Heart failure (HF) is a global pandemic reported to affect at least 26 million people worldwide and is increasing in prevalence. In the UK, HF is a significant and increasing public health problem, affecting approximately 920,000 people. It accounts for approximately 2% of the total NHS annual budget—an estimated £2 billion [1]. The incidence and prevalence of HF increase sharply with age, with the average age at diagnosis about 77% [2]. HF accounts for about 5% of all hospital admissions [2]. Management of HF requires long-term treatment with multiple medications, demonstrated with robust evidence to reduce morbidity and mortality and to improve signs and symptoms. However, even with advances in treatment, the regimens can only be beneficial if patients adhere to their prescribed therapy. Non-adherence to prescribed medications results in a multitude of issues which in 2013 was reported to cost the NHS more than £500 million each year [3].

Heart failure clinical presentation
Owing to the multitude of pathophysiological changes that occur in HF, the presentation can be varied. The clinical presentation of HF may be divided into symptoms and signs. Symptoms may include; wheezing, weight loss, peripheral swelling due to edema formation, dyspnoea, fatigue, exercise intolerance and lethargy. The latter three symptoms occur due to the inability of the heart to increase the cardiac output during exercise; as a result, the heart uses the cardiac reserve by fluid retention [6].

Signs of HF include [7]
- Hypotension
- Orthopnoea
- Paroxysmal nocturnal dyspnoea
- Tachycardia
- Cardiac heaves on palpation of the chest
- Third and fourth heart sounds (S3–gallop rhythm and S4) heard on cardiac auscultation
- Displaced apex beat from the 5th intercostal space; this is usually a lateral displacement and is a sign of cardiomegaly
- Bilateral crepitations noted on lung auscultation
- Elevated jugular venous pressure (JVP) secondary to the venous congestion.
- Hepatomegaly or hepatic tenderness on palpation of the abdomen due to systemic pooling of blood.
- Pulsus alternans—a cardiovascular phenomenon which displays alternating strong and weak pulse pressures during sinus rhythm. It is usually indicative of left ventricular systolic impairment.

The net effect of the changes that occur in HF are myocyte hypertrophy, ventricular dilatation, increased collagen synthesis, increased atrial natriuretic peptide (ANP) secretion, sympathetic stimulation, peripheral vasoconstriction, salt and water retention, altered myosin gene expression and altered sarcoplasmic Ca2+-ATPase density.
The burden of an illness can manifest in many ways; depression and anxiety being the most common. The link between the continuing development of heart disease and the onset of depression supports the main criteria, which is either a depressed mood or anhedonia [14]. depression and anxiety being the most common. The link between the continuing development of heart disease and the onset of depression supports the main criteria, which is either a depressed mood or anhedonia [14].

Management of heart failure

Due to the infrastructural changes and remodeling of the myocardium; there are recommended treatment plans to be implemented to improve the outcome of HF. The main aim according to Tamargo and Lopez-Sendon, (2011) are;

- Prevent organ system damage
- Manage the co-morbidities that may contribute to poor prognosis.
- To improve prognosis and reduce mortality
- To reduce symptoms and reduce morbidity by reversing or reducing the cardiac and peripheral dysfunction.
- Reduce the length of stay and subsequent readmission for in-hospital patients

Management for HF should be handled by a multidisciplinary team (MDT), aiming for an integrated approach across the sectors. Good communication is paramount, between healthcare professionals and between the patient and the healthcare professional. The MDT should involve specialist healthcare professionals, including doctors, pharmacists, specialist HF nurses, occupational therapists, physiotherapists and palliative care advisers [9].

Mental ill-health and other chronic diseases comorbidity

Comorbidities need to be effectively addressed as soon as they arise. Not only do they act as independent factors for the outcome; they also have the ability to impede the treatment plan for HF [10]. The burden of an illness can manifest in many ways; depression and anxiety being the most common. The link between the continuing development of heart disease and the onset of depression supports the theory that suffering from chronic stress due to living with illness, is a risk factor for the depression-anxiety disorder [10].

Patients with chronic disease suffer emotional stress over the years from the point of diagnosis or the initial acute presentation. Many find it difficult to cope with their illness and cannot manage to effectively adapt to their ever-changing psychosocial and physical situation, which eventually leads to a continuing loss of independence.

Mental illness and disorders

Depression belongs to a group of disorders known as the affective mood disorders [11]. Depression can occur as a single episode or as an ongoing condition with periods of remission and relapse [12]. It is one of the most common diagnoses in general practice (GP) and is associated with increased mortality and morbidity [13]. The Diagnostic and Statistical Manual of Mental Disorders (DSM-V), requires five or more symptoms to be present within a 2 w period to make a diagnosis of depression. One of the symptoms must be from the main criteria; which is either a depressed mood or anhedonia [14].

The secondary symptoms are

- Low energy levels/fatigue
- Appetite/weight changes
  - Comfort eating
  - Nausea causing reduced appetite
  - Intentional/non-intentional weight change
- >5% is significant
- Suicide ideation
- Have any plans been made to end their life
- Have they acted on any plans
- Has there been any self-harm
- Sleep disturbances
  - Insomnia
  - Hypersomnia
  - Repetitive waking during the night
  - Early morning waking
  - Feelings of worthlessness or excessive guilt
- Low self-worth, feeling useless and/or excessively guilty and helpless
- Reduced concentration/mentation
- Issues with information processing
- Psychomotor agitation or retardation

Symptoms may be grouped as somatic or non-somatic. The somatic items/symptoms include appetite or weight changes, sleeping difficulties, fatigue, poor concentration and psychomotor agitation/retardation. The non-somatic symptoms include depressed mood, anhedonia, feelings of worthlessness/excessive guilt, and suicide ideation. Severe depression is more associated with the non-somatic group of symptoms, where moderate depression is associated with the somatic cluster of symptoms [14]. Theories of the pathology of depression have been explored and the most widely accepted hypothesis has been that depression results from an underactivity of monoamine neurotransmitters in the synaptic cleft. However, when patients take antidepressant medication, the levels of noradrenaline and 5-HT increase within hours, but clinical improvement typically occurs only after 2-4 w. This suggests that secondary adaptive changes are occurring in the brain. These are thought to include desensitisation or down-regulation of the somatodendritic monoamine auto receptors rather than the simple increase in monoamine concentration alone. This would explain the delayed onset [15]. Recently research in this area has focussed on the glutamate and neuroplasticity theory, which is thought to provide a more complete explanatory structure for depression [16]. Neuroplasticity refers to the ability of the neural system to adapt to internal and external stimuli and to respond adaptively to future stimuli [17]. Neuroplasticity is a fundamental component of the brain’s adaptation to stress; any issues in adaptation may result in psychiatric disorders e.g., depression and other stress-related disorders [18]. Neuroplasticity occurs at different levels; from cellular changes to complete organisational changes. These changes will vary between individuals and are influenced by a person’s environment and life experiences, which is supported by observed increased RNA and protein synthesis [19] suggesting there are genetic aspects; genetic variation in humans can influence the expression and degree of neuroplasticity. The human genome has numerous gene polymorphisms known to influence neuroplasticity, the two most involved genes appear to be for brain derived neurotropic factor (BDNF) and apolipoprotein-E.
The mixed anxiety-depressive disorder is also common in primary care; where the patient exhibits broadly equal amounts of anxiety and depressive symptoms [25]. Stressful life events precipitate the symptoms of anxiety, so anxiety is the emotional response to a threat of loss, whilst depression is the response to the loss itself.

Anxiety disorder includes a variety of subgroups sharing features of disproportionate fear, anxiety and related behavioral problems [26]. They arise from a combination of biopsychosocial factors including genetic vulnerability, biochemical changes, personality type, mood and general behaviors, cultural, social, somatic status and medical status that interact life experiences leading to anxiety feelings [27]. Once these situations are encountered, various anatomical changes happen; the region of the brain thought to be most associated with anxiety is the amygdala [28]. Patients exhibiting anxiety symptoms have a 'hyper-responsive' amygdala generating feelings of anxiety and fear [29]. All nervous system functions; sleeping, memory, reflexes and higher cognitive tasks, result from neural activity. The mediators released are able to modify the neural circuit output to cause adaptation in different behaviors [30]. These neurotransmitters change the characteristics of the circuit's fundamental neurons, by controlling the input to these neurons and their synaptic connections.

Neuromodulation via these mechanisms produces various symptoms, including, apprehension motor tension, muscle stiffness, inability to relax becoming fatigued, muscle aches, irritability, hypervigilance (e.g. poor concentration, insomnia and irritability) and increased sympathetic activity [31]. In extreme cases, patients develop panic disorder, which is described by the DSM-V as 'a discrete period of intense fear or discomfort in which four (or more) of the symptoms developed abruptly and reached a peak within 10 min [32].

Approximately one-third of patients with depression will present with panic disorder. Overall a lifetime, around half of patients who have panic disorder will develop depression and about half of depressed patients will develop panic disorder [33].

The link between heart failure, depression and anxiety

The link between mental health and heart failure has been previously noted, but studies informing the best interventions to improve prognosis in both areas are limited. Chronic anxiety is an independent risk factor for CVD [34]. Panic disorder alone, predicts a significantly worse prognosis in chronic HF [35].

A meta-analysis (2006) discussed the prevalence, intervention effects and associations of depression with clinical outcome in HF [36]. Rutledge et al. [36], assessed three main areas; the prevalence of depression among patients with HF, the magnitude of the relationship between depression and clinical outcomes in the HF population and the evidence for treatment effectiveness in reducing depression in HF patients. They used clinical interview methods and diagnostic criteria from the DSM-V plus depression symptom inventories (e.g. Beck Depression Inventory and the Hospital Anxiety and Depression Scale) to diagnose depression in HF patients. This was compared to that documented into the patient's medical record and the current use of antidepressant medication.

The use of the diagnostic tools questionnaires resulted in a larger proportion of patients being diagnosed with clinically significant depression (33.6%); compared to 19.3% [36]. This suggests 'under' diagnosis of clinically significant depression. Conversely, the difference may reflect patients answering 'yes' to a question and perhaps overly their emotions at a certain time. This study concluded that overall, 21.5% of HF patients exhibited clinically significant depression. The combined diagnosis was explored further, suggesting higher rates of death and secondary events (risk ratio (RR) = 2.1 and 95% confidence interval (CI) 1.7 to 2.6) in the co-morbid group. Increased health care use and rates of hospitalization and emergency room visits were also noted.

The relative risk for onset of coronary artery disease (CAD) in depressed individuals was calculated to lie between 1.5 and 2.0; while the diagnosis of depression in patients who have a diagnosis of CAD was calculated to be between 1.5 and 2.5 [37]. Although no firm conclusions were drawn from this study; they based their theory on the underlying pathophysiological changes that occur in a depressed patient. Additionally, it is also thought that the altered natriuretic peptide levels in areas of the brain which regulate blood pressure and fluid control may contribute [38].

Plasma levels of natriuretic peptides are elevated in congestive heart failure. One study reported these have an antagonistic effect on blood pressure and fluid neurotransmitters in HF and are associated with the emotional and mental changes seen in HF [39]. Further investigating this concept, Herrmann-Lingen, et al., (2003) reported that anxiety tends to reduction with high atrial natriuretic pro- Peptide levels [40]. They suggested the reason may be a negative feedback loop, which helps the psychological distress a patient may experience and in turn, reduces the adverse autonomic implications seen in severe HF; volume or pressure overload leads to ventricular wall stress and subsequent BNP release. This causes peripheral vasodilatation, increase in natriuresis and diuresis and inhibition of the sympathetic nervous system and the RAAS [41]. Depression is thought to affect the regulation of the autonomic system; by reducing the parasympathetic tone and increasing the sympathetic tone; which ultimately leads to an increased heart rate, exaggerated response to physical stressors, higher variability in ventricular repolarization, reduced baroreceptor sensitivity and lowered tolerance for adverse cardiac events e.g. myocardial ischaemia [42]. Increased sympathetic output increases cortisol, serotonin, renin, aldosterone, angiotensin and free radicals [43].

High levels of circulating catecholamines increase blood pressure and coronary vascondstriction. They also induce platelet activation, predisposing this population group to an increased risk of thromboembolism through an inhibitory effect on the synthesis of the protective eicosanoids [44].

In depression, macrophage activation via the cholinergic anti-inflammatory pathway is no longer inhibited and therefore contributes to the elevation of pro-inflammatory markers such as C-reactive protein and cytokines (interleukin-1 beta, interleukin-6 and tumour necrosis factor-alpha (TNF-alpha). The TNF-alpha is known to reduce serotonin levels and produce an overall depressed mood, fatigue, loss of appetite, sleep disturbances, malaise and decreased libido [45]. The increased levels of inflammatory cytokines have been reported to be independent predictors of HF-related exacerbations and deaths [46]. The study also concluded that increased serum IL-6 is a powerful independent predictor of the combined-point; death, new heart failure episodes and the need for heart transplantation.

More complex mechanisms also exist; immune activation of leucocytes and natural killer cells; and the activation of the HPA axis ('stress axis') result in hypercortisolaemia, an increase in adrenocorticotropic hormone (ACTH) and ACTH-releasing factor; along with an increase in endogenous steroid hormone production [47]. The former contributes to components of the stress response are the paraventricular nucleus (PVN) of the hypothalamus, the anterior pituitary and the cortex of the adrenal glands [48]. Cells in the PVN release corticotrophin-releasing hormone (CRH) in response to the natural cardiac drive and also to stressors; trauma, psychosocial agitation or pharmacological agents etc. The CRH travels through...
the portal vascular system and binds to corticortrophs in the anterior pituitary; resulting in synthesis and release of ACTH [49]. This circulating ACTH binds to receptors on adrenocortical cells; causing the synthesis and release of cortisol into the bloodstream. The characteristic circular pattern of cortisol secretion shows an increase in the early morning, peaking just before the time of waking. An abundance of physiological stressors will have a contributing effect on the cortisol levels, which may result in raised afternoon and evening cortisol levels, far above the predicted circadian peak in the morning [49]. Cortisol elevation from chronic stress response would produce neurotoxic effects on the hippocampal neurons through the glucocorticoid and mineralocorticoid receptors, resulting in a decrease in neurogenesis, synaptogenesis and dendritic spines and increased apoptosis of neurons. The cortisol will ultimately exercise its effects throughout the brain and periphery [50]. The morphological loss of neurons leads to functional deficits, a long term depression (reduction in the efficacy of neuronal synapses) or long term potentiation (persistent increase in synaptic strength) of the hippocampus; which in turn, causes a reduction in GABA neurotransmitter control of the HPA axis [51]. Interestingly, this links in with the neuroplasticity theory of depression, as previously discussed. It has been reported that cortisol inhibits neuroplasticity in the CNS [52].

GABA reduces the HPA axis output in response to stress and the resulting reduction exacerbates the HPA axis stress output, causing a further morphological and functional loss in the hippocampus. A malicious cycle is thus formed; eventually causing structural atrophy and the functional deficit of the hippocampus. Atrophy levels usually range from 8%-19% something that is frequently seen in depression [53]. Chronic/long-term stress and therefore prolonged glucocorticoid secretion also cause a reduction in BDNF in the brain [54]. Interestingly, the biological activation of the HPA axis system seems to have a prognostic value, with evidence of an increased risk of depression relapse and even suicide [49].

Depression manifests clinically through autonomic, metabolic, immune-inflammatory and HPA axis dysfunction; all of which affect the incidence of CVD by initially causing thickening of the tunica intima and tunica media (the two innermost layers of the arterial wall), precipitating atherosclerosis [55]. Depression also decreases vagal tone and can also increase sympathetic tone, further raising CV risk [32]. The nervous system also regulates internal organ function so it has been suggested that neuroplasticity is also associated with the pathophysiology of other diseases including neuropsychiatric disorders [56].

If stress can influence the HPA axis, increasing glucocorticoid levels, this will reduce BDNF concentration and decrease neuroplasticity, leading to depression. If neuroplasticity is the ability of the nervous system to respond to stimuli by reorganizing its structure, function and connections [17], a decrease will impact the autonomic nervous system, both directly and through the HPA axis and the hippocampus; causing autonomic dysfunction, which could possibly lead to CVD [57]. This raises the question; are certain patients ‘predisposed’ to developing a mental illness with CVD? Patients with reduced neuroplasticity will be at risk of developing depression and also CVD. A recent study (n=10,341) provides evidence to support these links. They reported an association between depression and the future risk of developing CVD, which was reported to be similar across the sub-groups of CVD [58]. They also reported that moderately depressed patients were at a higher risk of developing CVD, compared to mildly and severely depressed patients. The reason for this is that moderately depressed patients exhibit somatic symptoms whilst severely depressed patients are at higher risk of suicide due to predominant non-somatic/cognitive-affective symptoms. Furthermore, the study reported a higher risk of CVD amid depressed patients who also suffered from anxiety symptoms.

RESULTS
Out of eleven studies compared, two disagreed with the theory that co-morbidity with mental ill-health and heart failure is associated with disease modification and worsening patient health outcomes. Three studies concluded that only anxiety has an effect, five studies concluded that both anxiety and depression produce an effect, whilst six concluded that only depression demonstrates an effect. However, all eleven state that more research is required (table 2).

Table 2: Analysis of studies conclusions in relation to the agreement or disagreement with the theory of mental ill-health and heart failure have disease modification and worsen patient health outcomes

| Paper | Citation | Sample | Type of study | Results (Direct quotation) | Agree with the theory of anxiety and HF comorbidity and disease modification | Agree with the theory of depression and HF comorbidity and disease modification | Disagree with the comorbidity diseases modification theory | More research required |
|-------|----------|--------|---------------|----------------------------|----------------------------------|---------------------------------|---------------------------------|----------------------|
| 1     | Almas A, Forsell Y, Iqbal R, Janszky I, Moller J. Severity of Depression, Anxious Distress and the Risk of Cardiovascular Disease in a Swedish Population-Based Cohort. PLoS One. 2015. 10: available at 10.1371/journal.pone.014072 | 10,443 patients | longitudinal cohort study | This study found that severity level of depression seems to be of significance for increased risk of CVD among depressed persons, a higher risk of CVD among depressed individuals with symptoms of anxious distress. | √ | √ | X | √ |
| 2     | Carrney R, Freedland K, Veith R. Depression, the autonomic nervous system, and coronary heart disease. Psychosomatic Medicine. 2005. 67: 29-33. | N/A | Review | Studies of medically well, depressed psychiatric patients have found elevated levels of plasma catecholamines and other markers of altered ANS function compared with controls. Studies of depressed patients with CHD have also uncovered evidence of ANS dysfunction, including elevated heart rate, low heart rate variability, exaggerated heart | X | √ | X | √ |
rate responses to physical stressors, high variability in ventricular repolarization, and low baroreceptor sensitivity. All of these indicators of ANS dysfunction have been associated with increased risks of mortality and cardiac morbidity in patients with CHD. Pro-ANP plasma levels are independently and inversely related to anxiety. This might be part of a negative feedback loop limiting psychological distress and its adverse autonomic consequences in severe heart failure.

Although anxiety and depression are highly correlated in CHF patients, depression alone predicts a significantly worse prognosis for these patients.

There is substantial evidence for a relationship between depression and adverse clinical outcomes. However, despite the availability of effective therapies for depression, there is a paucity of data to support the efficacy of these interventions to improve clinical outcomes for depressed CAD patients. Randomized clinical trials are needed to further evaluate the value of treating depression in CAD patients to improve survival and reduce morbidity.

Self-reported chronic stress is an independent risk factor for CVD. The adjustment itself might reflect mechanisms whereby psychosocial stress directly or indirectly exerts its effects on the body, indicating a possible over-adjustment.

Depression is four to five times as common in chronic heart failure (CHF) patients as in the general population, may confer a higher risk of developing CHF in susceptible populations, and is significantly related to higher hospital readmission rates and increased mortality in severe heart failure.

|   | Author(s) | Number of Patients | Study Type | Key Findings |
|---|-----------|--------------------|------------|--------------|
| 3 | Herrmann-Lingen C, Binder L, Klingen M, Sander J, Schenker W, Beyermann B, Von Lewinski D, et al. | 119 | Cross-sectional study | All of these indicators of ANS dysfunction have been associated with increased risks of mortality and cardiac morbidity in patients with CHD. Pro-ANP plasma levels are independently and inversely related to anxiety. This might be part of a negative feedback loop limiting psychological distress and its adverse autonomic consequences in severe heart failure. |
| 4 | Jiang W, Kuchibhatla M, Cuffe M, Christopher E, Alexander J, Clare G, Blazing M, et al. | 374 | Cross-sectional study | Although anxiety and depression are highly correlated in CHF patients, depression alone predicts a significantly worse prognosis for these patients. |
| 5 | Lett H, Blumethal J, Babyak M, Sherwood A, Strauman T, Kohrs C, Newman F. | N/A | Review | There is substantial evidence for a relationship between depression and adverse clinical outcomes. However, despite the availability of effective therapies for depression, there is a paucity of data to support the efficacy of these interventions to improve clinical outcomes for depressed CAD patients. Randomized clinical trials are needed to further evaluate the value of treating depression in CAD patients to improve survival and reduce morbidity. |
| 6 | Mbakwem A, Aina Fand Amadi C. | N/A | Expert opinion, metaanalysis | Results from metaanalysis suggest a twofold increase in mortality in HF patients with compared to those without depression. Pharmacological management of depression in HF has not been shown to improve major outcomes. No demonstrable benefits over cognitive behavioral therapy and psychotherapy have been demonstrated. |
| 7 | Öhlin B, Nilsson P, Nilsson L, Berglund G. | 13,609 | Population-based screening and intervention programme | Self-reported chronic stress is an independent risk factor for CVD. The adjustment itself might reflect mechanisms whereby psychosocial stress directly or indirectly exerts its effects on the body, indicating a possible over-adjustment. |
| 8 | Parisios J, Fountoulaki K, Paraskevaidis I, Kremastinos D. | N/A | Review | Depression is four to five times as common in chronic heart failure (CHF) patients as in the general population, may confer a higher risk of developing CHF in susceptible populations, and is significantly related to higher hospital readmission rates and increased mortality in severe heart failure. |
| REFERENCES | AUTHORS CONTRIBUTIONS | CONFLICT OF INTERESTS | REFERENCES |
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CONCLUSION

HF and mental health co-morbidity burden both the patient and the healthcare provider. Clinicians have an opportunity to intervene in such cases. The symptomatic perspective and the psychosocial aspects for an individual, need to be carefully considered from the presentation. Gauging the level of acceptance and adherence to therapy, will facilitate timely intervention and provide the opportunity to develop a comprehensive and tailored management plan for the patient. By addressing this issue, other facets of the symptomatic cube could also be simultaneously improved. The overall aim would be to promote improved quality of life for the patient. Non-adherence to a medical treatment plan can be detrimental to a patient’s health. This review of recent literature reveals no new information or consensus on the assessment or treatment of depression in patients with HF. Also, there is no routine use of any diagnostic tool to assess medication adherence when reviewing a patient.

AUTHORS CONTRIBUTIONS

All the authors have contributed equally

CONFLICT OF INTERESTS

Declare none

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