Guidelines

2023 SFMU/GICC-SFC/SFGG expert recommendations for the emergency management of older patients with acute heart failure. Part 1: Prehospital management and diagnosis

Nicolas Peschanski [a,*], Florian Zores [b], Jacques Boddaert [c], Bénedicte Douay [d], Clément Delmas [e], Amaury Broussier [f], Delphine Douillet [g], Emmanuelle Berthelot [h], Thomas Gilbert [i], Cédric Gil-Jardiné [j], Vincent Auffret [k], Laure Joly [l], Jérémy Guénézan [m], Michel Galinier [e], Marion Pépin [n,o], Pierrick Le Borgne [ag], Philippe Le Conte [p], Nicolas Girerd [q], Frédéric Roca [r], Mathieu Oberlin [s], Patrick Jourdain [h], Geoffroy Rousseau [t], Nicolas Lamblin [u], Barbara Villoing [v], Frédéric Mouquet [w], Xavier Dubucs [x], François Roubille [y], Maxime Jonchier [z], Rémi Sabatier [aa], Saïd Laribi [ab], Muriel Salvat [ac], Tahar Chouihed [ad], Jean-Baptiste Bouillon-Minois [ae], Anthony Chauvin [af], for the Société française de médecine d'urgence (SFMU) Groupe insuffisance cardiaque et cardiomyopathies de la Société française de cardiologie (GICC-SFC) , Société française de gériatrie et gérontologie (SFGG)[1],

[a] Emergency Department, University of Rennes, CHU de Rennes, 35000 Rennes, France
[b] GMS Premium, 67000 Strasbourg, France
[c] Department of Geriatrics, Hôpital Pitié-Salpêtrière, Sorbonne University, AP–HP, 75013 Paris, France
[d] Emergency Department, Hôpital Beaujon, AP–HP, 92110 Clichy, France
[e] Inserm I2MC, UMR 1048, Cardiology A Department, Université UPS, CHU de Toulouse, 31000 Toulouse, France
[f] Inserm, Department of Geriatrics, Hôpitaux Henri-Mondor/Émile Roux, AP–HP, University Paris-Est Créteil, IMRB, 94456 Limeil-Brevannes, France
[g] UMR MitoVasc CNRS 6015, Inserm 1083, FCRIN, INNOVTE, Emergency Department, University of Angers, CHU d'Angers, 49000 Angers, France
[h] Cardiology Department, Hôpital Bicêtre, Université Paris-Saclay, AP–HP, 94270 Le Kremlin-Bicêtre, France
[i] RESHAPE, Inserm U1290, Department of Geriatric Medicine, Hospices Civils de Lyon, Université Claude-Bernard Lyon 1, 69000 Lyon, France
[j] Inserm, Centre Inserm U1219-EBEP, ISPED, Emergency Department, Pellegrin Hospital, University Hospital of Bordeaux, 33000 Bordeaux, France
[k] Cardiology Department, CHU de Rennes, 35000 Rennes, France
[l] Inserm, Geriatric Department, DCAC, CHRU de Nancy, Université de Lorraine, 54000 Vandœuvre-Lès-Nancy, France
[m] Emergency Department and Pre-Hospital Care, University Hospital of Poitiers, 86000 Poitiers, France
[n] Department of Geriatrics, Ambroise-Paré Hospital, GHU, AP–HP, 92100 Boulogne-Billancourt, France
[o] Inserm, Clinical Epidemiology Department, University of Paris-Saclay, UVSQ, 94800 Villejuif, France
[p] Emergency Department, CHU de Nantes, 44093 Nantes, France
[q] Cardiology Department, CHRU de Nancy, 54000 Vandœuvre-lès-Nancy, France
[r] Inserm U1096, UNIROUEN, Department of Geriatric Medicine, Rouen University Hospital, Normandy University, 76000 Rouen, France
[s] Emergency Department, Groupe Hospitalier Sélestat-Obernai, 67600 Sélestat, France
[t] Emergency Medicine Department, CHRU de Tours, 37000 Tours, France
[u] Cardiology Department, Hôpital Cardiologique, Centre de Compétence de l'Hypertension Artérielle Pulmonaire Sévère, Université Lille Nord de France, CHRU de Lille, 59000 Lille, France
[v] Emergency Department, Hôpital Cochin-Hôtel-Dieu, AP–HP, 75014 Paris, France
[w] Department of Cardiology, Hôpital privé Le Bois, 59000 Lille, France
[x] Emergency Department, CHU de Toulouse, 31000 Toulouse, France
[y] Inserm, CNRS, PhyMedExp, Department of Cardiology, Montpellier University Hospital, Université de Montpellier, 34295 Montpellier, France
[z] Emergency Department, Groupe Hospitalier Littoral Atlantique, 17019 La Rochelle, France
[aa] Cardiovascular Department, University of Caen-Normandie, CHU de Caen-Normandie, 14000 Caen, France
[ab] Urgences SAMU37 SMUR de Tours, Centre Hospitalier Régional et Universitaire Tours, 37000 Tours, France
[ac] Department of Cardiology, University Hospital, Grenoble-Alpes, 38000 Grenoble, France
[ad] Inserm, UMR-S 1116, Emergency Department, University Hospital of Nancy, 54000 Vandœuvre-lès-Nancy, France
[ae] CNRS, LaPSCo, Physiological and Psychosocial Stress, Emergency Medicine Department, Université Clermont-Auvergne, CHU de Clermont-Ferrand, 63000 Clermont-Ferrand, France
[af] Emergency Department, Hôpital Lariboisière, AP–HP, 75010 Paris, France
[ag] Service d'accueil des Urgences, Hôpital de Hautepierre, CHU de Strasbourg, 67000 Strasbourg, France

* Corresponding author. Service des urgences adultes-SAMU35-SMUR, CHU de Rennes, 2, rue Henri-Le-Guilloux, 35033 Rennes, France.
  Adresses e-mail : n-peschanski@live.fr, nicolas.peschanski@chu-rennes.fr (N. Peschanski).
  [1] See Text A.1.

N. Peschanski, F. Zores, J. Boddaert et al.

I N F O   A R T I C L E

1. Abbreviations

ACS	acute coronary syndromes
AHF	acute heart failure
BNP	B-type natriuretic peptide
ED	emergency department
ECG	electrocardiogram
ESC	European Society of Cardiology
GICC-SFC	Groupe insuffisance cardiaque et cardiomyopathies de la Société française de cardiologie
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HF	heart failure
HFpEF	heart failure with preserved ejection fraction
HFrEF	heart failure with reduced ejection fraction
LVEF	left ventricular ejection fraction
NEWS	National Early Warning Score
NOVICA-3	De novo Insuficiencia Cardiaca Aguda 3
NT-proBNP	N-terminal pro-B-type natriuretic peptide
OPTIMIZE-HF	Organized Program To Initiate Lifesaving Treatment In Hospitalized Patients With Heart Failure
PE	pulmonary embolism
PICO	population, intervention, comparison, outcomes
PPV	positive predictive value
PROTECT	study Placebo-Controlled Randomized Study of the Selective A1 Adenosine Receptor Antagonist Rolofylline for Patients Hospitalized With Acute Decompensated Heart Failure and Volume Overload to Assess Treatment Effect on Congestion and Renal Function
SFGG	Société française de gériatrie et gérontologie
SFMU	Société française de médecine d'urgence
TTE	transthoracic echocardiography

2. Background

Acute heart failure (AHF) is a complex, multifactorial syndromic condition that, until now, did not have a consensual definition [1,2]. The difficulties in agreeing on a consensual definition of AHF also apply to research, since depending on the application of the field of investigation, the target populations concerned and the therapeutic goals or pathophysiological knowledge sought, the elements defining heart failure (HF) vary, especially among older patients. Thus, although the advent of echocardiography has made it possible to characterize disturbances in myocardial relaxation and altered ventricular filling, marking the birth of the concept of HF with preserved ejection fraction (HFpEF) versus HF with reduced ejection fraction (HFrEF), the different clinical presentations do not always make it possible to determine whether myocardial failure corresponds to a disease of ventricular filling of vascular origin [3].

AHF is most often characterized by dyspnoea, lower limb oedema and/or intense asthenia. It is a common presentation in emergency departments (EDs) and has become a major public health problem as its incidence and prevalence rise in line with an aging population in all developed countries. AHF represents a growing medico-economic burden and is associated with high morbidity and mortality [4]. Currently, AHF is the main reason for hospital admissions in patients aged > 65 years and acute cardiogenic pulmonary oedema accounts for approximately 1% of ED visits [3,4], involving approximately 200,000 patients per year in France (including 5% of the French population aged 75–85 years and 10% of those aged > 85 years) [5]. HF is a progressive pathology linked to aging, with mortality rising by 10% each year [6]. Indeed, the mortality rate remains appalling, reaching up to 12% during the hospital stay, 8–20% in the 2 months following hospitalization for an episode of AHF, and reaching 25–50% in the first 5 years after initial diagnosis. Moreover, mortality is increased in the presence of associated comorbidities such as anaemia, hypercholesterolemia or renal dysfunction, all of which become more frequent with age [3,4,6,7].

3. Methods

A group of 29 experts from the Société française de médecine d'urgence (SFMU; French Society of Emergency Medicine), the Groupe insuffisance cardiaque et cardiomyopathies de la Société française de cardiologie (GICC-SFC; Group of Heart Failure and Cardiomyopathy of the French Society of Cardiology) and the Société française de gériatrie et gérontologie (SFGG; French Society of Geriatrics and Gerontology) was convened. The main objective of the expert panel was to provide recommendations on the emergency management of AHF in older patients (aged > 75 years). The authors used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method to assess the level of evidence in the literature with grading from "No recommendation" to "Expert opinion" to "Moderate recommendation (G1)", and "Strong recommendation (G2)" and with level of evidence scaling from "Low (−)" to "High (+)" [8]. The potential drawbacks of making strong recommendations in the presence of only low-level evidence were highlighted and some recommendations with insufficient evidence were not graded. Five areas were discussed: prehospital management, diagnosis of AHF, therapeutics, pathway of care and ethics, of which the first two are included herein. For each area, the expert panel formulated questions according to the population, intervention, comparison, outcomes (PICO) model [9] and an extensive literature search was performed. The analysis of the literature and the formulation of recommendations were conducted according to the GRADE method [8].

4. Prehospital management of AHF in older patients

4.1. Question 1

In the prehospital emergency setting, is there any prognostic or diagnostic score that can help to manage older patients with AHF?

4.1.1. Rationale

Dyspnoea is a frequent reason for emergency calls, and AHF is one of the main causes requiring prehospital emergency care. Whatever the prehospital emergency care system, emergency

medical services with paramedics or on-board emergency physicians, numerous studies and guidelines have suggested that accurate, early diagnosis can improve patient prognosis [1,2,10]. Indeed, survival is increased in patients who receive early treatment (odds ratio [OR] 2.51, 95% confidence interval [CI] 1.37–4.55; $P < 0.01$) [11], but mortality is raised in patients with inappropriate treatment, and could double in older adults [12–14].

Aetiological scores are recommended by the European Society of Cardiology (ESC) [1,2]. The GASP4Ar score incorporates age and requires N-terminal prohormone-B-type natriuretic peptide (NT-proBNP) measurement, which limits its use in prehospital settings [15]. The National Early Warning Score (NEWS), a clinical score based on vital parameters only, has not been evaluated in diagnostic terms [16]. The Brest score, based on 11 simple and readily available variables, aims to determine the diagnostic probability of AHF causing dyspnoea, but has yet to be validated in an independent cohort, and has never been validated in the prehospital setting [17].

4.1.2. Experts' answer

There is insufficient evidence to recommend the use of diagnostic or prognostic scores in the prehospital setting for older patients with suspected AHF.

4.1.3. Experts' recommendation

None.

4.2. Question 2

Can telemedicine be used to reduce the need to transport older patients with AHF to hospital?

4.2.1. Rationale

Telemedicine encompasses several entities: teleconsultation, tele-expertise, remote medical monitoring and tele-counselling. The use of telemedicine platforms has risen considerably with the development of outpatient care for patients with HF. The literature on telemedicine in HF is very heterogeneous and focuses mainly on patients' cardiology follow-up who do not require emergency care. Compared with the usual care pathway involving several care providers (nurses, general practitioners, cardiologists, etc.), the telemedicine-based pathway of care includes the monitoring of acute decompensation and emergency care of patients with HF. According to a meta-analysis by Lin et al. [18], telemonitoring may be associated with a reduction in-hospital admission rates and mortality. In a meta-analysis by Zhu et al. [19], telemonitoring was associated with a reduction in the total number of all-cause hospitalizations (OR 0.82, 95% CI 0.73–0.91; $P = 0.0004$) and cardiac hospitalizations (OR 0.83, 95% CI 0.72–0.95; $P = 0.007$). Remote monitoring resulted in a statistically significant reduction in the risk of all-cause mortality (OR 0.75, 95% CI 0.62–0.90; $P = 0.003$) [19]. However, the odds of HF-related mortality did not differ significantly from that of conventional healthcare (OR 0.84, 95% CI 0.61–1.16, $P = 0.28$). Furthermore, although it seems that telemedicine can make a positive contribution to the early identification of acute decompensation in patients with HF in these meta-analysis [18,19], there are still few studies specific to the elderly. In 2020, a randomized controlled trial assesses the effect of a telemonitoring programme versus standard care in preventing all-cause death or unplanned hospitalization at 18 months and found no difference between the two groups (rate ratio 0.97, 95% CI 0.77–1.23; $P = 0.80$) [20].

4.2.2. Experts' answer

The experts suggest using a telemedicine device to detect and assess emergency situations in older patients with AHF.

4.2.3. Experts' opinion

Strong agreement.

5. Diagnosis of AHF in older patients

5.1. Question 1

In older patients with AHF, should we systematically look for triggering factors?

5.1.1. Rationale

Triggering factors for AHF are found in 45–75% of cases [21–25]. In a cohort of over 15,000 patients suffering from AHF, precipitating factors were identified in 8784 patients (55%) [21]. A single trigger was identified in 7764 patients (49%), while in 1020 patients (6%), a combination of two or more triggers was identified [21]. In the OPTIMIZE-HF (Organized Program To Initiate Lifesaving Treatment In Hospitalized Patients With Heart Failure) study, which included almost 50,000 patients, the three most frequently identified triggers were pulmonary infections (15%), myocardial ischaemia (15%) and arrhythmia (14%) [22]. The authors emphasized the need to determine a precipitating factor during hospitalization [22] as in the NOVICA-3 (De novo Insuficiencia Cardiaca Aguda 3) cohort study, Miró et al. [23] showed that detection of AHF triggers is feasible on admission to the ED.

Infections, particularly pulmonary infections, are the most frequent cause of AHF. Early and correct detection of infection in AHF is difficult, as the typical symptoms of dyspnoea and fatigue can be explained by both aetiologies. In AHF, biomarkers with an infectious spectrum (including C-reactive protein and procalcitonin) do not appear to improve diagnostic sensitivity [26,27].

Myocardial ischaemia can be a trigger for AHF, just as acute coronary syndromes (ACS) can be complicated by AHF, the combination of the two being associated with a poor prognosis [8]. The diagnosis of ACS as the cause of AHF is difficult to distinguish from myocardial damage resulting from AHF [28]. In the event of suspected ACS with a non-qualifying electrocardiogram (ECG), a troponin assay should be performed (see Question 5).

Atrial fibrillation and AHF can exacerbate each other. When atrial fibrillation is the cause of AHF, the outcome appears to be more favourable than in the presence of other contributing factors such as ACS or infection [2,21,29].

Pulmonary embolism (PE) can be a trigger for AHF but, to date, no study has reliably determined the prevalence of PE in patients with AHF. In 2005, Darze et al. [30] conducted a prospective study to assess the prevalence of PE using a systematic diagnostic approach. Of the 198 patients with HF recruited in this study, 18 (9%) were diagnosed with PE. Given the incidence of PE in patients with AHF, it is suggested that PE should be investigated according to clinical probability.

Anaemia is present in approximately 30% of patients with HF [31,32]. Although not strictly speaking a triggering factor, the presence of anaemia worsens the morbidity and mortality of patients with HF. The presence of anaemia should therefore be systematically sought in the ED [1,2,32]. Associated deficiencies should be investigated during hospitalization [1,2].

In the OPTIMIZE-HF study, worsening renal function was associated with higher mortality [22]. Based on daily creatinine measurements, the PROTECT study (Placebo-Controlled Randomized Study of the Selective A1 Adenosine Receptor Antagonist Rolofylline for Patients Hospitalized With Acute Decompensated Heart Failure and Volume Overload to Assess Treatment Effect

N. Peschanski, F. Zores, J. Boddaert et al.

on Congestion and Renal Function) also found that a creatinine increase of 26.4 µmol/L (0.3 mg/dL) between two measurements was associated with a poorer prognosis [33]. This notion is even truer is patients aged ≥ 80 years, where a rise in creatinine is strongly associated with prognosis, even in the absence of residual congestive signs [34].

Older patients, particularly women, are more likely to present with HFpEF, with elevated vascular resistance and consequent acute cardiogenic pulmonary oedema in the context of severely elevated blood pressure [35]. Moreover, high blood pressure is associated with a greater probability of HFpEF [36]. Regular monitoring of blood pressure in the ED is therefore essential [10].

ESC recommendations suggest that thyroid function (i.e. thyroid-stimulating hormone level) should be assessed in all HF patients [1,2]. However, this test should not be performed in the ED. In fact, thyroid function testing is part of the initial systematic hospital work-up for HF [2,37].

Non-adherence to pharmacological treatment or a low-salt diet is reported to be a cause of hospitalization in 5–20% of cases [38–41]. A systematic search for such non-adherence enables educational information to be adapted during hospitalization.

5.1.2. Experts' answer 1

Triggering factors such as the presence of an infectious focus, hypertension, ACS, arrhythmia, anaemia, renal failure or non-adherence to treatment should probably be systematically investigated.

5.1.3. Grade
G2+.

5.1.4. Experts' answer 2
The experts suggest that PE should not be systematically investigated.

5.1.5. Experts' opinion
Strong agreement.

5.1.6. Experts' answer 3
The experts suggest that dysthyroidism should not be systematically sought in the ED. This search should be carried out as part of the HF patient's healthcare journey.

5.1.7. Experts' opinion
Strong agreement.

5.2. Question 2

In older patients with AHF, does repeating the ECG or cardiac monitoring improve the diagnosis of the triggering factor?

5.2.1. Rationale
ECG on admission is a key element in the management of older patients with AHF. It helps exclude the diagnosis of ST-segment elevation myocardial infarction or arrhythmias potentially responsible for this condition [28,42]. AHF is a risk factor for the development of atrial and ventricular arrhythmias, and some treatments have significant pro-arrhythmogenic properties. Furthermore, in the older patient population, there is an increased risk of abnormal ECG on admission regardless of its origin [43]. In 2007, a retrospective study that analysed 9315 ECGs from patients with AHF aged 71 ± 13 years found that < 2% had a normal ECG [43]. In a post-hoc analysis, Benza et al. [44] analysed the occurrence of arrhythmias in 949 patients (median age 65 years) hospitalized for AHF. Six percent of patients presented with a cardiac rhythm disorder, of which 49% were atrial fibrillation or atrial flutter, 32%

sustained ventricular tachycardia and 19% ventricular fibrillation [44]. Unfortunately, there are no good-quality studies comparing the value of systematic ECG monitoring versus no monitoring after an initial non-pathological ECG in older patients. Recently, a prospective study by Sweda et al. [45] analysed the ECGs of 1915 patients presenting to the ED with a chief complaint of acute dyspnoea. They found that the median (interquartile range) angle between the QRS axis and the T-wave axis (QRS-T angle) was significantly higher in patients with AHF than in patients with acute dyspnoea of extra-cardiac origin (110° [46–156°] vs. 33° [15–57°]; $P < 0.001$) [45]. However, the area under the curve in the population of patients aged > 75 years was only 0.71 (95% CI 0.67–0.74) [45].

5.2.2. Experts' answer 1
The experts suggest systematically performing an ECG on admission to the ED and repeating it in the event of an intercurrent event.

5.2.3. Experts' opinion
Strong agreement.

5.2.4. Experts' answer 2
The experts suggest performing a second ECG if the patient is hospitalized, on admission into the medical ward and/or before the patient returns home from the ED.

5.2.5. Experts' opinion
Strong agreement.

5.2.6. Experts' answer 3
The experts suggest that older patients with established AHF should not be systematically monitored by electrocardioscope in the ED.

5.2.7. Experts' opinion
Strong agreement.

5.3. Question 3

In the dyspnoeic emergency patient, does natriuretic peptide (B-type natriuretic peptide [BNP] or NT-proBNP) measurement improve the diagnosis of AHF?

5.3.1. Rationale
The diagnosis of AHF in older patients is challenging, particularly due to their heterogeneous symptoms, comorbidities and polypathological nature. In this context, the use of biomarkers to confirm or refute the diagnosis is tempting. In a French study in 26 EDs, Chouihed et al. [6] found that biomarkers were used in > 90% of patients with suspected AHF. Threshold values for BNP (< 100 ng/L) and NT-proBNP (< 400 ng/L) in young and middle-aged patients are often used to exclude HF. However, in older patients, there are many confounding factors that raise the baseline level, including age, but also comorbidities (hypertension, cardiac pathologies, renal or chronic respiratory failure) and triggering factors such as ACS or atrial fibrillation [2,8,21,28,29,46]. While the ability to exclude a diagnosis of AHF for patients with BNP or NT-proBNP values below the defined thresholds seems to be preserved in studies [46–51], the probability that values in older patients are below these thresholds seems low [47]. More generally, the threshold values used in this population have not been established. As long ago as 2004, Maisel et al. [48] reported an age-related difference in BNP levels in a study of 1586 patients without being able to define a precise threshold beyond the age of 70 years. As there was a risk of not recognizing HF, the authors recommended that the threshold should not be modified. Zaphiriou et al. [49] studied

306 patients (mean age 74 years), 104 of whom were diagnosed with HF. They found negative predictive values between 0.87 and 0.97 for BNP and NT-proBNP at the defined thresholds, but positive predictive values (PPVs) of 0.44 and 0.59 respectively [49]. In 2005, Ray et al. [50] reported a moderate discriminatory capacity of BNP at the usual threshold of 100 ng/L for the diagnosis of HF in patients aged > 65 years (PPV = 0.65). At higher thresholds, sensitivity ranged from 0.63 to 0.81 [50]. A study by Plichart et al. [51] focused on patients aged > 80 years who were hospitalized for dyspnoea or desaturation. All patients underwent a BNP assay and a cardiologist who was blinded to the results established a diagnosis according to the recommendations of the ESC. In this study of 383 patients (including 238 with HF), the BNP assay was not discriminatory for the aetiological diagnosis [51]. Furthermore, due to the particularity of its pharmacological action, patients with HF who are taking an angiotensin-receptor neprilysin inhibitor will have an elevated BNP level irrespective of treatment efficacy, and any biological monitoring will need to be carried out using NT-proBNP [1,2].

5.3.2. Experts' answer

In the absence of a validated threshold in this population, BNP and NT-proBNP assays should probably not be used routinely to diagnose AHF in dyspnoeic older emergency patients.

5.3.3. Grade

G2−.

5.4. Question 4

In the dyspnoeic emergency patient, does natriuretic peptide (BNP or NT-proBNP) measurement improve the prognosis of AHF?

5.4.1. Rationale

Results on the use of natriuretic peptide level as a prognostic marker in the ED are not unequivocal. A study of 11,679 patients found a modest predictive effect (HR 1.07, 95% CI 1.05–1.08) of a 30% increase in natriuretic peptide level in older patients (≥ 65 years) who presented to the ED with AHF without atrial fibrillation [52]. The discrepancies surrounding the prognostic properties of this assay are possibly heightened by the variability in the choice of event measured (re-hospitalization, death, time to onset), the timing of the assay (in the ED or in the hospital ward) and – above all – the threshold used, which differs from one study to another and increases with age [53–56]. It should be noted that natriuretic peptide has been included in prognostic models in several studies, with interesting results [57,58]. In contrast to its measurement on admission, its prognostic value at discharge and during follow-up is well established [2].

5.4.2. Experts' answer

Natriuretic peptide measured in the ED should probably not be used as a prognostic factor in older patients consulting for AHF.

5.4.3. Grade

G2−.

5.5. Question 5

Do troponin assays (high-sensitivity cardiac troponin T and high-sensitivity cardiac troponin I) improve diagnosis in older patients with AHF?

5.5.1. Rationale

Numerous studies have shown that elevated troponin levels are associated with increased morbidity and mortality, whether

from cardiovascular or other causes. A meta-analysis by Aimo et al. [59] that included 10 studies with a total of 9289 patients aged 66 ± 12 years with HF and elevated troponin levels found increases in all-cause mortality (hazard ratio [HR] 1.48, 95% CI 1.41–1.45), cardiovascular mortality (HR 1.40, 95% CI 1.33–1.48) and cardiovascular hospitalizations (HR 1.42, 95% CI 1.36–1.49) over a mean follow-up of 2.4 years. Troponin measurement in older patients presenting to the ED with AHF also has a goal in the aetiological diagnosis. Indeed, the clinical presentation of an ACS is more likely to be atypical in older patients, with dyspnoea as the main symptom [60]. In this context, the experts reiterate that troponin assays cannot be interpreted independently of ECG analysis, but many factors are likely to raise baseline troponin levels [2,59]. Thus, in a 2012 prospective cohort study, Santhanakrishnan et al. [61] showed, in a small cohort of 51 patients, that those with HFpEF or HFrEF had higher high-sensitivity troponin T levels than the general population (23.7 or 35.6 pg/mL vs. 3.7 pg/mL, respectively) [61]. Furthermore, in a 2013 cohort study of 1514 patients with AHF and renal failure, Pfortmueller et al. [62] found that 382 patients (25%) with moderate to severe renal failure had significantly higher high-sensitivity troponin T levels than patients without impaired renal function (0.028 vs. 0.009 mg/L, P < 0.0001). Regarding the confounding factors that may elevate troponin according to the 2020 ESC recommendations [2], age and renal function are considered the most important, with variations of up to 300%. More recently, in a post-hoc study involving a cohort of 46,435 patients who underwent troponin testing in the ED, Lowry et al. [63] found that the specificity and PPV of troponin testing fell sharply with age. Inpatients aged ≥ 75 years, specificity and PPV were 82.6% (95% CI 81.9–83.4%) and 51.6% (95% CI 49.8–53.2%), respectively, much lower than among those aged 50–74 years: 95.5% (95% CI 95.2–95.8%) and 70.1% (95% CI 68.5–71.8%), respectively [63]. These results suggest that two consecutive measurements should be performed to detect real myocardial damage, rather than age-related variability. Overall, troponin measurement in older patients with AHF in the ED appears to be recommended solely for the purpose of aetiological diagnosis, and always in correlation with clinical and ECG analysis [2]. If there is a strong suspicion of ischaemia, and specific management is possible or envisaged, this assay should be repeated once to take account of inter-individual variability and a baseline level that is probably different in this population.

5.5.2. Experts' answer

Older patients with AHF should probably have a troponin assay performed in the ED. This assay is intended for aetiological diagnosis but should always be correlated with clinical findings and ECG analysis and may be repeated only once.

5.5.3. Grade

G2+.

5.6. Question 6

In an older dyspnoeic patient presenting to the ED, does a point-of-care thoracic ultrasound improve the diagnosis of AHF?

5.6.1. Rationale

Numerous studies and three meta-analyses have demonstrated that the presence of a bilateral B-line profile on lung ultrasound, which is more or less associated with impaired left ventricular systolic function, performs very well in the diagnosis of AHF (sensitivity 73–94%, specificity 83–94%), particularly in the congestive state [64–68]. The role of point-of-care thoracic ultrasound could be even more important in an older population, in whom the clinical presentation is sometimes atypical and the biology (NT-proBNP) less specific [69].

The experts highlight three key points:

- the bilateral B-line profile makes the diagnosis of bilateral interstitial lung disease without determining the aetiology (particularly AHF versus bilateral pneumopathy). The clinician must therefore interpret it in the light of the complete clinical picture, and prospective studies are still needed to identify the exact diagnostic thresholds in this population;
- the finding of impaired systolic function on point-of-care thoracic ultrasound, in addition to the bilateral B-line profile, reinforces the probability of AHF. However, the finding of normal left ventricular systolic function does not invalidate this diagnosis, as a significant proportion of AHF patients, particularly older patients, have HFpEF;
- the only way to diagnose AHF without considering left ventricular ejection fraction (LVEF) is to approach left ventricular filling pressures by assessment of the E/e' ratio. Indeed, a simple protocol combining lung ultrasound with measurement of the E/e' ratio offers excellent performance [70]. However, it can only be used by clinicians who have been trained in this practice.

5.6.2. Experts' answer

Clinical point-of-care thoracic ultrasound (pulmonary and cardiac) is probably required to diagnose AHF in older patients with dyspnoea in the ED.

5.6.3. Grade
G2+.

5.7. Question 7

In an older patient presenting to the ED with AHF, does transthoracic echocardiography (TTE) by a cardiologist modify therapeutic management?

5.7.1. Rationale

AHF can occur in the setting of HFpEF or HFrEF. TTE is an important diagnostic tool in the management of patients with AHF. The ESC recommends this examination as Class I and level of evidence C [1,2]. It should be performed on all patients presenting with AHF, on admission and during hospitalization. TTE can be used to assess LVEF and right ventricular function, the size of the heart chambers, the presence of diastolic dysfunction and/or to detect the presence of underlying heart disease such as dilated cardiomyopathy or valvular damage [70–72]. The prognostic value of ultrasound parameters varies between studies, but LVEF, the severity of tricuspid leakage and right ventricular dysfunction are the most important prognostic elements for the occurrence of events at 1 month at the start of hospitalization [73–76]. No parameter other than LVEF appears to be predictive of in-hospital outcome [73]. Although TTE can be used to monitor response to treatment, no study has been carried out to determine the value and timing of repeated TTE, except in the event of a major change in the clinical picture. After in-hospital admission, full cardiac TTE should be performed during hospitalization, when the patient is able to maintain decubitus [71].

5.7.2. Experts' answer

The experts suggest performing a TTE during hospitalization as soon as the patient is able to maintain a decubitus position.

5.7.3. Experts' opinion
Strong agreement.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.acvd.2024.08.002.

Références

[1] Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJS, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J 2016;37:2129–200, http://dx.doi.org/10.1093/eurheartj/ehw128.

[2] McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Bohm M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J 2021;42:3599–726, http://dx.doi.org/10.1093/eurheartj/ehab368.

[3] Gheorghiade M, Pang PS. Acute heart failure syndromes. J Am Coll Cardiol 2009;53:557–73, http://dx.doi.org/10.1016/j.jacc.2008.10.041.

[4] Roger VL. Epidemiology of heart failure. Circ Res 2013;113:646–59, http://dx.doi.org/10.1161/CIRCRESAHA.113.300268.

[5] Logeart D, Isnard R, Resche-Rigon M, Seronde MF, de Groote P, Jondeau G, et al. Current aspects of the spectrum of acute heart failure syndromes in a real-life setting: the OFICA study. Eur J Heart Fail 2013;15:465–76, http://dx.doi.org/10.1093/eurjhf/hfs189.

[6] Chouihed T, Manzo-Silberman S, Peschanski N, Charpentier S, Elbaz M, Savary D, et al. Management of suspected acute heart failure dyspnea in the emergency department: results from the French prospective multicenter DeFSSICA survey. Scand J Trauma Resusc Emerg Med 2016;24:112, http://dx.doi.org/10.1186/s13049-016-0300-x.

[7] Bui AL, Horwich TB, Fonarow GC. Epidemiology and risk profile of heart failure. Nat Rev Cardiol 2011;8:30–41, http://dx.doi.org/10.1038/nrcardio.2010.165.

[8] Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 2008;336:924–6, http://dx.doi.org/10.1136/bmj.39489.470347.AD.

[9] Schardt C, Adams MB, Owens T, Keitz S, Fontelo P. Utilization of the PICO framework to improve searching PubMed for clinical questions. BMC Med Inform Decis Mak 2007;7:16, http://dx.doi.org/10.1186/1472-6947-7-16.

[10] Mebazaa A, Gheorghiade M, Pina IL, Harjola VP, Hollenberg SM, Follath F, et al. Practical recommendations for prehospital and early in-hospital management of patients presenting with acute heart failure syndromes. Crit Care Med 2008;36:S129–39, http://dx.doi.org/10.1097/01.CCM.0000296274.51933.4C.

[11] Wuerz RC, Meador SA. Effects of prehospital medications on mortality and length of stay in congestive heart failure. Ann Emerg Med 1992;21:669–74, http://dx.doi.org/10.1016/s0196-0644(05)82777-5.

[12] Peacock WF, Emerman C, Costanzo MR, Diercks DB, Lopatin M, Fonarow GC. Early vasoactive drugs improve heart failure outcomes. Congest Heart Fail 2009;15:256–64, http://dx.doi.org/10.1111/j.1751-7133.2009.00112.x.

[13] Wang CS, FitzGerald JM, Schulzer M, Mak E, Ayas NT. Does this dyspneic patient in the emergency department have congestive heart failure? JAMA 2005;294:1944–56, http://dx.doi.org/10.1001/jama.294.15.1944.

[14] Ray P, Birolleau S, Lefort Y, Becquemin MH, Beigelman C, Isnard R, et al. Acute respiratory failure in the elderly: etiology, emergency diagnosis and prognosis. Crit Care 2006;10:R82, http://dx.doi.org/10.1186/cc4926.

[15] Steinhart BD, Levy P, Vandenberghe H, Moe G, Yan AT, Cohen A, et al. A randomized control trial using a validated prediction model for diagnosing acute heart failure in undifferentiated dyspneic emergency department patients-results of the GASP4Ar study. J Card Fail 2017;23:145–52, http://dx.doi.org/10.1016/j.cardfail.2016.08.007.

[16] Bilben B, Grandal L, Sovik S. National Early Warning Score (NEWS) as an emergency department predictor of disease severity and 90-day survival in the acutely dyspneic patient – a prospective observational study. Scand J Trauma Resusc Emerg Med 2016;24:80, http://dx.doi.org/10.1186/s13049-016-0273-9.

[17] Basset A, Nowak E, Castellant P, Gut-Gobert C, Le Gal G, L'Her E. Development of a clinical prediction score for congestive heart failure diagnosis in the emergency care setting: the Brest score. Am J Emerg Med 2016;34:2277–83, http://dx.doi.org/10.1016/j.ajem.2016.08.023.

[18] Lin MH, Yuan WL, Huang TC, Zhang HF, Mai JT, Wang JF. Clinical effectiveness of telemedicine for chronic heart failure: a systematic review and meta-analysis. J Investig Med 2017;65:899–911, http://dx.doi.org/10.1136/jim-2016-000199.

[19] Zhu Y, Gu X, Xu C. Effectiveness of telemedicine systems for adults with heart failure: a meta-analysis of randomized controlled trials. Heart Fail Rev 2020;25:231–43, http://dx.doi.org/10.1007/s10741-019-09801-5.

[20] Galinier M, Roubille F, Berdague P, Brierre G, Cantie P, Dary P, et al. Telemonitoring versus standard care in heart failure: a randomised multicentre trial. Eur J Heart Fail 2020;22:985–94, http://dx.doi.org/10.1002/ejhf.1906.

[21] Arrigo M, Gayat E, Parenica J, Ishihara S, Zhang J, Choi DJ, et al. Precipitating factors and 90-day outcome of acute heart failure: a report from the intercontinental GREAT registry. Eur J Heart Fail 2017;19:201–8, http://dx.doi.org/10.1002/ejhf.682.

[22] Fonarow GC, Abraham WT, Albert NM, Stough WG, Gheorghiade M, Greenberg BH, et al. Factors identified as precipitating hospital admissions for heart failure and clinical outcomes: findings from OPTIMIZE-HF. Arch Intern Med 2008;168:847–54, http://dx.doi.org/10.1001/archinte.168.8.847.

[23] Miró O, Garcia Sarasola A, Fuenzalida C, Calderon S, Jacob J, Aguirre A, et al. Departments involved during the first episode of acute heart failure and subsequent emergency department revisits and rehospitalisations: an outlook through the NOVICA cohort. Eur J Heart Fail 2019;21:1231–44, http://dx.doi.org/10.1002/ejhf.1567.

[24] Freund Y, Cachanado M, Delannoy Q, Laribi S, Yordanov Y, Gorlicki J, et al. Effect of an emergency department care bundle on 30-day hospital discharge and survival among elderly patients with acute heart failure: the ELISABETH randomized clinical trial. JAMA 2020;324:1948–56, http://dx.doi.org/10.1001/jama.2020.19378.

[25] Llorens P, Javaloyes P, Martin-Sanchez FJ, Jacob J, Herrero-Puente P, Gil V, et al. Time trends in characteristics, clinical course, and outcomes of 13,791 patients with acute heart failure. Clin Res Cardiol 2018;107:897–913, http://dx.doi.org/10.1007/s00392-018-1261-z.

[26] Pereira J, Ribeiro A, Ferreira-Coimbra J, Barroso I, Guimaraes JT, Bettencourt P, et al. Is there a C-reactive protein value beyond which one should consider infection as the cause of acute heart failure? BMC Cardiovasc Disord 2018;18:40, http://dx.doi.org/10.1186/s12872-018-0778-4.

[27] Möckel M, de Boer RA, Slagman AC, von Haehling S, Schou M, Vollert JO, et al. Improve Management of acute heart failure with ProcAlCiTonin in EUrope: results of the randomized clinical trial IMPACT EU Biomarkers in Cardiology (BIC) 18. Eur J Heart Fail 2020;22:267–75, http://dx.doi.org/10.1002/ejhf.1667.

[28] Harjola VP, Parissis J, Bauersachs J, Brunner-La Rocca HP, Bueno H, Celutkiene J, et al. Acute coronary syndromes and acute heart failure: a diagnostic dilemma and high-risk combination. A statement from the Acute Heart Failure Committee of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail 2020;22:1298–314, http://dx.doi.org/10.1002/ejhf.1831.

[29] Park JJ, Lee HY, Kim KH, Yoo BS, Kang SM, Baek SH, et al. Heart failure and atrial fibrillation: tachycardia-mediated acute decompensation. ESC Heart Fail 2021;8:2816–25, http://dx.doi.org/10.1002/ehf2.13354.

[30] Darze ES, Latado AL, Guimaraes AG, Guedes RA, Santos AB, de Moura SS, et al. Acute pulmonary embolism is an independent predictor of adverse events in severe decompensated heart failure patients. Chest 2007;131:1838–43, http://dx.doi.org/10.1378/chest.06-2077.

[31] Anand IS, Gupta P. Anemia and iron deficiency in heart failure: current concepts and emerging therapies. Circulation 2018;138:80–98, http://dx.doi.org/10.1161/CIRCULATIONAHA.118.030099.

[32] Ezekowitz JA, McAlister FA, Armstrong PW. Anemia is common in heart failure and is associated with poor outcomes: insights from a cohort of 12,065 patients with new-onset heart failure. Circulation 2003;107:223–5, http://dx.doi.org/10.1161/01.cir.0000052622.51963.fc.

[33] Metra M, Cotter G, Senger S, Edwards C, Cleland JG, Ponikowski P, et al. Prognostic significance of creatinine increases during an acute heart failure admission in patients with and without residual congestion: a post hoc analysis of the PROTECT data. Circ Heart Fail 2018;11:e004644, http://dx.doi.org/10.1161/CIRCHEARTFAILURE.117.004644.

[34] Odajima S, Fujimoto W, Kuroda K, Yamashita S, Imanishi J, Iwasaki M, et al. Association of congestion with worsening renal function in acute decompensated heart failure according to age. ESC Heart Fail 2022;9:4250–61, http://dx.doi.org/10.1002/ehf2.14157.

[35] Collins SP, Levy PD, Martindale JL, Dunlap ME, Storrow AB, Pang PS, et al. Clinical and research considerations for patients with hypertensive acute heart failure: a consensus statement from the Society of Academic Emergency Medicine and the Heart Failure Society of America Acute Heart Failure Working Group. J Card Fail 2016;22:618–27, http://dx.doi.org/10.1016/j.cardfail.2016.04.015.

[36] Kozhuharov N, Goudev A, Flores D, Maeder MT, Walter J, Shrestha S, et al. Effect of a strategy of comprehensive vasodilation vs. usual care on mortality and heart failure rehospitalization among patients with acute heart failure: the GALACTIC randomized clinical trial. JAMA 2019;322:2292–302, http://dx.doi.org/10.1001/jama.2019.18598.

[37] Baumgartner C, da Costa BR, Collet TH, Feller M, Floriani C, Bauer DC, et al. Thyroid function within the normal range, subclinical hypothyroidism, and the risk of atrial fibrillation. Circulation 2017;136:2100–16, http://dx.doi.org/10.1161/CIRCULATIONAHA.117.028753.

[38] Tromp J, Beusekamp JC, Ouwerkerk W, van der Meer P, Cleland JGF, Angermann CE, et al. Regional differences in precipitating factors of hospitalization for acute heart failure: insights from the REPORT-HF registry. Eur J Heart Fail 2022;24:645–52, http://dx.doi.org/10.1002/ejhf.2431.

[39] Kapoor JR, Kapoor R, Ju C, Heidenreich PA, Eapen ZJ, Hernandez AF, et al. Precipitating clinical factors, heart failure characterization, and outcomes in patients hospitalized with heart failure with reduced, borderline, and preserved ejection fraction. JACC Heart Fail 2016;4:464–72, http://dx.doi.org/10.1016/j.jchf.2016.02.017.

[40] Filippatos G, Angermann CE, Cleland JGF, Lam CSP, Dahlstrom U, Dickstein K, et al. Global differences in characteristics, precipitants, and initial management of patients presenting with acute heart failure. JAMA Cardiol 2020;5:401–10, http://dx.doi.org/10.1001/jamacardio.2019.5108.

[41] Kobayashi M, Voors AA, Girerd N, Billotte M, Anker SD, Cleland JG, et al. Heart failure etiologies and clinical factors precipitating for worsening heart failure: findings from BIOSTAT-CHF. Eur J Intern Med 2020;71:62–9, http://dx.doi.org/10.1016/j.ejim.2019.10.017.

[42] Steg PG, Dabbous OH, Feldman LJ, Cohen-Solal A, Aumont MC, Lopez-Sendon J, et al. Determinants and prognostic impact of heart failure complicating acute coronary syndromes: observations from the Global Registry of Acute Coronary Events (GRACE). Circulation 2004;109:494–9, http://dx.doi.org/10.1161/01.CIR.0000109691.16944.DA.

[43] Khan NK, Goode KM, Cleland JG, Rigby AS, Freemantle N, Eastaugh J, et al. Prevalence of ECG abnormalities in an international survey of patients with suspected or confirmed heart failure at death or discharge. Eur J Heart Fail 2007;9:491–501, http://dx.doi.org/10.1016/j.ejheart.2006.11.003.

[44] Benza RL, Tallaj JA, Felker GM, Zabel KM, Kao W, Bourge RC, et al. The impact of arrhythmias in acute heart failure. J Card Fail 2004;10:279–84, http://dx.doi.org/10.1016/j.cardfail.2003.12.007.

[45] Sweda R, Sabti Z, Strebel I, Kozhuharov N, Wussler D, Shrestha S, et al. Diagnostic and prognostic values of the QRS-T angle in patients with suspected acute decompensated heart failure. ESC Heart Fail 2020;7:1817–29, http://dx.doi.org/10.1002/ehf2.12746.

[46] Iacoviello M, Antoncecchi V. Heart failure in elderly: progress in clinical evaluation and therapeutic approach. J Geriatr Cardiol 2013;10:165–77, http://dx.doi.org/10.3969/j.issn.1671-5411.2013.02.010.

[47] Manzano L, Escobar C, Cleland JG, Flather M. Diagnosis of elderly patients with heart failure. Eur J Heart Fail 2012;14:1097–103, http://dx.doi.org/10.1093/eurjhf/hfs109.

[48] Maisel AS, Clopton P, Krishnaswamy P, Nowak RM, McCord J, Hollander JE, et al. Impact of age, race, and sex on the ability of B-type natriuretic peptide to aid in the emergency diagnosis of heart failure: results from the Breathing Not Properly (BNP) multinational study. Am Heart J 2004;147:1078–84, http://dx.doi.org/10.1016/j.ahj.2004.01.013.

[49] Zaphiriou A, Robb S, Murray-Thomas T, Mendez G, Fox K, McDonagh T, et al. The diagnostic accuracy of plasma BNP and NTproBNP in patients referred from primary care with suspected heart failure: results of the UK natriuretic peptide study. Eur J Heart Fail 2005;7:537–41, http://dx.doi.org/10.1016/j.ejheart.2005.01.022.

[50] Ray P, Arthaud M, Birolleau S, Isnard R, Lefort Y, Boddaert J, et al. Comparison of brain natriuretic peptide and probrain natriuretic peptide in the diagnosis of cardiogenic pulmonary edema in patients aged 65 and older. J Am Geriatr Soc 2005;53(4):643–8, http://dx.doi.org/10.1111/j.1532-5415.2005.53213.x.

[51] Plichart M, Orvoen G, Jourdain P, Quinquis L, Coste J, Escande M, et al. Brain natriuretic peptide usefulness in very elderly dyspnoeic patients: the BED study. Eur J Heart Fail 2017;19:540–8, http://dx.doi.org/10.1002/ejhf.699.

[52] Kociol RD, Greiner MA, Hammill BG, Eapen ZJ, Fonarow GC, Klaskala W, et al. B-type natriuretic peptide level and postdischarge thrombotic events in older patients hospitalized with heart failure: insights from the Acute Decompensated Heart Failure National Registry. Am Heart J 2012;163:994–1001, http://dx.doi.org/10.1016/j.ahj.2012.03.009.

[53] Sato T, Yamauchi H, Kanno Y, Suzuki S, Yoshihisa A, Yamaki T, et al. Comparisons of prognostic factors between young and elderly patients with chronic heart failure. Geriatr Gerontol Int 2015;15:435–42, http://dx.doi.org/10.1111/ggi.12293.

[54] Jensen J, Ma LP, Bjurman C, Hammarsten O, Fu ML. Prognostic values of NTpro BNP/BNP ratio in comparison with NTpro BNP or BNP alone in elderly patients with chronic heart failure in a 2-year follow up. Int J Cardiol 2012;155:1–5, http://dx.doi.org/10.1016/j.ijcard.2011.01.083.

[55] Passantino A, Guida P, Lagioia R, Ammirati E, Oliva F, Frigerio M, et al. Predictors of long-term mortality in older patients hospitalized for acutely decompensated heart failure: clinical relevance of natriuretic peptides. J Am Geriatr Soc 2017;65:822–6, http://dx.doi.org/10.1111/jgs.14561.

[56] Kociol RD, Horton JR, Fonarow GC, Reyes EM, Shaw LK, O'Connor CM, et al. Admission, discharge, or change in B-type natriuretic peptide and long-term outcomes: data from Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF) linked to Medicare claims. Circ Heart Fail 2011;4:628–36, http://dx.doi.org/10.1161/CIRCHEARTFAILURE.111.962290.

[57] Yang M, Tao L, An H, Liu G, Tu Q, Zhang H, et al. A novel nomogram to predict all-cause readmission or death risk in Chinese elderly patients with heart failure. ESC Heart Fail 2020;7:1015–24, http://dx.doi.org/10.1002/ehf2.12703.

[58] Jia Q, Wang YR, He P, Huang XL, Yan W, Mu Y, et al. Prediction model of in-hospital mortality in elderly patients with acute heart failure based on retrospective study. J Geriatr Cardiol 2017;14:669–78, http://dx.doi.org/10.11909/j.issn.1671-5411.2017.11.002.

[59] Aimo A, Januzzi Jr JL, Vergaro G, Ripoli A, Latini R, Masson S, et al. Prognostic value of high-sensitivity troponin T in chronic heart failure: an individual patient data meta-analysis. Circulation 2018;137:286–97, http://dx.doi.org/10.1161/CIRCULATIONAHA.117.031560.

[60] Collet JP, Thiele H, Barbato E, Barthelemy O, Bauersachs J, Bhatt DL, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Eur Heart J 2021;42:1289–367, http://dx.doi.org/10.1093/eurheartj/ehaa575.

[61] Santhanakrishnan R, Chong JP, Ng TP, Ling LH, Sim D, Leong KT, et al. Growth differentiation factor 15, ST2, high-sensitivity troponin T, and N-terminal pro brain natriuretic peptide in heart failure with preserved vs. reduced ejection fraction. Eur J Heart Fail 2012;14:1338–47, http://dx.doi.org/10.1093/eurjhf/hfs130.

[62] Pfortmueller CA, Funk GC, Marti G, Leichtle AB, Fiedler GM, Schwarz C, et al. Diagnostic performance of high-sensitive troponin T in patients with renal insufficiency. Am J Cardiol 2013;112:1968–72, http://dx.doi.org/10.1016/j.amjcard.2013.08.028.

[63] Lowry MTH, Doudesis D, Wereski R, Kimenai DM, Tuck C, Ferry AV, et al. Influence of age on the diagnosis of myocardial infarction. Circulation 2022;146:1135–48, http://dx.doi.org/10.1161/CIRCULATIONAHA.122.059994.

[64] Russell FM, Ehrman RR, Cosby K, Ansari A, Tseeng S, Christain E, et al. Diagnosing acute heart failure in patients with undifferentiated dyspnea: a lung and cardiac ultrasound (LuCUS) protocol. Acad Emerg Med 2015;22:182–91, http://dx.doi.org/10.1111/acem.12570.

[65] Martindale JL, Wakai A, Collins SP, Levy PD, Diercks D, Hiestand BC, et al. Diagnosing acute heart failure in the emergency department: a systematic review and meta-analysis. Acad Emerg Med 2016;23:223–42, http://dx.doi.org/10.1111/acem.12878.

[66] Staub LJ, Mazzali Biscaro RR, Kaszubowski E, Maurici R. Lung ultrasound for the emergency diagnosis of pneumonia, acute heart failure, and exacerbations of chronic obstructive pulmonary disease/asthma in adults: a systematic review and meta-analysis. J Emerg Med 2019;56:53–69, http://dx.doi.org/10.1016/j.jemermed.2018.09.009.

[67] Pivetta E, Goffi A, Nazerian P, Castagno D, Tozzetti C, Tizzani P, et al. Lung ultrasound integrated with clinical assessment for the diagnosis of acute decompensated heart failure in the emergency department: a randomized controlled trial. Eur J Heart Fail 2019;21:754–66, http://dx.doi.org/10.1002/ejhf.1379.

[68] Pellicori P, Platz E, Dauw J, Ter Maaten JM, Martens P, Pivetta E, et al. Ultrasound imaging of congestion in heart failure: examinations beyond the heart. Eur J Heart Fail 2021;23:703–12, http://dx.doi.org/10.1002/ejhf.2032.

[69] Rutten FH, Hoes AW. B-type natriuretic peptide assays for detecting heart failure in the elderly: same value as those in the younger? Int J Cardiol 2008;125:161–5, http://dx.doi.org/10.1016/j.ijcard.2007.10.006.

[70] Öhman J, Harjola VP, Karjalainen P, Lassus J. Rapid cardiothoracic ultrasound protocol for diagnosis of acute heart failure in the emergency department. Eur J Emerg Med 2019;26:112–7, http://dx.doi.org/10.1097/MEJ.0000000000000499.

[71] Čelutkienė J, Lainscak M, Anderson L, Gayat E, Grapsa J, Harjola VP, et al. Imaging in patients with suspected acute heart failure: timeline approach position statement on behalf of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail 2020;22:181–95, http://dx.doi.org/10.1002/ejhf.1678.

[72] Lancellotti P, Galderisi M, Edvardsen T, Donal E, Goliasch G, Cardim N, et al. Echo-Doppler estimation of left ventricular filling pressure: results of the multicentre EACVI Euro-Filling study. Eur Heart J Cardiovasc Imaging 2017;18:961–8, http://dx.doi.org/10.1093/ehjci/jex067.

[73] Galderisi M, Cosyns B, Edvardsen T, Cardim N, Delgado V, Di Salvo G, et al. Standardization of adult transthoracic echocardiography reporting in agreement with recent chamber quantification, diastolic function, and heart valve disease recommendations: an expert consensus document of the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging 2017;18:1301–10, http://dx.doi.org/10.1093/ehjci/jex244.

[74] Adamopoulos C, Zannad F, Fay R, Mebazaa A, Cohen-Solal A, Guize L, et al. Ejection fraction and blood pressure are important and interactive predictors of 4-week mortality in severe acute heart failure. Eur J Heart Fail 2007;9:935–41, http://dx.doi.org/10.1016/j.ejheart.2007.06.001.

[75] Vanhercke D, Pardaens S, Weytjens C, Vande Kerckhove B, De Laet N, Janssens E, et al. Prevalence, determinants, and prognostic significance of pulmonary hypertension in elderly patients admitted with acute decompensated heart failure: a report from the BIO-HF registry. Echocardiography 2015;32:1333–8, http://dx.doi.org/10.1111/echo.12857.

[76] Palazzuoli A, Ruocco G, Evangelista I, De Vivo O, Nuti R, Ghio S. Prognostic significance of an early echocardiographic evaluation of right ventricular dimension and function in acute heart failure. J Card Fail 2020;26:813–20, http://dx.doi.org/10.1016/j.cardfail.2020.01.002.