patients who agreed to be tested by home monitoring.

6 patients were selected as described above to form the control group. The subjects in the control group were offered the same questionnaires used in the experimental group.

Patient characteristics from both experimental group and control group are summarized in table 2. The experimental group

Table 2. Patient characteristics

Experimental group										
Patient	Sex	Age	Weight	Height	BMI	BP	Pulse	Profession	ACTIVE	PRIVATE LIFE
2	F	46	60	165	22	130/80	83; reg	Kindergarten teacher	NO	Single No children
3	F	30	75	165	27,6	140/70	63: reg	IT-professional	NO	Single No children
4	M	50	83	176	27	135/75	90; reg	Truck driver	NO	Married 3 children
5	F	47	65	172	22	152/78	72; reg	Nurse	NO	Married 2 children
7	F	56	50	170	17,3	130/80	76; reg	Secretary	NO	Divorced No children
9	F	44	79	165	29	130/75	68; reg	Administrative employee	YES	Single No children
10	F	26	65	156	27,1	140/85	84; reg	Waitress	NO	Cohabitant 2 step children
12	F	51	55	156	22	110/60	80; reg	Family care worker	NO	Married 1 child
Control group										
Patient	Sex	Age	Weight	Height	BMI	BP	Pulse	Profession	ACTIVE	PRIVATE LIFE
13	F	26	60	165	22	110/70	72; reg	Medical student	YES	Cohabitant No children
14	M	27	72	180	22,2	120/80	76; reg	Consultancy	YES	Cohabitant No children
15	F	55	65	162	24,8	130/70	76; reg	Family doctor	YES	Married 3 children
16	M	54	64	170	22,1	115/80	64; reg	Administrative employee	YES	Married 1 child
17	F	56	75	160	29,3	125/75	68; reg	Administrative employee	YES	Married 2 children
18	M	56	80	180	24,7	130/85	72; reg	Bank Clerk	YES	Married 2 children

counted 7 women and 1 man; the control group 3 women and 3 men. The mean age of the experimental group was 44 years with a minimum and maximum of respectively 26 and 56 years, compared to an average age of 46 years in the control group with a minimum and maximum of 25 and 56 years respectively. An overview of all questionnaire scores is given in table 3. The mean BMS-10 score in the burnout group was 5,2 points with a minimum and maximum of respectively 4,4 and 6,3 points. The mean BMS-10 score in the control population was 2,0 points with a minimum and maximum of 1,5 and 2,9 points respectively.

Stress events

As described above, both the experimental population and control patients were asked to tap the Chill Band® device twice until a blue light lit up when they subjectively experienced any stress or nervousness, which would be noted as a stress event in the analysis of the Chill Band®.

The patients of this study were sometimes unsure if the event was registered on the wristband. Therefore, several events seemed to follow within seconds after the first tap was registered. It would not be correct to register all those consecutive taps as separate events. Therefore all events in a window of five minutes were considered as one event in order to avoid successive tapping regarded as one event.

Figure 4 represents an overview of the total number of stress events that were registered over the total observation period of 7 days for each patient individually. Both experimental and control group show patients with as well no or numerous stress events and demonstrate a great variation in amount of stress events among patients in both groups. The average number of registered stress events in the 8 burnout patients is 27,13; as compared to 29,83 stress events in the 6 control patients. The median of registered stress events is 8 and 31,5 respectively in the burnout patients and the control group. We see that the mean is approximately equal between the control group and the burnout population. Nevertheless, in case of a small amount of samples, mean values are highly influenced by possible outliers in the data set. Therefore, in this case, the median would be a better factor to discriminate differences between control and burnout patients. We clearly see in that the median amount of stress events for the control group is higher than the median for the

Table 3. Scores questionnaires

Patient	BMS-10	BDCL			4DCL		
		BURNOUT	DEPRESSION	DISTRESS	DEPRESSION	ANXIETY	SOMATISATION
Experimental group							
2	5	27	19	21	0	6	19
3	5,1	26	31	27	2	0	14
4	4,4	33	15	15	0	2	23
5	4,9	27	25	18	0	3	8
7	4,7	25	23	21	3	3	13
9	5	30	31	26	5	2	15
10	6,3	35	28	26	4	5	26
12	6	31	23	25	4	3	10
Control group							
13	1,5	15	12	6	0	0	5
14	1,6	16	11	8	0	0	0
15	2,1	15	14	13	0	1	3
16	1,6	15	14	4	0	0	0
17	2,5	21	15	13	1	0	7
18	2,9	17	13	10	0	1	4

burnout population. To determine if people with burnout have on average more stress events than people in the control group, a t-test was performed. The p-value for this test is 0.88 (and 0.21 excluding a possible outlier). Based on this p-value one can conclude that - given this data - on average there is no difference in the number of stress events of people with and without burnout.

Subsequently, the authors wished to investigate whether there is a relation between the severity of burnout, reflected by the BMS-10 score, and the amount of registered stress events. The results of this analysis are displayed in figure 5. A variable amount of stress events was registered regardless of the attained BMS-10 score.

Figure 6 shows a demo chart of the event timings troughout the day for patient 18, as was developed for all other burnout and control patients. The authors divided all seven days in windows of four hours in order to investigate whether there is any correlation between amount of registered stress events and working hours and if there would be any difference between burnout patients and control patients (e.g. whether burnout patients would equally experience stress outside the working hours or during the night). Two of the established time windows fall within working hours (8-12am and 12-4pm), two other time windows are located before or after working hours (4-8am and 4-8pm), the final two time windows comprise sleeping or resting period (8-12pm and 12-4am).

The total amount of stress events per time window for the burnout population and control group is summarized in the boxplot overview in figure 7. Note that, for better visualization, the maximum is set to 30 in which one data point is not visualized by this restriction (data point outlier in the burnout group in the 8-12 window). For each time window there was no significant difference between both groups in average amount of stress events with successive p-values of 0,76; 0,30; 0,66; 0,93; 1,0; 1,44 (significance level of 0,05).

Biometric parameters

During the observation period of 1 week, five main biometric parameters were recorded which are mean

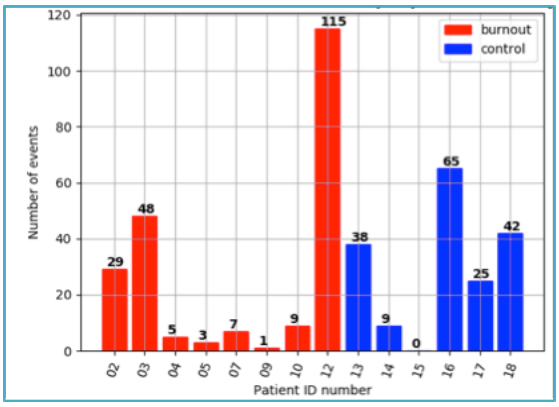


Figure 4: Overview of total amount of stress events per patient during 7 days

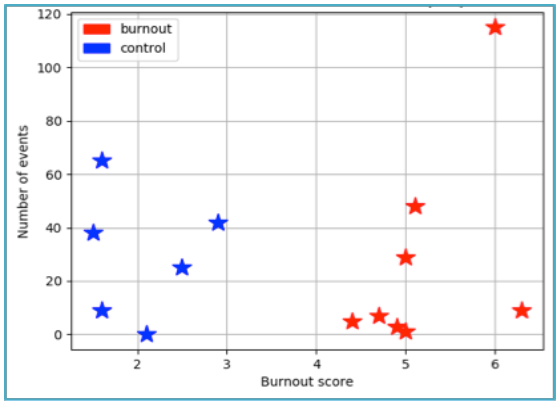


Figure 5: Correlation between total number of stress events and BMS-10 score per patient

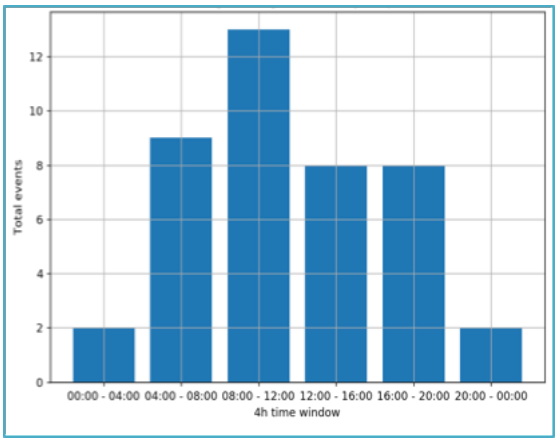


Figure 6: Graph example of time windows and event timings troughout the day for patient 18

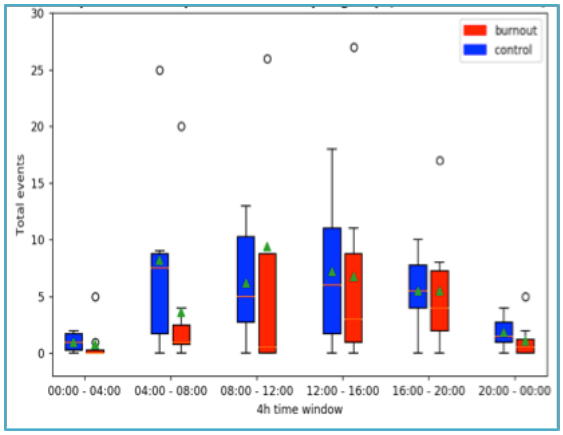


Figure 7: Boxplot overview of amount of stress events per time window per group

successive p-values 0,76; 0,30; 0,66; 0,93; 1,0; 1,44

heart rate (HR), heart rate variability (HRV), skin conductance (GSR), skin temperature (ST) and activity level (ACC).

Since everyone's metabolism and biometric parameters are patient specific and activity dependent, it is of paramount importance to compare these biometric parameters during moments in which the activities are reduced to a minimum (e.g. analysis of mean heart rate in someone who runs five times per week compared to a non-active person; e.g. analysis of skin conductance in someone who works outside in warm conditions vs someone who works in a continuously airconditioned environment). Based on the reasoning above we used the parameter 'activity' (Std_ACC) to filter the datapoints for further analysis, so we could exclusively compare activities under 'basal conditions'.

An example of this workflow is illustrated in figure 8 and figure 9 for the parameter 'mean heart rate'. In the upper graph of figure 8 the course of the mean heart rate of one patient (patient 15) is demonstrated during the entire observation period of 7 days. The green dashed line points the mean heart rate calculated for the whole week, regardless of the activity level ('general mean heart rate'). The lower graph in figure 8 represents the overall activity level for this same week and same patient. The red line segregates the overall activity into basal activity (below the red line) and higher activities (above the red line). The threshold for the accelerometer/activity (Std_ACC) was set at 0,04. Below this value (below the red line), possible activities comprise sitting, lying down and standing. Above 0,04 (above the red line), more intense activities such as walking, moving, running… are covered. Please note that this threshold is not exact but it renders a certain indication. In summary, only mean heart rates during these basal activities (under the red line) were isolated and converted to form the 'basal mean heart rate'.

In this way, figure 9 comes about where clearly two dashed lines are indicated. As discussed earlier (upper graph figure 8), the dark green dashed line represents the 'general mean heart rate' in overall conditions and regardless of activity level. The pale blue dashed line depicts the 'basal mean heart rate', which implies the mean heart rate under non-active conditions (activity level < 0,04). The subtraction of these two values ('general mean heart rate' - 'basal mean heart rate') provide a good indication of the 'normalized basal mean heart rate' in order to neutralize interindividual and patient specific differences in mean heart rate.

This workflow was performed for all patients and all biometric parameters (heart rate, heart rhythm variability, galvanic skin response and mean skin temperature):

1) Patient X: calculate 'general mean' for specific parameter during 7 days in overall conditions regardless of activity level
2) Patient X: Calculate 'basal mean' for this same parameter during 7 days under activity level < 0,04
3) Perform step 1 and 2 for all patients
4) Divide all patients in burnout population and control group
5) Perform T-test on both groups

Subsequently, patients were divided into burnout patients and control patients to distinguish if there was a difference for this 'normalized basal mean heart rate' between these two groups, which is displayed in Figure 10 (p-value 0,88). One would expect positive values at all times when calculating the difference between 'general mean heart rate' and 'basal mean heart rate', shortly the 'normalized basal mean heart rate', since resting conditions provoke a slowing of the heart rate causing a lower value of the 'basal mean heart rate' and a positive difference value between 'general mean heart rate' and 'basal mean heart rate'. However, in both groups also

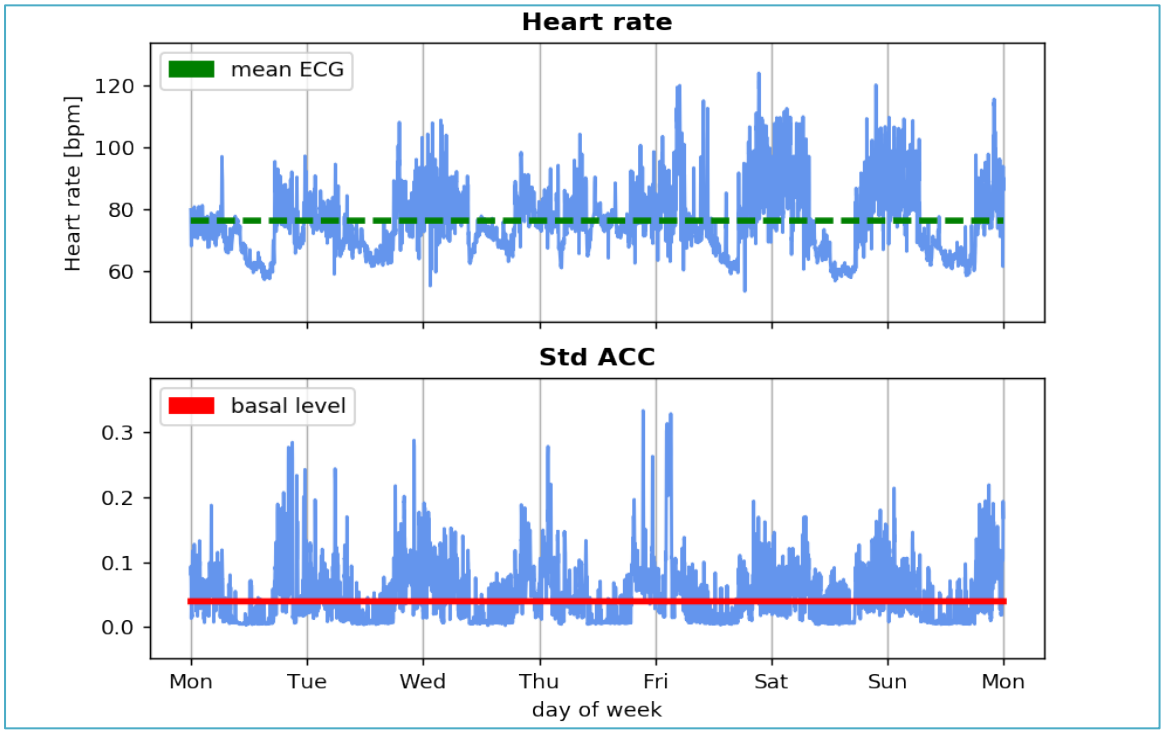


Figure 8: Example of workflow for 'mean heart rate' for patient 15

Upper graph: course of mean heart rate during entire observation period of 7 days. Green dashed line = mean heart rate calculated for whole week, regardless of activity level ('general mean heart rate')

Lower graph: overall activity level during entire observation period of 7 days. Red line segregates overall activity into basal activity (below red line) and higher activities (above red line) with threshold for activity 0,04.

** (Std_ACC) = activity level*

negative difference values can be noted, possibly explained by the presence of activities that were not registered by the accelerometer of the Stingray® such as non-accelerating movements or peripheral activity (limb movement) with rise of the heart rate under false basal circumstances. The median 'normalized basal mean heart rate' (subtraction of 'general mean heart rate' and 'basal mean heart rate') is higher in the control group than the burnout population which corresponds to the fact that in many patients of the control group their 'basal mean heart rate' differs more from their 'general mean heart rate' and which means that there is a smaller difference between 'basal mean heart rate' and 'general mean heart rate'.

Figure 11 represents a boxplot overview of the difference values for both patient groups between 'general mean heart rate variability' and 'basal mean heart rate variability', shortly the 'normalized basal mean heart rate variability'. As depicted in this graph, there are hardly no negative difference values for the heart rate variability (HRV) since the HRV under basal circumstances is normally lower than the 'general mean heart rate variability'. The mean and median 'normalized basal mean heart rate variability' and overall boxplots are comparable between both groups (p-value 0,84).

Figure 12 (p-value 0,33) depicts a boxplot overview of the difference values for both patient groups between 'general mean galvanic skin response' and 'basal mean galvanic skin response', shortly the 'normalized basal mean galvanic skin response'. For both groups, mainly negative difference values could be noted which corresponds to a lower 'general mean galvanic skin response' compared to a higher 'basal mean galvanic skin response'. The boxplot of the burnout population is shifted towards the negative values as compared to the control group which could correlate with a higher mean galvanic skin response under basal conditions or a lower 'general mean galvanic skin response' in a burnout population compared to the control group. Please note that (i) all data were normalized in order to eliminate physiological sweating, (ii) unfortunately there were no data for the Chill Band® device for patients 10 (burnout patient) and patient 14 (control patient) so these two patients had to be excluded from this analysis.

In figure 13 (p-value 0,63), a boxplot overview is displayed of the difference values for both patient groups between 'general mean skin temperature' and 'basal mean skin temperature', shortly the 'normalized basal mean skin temperature'. Comparable median en mean values can be noted between both groups. The overall

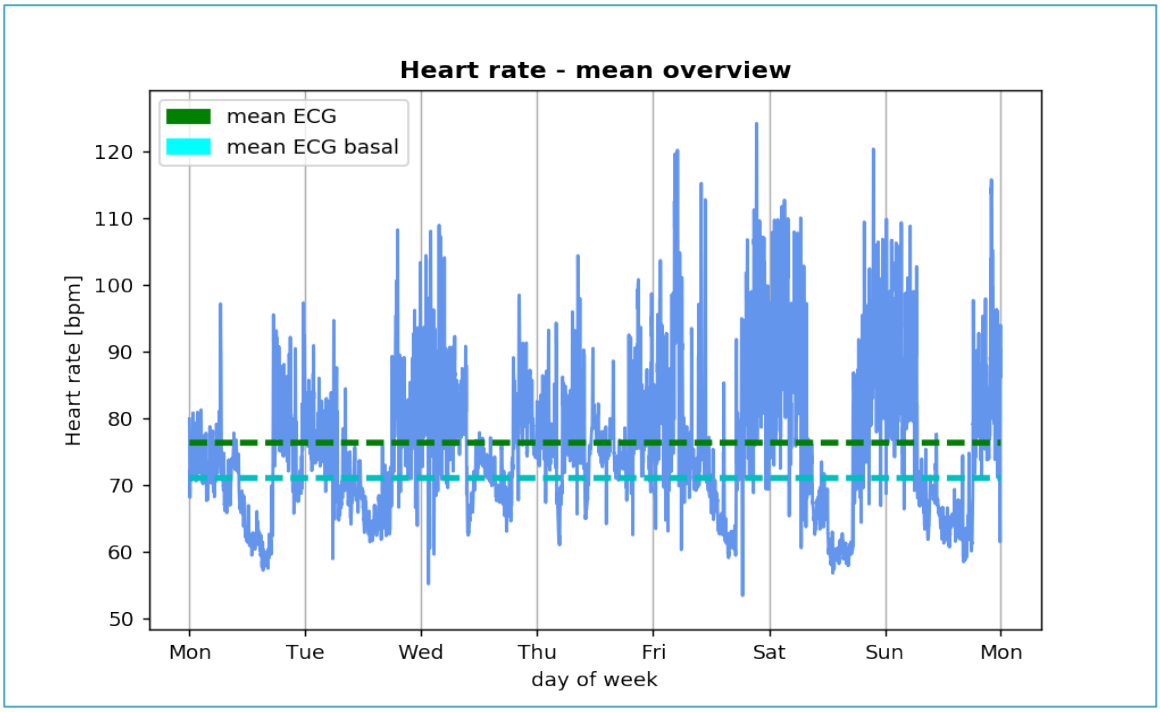


Figure 9: Analysis and conversion of 'mean heart rate' for patient 15 to form 'basal mean heart rate'
Dark green dashed line: 'general mean heart rate' in overall conditions and regardless of activity level
Pale blue dashed line: 'basal mean heart rate' = mean heart rate with activity level < 0,04

boxplot in the burnout population seams slightly shifted towards more negative values which could correlate with a higher mean skin temperature under basal conditions or a lower 'general mean skin temperature' in a burnout population compared to the control group. Please note that, unfortunately there were no data for the Chill Band® device for patients 10 (burnout patient) and patient 14 (control patient) so these two patients had to be excluded from this analysis.

Finally, in figure 14 the 'mean nightly activity' was analyzed and compared between the burnout population and the control group. A discrete higher median and mean values can be noted in the burnout population and the overall boxplot implicates a modest higher 'mean nightly activity' in the burnout population compared to the control group.

User friendliness

Each patient was also questioned about the utility and user friendliness of the Chill Band® and the Stingray® device *(Appendix 4)*. Overall, the patients experienced the devices as comfortable and they reported an untroubled sleep (score 9,42/12). Two patients had the subjective feeling of having slept less than usual. There were a few main remarks on wearing both devices. First, the Stingray® device was attached with a synthetic patch that caused itchiness or discrete skin irritation in 5 subjects. Secondly, the Stingray® device was shielded by an elastic patch to prevent any exposure to water. Patients were given instructions on how to take a shower or bath and how to rinse their hair in order to prevent the ingress of moisture into the Stingray® device. Finally, some patients noted some discomfort by wearing a seat belt while driving their car since the attachment of the Stingray® device corresponded to the crossing of the seatbelt.

DISCUSSION

In this pilot study, a total of 19 patients aged 18-65 years old reported complaints suggestive of burnout

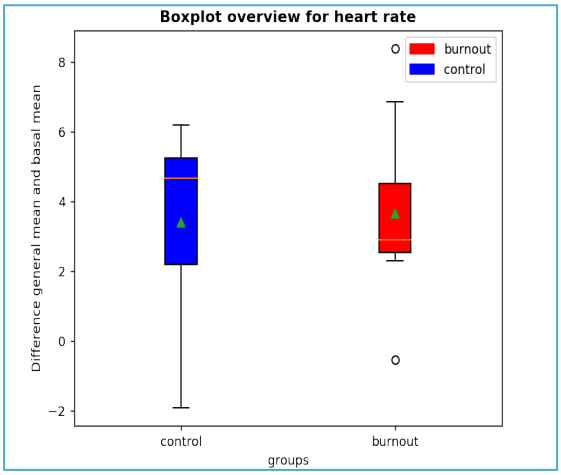


Figure 10: Boxplot overview for 'normalized basal mean heart rate' *(p-value 0,88)*

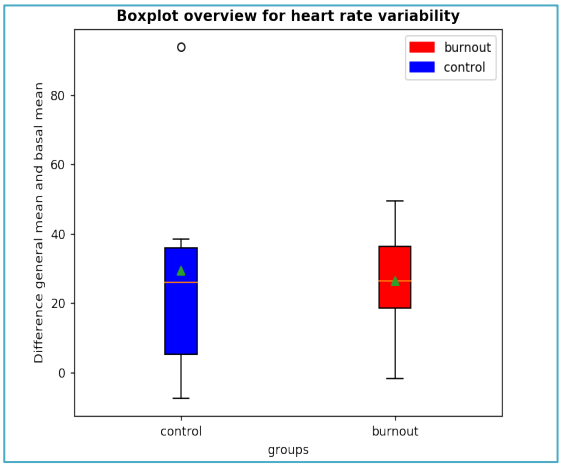


Figure 11: Boxplot overview for 'normalized basal mean heart rate variability' *(p-value 0,84)*

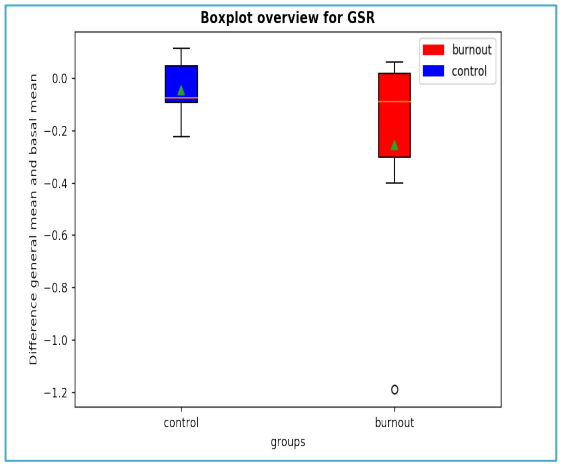


Figure 12: Boxplot overview for 'normalized basal mean galvanic skin response' *(p-value 0,33)*

when presenting them to the GP practice during a period of 6 months. Patients who attained an BMS-10 score of 3,4 or more and who showed no sign of other psychological diagnoses on the Burnout-Depression-Complaint List and 4-Dimensional-Complaint List were offered a further diagnostic evaluation with the Stingray® device and the Chill Band® in order to form an experimental burnout population of 8 patients. In addition, the researcher also selected 6 patients mathing the experimental burnout group for age and sex and achieving a score of not more than 3,4 on the BMS-10 questionnaire to form a control group with a low risk of having burnout and to be equally investigated with Stingray® and Chillband®.

A few conclusions can be drawn from the data obtained from the patient characteristics. The first thing that caught our eye was the predominant number of women compared to one man that were included in the burnout population. These results do not match previous studies where no significant gender differences in burnout were observed. This is probably due to the limited sample size that was obtained and consequently the small amount of men scoring positive for burnout on the BMS-10 questionnaire. No statistically significant differences were found in other patient characteristics such as age and other biometric parameters (BMI, blood pressure, heart rate) between the patient population diagnosed positive for burnout and the control group. We conclude that more large-scale studies should be executed which could possibly demonstrate an association between burnout and biometric or demographic characteristics as has been described by previous studies.

Regarding the data obtained from the Stingray® and Chillband® devices, the possible parameters being used for the detection of stress are heart rate (HR), heart rate variability (HRV), skin temperature (ST) and galvanic skin response (GSR). During the last few decades, researchers have used HR and HRV to measure mental stress. Previous studies have already demonstrated that stress induces an increased HR and decreased HRV. In this

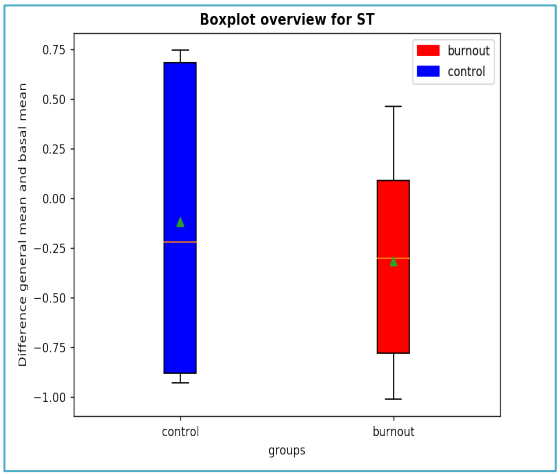


Figure 13: Boxplot overview for 'normalized basal mean skin temperature' *(p-value 0,63)*

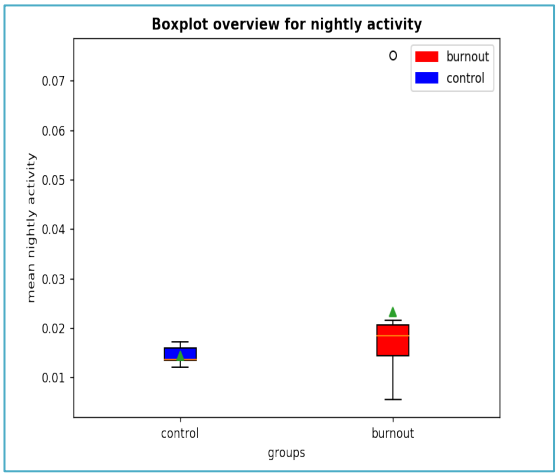


Figure 14: Boxplot overview for 'mean nightly activity' *(p-value 0,35)*

pilot study, we found that there was no significant difference in mean heart rate between burnout patients and the control group. The median 'normalized basal mean heart rate' (subtraction of 'general mean heart rate' and 'basal mean heart rate') was higher in the control group than the burnout population which corresponds to the fact that in many patients of the control group their 'basal mean heart rate' differs more from their 'general mean heart rate' and which means that there is a smaller difference between 'basal mean heart rate' and 'general mean heart rate' in the burnout population, which could reflect a certain continuous arousal in burnout patients. Concerning HRV, a comparable 'normalized basal mean heart rate variability' (subtraction of 'general mean heart rate variability' and 'basal mean heart rate variability') was noted in both burnout population and control group. In burnout patients, one would expect a smaller 'normalized basal mean heart rate variability' close to zero since chronic stress causes a more continuous low heart rate variability but this was not at all the case.

There is existing evidence available that an increase in arousal causes an increase in skin conductance (GSR). Additionally, stress causes vasoconstriction with subsequently a subtle drop in skin temperature (ST). Concerning the data for GSR, one would thus expect a higher mean basal GSR in burnout patients even when the activity level is reduced to a minimum compared to the control group. Our results confirmed this hypothesis since a greater mean GSR was noted in basal conditions as compared to the overall mean GSR (thus a lower 'normalized basal mean galvanic skin response'), which could reflect a certain arousal or stress level even in basal 'resting' conditions. Parallel, regarding skin temperature, one would expect a lower 'basal mean skin temperature' in burnout patients compared to the overall mean skin temperature and compared to the control group. Unfortunately, our results did not confirm this hypothesis and depict comparable values in both groups.

Both the experimental population and control patients were asked to tap the Chill Band® device twice until a blue light lit up when they subjectively experienced any stress or nervousness, which would be noted as a stress event in the analysis of the Chill Band®. We expected to note a higher amount of registered stress events by the burnout population compared to the control group. Furthermore the authors anticipated recording a higher amount of stress events in patients with a higher BMS-10 score within the burnout population. Unfortunately, as can be derived from the several figures, no correlation could be demonstrated between the amount of registered stress events and established diagnosis of burnout or control population nor was there a higher amount of stress events as patients attained a higher BMS-10 score. Perhaps this is due to the fact that burnout patients chronically and subjectively experience a higher amount of stress so that the threshold to tap the device into recording a stress event is shifted compared to the control group.

Strenghts

Stress is a huge problem in today's society. Being able to measure stress, therefore, may help to address this problem. A system that can measure stress levels based on physiological signals will create interesting applications in real life situations. Ultimate goal is to design an easily wearable wireless system that can measure real time stress levels. In this explorative pilot study, we focused on using a wearable sensor system to find physiological signals and features that show the most distinct reaction to mental stress in patients aged between 18-65 years old. Once these features are identified, it should be possible to construct a reliable stress measure out of these features. Furthermore, we wished to research whether there are differences in these biometric parameters in patients diagnosed with burnout. So far little scientific evidence is available in this subgroup of the general population, which makes this pilot study an absolutely valuable component for further research in this area of expertise. The majority of our study population suffered little to no problems during the monitoring with Stingray® and Chill Band® devices and experienced the devices as comfortable and very user-friendly. The researchers included the different patients in the uniform particular way described earlier in order to optimise the unity of the study so that little bias would creep in.

Limitations

The researchers included the different patients in the uniform particular way described earlier in order to optimise the unity of the study so that little bias would creep in. The researchers are well aware of the limitations this pilot study may contain.

Primarily, the sample size of this pilot study was not extensive enough to draw any statistically significant conclusions, mainly and unfortunately due to the limited time period during which patients could be included.

Secondly, parameters such as heart rate, heart rate variability, galvanic skin response and skin temperature exhibit an interindividual variability. This makes that there are no general reference values at population level and the different parameters were evaluated per individual patient.

Additionally, in 3 subjects there were short periods of incomplete data due to lacking sensor response because of various reasons (non-adherence

to the body, hardware/software failures, signal noise…).

Finally, there might have entered some interpatient subjectivity in filling in the different questionnaires.

CONCLUSION

Mental stress is a huge problem in today's society: about half of work-related illnesses are directly or indirectly related to stress. In scientific research, there is little doubt about the correlation between professional stress and the heightened risk for cardiovascular events. In practice, somatic medicine is not actively concerned with this risk factor. Being able to measure stress may help to address this problem. A system that can measure stress levels based on physiological signals will create interesting applications in real life situations. Ultimate goal is to design an easily wearable wireless system that can measure real time stress levels. This explorative pilot study set up a case-finding strategy in order to use a wearable sensor system to find physiological signals and features that show the most distinct reaction to mental stress in patients aged between 18-65 years old. Once these features are identified, it should be possible to construct a reliable stress measure out of these features. Moreover, the authors wanted to explore whether there are differences in biometric parameters such as heart rate, heart rate variability, galvanic skin response and skin temperature in patients diagnosed with burnout compared to a control group. So far little scientific evidence is available in this subgroup of the general population, which makes this pilot study an absolutely valuable component for further research in this area of expertise. The authors compared these different relevant parameters in a burnout population with a control group after taking into account the interpatient physiological variability, but no significant differences were detected between both groups. Patients experience both applied devices, the Stingray® and the Chill Band®, as very user-friendly and more homely. In the future the authors believe that further research with a more extensive sample size is required in order to explore this uncovered ground.

COMPETING INTERESTS

The authors declare that they have no competing interests. This study was only financially supported by KULeuven and IMEC. No other companies were involved financially.

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ADDITIONAL FILES

1. Maslach-Pines Burnout Measure Short Version (BMS-10)

Als u aan uw werk denkt, hoe vaak heeft u dit gevoel?

	1 nooit	**2** bijna nooit	**3** zelden	**4** soms	**5** dikwijls	**6** heel dikwijls	**7** altijd
Vermoeid							
Teleurgesteld in mensen							
Hopeloos							
Gevangen							
Hulpeloos							
Depressief							
Fysiek zwak/ziek							
Waardeloos/mislukkeling							
Moeilijkheden om te slapen							
"Ik heb er genoeg van"							

Uw score = soms van de scores voor de 10 vragen gedeeld door 10. **UW SCORE**

BMS-10 score	Graad van burn-out
≤ 2,4	Zeer laag
2,5-3,4	Laag
3,5-4,4	Matig
4,5-5,4	Hoog
≥ 5,5	Zeer hoog

2. Four Dimensional Complaint List (4DCL)

De volgende vragenlijst betreft verschillende klachten en verschijnselen die u mogelijk hebt. Het gaat steeds om klachten en verschijnselen die u de afgelopen week (de afgelopen 7 dagen met vandaag erbij) hebt ervaren. Klachten die u daarvoor wel had, maar de afgelopen week niet meer, tellen niet mee. Wilt u per klacht aangeven hoe vaak u dit in de afgelopen week bij uzelf hebt opgemerkt, door het hokje aan te kruisen dat staat voor het meest passende antwoord.

		Nee	Soms	Regelmatig	Vaak	Heel vaak of voortdurend
Hebt u de afgelopen week last van:						
1.	Duizeligheid of een licht gevoel in het hoofd?					
2.	Pijnlijke spieren?					
3.	Flauw vallen?					
4.	Pijn in de nek?					
5.	Pijn in de rug?					
6.	Overmatige transpiratie?					
7.	Hartkloppingen?					
8.	Hoofdpijn?					
9.	Opgeblazen gevoel in de buik?					
10.	Wazig zien of vlekken voor de ogen zien?					
11.	Benauwdheid?					
12.	Misselijkheid of een maag die van streek is?					
Hebt u de afgelopen week last van:						
13.	Pijn in de buik of maagstreek?					
14.	Tintelingen in de vingers?					
15.	Een drukkend of beklemmend gevoel op de borst?					
16.	Pijn in de borst?					
17.	Neerslachtigheid?					
18.	Zomaar plotseling schrikken?					
19.	Piekeren?					
20.	Onrustig slapen?					
21.	Onbestemde angst-gevoelens?					
22.	Lusteloosheid?					
23.	Beven in gezelschap van andere mensen?					
24.	Angst- of paniekaanvallen?					
Voelt u zich de afgelopen week:						
25.	Gespannen?					
26.	Snel geïrriteerd?					
27.	Angstig?					
Hebt u de afgelopen week het gevoel:						
28.	Dat alles zinloos is?					
29.	Dat u tot niets meer kunt komen?					
30.	Dat het leven niet de moeite waard is?					
31.	Dat u geen belangstelling meer kunt opbrengen voor de mensen en dingen om u heen?					
32.	Dat u het niet meer aankunt?					
33.	Dat het beter zou zijn als u maar dood was?					
34.	Dat u nergens meer plezier in kunt hebben?					
35.	Dat er geen uitweg is uit uw situatie?					

36.	Dat u er niet meer tegenop kunt?					
37.	Dat u nergens meer zin in hebt?					
Hebt u <u>de afgelopen week:</u>						
38.	Moeite met helder denken?					
39.	Moeite om in slaap te komen?					
40.	Angst om alleen het huis uit te gaan?					
Bent u <u>de afgelopen week:</u>						
41.	Snel emotioneel?					
42.	Angstig voor iets waarvoor u helemaal niet bang zou hoeven te zijn? (dieren, hoogten, kleine ruimtes,…)					
43.	Bang om te reizen in bussen, treinen of trams?					
44.	Bang om in verlegenheid te raken in gezelschap van andere mensen?					
45.	Een gevoel of u door een onbekend gevaar bedreigd wordt?					
46.	Denkt u de afgelopen week weleens “was ik maar dood”?					
47.	Schieten u de afgelopen week weleens beelden in gedachten over (een) aangrijpende gebeurtenis(sen) die u hebt meegemaakt?					
48.	Moet u de afgelopen week weleens uw best doen om gedachten of herinneringen aan (een) aangrijpende gebeurtenis(sen) van u af te zetten?					
49.	Moet u de afgelopen week bepaalde plaatsen vermijden omdat u er angstig van wordt?					
50.	Moet u de afgelopen week sommige handelingen een aantal keer herhalen voordat u iets anders kunt gaan doen?					

Scoringsformulier voor de 4DKL

Nee = Score 0

Soms = Score 1

Regelmatig of vaker = Score 2

17		28		18		1	
19		30		21		2	
20		33		23		3	
22		34		24		4	
25		35		27		5	
26		46		40		6	
29				42		7	
31				43		8	
32				44		9	
36				45		10	
37				49		11	
38				50		12	
39						13	
41						14	
47						15	
48						16	

	Distress	Depressie	Angst	Somatisatie
Interpretatie				
Matig verhoogd	> 10	> 2	> 3	> 10
Sterk verhoogd	> 20	> 5	> 9	> 20

Elke vraag van de 4DKL levert 0, 1 of 2 punten op: 0 punten voor een klacht die afwezig is, 1 punt voor een klacht die 'soms' aanwezig is en 2 punten voor een klacht die 'regelmatig' of vaker aanwezig is. Elke 4DKL-schaal heeft twee afkappunten, die de scores verdelen in 'laag', 'matig verhoogd' of 'sterk verhoogd'. Onderstaande tabel geeft een overzicht van de afkappunten en hun betekenis per schaal.

Tabel. Interpretatie van de 4DKL-scores

Schaal	Laag	Matig verhoogd	Sterk verhoogd
Distress	0-10: normale spanningen; in principe geen actie nodig	11-20: verhoogde spanningen met de dreiging van disfunctioneren; stressreductie is wenselijk	21-32: ernstige spanningen met grote kans op disfunctioneren (ziekteverzuim); stressreductie is aangewezen
Depressie	0-2: waarschijnlijk geen depressieve stoornis	3-5: mogelijke depressieve stoornis; aanzien en na enkele weken herevalueren; eventueel depressiediagnostiek	6-12: relatief grote kans op een depressieve stoornis; depressiediagnostiek is aangewezen
Angst	0-3: waarschijnlijk geen angststoornis	4-9: mogelijke angststoornis; aanzien en na enkele weken herevalueren; eventueel diagnostiek van angststoornissen	10-24: relatief grote kans op één of meer angststoornissen; diagnostiek van angststoornissen is aangewezen
Somatisatie	0-10: relatief normale lichamelijke spanningsklachten	11-20: mogelijke somatisatie met dreigend disfunctioneren; bespreken met patiënt	21-32: grote kans op somatisatie; bespreken met patient, overweeg cognitieve gedragstherapie of verwijzing

3. Burnout Depression Complaint List (BDCL)

INSTRUCTIE:
- Wij willen graag weten hoe gezond u zich voelt en welke klachten of stemmingen U de afgelopen paar maanden heeft gehad. Het gaat dus niet over klachten of stemmingen die U vroeger wel eens hebt gehad. Het gaat om recente klachten.
- Wilt u daarom alle onderstaande vragen beantwoorden door bij iedere vraag het antwoord dat het meest op U van toepassing is aan te kruisen.

	Helemaal niet waar	Niet waar	Waar	Helemaal waar
1. Ik ben soms helemaal uitgeput, moe of uitgeblust	1	2	3	4
2. Ik voel me gevangen in mijn werk en kan geen kanten uit	1	2	3	4
3. Een kleine belasting brengt me al uit mijn evenwicht	1	2	3	4
4. Ik kan niets zelf regelen op mijn werk. Ik doe gewoon wat ze me zeggen.	1	2	3	4
5. Ik heb geen vertrouwen meer in mezelf. Ik heb meer en meer het gevoel dat ik niets aankan.	1	2	3	4
6. Niemand waardeert wat ik allemaal doe	1	2	3	4
7. Mijn energie is op	1	2	3	4
8. Ik heb geen of weinig vertrouwen in mijn collega's	1	2	3	4
9. Ik vind dat ik niet veel inspraak heb op mijn werk	1	2	3	4
10. Ik kan moeilijk enthousiast zijn over mijn werk. Ik kijk vanop een veilige afstand toe.	1	2	3	4
SCORE OP DE VRAGEN VAN 1 TOT EN MET 10: DEZE SCORE GAAT VAN 10 TOT 40:				
11. Ik beleef weinig plezier aan mijn gewone dagelijkse bezigheden, op het werk of privé	1	2	3	4
12. Ik ben geen waardevol iemand	1	2	3	4
13. Het leven is zinloos en ik leef niet graag	1	2	3	4
14. Ik beleef geen voldoening aan mijn intiem of mijn seksueel leven	1	2	3	4
15. Ik ben zelden opgewekt of vrolijk	1	2	3	4
16. Ik slaap slecht	1	2	3	4
17. Ik eet niet graag. Ik beleef daar helemaal geen plezier aan	1	2	3	4
18. Ik hou me regelmatig bezig met gedachten of fantasieën over de dood	1	2	3	4
19. Ik ben dikwijls in een sombere stemming. Ik kan zonder hulp moeilijk in een betere stemming geraken	1	2	3	4
20. Ik voel me vlug schuldig	1	2	3	4
SCORE OP DE VRAGEN VAN 11 TOT EN MET 20: DEZE SCORE GAAT VAN 10 TOT 40:				

SCORE OP DE VRAGEN VAN 1 TOT EN MET 10: DEZE SCORE GAAT VAN 10 TOT 40:

INTERPRETATIE SCORE: BURN-OUT RISICO

Van 10 tot 20: op dit ogenblik is geen burn-out aanwezig. Indien er toch klachten zijn van vermoeidheid of een gevoel van vervreemding of een licht cynische houding tegenover het werk en de wereld, dan kan dat toch een aanwijzing zijn. Dit is maar een indicatieve test. Andere ziekteprocessen dienen uitgesloten te worden.
Van 21 tot 32: er is een licht gevaar voor het optreden van een burn-out. Dit kan een beginnende vorm zijn. Een actieplan en preventie zijn absoluut aangewezen.
Van 33 tot 40: dit kan wijzen op een aanwezige burn-out. Hier is een doortastende aanpak aangewezen. Andere ziekteprocessen dienen uitgesloten te worden.
Belangrijke opmerking: het gaat hier maar om een kleine indicatieve test met 10 vragen. Dergelijke test is natuurlijk onvoldoende om een diagnose te stellen. Beschouw de resultaten als een aanwijzing. Men moet de resultaten zien in het geheel van alle gegevens, ook de klinische symptomen en de duur van de klachten.

SCORE OP DE VRAGEN VAN 11 TOT EN MET 20: DEZE SCORE GAAT VAN 10 TOT 40:

INTERPRETATIE SCORE: DEPRESSIE RISICO

Van 10 tot 20: op dit ogenblik is geen depressie aanwezig. Indien er toch klachten zijn van somberheid, moeheid of zinloosheid of suicidale klachten aanwezig zijn, dan moet er toch opgetreden worden. Dit is maar een indicatieve test. Andere ziekteprocessen dienen uitgesloten te worden.

Van 21 tot 32: er is een licht gevaar voor het optreden van een depressie. Dit kan een beginnende vorm zijn. Een actieplan en preventie zijn absoluut aangewezen.

Van 33 tot 40: dit kan wijzen op een aanwezige depressie. Hier is een doortastende aanpak aangewezen. Andere ziekteprocessen dienen uitgesloten te worden.

Belangrijke opmerking: het gaat hier maar om een kleine indicatieve test met 10 vragen over elk onderwerp. Dergelijke test is natuurlijk onvoldoende om een diagnose te stellen. Beschouw de resultaten als een aanwijzing. Men moet de resultaten zien in het geheel van alle gegevens, ook de klinische symptomen en de duur van de klachten.

4. Questionnaire to test the user friendliness of the Chill Band® and the Stingray® device

Question 1 - Did you have a good night sleep with the devices?

0 not at all
1 a little
2 neutral
3 rather good night
4 very good night

Question 2 - Did you experience both of the devices as user-friendly monitors?

0 not at all
1 a little
2 neutral
3 rather user friendly
4 very user friendly

Question 3 - Did you experience discomfort during your week with the devices?

0 very discomfortable
1 rather discomfortable
2 neutral
3 a little discomfortable
4 no discomfort at all

Technical problems

1. Did any of the sensors get loose during the past week? YES/NO
2. Did you experience the attachment and retrieval as discomforting? YES/NO

5. Dutch Protocol approved by the Medical Ethics Committee of the Catholic University Hospital Leuven (MP12505)

Inleiding

Steeds meer mensen krijgen op één of ander moment in hun carrière af te rekenen met een burn-out. Hoe je een burn-out oploopt, is intussen wel bekend. Burn-out is een mentale aandoening die ontstaat ten gevolge van langdurige blootstelling aan een overdosis stress, zowel op als naast de werkvloer. Een zware werklast en hoge eisen- vooral voor zichzelf- vormen de belangrijkste bron voor het ontwikkelen van een burn-out, maar deze verklaren lang niet alles. Ook belastende werkomstandigheden, gebrek aan afwisseling in de job of onvoldoende autonomie vormen belangrijke risicofactoren voor het ontwikkelen van een burn-out. Bovendien blijken geslacht en leeftijd een grote rol te spelen, gezien vrouwen iets vatbaarder lijken voor een burn-out dan mannen en de incidentie van burn-out symptomen toeneemt met de leeftijd. Ten slotte blijken perfectionistische of altruïstische personen die hun emoties niet kunnen ventileren vatbaarder voor het ontwikkelen van een burn-out. Hoewel burn-out zich vooral als psychologisch gegeven laat herkennen, zijn er toch ook heel wat fysieke componenten aanwezig. Mensen met een burn-out kampen met drie grote problemen. Allereerst ervaren zij een gevoel van fysieke en mentale uitputting, vaak ten gevolge van slaapstoornissen (problemen met inslapen, slapeloosheid of vermoeid ontwaken), wat vaak gepaard gaat met chronische vermoeidheid en een verminderd recuperatievermogen. Daarnaast vertonen mensen met een burn-out nogal cynische gedachten en gevoelens naar klanten of collega's toe. Tot slot hebben deze werknemers vaak een laag zelfbeeld of angstgevoelens en schatten ze hun eigen competenties lager in dan die in realiteit zijn. De gevolgen van een burn-out hebben ook zware economische gevolgen gezien deze mensen vaak minder efficiënt werken, wat kan leiden tot verminderde kwaliteit van zorg of service. Werknemers met burn-out symptomen zijn ook frequenter en langduriger afwezig, overwegen sneller ander werk te zoeken en achten zich minder in staat hun job uit te oefenen tot aan hun pensioen en vallen dus sneller uit in de arbeidsmarkt. De diagnose van burn-out is nog steeds moeilijk te stellen gezien het gaat om een veelheid aan symptomen die al dan niet samen opduiken en erop wijzen dat er iets grondig fout is. Bovendien wordt de zaak nog eens extra complex aangezien de afzonderlijke verschijnselen niet specifiek zijn voor burn-out. Vandaag de dag zijn de mogelijkheden om somatische parameters na te gaan bij patiënten enorm toegenomen, mede dankzij de ontwikkeling van nieuwe technologieën zoals smartphone apps en "wearables". Zo kunnen makkelijk metingen gedaan worden die in de toekomst een toegevoegde waarde kunnen hebben voor de diagnostiek als huisarts in allerhande domeinen. Wat betreft burn-out zijn in de literatuur vooral onderzoeken beschreven die plaatsvinden aan de hand van vragenlijsten (cfr Dewitte, Schaufeli) die vooral peilen naar psychologische factoren en gevoelen maar minder naar deze fysieke componenten.

Concrete vraagstelling:

Wij wensen met deze exploratieve pilootstudie te onderzoeken of wij met behulp van wearable technology een verschil kunnen meten in hartfrequentie, hartritmevariabiliteit, slaappatroon en zweetsecretie bij mensen met een (naderende) burn-out ten opzichte van een "gezonde" populatie? Kunnen wij met behulp van wearable technology bovenstaande parameters permanent en ambulant registreren en objectiveren en zo bepaalde somatische correlaten van burn-out identificeren? Daarnaast willen wij op basis van de analyse van deze data retrospectief bekijken of er bepaalde triggers correleren met de veranderingen in deze parameters? Wat zijn met andere woorden de mogelijkheden van wearables bij burn-out als aanzet voor verder onderzoek in de toekomst?

Geplande methode

Wij zullen op een willekeurige manier tussen 1/3/2016 en 31/08/2017 patiënten tussen 18 en 65 jaar selecteren die zich aanmelden tijdens de consultatie in een huisartsenpraktijk in Deurle, Oost-Vlaanderen. Wanneer deze patiënten zich aanmelden met klachten die voor ons, huisartsen, suggestief zijn voor of het vermoeden opwekken van een burn-out *(vermoeidheid, geen energie, slaapstoornissen, angst, gevoel van tekortschieten, slapeloosheid, concentratieproblemen, maagpijn, hoofdpijn, futloos, hartkloppingen, maag-en darmproblemen, daling motivatie, prikkelbaar, frustratie,…)*, zullen wij hen vragen de gevalideerde BMS-10 vragenlijst in te vullen (Maslach-Pines BurnoutMeasure Short Version).Wanneer patiënten voor deze vragenlijst een score > 3,4 bereiken, zullen zij worden geïncludeerd in de studie. Bij inclusie in de studie zullen wij eveneens de uitgebreide vragenlijst voor burn-out (MBI-HSS) afnemen om bredere demografische variabelen te registreren en mee in rekening te brengen en de VierDimensionaleKlachtenLijst (4DKL) om een onderscheid te maken tussen burn-out, depressie, angststoornis en somatisatie. Wij hanteren volgende exclusiecriteria: aanwezigheid van onderliggende depressie, (early-onset) dementie (vooraf gekende diagnose of MMSE < 21), patiënten in een terminale setting (levensverwachting < 3 maanden), zwangerschap, voorgeschiedenis van cardiale aritmieën inname van medicatie zoals anti-aritmica en betablokkers of eventuele andere overrulende pathologie die zou kunnen interfereren met onze resultaten. Tijdens een rustige en uitgebreide consultatie verschaffen wij deze patiënten uitgebreide informatie omtrent de lopende studie, leggen extensief uit hoe de metingen en de wearables precies in zijn werk gaan. De patiënten zullen tevens

geïnformeerd worden over mogelijke fysieke reacties (allergie op de bevestigende pleisters van de wearables,…) of mentaal hinderlijke ervaringen. Bij een weigerachtige houding zullen ook deze patiënten worden geëxcludeerd. Voor vragen of opmerkingen tijdens de studie wordt aan de patiënten een noodnummer geboden waarop zij ten allen tijde de uitvoerende arts kunnen bereiken. Ten slotte vragen wij aan de deelnemende patiënten een schriftelijk informed consent te ondertekenen. Tijdens het volledige verloop van de studie zullen de geïncludeerde patiënten ten allen tijde de mogelijkheid geboden worden om de studie stop te zetten.
Onze studie houdt in om twee zeer subtiele wearables ('hartslagmeter' en de 'wristbandChill') te dragen die hartfrequentie, hartritmevariabiliteit samen met lichaamspositie en zweetsecretie ter hoogte van de pols voor een vooraf bepaalde periode. Omdat patiënten deze wearables initieel als stressvol kunnen ervaren, zullen wij dit tot het minimum proberen reduceren. Dit zullen we doen door enerzijds een gewenningsfase van een aantal dagen in te lassen waarbij de geanalyseerde data tijdens deze gewenningsfase zullen worden geëxcludeerd. Anderzijds zullen wij op de klassieke opvolgconsultaties eveneens polsen bij de patiënten naar de gebruikservaring van deze wearables. Zo trachten wij tevens om eventuele stress tijdens de initiële aanpassingsperiode bij de patiënt zo weinig mogelijk onze resultaten te laten beïnvloeden. De frequentie, aard en opbouw van de opvolgconsultaties zullen niet verschillen ongeacht of de patiënt met burn-out wel of niet deelneemt aan de studie en verlopen volledig volgens de gangbare aanpak binnen de praktijk zodat dit financieel geen enkele invloed kan hebben. Na 1 week analyse met deze wearables, kan de patiënt deze wearables opnieuw in de praktijk indienen. De data zullen digitaal worden opgeladen en elektronisch doorgestuurd worden voor verdere analyse door specifieke data analysts. Wij zullen naast deze subpopulatie tevens een "gezonde" populatie patiënten at random selecteren. Deze "gezonde" patiënten omvatten oa sporters, patiënten zonder enige co-morbiditeit die kan interfereren met onze resultaten, patiënten die heden geen stress of angst ervaren,… Wanneer dergelijke patiënten zich aanbieden op de consultatie zal hen tevens het concept van de studie en dezelfde informatie verschaft worden als de subpopulatie met burn-out (zie boven). Deze "gezonde" patiënten dienen als controle of baseline waarbij wij dezelfde parameters ambulant zullen registreren met dezelfde wearables tijdens een totale periode van 1 week. Zij zullen worden gevraagd in de mate van het mogelijke een dagboek met de dagelijkse activiteiten bij te houden tijdens dezelfde periode. Na deze registratie kunnen zij kosteloos het toestel inleveren bij de verpleegkundige die deze data zal uploaden en elektronisch doorsturen voor gespecialiseerd data-analyse.

Geplande resultaten
Met deze studie willen wij pogen met behulp van wearable technology een correlatie te vinden tussen (veranderingen in) biologische parameters en het verloop van een burn-out. Wij verwachten bij patiënten die zich aanmelden met burn-outklachten gemiddeld een hogere hartfrequentie en kleinere hartritmevariabiliteit te kunnen registreren in vergelijking met een "gezonde" controlepopulatie. De laatste fysiologische verandering die we kunnen meten, betreft de subtiele zweetsecretie ter hoogte van de pols. Het is reeds in andere studies bewezen dat in stresssituaties de huidgeleiding verhoogt en dat hierdoor de zweetsecretie (subtiel) verhoogt. Wij verwachten dit ook eventueel bij burn-outpatiënten te objectiveren mbv onze wearables en dit achteraf dmv analyse van data eventueel te correleren aan specifieke stresssituaties.

Welke winst levert dit project op?
Met deze exploratieve pilootstudie en technologie zouden wij op een patiëntvriendelijke manier meer inzicht kunnen krijgen in eventuele somatische correlaten van burnout. Deze technologie zou het de artsen kunnen mogelijk maken om op een gebruiksvriendelijke en subtiele manier patiënten in hun vertrouwde thuissituatie op te volgen en klachten te objectiveren tussen consultaties in want vaak is de behandelend arts beperkt tot subjectieve rapporteringen. Bovendien kunnen wij dankzij de geregistreerde data een groter inzicht krijgen in de fysiologische reacties bij burnout en in de toekomst met behulp van verdere studies een meer patiëntspecifieke behandeling instellen. Zo kan deze pilootstudie een eerste stap zijn naar een grote economische meerwaarde gezien een snellere herkenning en patiëntspecifieke behandeling getroffen patiënten sneller terug arbeidsklaar kunnen krijgen.

Reg. nr.	Titel van de studie	Status	Beheer
	mp12505	Registratie biologische parameters bij burn-out: permanente ambulante follow-up met wearable technology **Student(en):** Céline Degrande **Promotor:** Jo Goedhuys	Gunstig advies van OBC

Gunstig advies van OBC

2016-05-25 07:24:18

Bekijk status geschiedenis

Ethisch ok, MAAR er blijft een delicaat punt namelijk dat best vermeld zou worden dat wat de arts aanbiedt ‘usual care‘ is. Al is het dit niet echt. Waarom: als iemand van het Riziv dit onder ogen krijgt, kan het honorarium teruggevorderd worden. Een veilige piste is aan te geven dat deze werkwijze, usual care, conform is met de richtlijn die daarover op ebmpracticenet terug te vinden is.

Student(en):
Céline Degrande
Promotor:
Jo Goedhuys (jo.goedhuys@kuleuven.be - u0005986 - Acad. Centr. voor Huisartsgeneeskunde)
Hoofdonderzoeker:
Chris Van Hoof (chris.vanhoof@imec.be - u0012734 - Afdeling ESAT - MICAS)
Faculteit:
Geneeskunde
Opleiding:
Master in de huisartsgeneeskunde (Leuven e.a.)
Het onderzoek is:
monocentrisch
De opdrachtgever is:
academisch (universiteit,...)

Het onderzoek is:
Het onderzoek is (gedeeltelijk) prospectief.
Het onderzoek is:
Prospectief observationeel onderzoek
Gebruikte methode:
andere: vragenlijsten + ambulante parameterregistratie

BIJKOMENDE GEGEVENS:

Achtergrond:
Steeds meer mensen krijgen op één of ander moment in hun carrière af te rekenen met een burn-out.
Hoe je een burn-out oploopt, is intussen wel bekend. Burn-out is een mentale aandoening die ontstaat ten gevo van langdurige blootstelling aan een overdosis stress, zowel op als naast de werkvloer. Een zware werklast en hoge eisen- vooral voor zichzelf- vormen de belangrijkste bron voor het ontwikkelen van een burn-out, maar de

verklaren lang niet alles. Ook belastende werkomstandigheden, gebrek aan afwisseling in de job of onvoldoend autonomie vormen belangrijke risicofactoren voor het ontwikkelen van een burn-out. Bovendien blijken geslacht leeftijd een grote rol te spelen, gezien vrouwen iets vatbaarder lijken voor een burn-out dan mannen en de incidentie van burn-out symptomen toeneemt met de leeftijd. Ten slotte blijken perfectionistische of altruïstische personen die hun emoties niet kunnen ventileren vatbaarder voor het ontwikkelen van een burn-out.
Hoewel burn-out zich vooral als psychologisch gegeven laat herkennen, zijn er toch ook heel wat fysieke componenten aanwezig. Mensen met een burn-out kampen met drie grote problemen. Allereerst ervaren zij eer gevoel van fysieke en mentale uitputting, vaak ten gevolge van slaapstoornissen (problemen met inslapen, slapeloosheid of vermoeid ontwaken), wat vaak gepaard gaat met chronische vermoeidheid en een verminderd recuperatievermogen. Daarnaast vertonen mensen met een burn-out nogal cynische gedachten en gevoelens r klanten of collega's toe. Tot slot hebben deze werknemers vaak een laag zelfbeeld of angstgevoelens en schatt ze hun eigen competenties lager in dan die in realiteit zijn. De gevolgen van een burn-out hebben ook zware economische gevolgen gezien deze mensen vaak minder efficiënt werken, wat kan leiden tot verminderde kwal van zorg of service. Werknemers met burn-out symptomen zijn ook frequenter en langduriger afwezig, overweg sneller ander werk te zoeken en achten zich minder in staat hun job uit te oefenen tot aan hun pensioen en valle dus sneller uit in de arbeidsmarkt.
De diagnose van burn-out is nog steeds moeilijk te stellen gezien het gaat om een veelheid aan symptomen die dan niet samen opduiken en erop wijzen dat er iets grondig fout is. Bovendien wordt de zaak nog eens extra complex aangezien de afzonderlijke verschijnselen niet specifiek zijn voor burn-out.
Vandaag de dag zijn de mogelijkheden om somatische parameters na te gaan bij patiënten enorm toegenomen mede dankzij de ontwikkeling van nieuwe technologieën zoals smartphone apps en "wearables". Zo kunnen makkelijk metingen gedaan worden die in de toekomst een toegevoegde waarde kunnen hebben voor de diagnostiek als huisarts in allerhande domeinen. Wat betreft burn-out zijn in de literatuur vooral onderzoeken beschreven die plaatsvinden aan de hand va n vragenlijsten (cfr Dewitte, Schaufeli) die vooral peilen naar psychologische factoren en gevoelen maar minder naar deze fysieke componenten.

Vraagstelling:

Wij wensen met deze exploratieve pilootstudie te onderzoeken of wij met behulp van wearable technology een verschil kunnen meten in hartfrequentie, hartritmevariabiliteit, slaappatroon en zweetsecretie bij mensen met ee (naderende) burn-out ten opzichte van een "gezonde" populatie? Kunnen wij met behulp van wearable technolo bovenstaande parameters permanent en ambulant registreren en objectiveren en zo bepaalde somatische correlaten van burn-out identificeren? Daarnaast willen wij op basis van de analyse van deze data retrospectief bekijken of er bepaalde triggers correleren met de veranderingen in deze parameters? Wat zijn met andere woorden de mogelijkheden van wearables bij burn-out als aanzet voor verder onderzoek in de toekomst?

Methodologie:

Geplande methode

Wij zullen op een willekeurige manier tussen 1/3/2016 en 31/08/2017 patiënten tussen 18 en 65 jaar selecteren zich aanmelden tijdens de consultatie in een huisartsenpraktijk in Deurle, Oost-Vlaanderen. Wanneer deze patiënten zich aanmelden met klachten die voor ons, huisartsen, suggestief zijn voor of het vermoeden opwekk van een burn-out *(vermoeidheid, geen energie, slaapstoornissen, angst, gevoel van tekortschieten, slapelooshe concentratieproblemen, maagpijn, hoofdpijn, futloos, hartkloppingen, maag-en darmproblemen, daling motivatie prikkelbaar, frustratie,…)*, zullen wij hen vragen de gevalideerde BMS-10 vragenlijst in te vullen (Maslach-Pines BurnoutMeasure Short Version).Wanneer patiënten voor deze vragenlijst een score > 3,4 bereiken, zullen zij worden geïncludeerd in de studie. Bij inclusie in de studie zullen wij eveneens de uitgebreide vragenlijst voor bu out (MBI-HSS) afnemen om bredere demografische variabelen te registreren en mee in rekening te brengen. W hanteren volgende exclusiecriteria: aanwezigheid van onderliggende depressie, (early-onset) dementie (vooraf gekende diagnose of MMSE < 21), patiënten in een terminale setting (levensverwachting < 3 maanden), zwangerschap, voorgeschiedenis van cardiale aritmieën inname van medicatie zoals anti-aritmica en betablokk

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of eventuele andere overrulende pathologie die zou kunnen interfereren met onze resultaten. Tijdens een rustig en uitgebreide consultatie verschaffen wij deze patiënten uitgebreide informatie omtrent de lopende studie, legg extensief uit hoe de metingen en de wearables precies in zijn werk gaan. De patiënten zullen tevens geïnforme worden over mogelijke fysieke reacties (allergie op de bevestigende pleisters van de wearables,…) of mentaal hinderlijke ervaringen. Bij een weigerachtige houding zullen ook deze patiënten worden geëxcludeerd. Voor vra of opmerkingen tijdens de studie wordt aan de patiënten een noodnummer geboden waarop zij ten allen tijde de uitvoerende arts kunnen bereiken. Ten slotte vragen wij aan de deelnemende patiënten een schriftelijk informed consent te ondertekenen. Tijdens het volledige verloop van de studie zullen de geïncludeerde patiënten ten alle tijde de mogelijkheid geboden worden om de studie stop te zetten.

Onze studie houdt in om twee zeer subtiele wearables (‘hartslagmeter’ en de ‘wristbandChill’) te dragen die hartfrequentie, hartritmevariabiliteit en respiratoir patroon in rust volgen samen met slaapactiviteit en –positie er zweetsecretie ter hoogte van de pols voor een vooraf bepaalde periode. Omdat patiënten deze wearables initie als stressvol kunnen ervaren, zullen wij dit tot het minimum proberen reduceren. Dit zullen we doen door enerzi een gewenningsfase van ee n aantal dagen in te lassen waarbij de geanalyseerde data tijdens deze gewenningsfase zullen worden geëxcludeerd. Anderzijds zullen wij op de klassieke opvolgconsultaties eveneen polsen bij de patiënten naar de gebruikservaring van deze wearables. Zo trachten wij tevens om eventuele stres tijdens de initiële aanpassingsperiode bij de patiënt zo weinig mogelijk onze resultaten te laten beïnvloeden.

Daarnaast zal bij deze patiënten dmv een smartphone-applicatie op onregelmatige tijdstippen gepeild worden n het stressniveau. De frequentie, aard en opbouw van de opvolgconsultaties zullen niet verschillen ongeacht of d patiënt met burn-out wel of niet deelneemt aan de studie en verlopen volledig volgens de gangbare aanpak binn de praktijk zodat dit financieel geen enkele invloed kan hebben. Tijdens het eerst geplande follow-up consult 1-2 weken later zullen zullen deze data digitaal worden opgeladen door onze verpleegkundige en elektronisch doorgestuurd worden voor verdere analyse door specifieke data analysts. De patiënt wordt gelijktijdig door de behandelend arts ontvangen voor de klassieke consultatie bij burn-out. De arts is ten allen tijde geblindeerd voo geregistreerde data zodat dit geen enkele invloed kan hebben op het verdere beleid of te volgen (therapeutisch advies.Op basis van de anamnese en klinische bevindingen in het consult zal de arts een persoonlijk en individ advies meegeven aan de patiënt zoals dit ook gegeven wordt aan patiënten met burn-out die niet zouden deelnemen aan de studie, als copingstrategie en in een eerste stap naar herstel/recuperatie van de burn-out. D advies kan omvatten: start lichaamsbeweging, gespecialiseerde psychologische begeleiding, eventueel start medicatie volgens indicatie,… Er vindt eveneens herevaluatie van BMS-10 plaats en er wordt gepeild naar de ervaring en gebruiksvriendelijkheid van de wearables. Gedurende 2 weken zal er opnieuw een registratieperiod plaatsvinden mbv de hartslagmeter, chill band en smartphone app ter observatie van de korte termijneffecten va therapeutisch advies door de behandelend arts. Daarna zullen de data van de wearables digitaal worden opgeladen door onze verpleegkundige en elektronisch doorgestuurd worden voor verdere analyse door specifie data analysts. Tijdens de volgende periode van 6 weken zal de patiënt enkel nog gebruik maken van de smartphone app die op onregelmatige tijdstippen peilt naar het stressniveau bij de patiënt. Burn-out patiënten zowel zij die werden geïncludeerd in de studie als zij die niet aan de studie deelnemen worden ontvangen op de consultatie met de arts met een interval van 3 en 6 weken. Na deze 6 weken zal de patiënt opnieuw gevraagd worden om de hartslagmeter en de wrist band gedurende 1-2 weken te dragen zodat wij de langetermijneffecten bovenstaande parameters kunnen registreren. Daarna zullen deze data op nieuw digitaal worden opgeladen do onze verpleegkundige en elektronisch doorgestuurd worden voor verdere analyse door specifieke data analysts Opnieuw zal de arts tijdens de consultatie geblindeerd zijn voor de geregistreerde data zodat dit geen invloed ka hebben op het verloop van de consultatie of het geven van advies aan de patiënt. De arts zal pas na de totale analyse periode alle data kunnen verzamelen en collecteren voor elke patiënt onafhankelijk. Wij zullen naast de subpopulatie tevens een “gezonde” populatie patiënten at random selecteren. Deze “gezonde” patiënten omvat oa sporters, patiënten zonder enige co-morbiditeit die kan interfereren met onze resultaten, patiënten die heden geen stress of angst ervaren,… Wanneer dergelijke patiënten zich aanbieden op de consultatie zal hen tevens h concept van de studie en dezelfde informatie verschaft worden als de subpopulatie met burn-out (zie boven). De

“gezonde” patiënten dienen als controle of baseline waarbij wij dezelfde parameters ambulant zullen registreren met dezelfde wearables tijdens een totale periode van 2 weken. Zij zullen worden gevraagd in de mate van het mogelijke een dagboek met de dagelijkse activiteiten bij te houden tijdens dezelfde periode. Na deze registratie kunnen zij kosteloos het toestel inleveren bij de verpleegkundige die deze data zal uploaden en elektronisch doorsturen voor gespecialiseerd data-analyse.

Geplande resultaten

Met deze studie willen wij pogen met behulp van wearable technology een correlatie te vinden tussen (veranderingen in) biologische parameters en het verloop van een burn-out. Wij verwachten bij patiënten die zic aanmelden met burn-outklachten gemiddeld een hogere hartfrequentie en kleinere hartritmevariabiliteit te kunne registreren in vergelijking met een “gezonde” controlepopulatie. Daarnaast stelt deze technologie ons in staat o tijdens rustfases en de nachtelijke slaap het respiratoir patroon van dergelijke patiënten te analyseren en dit in combinatie met registratie van de lichamelijke bewegingen of activiteit en de lichaamspositie. Wij verwachten hi een meer onrustige ademhaling en meer onrustige bewegingen tijdens de slaap te kunnen registreren dan bij d “gezonde” baselinepopulatie. De laatste fysiologische verandering die we kunnen meten, betreft d e subtiele zweetsecretie ter hoogte van de pols. Het is reeds in andere studies bewezen dat in stresssituaties de huidweerstand verlaagt en dat hierdoor de huidgeleiding en de zweetsecretie (subtiel) verhoogt. Wij verwachter ook eventueel bij burn-outpatiënten te objectiveren mbv onze wearables en dit achteraf dmv analyse van data v de smartphone-app eventueel te correleren aan specifieke stresssituaties. Tenslotte verwachten wij enige verbetering in deze klinische parameters door het doktersadvies dat gegeven wordt tijdens het eerste follow-up consult en dit zowel op korte als lange termijn.

Welke winst levert dit project op?

Met deze exploratieve pilootstudie en technologie zouden wij op een patiëntvriendelijke manier meer inzicht kur krijgen in eventuele somatische correlaten van burnout. Deze technologie zou het de artsen kunnen mogelijk maken om op een gebruiksvriendelijke en subtiele manier patiënten in hun vertrouwde thuissituatie op te volger klachten te objectiveren tussen consultaties in want vaak is de behandelend arts beperkt tot subjectieve rapporteringen. Bovendien kunnen wij dankzij de geregistreerde data een groter inzicht krijgen in de fysiologisch reacties bij burnout en in de toekomst met behulp van verdere studies een meer patiëntspecifieke behandeling instellen. Zo kan deze pilootstudie een eerste stap zijn naar een grote economische meerwaarde gezien een snellere herkenning en patiëntspecifieke behandeling getroffen patiënten sneller terug arbeidsklaar kunnen krijg

Keuze van de proefpersonen :

- Gezonde proefpersonen ? **JA** (Patiënten lijdend aan burn-out + Gezonde controlepopulatie)
- Zwangere vrouwen of vrouwen die tijdens het onderzoek zwanger kunnen worden? **NEEN**
- Aantal proefpersonen: **10-30**
- Leeftijd : **18 tot en met 65 jaar**
- Geslacht : **mannen & vrouwen**

Referenties:

1) Er is een studie lopende, ook onder leiding van professor van hoof (ku leuven), waarbij men gebruik maakt va wearable technology om bij 1000 gezonde personen/deelnemers een subgroep te kunnen vormen van zogenaamde “stressgevoelige personen”. dit onderzoek is echter nog lopende en de resultaten hiervan zijn nog niet gepubliceerd. onze focus ligt echter bij patiënten waarbij wij als behandelend arts een klinisch vermoeden hebben van een burn-out. ook ons perspectief is anders aangezien wij een correlatie wensen te vinden tussen d opvolging van biologische parameters en de ernst en het verloop van een burn-out.

2) Wijsman J, Grundlehner B, Liu H, Hermens H & Penders J. Towards mental stress detection using wearable physiological sensors. Conf Proc IEEE Eng Med Biol Soc. 2011;2011:1798-801.

Informed consent / vragenlijsten / interviewprotocols:

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35129_1462894682_8417_Burn_out_informatieformulier_pdf.pdf

Req. nr.	Titel van de studie	Status	Beheer
42467_1462894703_5493_Burn_out_toestemmingsformulier_pdf.pdf 90773_1462894711_5549_Burn_out_MBI_HSS_pdf.pdf 74040_1462894993_893_EthischeCommissie_Protocol_Versie6_pdf.pdf			