REVIEW ARTICLE

End-Stage Heart Disease in the Elderly

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This document was produced by the Spanish Society of Cardiology Section on Geriatric Cardiology "Endstage heart disease in the elderly" working group. Its aim was to provide an expert overview that would increase understanding of the last days of life of elderly patients with heart disease and improve treatment and clinical decision-making. As elderly heart disease patients form a heterogeneous group, thorough clinical evaluation is essential, in particular to identify factors that could influence prognosis (eg, heart disease, comorbid conditions, functional status, and frailty). The evaluation should be carried out before any clinical decisions are made, especially those that could restrict therapy, such as do-not-resuscitate orders or instructions to deactivate an implantable cardioverter-defibrillator.

Elderly patients with terminal heart disease have the right to expect a certain level of care and consideration: they should not suffer unnecessarily, their freely expressed wishes should be respected, they should be fully informed about their medical condition, they should be able to express an opinion about possible interventions, and they should be entitled to receive psychospiritual care. After an incurable disease has been diagnosed, the aim of palliative care should be to control symptoms. It should not be used only when the patient is close to death. Although palliative care is relatively undeveloped in heart disease, its use must be borne in mind in elderly patients with advanced heart failure. The main aims are to make the patient as comfortable as possible in all senses and to optimize quality of life in the patient's final days, while avoiding the use of aggressive treatments that consume health-care resources without providing any benefits.

Key words: *Elderly. Age. Palliative care. Heart failure. Health status.*

El anciano con cardiopatía terminal

El objetivo de este documento del Grupo de Estudio «El anciano con cardiopatía terminal», de la Sección de Cardiología Geriátrica de la Sociedad Española de Cardiología, es aportar un punto de vista experto que permita un mejor conocimiento de la situación y una mejora en el manejo y la toma de decisiones en los últimos días de vida del paciente de edad avanzada que sufre una cardiopatía. Los cardiópatas ancianos constituyen un grupo heterogéneo y es necesaria una valoración exhaustiva, especialmente de los factores que condicionan el pronóstico (cardiopatía, comorbilidad, situación funcional y datos de fragilidad) antes de tomar decisiones, sobre todo aquellas que conlleven limitación del esfuerzo terapéutico como las órdenes de no reanimar o la desactivación de desfibriladores automáticos implantables.

Los ancianos con cardiopatías terminales tienen derecho a disponer de una serie de cuidados y atenciones, entre ellos no sufrir inútilmente, respeto a su libertad de conciencia, conocer su situación, opinar sobre posibles intervenciones y recibir asistencia psicoespiritual. Los cuidados paliativos deben dirigirse al control de los síntomas tras el diagnóstico de la enfermedad incurable y no iniciarse únicamente en la fase de agonía. Estos cuidados están poco desarrollados en las cardiopatías y deben de tenerse presentes en los ancianos con insuficiencia cardiaca avanzada. Su objetivo es conseguir el máximo bienestar para el paciente desde un punto de vista integral, mejorar su calidad de vida antes del fallecimiento y evitar el empleo de tratamientos agresivos que consumen recursos sin resultados.

Palabras clave: *Anciano. Edad. Cuidados paliativos. Insuficiencia cardiaca. Estado de salud.*

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ABBREVIATIONS

HF: heart failure
ICD: implantable cardioverter-defibrillator

INTRODUCTION

The steady aging of the population and progress in the management of cardiovascular disease has led to the situation where the vast majority of patients who die from heart disease are elderly. However, there is still little information available on care for the elderly with heart disease in their final stage of life. The present document was produced by the Spanish Society of Cardiology Section on Geriatric Cardiology "Endstage heart disease in the elderly" working group. Its aim was to provide an expert overview that would increase understanding of the last days of life of elderly patients with heart disease and improve treatment and clinical decision-making.

In daily clinical practice we often find ourselves facing examples of discrimination or limited resources due to age issues of the type referred to in the literature. This kind of age-based discrimination, also known as ageism, has been demonstrated in many cardiovascular heart disease contexts, such as acute myocardial infarction and heart failure (HF), and includes poorer adherence to protocols and reduced access to advanced technologies, special units, waiting lists, or palliative care programs.[1-3] As elderly patients form a very heterogeneous group, thorough geriatric assessment is essential, in particular to identify the main factors that could influence prognosis before any clinical decisions are made, especially those that could involve restricting therapy.[4-8] This evaluation should include collecting clinical data (medical history, physical examination and taking special note of any drugs consumed, renal function, comorbidity, and nutritional status), as well as information on physical functioning (whether the patient is able to engage in the basic and instrumental activities of daily life), mental functioning (cognitive and mental assessment) and the patient's social situation (housing, care, etc).

The present document, although referring to terminal heart disease in the elderly person in general, mainly focuses on HF, as this is the final outcome of most heart diseases, and due to its duration and symptoms, decisions very often have to be made that go beyond the treatment itself. Naturally, many such decisions may be appropriate for younger patients in the final stages of HF. However, HF is an eminently geriatric syndrome, since more than 95% of women and more than 92% of men admitted for HF are ≥65 years of age.[9] Furthermore, young patients with terminal heart disease often have the option of a cardiac transplant.

END-STAGE CRITERIA FOR HEART DISEASE. ADVANCED HEART FAILURE

Heart failure, the typical end-stage of most heart disease, has a heterogeneous course, and this makes it more difficult to be certain if a patient is in the terminal stage. It is a progressive syndrome ranging from stages where there is only increased risk (stages A-B), to the onset of persistent symptoms or not (stage C), and finally to the stage in which there are symptoms that are resistant to treatment (stage D).[10] A high percentage of patients with HF die from cardiac causes, but very often the patient, their family or caretakers are not told the prognosis, nor is this done at the time of diagnosis or during the first years of onset. Furthermore, the loss of functional capacity or autonomy due to this disease can occur gradually, with a pattern of outbreaks without complete recovery after each outbreak, or abruptly, as in the case of an acute myocardial infarction. It is of importance to know the course of functional loss in a patient to better fine tune their prognosis. Except for HF (and only in its most advanced stages), there are few cardiovascular diseases where the physician can predict life expectancy in months.

Multiple factors contribute to the fact that patients with HF, and even the physician treating them, are optimistic when assessing life expectancy in the final stages of this disease. The typical patient with HF can be admitted to hospital due to flare-ups several times before death occurs and, unlike situations involving cancer, may be discharged with a clear improvement in symptoms, based on the model of "organ failure" (Figure 1).[11] Patients with HF have little knowledge of their disease or its treatment[12]; in addition, patients and their families usually do not perceive it as being as serious as oncological disease, despite the deterioration in the quality of life that occurs in patients with HF.[13] All these circumstances lead to patients in the final stages of HF frequently receiving aggressive medical therapies up to the time of death, including intubation, resuscitation, and other measures only a few days before they die.

The CARING criteria are useful tools when selecting patients who may benefit from a palliative therapeutic approach. These are based on easy-to-detect clinical characteristics from the time of admission onward, and identify people nearing the end of life regardless of the reasons for admission. CARING is the acronym for a group of criteria (Cancer, Admissions ≥2, Residence in a nursing home, Intensive care unit admit with multiorgan

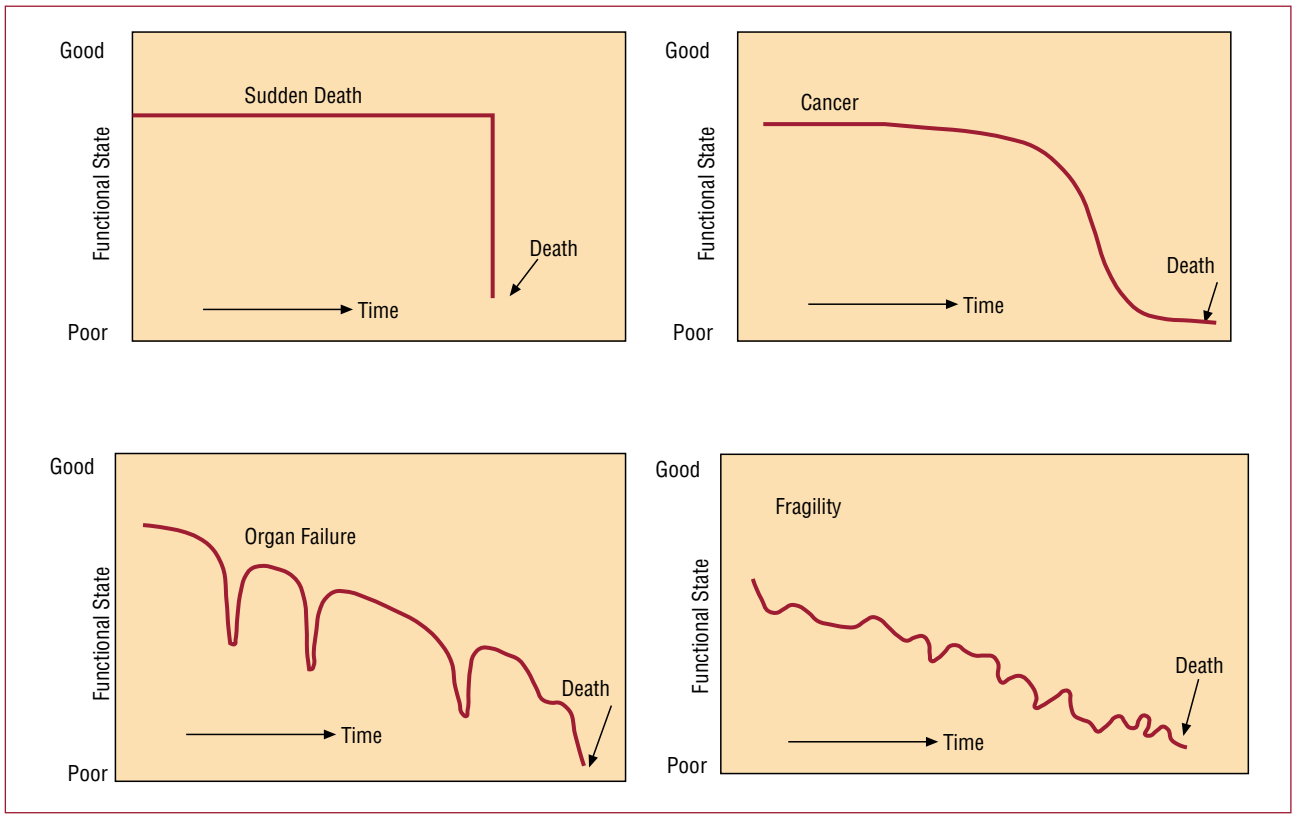

Figure. 1. Different disease progression models toward the end of life. The saw-tooth model of heart failure is the one which typically matches with the elderly patient with HF in the terminal phase. Modified from Lunney et al.[11]

failure, ≥2 Non-cancer hospice Guidelines) associated with high sensitivity and specificity for death at 1 year.[14] However, this is a general index, and is not specifically designed for patients with HF. The criteria for terminality most used are those of the National Hospice Organization (NHO) in the United States. These were defined to select patients with an expected life-expectancy <6 months who could be offered free care in hospices (centers specialized in palliative care).[15] In addition to some general guidelines that include terminality, informed consent regarding symptom relief as a therapeutic aim, documentation concerning disease course, and undernutrition, the National Hospice Organization defines some specific criteria for patients with HF. As may be seen in Table 1, these criteria are quite restrictive, since they were fundamentally based on economic concerns, and lack sensitivity or are inadequate when selecting patients, especially among the elderly, in whom symptomatic treatment would contribute more benefit that other more aggressive treatments. Other criteria have also been proposed for admission to palliative care programs in a clinical situation of low cardiac output with sodium levels <134 mmol/L or creatinine concentrations >2 mg/dL.[16] In addition to hyponatremia and kidney failure,

TABLE 1. **Criteria for Terminal-Phase Heart Failure of the National Hospice Organization (NHO)**

Functional class IV despite optimal treatment
Left ventricle ejection fraction <20%
Presence of other factors indicating poor prognosis:
Unable to control arrhythmias with medication
History of cardiopulmonary resuscitation
History of syncope
History of cardiac embolism
HIV infection

Adapted from Fox et al.[15]

2 more variables have recently been proposed to help identify the elderly with HF who may a candidate for palliative care: peripheral arterial disease and systolic blood pressure.[17] Other authors[18] have established the lack of indications or rejection of advanced treatment as criteria for these programs. Models exist which predict mortality specific to patients with HF.[19-21] These models, which have been obtained mainly from populations with few elderly patients, are complex, very focused on heart disease, and have important limitations in elderly patients, particularly when predicting short-term mortality.

COMORBIDITY, FRAILTY, AND FUNCIONALITY AS PROGNOSTIC FACTORS

Comorbidity, defined as the concomitant course of 2 or more medical diseases in the same patient, is practically the norm in the elderly population. Population studies have shown that both the prevalence of comorbidity and the number of simultaneous diseases in a single patient increase with age. Elderly patients with HF often have other diseases or disabilities, which makes this disease behave very differently compared to younger patients, thus contributing to worse progress. More than half the elderly patients hospitalized for HF are readmitted within 6 months following hospital discharge, and most of these readmissions are due to non-cardiac causes.[22] Comorbidity quantifiable using the Charlson index is an independent predictor of mortality in the elderly patient with HF.[23]

The prognosis of elderly patients also depends on their frailty and functional state, which are aspects that are not included in most prognostic indexes. The concept of fragility refers to the reduced ability to overcome times of stress that places the individual at risk. Frailty is progressive, tends to be associated with chronic disease, worsens with advancing age and often culminates in dependency on other people.[24] Although frailty has many components[25] (Table 2), some authors have proposed identifying it using 5 objective criteria:

– Weight loss (>10% weight at 60 years or body mass index <18.5)
– Lack of energy (≤3 on a scale ranging from 0 to 10 or feelings of being abnormally tired or weak during the previous month)
– Limited physical activity (on an activity scale)
– Reduced walking velocity (time spent in walking 4.6 m compared to age-adjusted speed)
– Muscular weakness (as measured by strength test)[24]

The presence of 3 or more of these signs or symptoms of frailty has been associated with a worse clinical course, with greater rates of dependency, hospitalization and death. When this situation progresses and frailty becomes severe, it would be correct to prioritize alleviating symptoms and improve the quality of life.

The patient's functional state, defined as the group of activities and functions needed to maintain autonomy in everyday physical, mental, and social functions, is of crucial importance to changes in the health parameters in the elderly person. Measurements of functional state have demonstrated their great value as predictors of hospital evolution. Even more, they carry greater weight in predicting hospital stay, institutionalization or death than the diagnosis, diagnosis-associated groups or other standard indexes for measuring disease. In fact, physical functionality is the single most important factor in predicting hospital mortality in the elderly person[26] and it surpasses other indexes of disease severity.

TABLE 2. **Criteria for Characterizing the Frail Elderly Person**

1. Clinical criteria	Multiple comorbidities
	Polymedication
	Frequent hospitalizations
	Repeat falls
	Sensory deficit
	Urinary incontinence
2. Functional criteria	Dependency in the basic activities of daily life
	Dependency in the instrumental activities of daily life
3. Socioeconomic criteria	Lives alone
	Recently widowed
	Institutionalization
	Age >80 y
	Low economic status
4. Cognitive-affective criteria	Depression
	Cognitive deterioration

Adapted from Martínez Martín et al[25].

Thus, it is important to thoroughly evaluate the degree of independence of the elderly person before the acute situation leading to admission begins, as well as the main cause of the limitation. A study conducted by Inouye et al[27] identified 3 functional variables independently associated with 90-day and 2-year mortality in the elderly hospitalized due to medical disease: dependency in the instrumental activities of daily life, cognitive dysfunction, and symptoms of depression. A simple predictive model based on these 3 variables can predict which elderly patients with medical disease are at high, intermediate or low risk of mortality in the 2 following years. Furthermore, the inclusion of these functional measurements in other prognostic indexes based on the disease improves the predictive capacity of mortality after 2 years in elderly patients. Measures of functional state, such as the Barthel basal index applied prior to hospitalization due to decompensated HF, have shown to be predictors of mortality in elderly patients hospitalized for HF.[28]

TREATMENT AND PREVENTION OF SUDDEN DEATH. DO-NOT-RESUSCITATE ORDERS

The therapeutic decisions taken to prevent sudden death in elderly patients with heart disease should

be based not only on the results of clinical trials, but also on the risk of the intervention itself, comorbidity, life expectancy and, of course, the patient's preferences. The options for preventing sudden death are antiarrhythmic drugs, ablation, and implantable cardioverter-defibrillators (ICD). Amiodarone is the only antiarrhythmic which has shown not to increase mortality in patients with heart disease, but neither does it improve survival.[29] Given that it does reduce the rate of ventricular tachyarrhythmias, it could be an alternative in the event that other invasive options are discarded, as it improves quality of life by reducing the number of episodes. On the other hand, a recently published study, in which most patients were older than 70 years, demonstrated that catheter ablation in patients who had received a defibrillator reduced the frequency of arrhythmic episodes.[30] Thus, it could also be an alternative when preventing new episodes of ventricular tachyarrhythmias in some patients, but we should bear in mind that this is an invasive treatment. In any case, and for the time being, the only option which has been demonstrated as reducing sudden death in patients is the ICD. However, the elderly have barely been represented in the clinical trials that have evaluated these devices. Regarding primary prevention, a substudy of the MADIT II (Multicenter Automatic Defibrillator Implantation Trial II) study found that patients over 75 years of age who had received an ICD obtained benefits similar to those in younger patients.[31] However, a metaanalysis of the 5 main studies of secondary prevention indicated that ICD provided no benefit in patients of over 75 years of age.[32] This is probably due to the fact that the selection of patients who have already had tachyarrhythmias is lower. It should be mentioned that, in most of the studies, the rate of complications during ICD implantation in elderly patients was similar to the rest of the population,[33] and therefore age itself should not be a limitation for intervention.

In view of the fact that the benefits of ICD become evident 1 year from implantation,[8] their use does not appear to be indicated in patients with a life expectancy less than this period. One registry found that life expectancy among octogenarian patients receiving an ICD is less than that of patients aged between 60 and 70 years; however, the average life expectancy was over 4 years, which means that other aspects that reduce survival apart from age should be identified.[34] On the one hand, heart disease itself is one such aspect. We should recall that these devices can prevent arrhythmic death, but not death due to pump failure, and thus their implantation in patients with advanced heart disease with a life expectancy <1 year is not indicated. On the other hand, it has been shown that noncardiac comorbidities (such as chronic obstructive pulmonary disease, peripheral vascular disease, kidney failure, and cancer) shorten the survival of patients receiving an ICD, especially when the patient presents 2 or more of these diseases at the same time.[35] Taken together, we can say that indications for ICD implantation are similar to those of younger patients, but comorbidities should be taken into account, as well as how far the heart disease has advanced, and the decision of the patient.

Beyond the measures taken to prevent sudden death lies the attitude toward therapy that should be adopted when dealing with the elderly person with advanced heart disease presenting cardiac arrest. One of the most difficult decisions to take when caring for the elderly with advanced heart disease involves terminality and the do-not-resuscitate order. This order, that taken strictly means not implementing cardiopulmonary resuscitation maneuvers, is often associated with a reduction in other treatment and care. After adjusting for the severity of the disease, prognostic factors and age, the patients with these orders are 30 times more likely to die than those without them, which may indicate a reduction in the quality of care.[4] These orders are used more frequently for the elderly and, in the United States, for black people, alcohol abusers, and non-English speakers, which indicates a certain degree of discrimination in the decision not to resuscitate.[4] Age is the variable most frequently associated with do-not-resuscitate orders and in up to two-thirds of patients this decision is made without taking into account the wishes of the patient or their family,[4] and without correlation with the existing quality-of-life indexes.

A fact that physicians and patients are barely aware of is that the success rate of resuscitation after cardiopulmonary arrest is low (close to 22%), with similar percentages in the general and elderly population.[5] Goodlin et al[6] studied 2505 cardiac arrests in patients admitted to hospital who were more than 80 years old and found that only 514 patients (21%) received cardiopulmonary resuscitation, which was successful in 93 (18%); of these, only 4% survived arrest. The authors also demonstrated that 11% of the elderly who had previously expressed their wish not to undergo resuscitation received it and 37% of those who wanted resuscitation did not. Furthermore, the prevalence of do-not-resuscitate orders in patients admitted for HF is less than 5% and the subject of resuscitation is discussed less frequently in relation to patients with HF than in those with other diseases such as cancer. In fact, in a ward of patients with HF, physicians have a mistaken view regarding the desire of the patient to receive cardiopulmonary resuscitation or not.[21] The do-not-resuscitate decision should explicitly appear in the medical record of the patient with terminal

disease after being agreed with the patient and, if possible, their family, and the medical team. This decision should be made after thorough assessment of the prognostic and quality of life indexes.

Another controversial aspect, and one that is scarcely addressed in the terminal patient, is the decision to deactivate an implanted ICD. A study based on interviews with the relatives of 100 dead patients who received an ICD showed that deactivation was only proposed to 27 patients, of whom 21 accepted it.[7] The ICD produced shocks in the last month of life in 27 patients and in the last minutes of life in 8 patients. Even among patients with do-not-resuscitate orders, the ICD was deactivated in less than 45% of the patients. The most recent American guidelines[36] on the use of devices to control arrhythmias recommend that the terminal patient and the family members should be informed about the outcome of ICD deactivation, and that this decision and a brief summary of the conversation should be noted in the medical record, and finally, that the ICD deactivation order should be accompanied by the do-not-resuscitate order. In case of disagreement among the medical team, the hospital ethical committee should be consulted for their assessment and advice.

AUTONOMY AND VITAL WILL. THE PERCEPTION OF DIGNITY

Experience shows that patients who know their diagnosis and its prognosis and participate in decision-making have better symptomatic control. However, we should not overestimate the autonomy of the patient, since the decision-making capacity of the elderly person with terminal heart disease may be affected by situations inherent to their disease (denial, depression, despair, fear). In order to accept the decision made by the elderly person with advanced heart disease, the physician should evaluate their competence, reviewing the mental abilities needed to make decisions. On the other hand, it is known that the patients often have ambivalent and changing opinions[37,38]; for example, up to 40% of the patients with advanced HF change their decision regarding the possibility of receiving resuscitation in less than 2 months.[39] On the other hand, documents such as the "last will and testament," "vital will," or "previous instructions" are not always of help when making decisions. Some studies have shown that there is little agreement between the wishes of the patient and those expressed by the family member in charge of decision-making (or by the physician). However, most patients prefer that, in the event of conflict, the opinion of the family member (or that of their physician) should be followed and not their own previously expressed wishes.[38] Bearing in mind all their limitations, these documents may be useful in specific circumstances and provide the opportunity to select the person to whom decision-making is delegated in case the patient is not able to do this, which helps to solve the problem of possible differences of opinion among those closest to the patient.

In a recently published review, Chochinov[40] showed that the patient's perception of dignity, particularly among those with terminal disease, depends to a great extent on their physician and proposes several approaches to care aimed at conserving dignity, summarized as the ABCD (Table 3).

PALLIATIVE CARE

Palliative care refers to those activities aimed at improving the quality of life of the patients and their families facing the problem of a potentially fatal disease, through the prevention and relief of suffering by means of early identification, evaluation and treatment of pain as well as other problems, including physical, psychological, and spiritual.[41] The quality of life of the patients with HF tends to be poor and the lack of education among the professionals performing palliative care in HF, and vice versa, is worrying.[42] Such care should begin when incurable disease is diagnosed, and its need increases as the disease progresses and "curative" or "life prolonging" therapeutic measures are shown to be increasingly ineffective[41,43,44] (Figure 2). Care should not end when the patient dies, since it includes assisting with the grieving process among the family. Grieving is the set of mental representations and behaviors related to emotional bereavement and is an adaptation process that helps to reestablish the personal and family equilibrium shattered by the death of a loved one. The normal or uncomplicated grieving process does not usually exceed 2 years, but may become pathological when the mental adaptation process fails. It is important to emphasize that various predisposing and avoidable factors lead to pathological grieving and these include poor physician-family communication, being unprepared, failure to satisfy the family, poor symptom control and the lack of involvement of the health personnel during all stages, especially the last one. Early intervention in the patient's family would be of great help in identifying risk factors, guiding action and offering advice to them in a more focused manner.[45]

Palliative care should not be withheld until the last moments of life. The death throes form the final phase of the disease in which the patient is very close to the death (days or hours). It is imperative that in this phase the therapeutic aims should be redefined and, due to increasing distress,

TABLA 3. **The ABCD of Care Focused on Conserving Dignity According to Chochinov**[40]

A	Attitude. A positive attitude within the health system has an impact on the attitude of the patient facing the disease
B	Behavior. To maintain dialogue, demonstrate interest, provide understandable daily information, take care during examinations, and respect modesty. Suggest having a family member present, especially if giving complex or "difficult" information, and address private subjects in an environment that respects privacy and from a nearby position
C	Compassion. The patient should perceive that the health personnel understand, respect, and empathize with their suffering
D	Dialogue. Dialogue should help us to know the patient as person. Knowing the vital state of the patient is basic to treatment focused on the conservation of dignity

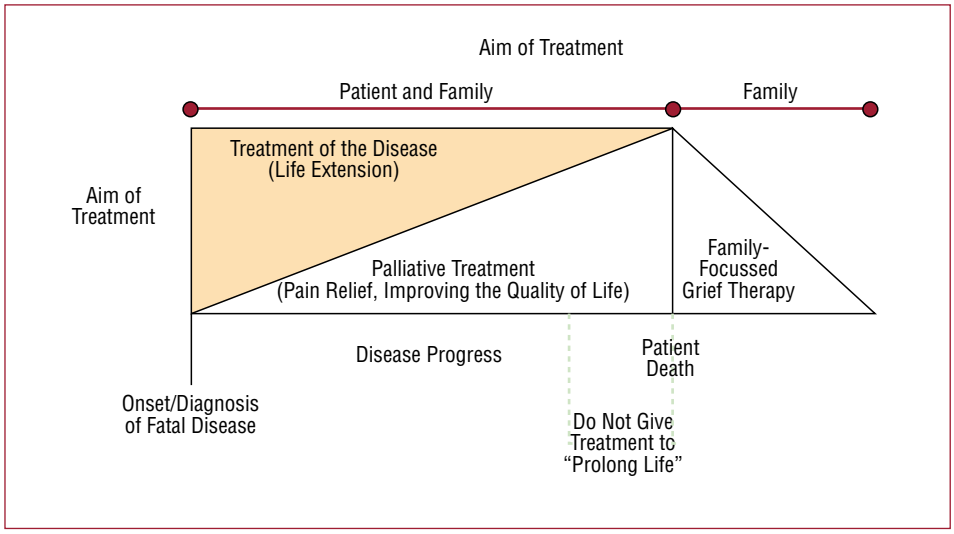

Figure 2. The aim of treatment in relation to the duration of fatal disease progression. The figure shows that there is no incompatibility between curative and palliative medicine; both approaches should be combined in the elderly patient with terminal heart disease from the beginning. Modified from Gibbs et al.[43]

intervention should be centered on the family and the patient. The aim in this period is to keep the patient as comfortable as possible. However, treatment should again be reviewed with the aim of simplifying it, since in patients close to death some drugs may be irrelevant. Another circumstance that must be taken into account is that, if the main route of drug administration is oral and this means is not available, less simple alternative routes should be sought. The most convenient alternative route in this phase is often the subcutaneous one. Palliative care can be conducted in hospital, in specialized institutions, or in the patient's home. The latter option is of special interest when the need for medical care allows for this and there is good family support, as the patient will be in the most familiar environment, with their loved ones, and in a greater degree of comfort. In fact, studies have shown that patients prefer to die at home with their family present. Formiga et al[46] found that when a group of patients with advanced HF were asked about their preferences when recovery was unlikely, the patients preferred to continue being treated at home and that more than three-quarters wanted to have their family or friends with them. However, death among the elderly with advanced HF usually occurs in hospital, even in patients who have been treated at home for long periods.[39,47,48] Regardless of the different palliative care programs established in each place, it is important to ensure homecare for the patient, with multidisciplinary teams available which include the main physician and support teams or equivalent. In addition, any social resources should be mobilized that help the patient to remain at home until the time of death, if desired.

PALLIATIVE TREATMENT OF THE SYMPTOMS OF TERMINAL HEART DISEASE

Limited studies refer to the symptoms of the patient with terminal heart disease. Palliative treatment involves diagnosing the cause or causes of each symptom to attempt to treat them. Even if the cause of the symptom is irreversible, knowledge of the underlying mechanism should suggest the most appropriate symptomatic treatment.

Dyspnea

A total of 60% of patients who die from advanced HF suffer from severe dyspnea.[49] Together with optimal vasodilator and diuretic treatment, other likely causes should be investigated and treated,

such as pleural effusion which can be alleviated by thoracocentesis. When dyspnea persists despite treatment, opioids should be used and these can lead to significant improvement.[50] Morphine sulfate or morphine chlorhydrate have the advantage of being able to be administered orally; doses range from 5 mg/4 h to 15 mg/4 h. In the absence of pain, doses higher than 15 mg/4 h do not contribute benefit. This treatment does not alter gasometric parameters or pulmonary function and can also be administered subcutaneously; the equivalent dose is half the oral dose. Phenothiazines can be also be used (chlorpromazine 25 mg) at night, but benzodiazepines (eg, diazepam 2-10 mg per day) should only be used for their anxiolytic effect, since they do not act on the mechanism of dyspnea. Oxygen therapy, even when the patient is not hypoxemic, as well as fresh air directed at the patient's face (fan, ventilator, etc) can contribute to the relief of this symptom.

Pain

A total of 78% of patients describe pain as the worst of their symptoms in the final phases of HF,[51] and is severe 3 days before death in 41% of patients. This pain may be due to cardiac causes, comorbidity (arthrosis, diabetic, or herpetic neuropathy, etc) or to the medical treatment itself. Although there is little information available on the prevalence and etiology of pain in the patients with HF, the PAIN-HF study (Pain Assessment, Incidence & Nature in Heart Failure), which is currently being conducted in a mainly elderly population, may help to clarify the differential characteristics of pain among these patients.[52] Regardless of the cause, pain should be assessed and treated. Analgesics are the first line (paracetamol and non-steroid antiinflammatories, although the latter can facilitate deterioration of renal function and HF decompensation). If there is no improvement, second-line analgesics should be used (codeine or dihydrocodeine) in combination with first-line drugs together with adjuvant therapy, if necessary. If pain persists morphine should be administered combined with first-line drugs, together with adjuvant therapy, if needed. In some situations palliative sedation may be needed to control dyspnea or pain. Although sedation in specific cases is administered before death, this should not be confused with euthanasia, since they differ in their aims (the relief of suffering versus causing the death of the patient), their indication (control of persistent symptoms vs intentionally causing the death of the patient), the procedure (use of the minimum possible dose in graduated steps versus the dose known to cause death) and the parameter of success (relief of suffering versus death).

Depression

Although it is normal for the patient to experience sadness and grief with regard to the disease progressing, clinical depression is pathological and should be treated. It is at times difficult to distinguish if the characteristic somatic symptoms of depression—such as anorexia, insomnia, anhedonia, or asthenia—are due to this disorder or to the disease itself. Depression leads to deterioration in the quality of life of the patient and can worsen their prognosis.[53] It should be managed with selective serotonin reuptake inhibitors, since tricyclic antidepressants have a strong anticholinergic effect and can give rise to hypotension and arrhythmias. In addition to pharmacological treatment, other effective measures exist for the prevention and treatment of depression. We emphasize the importance of social support and the need to offer suitable spiritual support to the patients who desire this, since its usefulness has been demonstrated in relation to reducing depression and anxiety.

Asthenia

Weakness among these patients may be due to HF itself, HF-associated cachexia or depression. It may respond to more intense medical treatment and to an increase in physical activity if the patient is able to do this. If asthenia and weight loss are due to concomitant depression, the patient should be treated with antidepressants.

Other Symptoms

The patients with HF may present many other symptoms: delirium, insomnia, nausea, vomiting, anorexia, weight loss, edema in the legs with ulcerations or cellulitis, constipation, diarrhea, anxiety, reduced mobility, or pruritus. All these make the last stages of life more unpleasant and should be relieved using the most effective means possible.

Specific invasive treatments have been used exclusively for palliative purposes in the last stages of the heart disease in the elderly person. Percutaneous revascularization through focal and partial revascularizations can help to control the symptoms of angina in situations of extensive severe coronary disease in inoperable patients, once strategies with recognized prognostic value have been exhausted and before the final stages of the terminal situation. Percutaneous treatment of valvular stenosis can be used to mitigate symptoms.

PROPORTIONATE USE OF DIAGNOSTIC AND THERAPEUTIC MEASURES IN TERMINAL CARDIOVASCULAR DISEASES. THE CONCEPT OF FUTILITY

We use the term "futility" to refer to the "medical act whose application to a patient is advised against because it is clinically ineffective, does not improve symptoms or intercurrent disease or because it foreseeably causes personal, familial, economic or social harm disproportionate to the expected benefit." The question is up to what point a diagnostic or therapeutic measure is "proportionate" or "disproportionate or futile" for a given patient, with a specific disease and at a given time.

The recommendations of the standard clinical practice guidelines offer little help when assessing if a given action should be carried out in a patient in whom it is doubtful whether any benefit can be gained by its implementation, but where this may be a remote possibility. It should be noted that the search for this remote possibility may be accompanied by a worsening in the patient's quality of life, the risk of precipitating their death, painful, or disagreeable maneuvers and a specific economic cost.

Due to the poor outcomes and shortage of donors, an age limit has been set for heart transplants. Currently, this limit has been increased, but older patients are generally offered organs donated by "suboptimal" patients on alternative donation lists. Even with these modifications, advanced age is a limiting factor when indicating transplantation in cases of terminal HF, and on very rare occasions leads to ethical or moral conflict. In the case of ICD, the guidelines recommend following the same approach in the elderly as in younger patients.[54] There are no specific recommendations regarding age in relation to surgical or percutaneous coronary revascularization in the elderly person and even fewer regarding terminal heart disease. At present, the availability and good immediate outcomes of percutaneous coronary intervention mean that this technique can be have palliative use in patients where there is marked clinical angina, even in the patient with very poor short-term prognosis. Although age continues to influence indication,[55,56] and that percutaneous intervention in the elderly person involves a high rate of complications,[57,58] there is currently no justification to discard cardiac catheterization due to the simple fact of the patient being in their eighties or even in their nineties. It should be taken into account that, according to the most recent risk indexes,[59] being 80 years of age has the same value when predicting complications in percutaneous or surgical intervention as severe ventricular dysfunction in a patient less than 70 years of age. Advanced age remains an indicator of complications in both surgical and percutaneous coronary revascularization.

Regarding coronary revascularization during cardiogenic shock, the current guidelines provide different recommendations in relation to the age of the patient, given the futility of invasive action shown in studies conducted in a subgroup of patients older than 75 years.[60] Even given this recommendation, decisions should be made on an individual basis before denying treatment that can be as effective in specific older patients as in younger ones.

Coronary revascularization may be associated with greater benefit in prognostic terms and in improvements in the quality of life of the elderly person than in the younger patient.[61,62] Although some studies have reported better outcomes using offpump surgical techniques in elderly patients,[63] other studies have found similar outcomes when onpump techniques are used.[64,65] Providing patients have been carefully selected, good long-term outcomes of surgical revascularization in the elderly patient are possible, although the mortality and complication rates are clearly higher than in younger patients.[66] In the postoperative period, prolonged average stay, worsening of renal function, hemorrhages, cognitive deficits, mediastinitis, and greater mortality are more common in the elderly patient than in younger ones[66] (Table 4).

Despite the feasibility of surgical revascularization in the elderly patient, in the most advanced cases of the disease, percutaneous coronary revascularization, due to its low aggressiveness and immediate effect, is more applicable in the more advanced stages of the disease when symptomatic relief is sought. Its use, even with traditional surgical indications such as left main coronary artery disease, can provide outcomes similar to those of surgery.[67] Drug-eluting stents have been safely and effectively employed in elderly patients.[68-70] Regarding their use in such patients, great care should be taken to assess the possible need for non-heart surgery in the first year after implantation, the concomitant need for oral anticoagulation treatment, or the presence of minor undefined bleeding, given the necessity for prolonged dual antiplatelet therapy and the risks of their early withdrawal.

An early invasive strategy in non-ST-segment elevation acute coronary syndrome in the elderly person is associated with greater benefits than conservative management. This strategy should not be discarded based on age criteria alone,[71] although its therapeutic aims are prognostic and non-symptomatic, and thus it is not applicable in situations where the terminal nature of the disease has been established as short term.

The terminal phases of valvular heart disease in the elderly person usually occur due to prosthetic

TABLE 4. **Hospital Complications in Coronary Surgery (%) by Age Group**

	Age, y		
	<80	80-84	>85
Mortality	2.8	6.7	12.4
Preoperative stroke	1.5	2.9	2.9
Reintervention due to bleeding	2.3	4.7	4.7
Mediastinitis/sternal dehiscence requiring surgery	1.2	1.1	2
Atrial fibrillation	23.9	41.6	39.4
Saphenectomy wound infection	0.7	1.3	1.8
Length of stay	8	10.9	11.5

Adapted from Likosky et al.[66]

dysfunction years after surgery or in situations where surgical intervention on a native valve has been discarded. In the case of mitral valve stenosis, percutaneous mitral valvuloplasty is an acceptable option as symptomatic treatment in inoperable patients, even in patients with a stenotic valve with a suboptimal echocardiographic score.[72] In the case of severe aortic stenosis in the elderly person, the percutaneous implantation of aortic valve prostheses, if the technique is successful, can modify the terminal nature of the disease in patients considered inoperable. Even though surgical mortality in aortic valve replacement is less than 3%, comorbidity in the elderly patient often contraindicates this intervention. For the time being it should also be taken into account that percutaneous implantation is not possible in some cases and can involve serious complications in the most unfavorable cases.[73]

The foregoing are simply examples of clinical situations where it has to be decided if the proposed treatment will contribute to the patient's well-being or will only prolong suffering by raising false hopes regarding improving survival. Deciding on which intervention to follow in very elderly patients with aortic stenosis or severe coronary disease is a situation where the trade-off between the risk involved in the measures to use and expected benefit has to be carefully analyzed. Finally, also in relation to medical treatment in the elderly person with terminal heart disease, the comprehensive geriatric assessment of the patient (in order to know their functional, mental, and social situation as accurately as possible) is the best instrument for correct decision-making. For example, in relation to offering or withdrawing anticoagulant therapy, in addition to any comorbidity contraindicating this, other factors have to be taken into account, such as the risk of the patient having falls or their capacity to comply with the therapy (due to cognitive deterioration, a lack of supervision or other factors such as the visual deficits).

CONCLUSIONS

Elderly people with terminal heart disease have the right to care and attention in the last stage of their life. This includes: preventing all needless suffering, respecting their freedom of conscience, understanding and thinking about their situation and the interventions they will undergo, maintaining a trusting dialogue among the physicians, family members, and friends, and receiving psychospiritual support. The elderly person with a certain degree of cognitive deficit is not totally excluded from simple decision-making, and so the attempt should always be made to solicit their opinion regarding their care and treatment. Deciding that an elderly patient is in the final phase of their heart disease requires correct evaluation of the characteristic prognostic factors of the heart disease and thorough geriatric assessment to check for comorbidity, the state of concomitant disease, frailty, and the patient's functional, physical, mental, and psychosocial situation. In this context, as in any other, age itself should never be a definitive criterion when making decisions. The palliative care stage, considered as treatment basically aimed at controlling symptoms, may last a long time in some patients and should not simply be regarded as the final phase. Such levels of care have barely been developed in heart disease and should be taken into account in the elderly with advanced HF. Their aim is to obtain the maximum quality of life for the patient based on a comprehensive approach. The organization of palliative care systems can improve the quality of life of patients before their death, and prevent the use of aggressive treatments that consume resources without having any effect on extending the patient's life, increasing patient satisfaction or that of the family.

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REFERENCES

1. Martínez-Sellés M, López-Palop R, Pérez-David E, Bueno H. Influence of age on gender differences in the management of acute inferior or posterior myocardial infarction. Chest. 2005;128:792-7.
2. Bowling A. Ageism in cardiology. BMJ. 1999;319:1353-5.
3. Martínez-Sellés M, García Robles JA, Prieto L, Domínguez Muñoa M, Frades E, Díaz-Castro O, et al. Systolic dysfunction is a predictor of long term mortality in men but not in women with heart failure. Eur Heart J. 2003;24:2046-53.
4. Ebrahim S. Do not resuscitate decisions: flogging dead horses or a dignified death? Resuscitation should not be withheld from elderly people without discussion. BMJ. 2000;320: 1155-6.
5. Frank C, Heyland DK, Chen B, Farquhar D, Myers K, Iwaasa K. Determining resuscitation preferences of elderly inpatients: a review of the literature. CMAJ. 2003;169:795-9.
6. Goodlin SJ, Zhong Z, Lynn J, Teno JM, Fago JP, Desbiens N, et al. Factors associated with use of cardiopulmonary resuscitation in seriously ill hospitalized adults. JAMA. 1999;282:2333-9.
7. Goldstein NE, Lampert R, Bradley E, Lynn J, Krumholz HM. Management of implantable cardioverter defibrillators in end-of-life care. Ann Intern Med. 2004;141:835-8.
8. Moss AJ, Zareba W, Hall WJ, Klein H, Wilber DJ, Cannom DS, et al. Prophylactic implantation of a defibrillator in patients with myocardial infarction and reduced ejection fraction. N Engl J Med. 2002;346:877-83.
9. Schaufelberger M, Swedberg K, Köster M, Rosén M, Rosengren A. Decreasing one-year mortality and hospitalization rates for heart failure in Sweden; Data from the Swedish Hospital Discharge Registry 1988 to 2000. Eur Heart J. 2004;25:300-7.
10. Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJ, Ponikowski P, Poole-Wilson PA, et al. Guías europeas de práctica clínica para el diagnóstico y tratamiento de la insuficiencia cardiaca aguda y crónica (2008). Grupo de Trabajo de la ESC para el diagnóstico y tratamiento de la insuficiencia cardiaca aguda y crónica (2008). Desarrollada en colaboración con la Heart Failure Association (HFA) de la ESC y aprobada por la European Society of Intensive Care Medicine (ESICM). Rev Esp Cardiol. 2008;61:1329.e1-e70.
11. Lunney JR, Lynn J, Hogan C. Profiles of older medicare decedents. J Am Geriatr Soc. 2002;50:1108-12.
12. Martínez-Sellés M, García Robles JA, Muñoz R, Serrano JA, Frades E, Domínguez Munoa M, et al. Pharmacological treatment in patients with heart failure: patients knowledge and occurrence of polypharmacy, alternative medicine and immunizations. Eur J Heart Fail. 2004;6:219-26.
13. Banegas JR, Rodríguez-Artalejo F. Insuficiencia cardiaca e instrumentos para medir la calidad de vida. Rev Esp Cardiol. 2008;61:233-5.
14. Fischer S, Gozansky WS, Sauaia A, Min SJ, Kutner JS, Kramer A. A practical tool to identify patients who may benefit from a palliative approach: the CARING Criteria. J Pain Symptom Manage. 2006;31:285-92.
15. Fox E, Landrum-McNiff K, Zhong Z, Dawson NV, Wu AW, Lynn J, the SUPPORT Investigators. Evaluation of prognostic criteria for determining Hospice Eligibility in patients with advanced lung, heart or liver disease. JAMA. 1999;282:1638-45.
16. Casarett DJ, Quill TE. "I'm not ready for hospice": strategies for timely and effective hospice discussions. Ann Intern Med. 2007;146:443-9.
17. Huynh BC, Rovner A, Rich MW. Identification of older patients with heart failure who may be candidates for hospice care: development of a simple four-item risk score. J Am Geriatr Soc. 2008;56:1111-5.
18. Hauptman PJ, Havranek EP. Integrating palliative care into heart failure care. Arch Intern Med. 2005;165:374-8.
19. Lee DS, Austin PC, Rouleau JL, Liu PP, Naimark D, Tu JV. Predicting mortality among patients hospitalized for heart failure: derivation and validation of a clinical model. JAMA. 2003;290:2581-7.
20. Brophy JM, Dagenais GR, McSherry F, Williford W, Yusuf S. A multivariate model for predicting mortality in patients with heart failure and systolic dysfunction. Am J Med. 2004;116: 300-4.
21. Levy WC, Mozaffarian D, Linker DT, Sutradhar SC, Anker SD, Cropp AB, et al. The Seattle Heart Failure Model. Prediction of Survival in Heart Failure. Circulation. 2006;113:1424-33.
22. Kosiborod M, Lichtman JH, Heidenreich PA, Normand SL, Wang Y, Brass LM, et al. National trends in outcomes among elderly patients with heart failure. Am J Med. 2006;119:616 e611-7.
23. Subramanian U, Eckert G, Yeung A, Tierney WM. A single health status question had important prognostic value among outpatients with chronic heart failure. J Clin Epidemiol. 2007;60:803-11.
24. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56:M146-56.
25. Martínez Martín ML, González Montalvo JI, Otero Puime A. Anciano frágil: hablamos todos de lo mismo. Rev Esp Geriatr Gerontol. 2007;42:357-60.
26. Lunney JR, Lynn J, Foley DJ, Lipson S, Guralnik JM. Patterns of functional decline at the end of life. JAMA. 2003;28: 2387-92.
27. Inouye S, Peduzzi PN, Robinson JT, Hughes JS, Howitz RI, Concato J. Importance of functional measures in predicting mortality among older hospitalised patients. JAMA. 1998;279: 1187-93.
28. Formiga F, Chivite D, Casas S, Manito N, Pujol R. Valoración funcional en pacientes ancianos ingresados por insuficiencia cardiaca. Rev Esp Cardiol. 2006;59:740-2.
29. Bardy GH, Lee KL, Mark DB, Poole JE, Packer DL, Boineau R, et al; Sudden Cardiac Death in Heart Failure Trial (SCD-HeFT) Investigators. Amiodarone or an implantable cardioverter-defibrillator for congestive heart failure. N Engl J Med. 2005;352:225-37.
30. Reddy VY, Reynolds MR, Neuzil P, Richardson AW, Taborsky M, Jongnarangsin K, et al. Prophylactic catheter ablation for the prevention of defibrillator therapy. N Engl J Med. 2007;357:2657-65.
31. Huang DT, Sesselberg HW, McNitt S, Noyes K, Andrews ML, Hall WJ, et al; for the MADIT-II Research Group. Improved survival associated with prophylactic implantable defibrillators in elderly patients with prior myocardial infarction and depressed ventricular function: a MADIT-II substudy. J Cardiovasc Electrophysiol. 2007;18:833-8.
32. Connolly SJ, Hallstrom AP, Cappato R, Schron EB, Kuck KH, Zipes DP, et al. Meta-analysis of the implantable cardioverter defibrillator secondary prevention trials. Eur Heart J. 2000;21:2071-8.
33. Reynolds MR, Cohen DJ, Kugelmass AD, Brown PP, Becker ER, Culler SD, et al. The frequency and incremental cost of major complications among Medicare beneficiaries receiving implantable cardioverter defibrillators. J Am Coll Cardiol. 2006;47:2493-7.
34. Koplan BA, Epstein LM, Albert CM, Stevenson WG. Survival in octogenarians receiving implantable defibrillators. Am Heart J. 2006;152:714-9.
35. Lee DS, Tu JV, Austin PC, Dorian P, Yee R, Chong A, et al. Effect of cardiac and noncardiac conditions on survival after defribrillator implantation. J Am Coll Cardiol. 2007;49: 2408-15.
36. Epstein AE, DiMarco JP, Ellenbogen KA, Estes NA, Freedman RA, Gettes LS, et al. ACC/AHA/HRS 2008 Guidelines for

Device-Based Therapy of Cardiac Rhythm Abnormalities: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the ACC/AHA/NASPE 2002 Guideline Update for Implantation of Cardiac Pacemakers and Antiarrhythmia Devices) developed in collaboration with the American Association for Thoracic Surgery and Society of Thoracic Surgeons. J Am Coll Cardiol. 2008;51:e1-62.
37. Steinhauser KE, Christakis NA, Clipp EC, McNeilly M, McIntyre L, Tulsky JA. Factors considered important at the end of life by patients, family, physicians, and other care providers. JAMA. 2000;284:2476-82.
38. Drought TS, Koenig BA. "Choice" in end-of-life decision making: researching fact or fiction? Gerontologist. 2002;42: 114-28.
39. Krumholz HM, Phillips RS, Hamel MB, Teno JM, Bellamy P, Broste SK, et al. Resuscitation preferences among patients with severe congestive heart failure: results from the SUPPORT project. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments. Circulation. 1998;98:648-55.
40. Chochinov HM. Dignity and the essence of medicine: the A, B, C, and D of dignity conserving care. BMJ. 2007;335:184-7.
41. WHO Definition of Palliative Care [citado 15 Ene 2008]. Disponible en: http://www.who.int/cancer/palliative/definition/en/
42. Hauptman PJ. Palliation in heart failure: when less and more are more. Am J Hosp Palliat Care. 2006;23:150-2.
43. Gibbs JS, McCoy AS, Gibbs LM, Rogers AE, Addington-Hall JM. Living with and dying from heart failure: the role of palliative care. Heart. 2002;88 Suppl 2:ii36-9.
44. Abernethy AP, Currow DC, Frith P, Fazekas BS, McHugh A, Bui C. Randomised, double blind, placebo controlled crossover trial of sustained release morphine for the management of refractory dyspnoea. BMJ. 2003;327:523-8.
45. Kissane DW, McKenzie M, Bloch S, Moskowitz C, McKenzie DP, O'Neill I. Family focused grief therapy: a randomized, controlled trial in palliative care and bereavement. Am J Psychiatry. 2006;163:1208-18.
46. Formiga F, Chivite D, Ortega C, Casas S, Ramon JM, Pujol R. End-of-life preferences in elderly patients admitted for heart failure. QJM. 2004;97:803-8.
47. Formiga F, Olmedo C, López SA, Pujol R. Dying in hospital of severe dementia: palliative decision-making analysis. Aging Clin Exp Res. 2004;16:420-1.
48. Roig E, Pérez-Villa F, Cuppoletti A, Castillo M, Hernández N, Morales M, et al. Programa de atención especializada en la insuficiencia cardíaca terminal. Experiencia piloto de una unidad de insuficiencia cardíaca. Rev Esp Cardiol. 2006;59:109-16.
49. Levenson JW, McCarthy EP, Lynn J, Davis RB, Phillips RS. The last six months of life for patients with congestive heart failure. J Am Geriatr Soc. 2000;48:S101-9.
50. Williams SG, Wright DJ, Marshall P, Reese A, Tzeng BH, Coats AJ, et al. Safety and potential benefits of low dose diamorphine during exercise in patients with chronic heart failure. Heart. 2003;89:1085-6.
51. Pantilat SZ, Steimle AE. Palliative care for patients with heart failure. JAMA. 2004;291:2476-82.
52. Goodlin SJ, Wingate S, Pressler SJ, Teerlink JR, Storey CP. Investigating pain in heart failure patients: rationale and design of the Pain Assessment, Incidence & Nature in Heart Failure (PAIN-HF) study. J Card Fail. 2008;14:276-82.
53. Pelle AJ, Gidron YY, Szabó BM, Denollet J. Psychological predictors of prognosis in chronic heart failure. J Card Fail. 2008;14:341-50.
54. Zipes DP, Camm AJ, Borggrefe M, Buxton AE, Chaitman B, Fromer M, et al. Guías de Práctica Clínica del ACC/AHA/ESC 2006 sobre el manejo de pacientes con arritmias ventriculares y la prevención de la muerte cardiaca súbita. Versión resumida. Rev Esp Cardiol. 2006;59:1328.e1-64.
55. Schoenenberger AW, Radovanovic D, Stauffer JC, Windecker S, Urban P, Eberli FR, et al. Age-Related differences in the use of guideline-recommended medical and interventional therapies for acute coronary syndromes: a cohort study. J Am Geriatr Soc. 2008;56:510-6.
56. Rosengren A, Wallentin L, Simoons M, Gitt Ak, Behar S, Battler A, et al. Age, clinical presentation, and outcome of acute coronary syndromes in the Euroheart Acute Coronary Syndrome Survey. Eur Heart J. 2006;27:789-95.
57. de Gregorio J, Kobayashi Y, Albiero R, Reimers B, Di MC, Finci L, et al. Coronary artery stenting in the elderly: short-term outcome and long-term angiographic and clinical follow-up. J Am Coll Cardiol. 1998;32:577-83.
58. Eckart RE, Shry EA, Simpson DE, Stajduhar KC. Percutaneous coronary intervention in the elderly: procedural success and 1-year outcomes. Am J Geriatr Cardiol. 2003;12:366-8.
59. Singh M, Gersh BJ, Li S, Rumsfeld JS, Spertus JA, O'Brien SM, et al. Mayo Clinic Risk Score for percutaneous coronary intervention predicts in-hospital mortality in patients undergoing coronary artery bypass graft surgery. Circulation. 2008;117:356-62.
60. Smith SC, Feldman TE, Hirshfeld JW, Jacobs AK, Kern MJ, King SB, et al. ACC/AHA/SCAI 2005 guideline update for percutaneous coronary intervention a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/SCAI Writing Committee to Update the 2001 Guidelines for Percutaneous Coronary Intervention). J Am Coll Cardiol. 2006;47:1-121.
61. Graham MM, Ghali WA, Faris PD, Galbraith PD, Norris CM, Knudtson ML. Survival after coronary revascularization in the elderly. Circulation. 2002;105:2378-84.
62. Graham MM, Norris CM, Galbraith PD, Knudtson ML, Ghali WA. Quality of life after coronary revascularization in the elderly. Eur Heart J. 2006;27:1690-8.
63. Panesar SS, Athanasiou T, Nair S, Rao C, Jones C, Nicolaou M, et al. Early outcomes in the elderly: a meta-analysis of 4921 patients undergoing coronary artery bypass grafting —comparison between off-pump and on-pump techniques. Heart. 2006;92:1808-16.
64. Jensen BO, Hughes P, Rasmussen LS, Pedersen PU, Steinbruchel DA. Health-related quality of life following off-pump versus on-pump coronary artery bypass grafting in elderly moderate to high-risk patients: a randomized trial. Eur J Cardiothorac Surg. 2006;30:294-9.
65. Jensen BO, Hughes P, Rasmussen LS, Pedersen PU, Steinbruchel DA. Cognitive outcomes in elderly high-risk patients after off-pump versus conventional coronary artery bypass grafting: a randomized trial. Circulation. 2006;113:2790-5.
66. Likosky DS, Dacey LJ, Baribeau YR, Leavitt BJ, Clough R, Cochran RP, et al. Long-term survival of the very elderly undergoing coronary artery bypass grafting. Ann Thorac Surg. 2008;85:1233-7.
67. Palmerini T, Barlocco F, Santarelli A, Bacchi-Reggiani L, Savini C, Baldini E, et al. A comparison between coronary artery bypass grafting surgery and drug eluting stent for the treatment of unprotected left main coronary artery disease in elderly patients (aged > or =75 years). Eur Heart J. 2007;28:2714-9.
68. Groeneveld PW, Matta MA, Greenhut AP, Yang F. Drug-eluting compared with bare-metal coronary stents among elderly patients. J Am Coll Cardiol. 2008;51:2017-24.
69. Vlaar PJ, Lennon RJ, Rihal CS, Singh M, Ting HH, Bresnahan JF, et al. Drug-eluting stents in octogenarians: early and intermediate outcome. Am Heart J. 2008;155:680-6.
70. Vijayakumar M, Lemos PA, Hoye A, Ong AT, Aoki J, Granillo GR, et al. Effectiveness of sirolimus-eluting stent implantation for the treatment of coronary artery disease in octogenarians. Am J Cardiol. 2004;94:909-13.

71. Alexander KP, Newby LK, Cannon CP, Armstrong PW, Gibler WB, Rich MW, et al. Acute coronary care in the elderly, part I: Non-ST-segment-elevation acute coronary syndromes: a scientific statement for healthcare professionals from the American Heart Association Council on Clinical Cardiology: in collaboration with the Society of Geriatric Cardiology. Circulation. 2007;115:2549-69.
72. Bonow RO, Carabello BA, Kanu C, De LA Jr, Faxon DP, Freed MD, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease): developed in collaboration with the Society of Cardiovascular Anesthesiologists: endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. Circulation. 2006;114:e84-231.
73. Descoutures F, Himbert D, Lepage L, Iung B, Detaint D, Tchetche D, et al. Contemporary surgical or percutaneous management of severe aortic stenosis in the elderly. Eur Heart J. 2008;29:1410-7.