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Editor's Choice-The role of the emergency department in the management of acute heart failure: An international perspective on education and research

Peter S Pang[1], Sean P Collins[2], Òscar Miró[3], Hector Bueno[4], Deborah B Diercks[5], Salvatore Di Somma[6], Alasdair Gray[7], Veli-Pekka Harjola[8], Judd E Hollander[9], Ekaterini Lambrinou[10], Phillip D Levy[11], AnnMarie Papa[12] and Martin Möckel[13]

Abstract

Emergency departments are a major entry point for the initial management of acute heart failure (AHF) patients throughout the world. The initial diagnosis, management and disposition – the decision to admit or discharge – of AHF patients in the emergency department has significant downstream implications. Misdiagnosis, under or overtreatment, or inappropriate admission may place patients at increased risk for adverse events, and add costs to the healthcare system. Despite the critical importance of initial management, data are sparse regarding the impact of early AHF treatment delivered in the emergency department compared to inpatient or chronic heart failure management. Unfortunately, outcomes remain poor, with nearly a third of patients dying or re-hospitalised within 3 months post-discharge. In the absence of robust research evidence, consensus is an important source of guidance for AHF care. Thus, we convened an international group of practising emergency physicians, cardiologists and advanced practice nurses with the following goals to improve outcomes for AHF patients who present to the emergency department or other acute care setting through: (a) a better understanding of the pathophysiology, presentation and management of the initial phase of AHF care; (b) improving initial management by addressing knowledge gaps between best practices and current practice through education and research; and (c) to establish a framework for future emergency department-based international education and research.

Keywords

Emergency department, acute heart failure, patient management, education, outcome

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[1]Department of Emergency Medicine, Indiana University School of Medicine and the Regenstrief Institute, USA
[2]Department of Emergency Medicine, Vanderbilt University and The Veterans Health Administration, USA
[3]Emergency Department, Hospital Clínic, Spain
[4]Department of Cardiology, Hospital General Universitario Gregorio Marañón, Spain
[5]Department of Emergency Medicine, University of Texas Southwestern, USA
[6]Department of Medical-Surgery Sciences and Translational Research, University Sapienza Rome, Italy
[7]Emergency Medicine Research Group, Royal Infirmary of Edinburgh, UK
[8]Department of Emergency Care, Helsinki University and Helsinki University Hospital, Finland
[9]Sidney Kimmel Medical College and the National Academic Center for Telehealth, Thomas Jefferson University, USA
[10]Department of Nursing, Cyprus University of Technology, Cyprus
[11]Department of Emergency Medicine and Cardiovascular Research Institute, Wayne State University School of Medicine, USA
[12]Einstein Medical Center Montgomery, USA
[13]Department of Cardiology, Charité-Universitätsmedizin Berlin, Germany

Corresponding author:
Martin Möckel, Department of Cardiology, Division of Emergency Medicine, Charité-Universitätsmedizin Berlin, Campus Virchow-Klinikum und Charité Mitte, Berlin, Germany.
Email: martin.moeckel@charite.de

Introduction

Emergency departments (EDs) are a major entry point for the initial management of acute heart failure (AHF) patients throughout the world. Once in the ED, few AHF patients are discharged within 4–6 hours of initial evaluation,[1–5] marking an inflection point in a heart failure patient's trajectory. Once hospitalised, mortality rates are significantly higher compared to non-hospitalised patients.[6,7]

The initial diagnosis, management and disposition – the decision to admit or discharge – of AHF patients in the ED has significant downstream implications. Misdiagnosis, under or overtreatment, or inappropriate admission may place patients at increased risk for adverse events, and add costs to the healthcare system. Despite the critical importance of initial management, data are sparse regarding the impact of early AHF treatment delivered in the ED compared to inpatient or chronic heart failure management.

The current state of AHF treatment is best summarised by guidelines; at the present time, no therapies for AHF receive a level of evidence A or 'best evidence' recommendation. Furthermore, most guidelines focus on inpatient management. The lack of evidence has led to a wide range of opinions, some with more supportive data than others, from a diuretic-sparing approach emphasising intravenous angiotensin-converting enzyme inhibitors or nitrates for vasodilation to a seemingly contradictory high-dose diuretic strategy. Although both approaches may be correct for specific AHF patients, practising clinicians would benefit from a description of an evidence-based comprehensive approach combined with expert consensus to ED AHF care.

Outcomes from AHF are dismal.[1,8,9] While some improvements have been made, these achievements have come through improved quality of care and adherence to existing chronic heart failure evidence, not through novel therapies.[10] Nearly a third of patients hospitalised with AHF will be dead or re-hospitalised within 3 months after discharge.[11,12] Within 1 year, 25–50% of patients will have died.[13] The poor outcomes for AHF patients stands in marked contrast to the progress made in other cardiovascular fields.[14,15] There continues to be over a million hospitalisations with a primary diagnosis of AHF in the USA, with comparable numbers in Europe.[9,16] Heart failure is the most expensive reason for admission and re-admission in the USA for older patients.[17] As the population continues to age and patients live longer with other cardiovascular diseases, this burden will continue to rise.[18]

In the absence of robust research evidence, consensus is an important source of guidance for AHF care.[19] Thus, we convened an international group of practising emergency physicians, cardiologists and advanced practice nurses in December of 2013 and 2014. Our goal is to improve outcomes for AHF patients who present to the ED or other acute care setting through: (a) a better understanding of the pathophysiology, presentation and management of the initial phase of AHF care; (b) improving initial management by addressing knowledge gaps between best practices and current practice through education and research; and (c) to establish a framework for future ED-based international education and research.

AHF in the ED setting

Patients presenting to the ED with AHF primarily complain of dyspnoea, with multiple other signs and symptoms of heart failure.[20,21] However, not all dyspnoea is AHF. Nearly 7.4% of all non-traumatic ED admissions present with dyspnoea, which are associated with a mortality rate of 9.4%. For those non-traumatic dyspnoeic patients admitted to the hospital, only 16.1% had the discharge diagnosis 'heart failure', highlighting the diversity of ED patients and the diagnostic challenges.[22] Registries provide the broadest perspective of patients with AHF who present to the ED.

Although a large comorbid burden, including coronary artery disease, hypertension, diabetes and atrial fibrillation, is commonplace, there is tremendous heterogeneity regarding baseline characteristics of AHF patients, as shown by several registries (Table 1).[13,23–25] While most patients have typical signs and symptoms of AHF, a sizeable proportion do not have rales, peripheral oedema, or jugular venous distention. Overall, it is difficult to create a prototypical AHF patient constructed from various registries, studies and administrative data. Despite the breadth and power of registry data, they also include patients directly admitted or transferred from outside hospitals, and with much of the data collected after the initial work-up. This may be less applicable to the emergent setting. Moreover, registries usually do not include patients who have another major diagnosis such as pneumonia, sepsis or acute myocardial infarction and therefore are not primarily classified as 'heart failure' patients. In contrast to the wide variation in clinical profiles, treatment is remarkably uniform; most patients receive intravenous diuretics, oxygen and little else (Figure 1), highlighting the relatively weak therapeutic armamentarium in this field. The lack of a clear definition that accommodates the wide variety of patient profiles and presentations hinders both treatment and research. While there are common features, focusing on typical patient characteristics ignores a substantial subset of patients.

The major limitation of hospital registries is the absence of data on AHF patients discharged directly. Thus, the characteristics of patients who are discharged from the ED are less well known, especially subsequent outcomes. Although a significant portion of patients may be safe for discharge from the ED,[26,27] administrative database studies suggest that EDs may not discriminate well who is safe for discharge.[3]

Table 1. Acute heart failure registries.

Study	ADHERE[1]	ADHERE-EM[2]	OPTIMIZE-HF[3]	ATTEND[4]	AHEAD[5]	RO-AHFS[6]	EHFS II[7]	ESC HF pilot[8]	ALARM-HF[9]	IN-HF[10]	Italian S[11]	OFICA[12]	Canadian Cohort Study[13]*	RICA[14]	EAHFE[15]
Epidemiology															
Country	USA	USA	USA	Japan	Czech Republic	Romania	Europe	Europe	Europe, Turkey, Australia, Mexico	Italy	Italy	France	Canada	Spain	Spain
Number of participating centres	274	83	259	32	7	13	133	136	668	61	206	170	86	52	29
Year of the study (months of inclusion)	2001–4 (36)	2004–5 (21)	2003–4 (22)	2007–9 (27)	2006–9 (38)	2008–9 (12)	2004–5 (10)	2009–10 (8)	2006–7 (6)	2007–9 (23)	2004 (3)	2009 (1 día)	2004–7 (36)	2008–9 (10)	2007–11 (4)
Type of study	R	R	R	P	R	P	P	P	R	P	P	P	R	P	P
Setting	Hosp.	HED	Hosp.	Hosp.	Hosp./Card.	Hosp./Card.	Hosp.	Hosp./Card.	Hosp.	Hosp. /Card.	Hosp./Card.	Hosp./Card.	HED	Hosp./IM	HED
Number of patients included	105388	10984	48612	2867	4153	3224	3580	1892	4953	1855	2807	1648	12591	1172	5845
Age, years, mean (SD)	72 (14)	73 (14)	73 (14)	73 (14)	71 (12)	69 (22)	71 (NA)	70 (13)	66–70	70 (13)	73 (11)	76 (13)	75 (11)	7 (8)	79 (10)
Women (%)	52	52.2	52	41	42.4	44	39	37	62.4	40	39.5	46	48.5	54.9	56.5
Form of presentation															
Cardiogenic shock (%)	NA	NA	NA	NA	14.5	5	4	2	11.7	2	7.7	6	NA	NA	0.7
Acute pulmonary oedema (%)	NA	NA	NA	NA	18.4	29	16	NA	36.7	27	49.6	38	NA	NA	11
Right CI (%)	NA	NA	NA	NA	3.8	4	3	NA	4.5	9	NA	6	NA	NA	2.6
Acute coronary syndrome (%)	NA	NA	NA	NA	36.2	11.3	30	NA	36.9	13	33	13	NA	NA	2.8
Infection triggering factor (%)	NA	NA	15	NA	NA	NA	17.6	NA	16.3	NA	NA	27	NA	NA	32.1
Physical and laboratory findings															
Mean SBP (mmHg)	144	NA	143	147	135	143	135	133	130 (debut) 130 (crónica)	134	141	130	146	NA	142
Mean HR (bpm)	NA	89	87	99	90	98	95	88	107 (crónica) 110 (debut)	93	97	89	89	NA	90
Mean creatinine (mg/dl)	1.8	1.8	1.8	1.4	1.2	1.3	NA	NA	NA	1.5	1.7	1.5	0.76	NA	1.3

(Continued)

Table 1. (Continued)

Study	ADHERE[1]	ADHERE-EM[2]	OPTIMIZE-HF[3]	ATTEND[4]	AHEAD[5]	RO-AHFS[6]	EHFS II[7]	ESC HF pilot[8]	ALARM-HF[9]	IN-HF[10]	Italian S[11]	OFICA[12]	Canadian Cohort Study[13]*	RICA[14]	EAHFE[15]
Anaemia (%)	NA	NA	NA	NA	35.1‡	NA	14.7¶	31.4§	14.4¶	38.7§	46§	NA	NA	45.1§	57.1‡
Hyponatremia (%)	NA	NA	NA	NA	5**	NA	NA	NA	NA	18.8~	45~	NA	NA	NA	5.9**; 20.8~
BNP performed (%)	63	NA	8	NA	NA	NA	16	37	NA	30	NA	82	NA	NA	34
Mean LVEF (%)	34	38	39	NA	37	38	38	38	40 (debut) 37 (crónica)	38	37	42	NA	50	50
Treatment of the acute episode															
NIV (%)	NA	NA	NA	36.1	8.9	NA	13.9	NA	9.6	NA	NA	12.4	NA	NA	6.4
Diuretics (%)	NA	NA	NA	80.4	NA	80	84.4	84.6	89.7	99	95.3	NA	NA	NA	96.8
Vasodilators (%)	21	NA	14.3	45.8	NA	33	38.7	18.5	41.1	29.9	51.3	NA	NA	NA	20.7
Inotropes (%)	15	NA	10.9	20.7	22.3	18	29.8	10.5	39	19.4	24.6	13.8	NA	NA	2.1
Outcome															
Hospital stay (days) median/mean	4.3/NA	NA/NA	4/5.7	21/31	7.1/NA	NA/8.4	NA/9	NA/NA	6/NA	10/NA	9/NA	13/NA	NA/NA	NA/NA	7/9.4
Admission in the ICU (%)	18.7	NA	NA	NA	NA	NA	51	48	17	51.9	69	43	NA	NA	1.9
Inhospital mortality (%)	4	5.8	3.8	7.7	12.7	7.7	7.3	3.8	17.8	6.4	7.3	8.2	NA†	NA	7.6

Acute heart failure registries. Reproduced from EMERGENCIAS with permision of the publishers (5). References can be retrieved from the original publication.
R: retrospective; P: prospective; Hosp.: hospitalised; Card.: cardiology; HED: hospital emergency department; COPD: chronic obstructive pulmonary disease; CI: cardiac insufficiency; ACEI/ARBs: angiotensin-converting enzyme inhibitor/angiotensin-II antagonist; LVEF: left ventricular ejection fraction; SBP: systolic blood pressure; HR: heart rate; BNP: natriuretic peptides; NIV: non-invasive ventilation; ICU: intensive care unit; IM: internal medicine.
*The data were obtained from the sum of the cohort derivation and validation cohort.
†Mortality at 7 days: 2%.
‡Haemoglobin <12 in women and <13 g/dl in men.
§Haemoglobin < 2 g/dl.
¶Limit not available.
**Sodium <130 mmEq/l.
~Sodium <136 mmEq/l.
∞Chronic dialysis.
ˇEstimated glomerular filtration rate <60 ml/min.
^Medication at discharge.
¥Data obtained from a substudy.

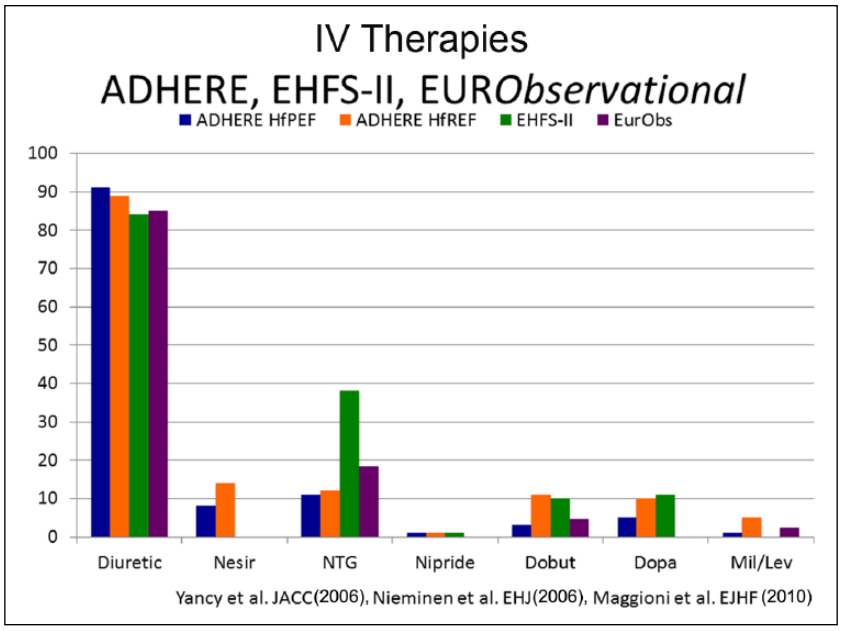

Figure 1. Intravenous therapies from 3 different registries.
ADHERE: acute decompensated heart failure registry; Dobut: dobutamine; Dopa: dopamine; EHFS-II: euroheart failure survey 2; Lev: levosimendan; Mil: milrinone; Nesir: nesiritide; NTG: nitroglycerin.

Initial approach to the ED patient with suspected AHF

Patients present to the ED with signs and symptoms, not diagnoses. Thus, the initial approach to AHF patients starts with a signs and symptoms, chief complaint-based approach (see Figure 2). When faced with a patient in respiratory distress, the challenges of making a rapid diagnosis of AHF become readily apparent: (a) shortness of breath is a symptom common to other pathologies; (b) the myriad precipitants and mechanisms that lead to AHF may not be immediately identifiable; (c) heart failure patients are multi-morbid, with many acute as well as chronic comorbid conditions that may obfuscate the clinical picture; (d) heart failure patients are older and often frail, and may require more time to elicit the reasons for decompensation, such as self-care and caregiver status; (e) there is time pressure to disposition patients rapidly due to the large volume of undifferentiated patients waiting to be seen; (f) the burden of AHF disproportionately impacts those in the lower socioeconomic status groups, thus more resources may be needed for both assessment and assistance than is possible in a brief ED intervention; both psychosocial and socioeconomic factors limit adherence to treatment and compliance;[28] (g) there continues to be an unmet need for valid and facile risk stratification instruments.[1,27,29,30] Therefore, the use of well-structured decision-making algorithms is essential to optimise the management of patients with suspected AHF in the ED. These should incorporate guidance for both ruling out and treating life-threatening conditions initially, with guidance to facilitate accurate diagnosis with an appropriate differential diagnosis (Figure 2).

For treatment of the AHF patient, we advocate for education centred on a phenotype/precipitant approach. This algorithm begins with the undifferentiated patient who presents with a chief complaint, not a diagnosis, consistent with current emergency medicine practice. First, whether or not the patient requires immediate intervention is addressed. Once stable enough for a more traditional history and physical examination, the patient is then classified based on easily measureable phenotypic characteristics, with treatment directed towards that classification. Importantly, diagnostic and therapeutic plans commonly occur in parallel, unlike a traditional medical encounter in which actions occur in series. Finally, diagnostic uncertainty is directly addressed; frequent re-assessment and re-evaluation is emphasised to ensure patients are improving.

Differences in emergency care settings

We acknowledge that emergency care differs throughout the world, compounding the challenges of ED AHF management. Usually patients cluster according to the local geography of their hospitals. Resource limitations, educational background and specialisation of physicians and nurses appear to be very important for clinical outcomes.[31–33] The specialty of emergency medicine itself is most well established in the USA, yet it is only 50 years old. In many countries, there is no specialty of emergency medicine. We also acknowledge that in many countries, EDs function as safety nets for healthcare – the place to go when there is no other place to go, when time is of the essence, or for when office-based practices are not open,

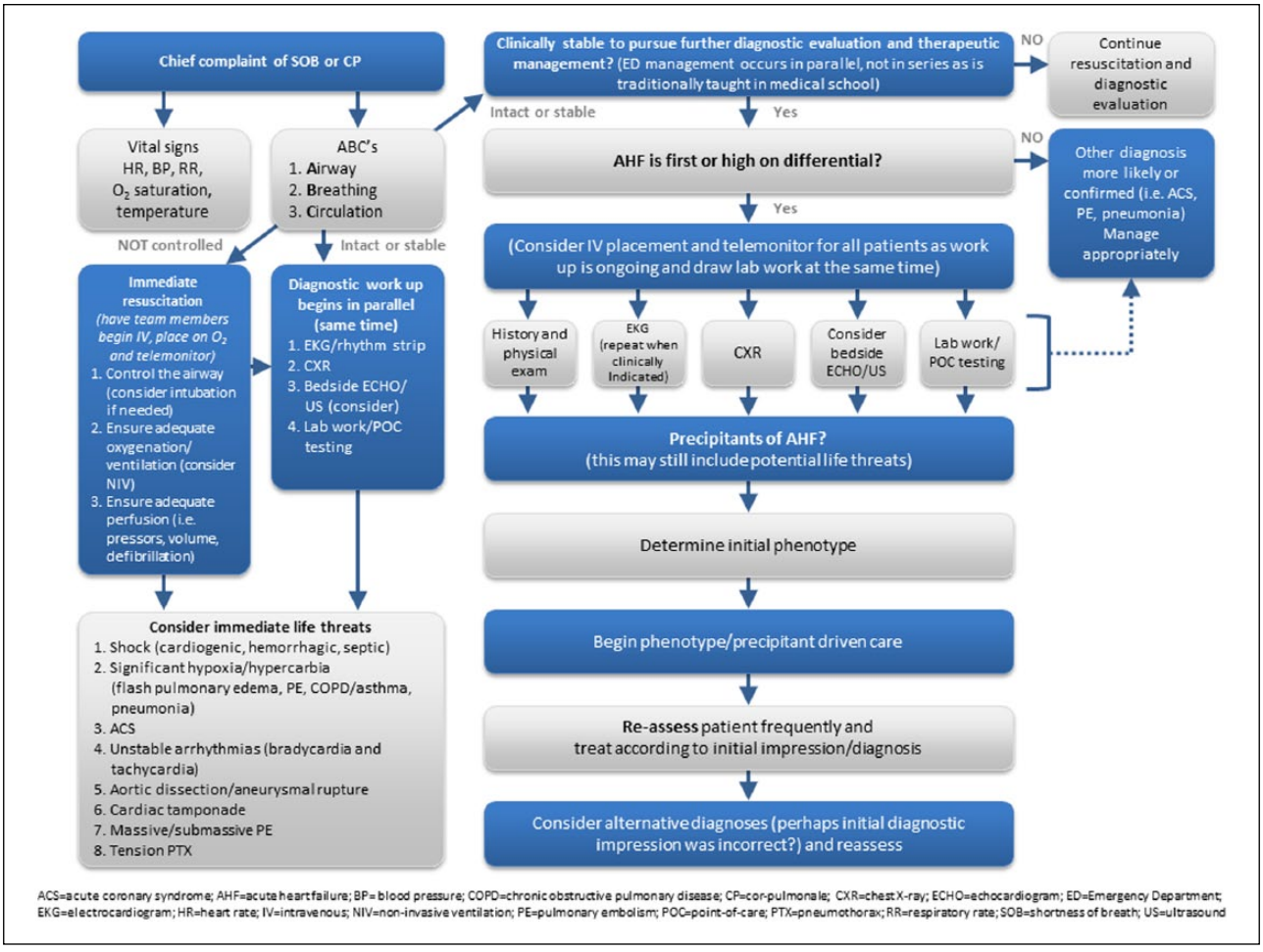

Figure 2. Initial Approach to the AHF Patient.

such as nights, weekends and holidays. For these reasons, we believe that education through a case-based learning approach may be particularly appropriate for improving the management of AHF in the emergency care setting.

Future directions

Ideally, future educational efforts will bridge research and education (Table 2). As more knowledge accumulates, more robust recommendations will be provided. Simulated patient cases will continue to be developed, as repetition combined with variations of common AHF presentations will strengthen clinical management. This is especially important given continuing evidential uncertainties. A brief overview of future directions will be covered below.

Risk-stratification is a major focus of our consensus group, as the decision to admit or discharge from the ED has significant downstream implications. At present, the vast majority of patients are admitted.[1] While several risk scores have been developed, none are widely used due to either validation, discrimination, calibration or ease of use issues.[26] Nevertheless, strategies to improve discharge decision-making should be developed, as proved by strategies to reduce readmissions for heart failure patients admitted to the ward.[34] This includes innovative strategies of care, such as observation medicine for heart failure or community paramedicine with trained paramedics visiting patients after an ED or hospital visit.

The ED plays a role in the prevention of heart failure or maintenance of guideline therapy. While this may be initially counterintuitive, patients with chronic conditions may present for other reasons. For example, a heart failure patient may present with gout, or a stage B patient may present with a laceration. Such encounters present potential opportunities to partner with nursing homes, extended care and skilled nursing facilities, advanced practice providers, primary care physicians (including comprehensive primary care models, i.e. 'medical home'), cardiologists and other multidisciplinary stakeholders. Rather than view the ED as a single transaction, there is ample opportunity to participate in the overall care of patients.

As highlighted above, there is a lack of data concerning details of current clinical practice of AHF management in the ED as well as evidence-based therapies. Novel therapies are

Table 2. Future Directions.

Clinical needs	1. Improved inter and multidisciplinary collaboration 2. Common goal setting and agreed upon quality benchmarks among HF providers 3. Standardised approach to reassessment and mutually defined endpoints of therapy
Education & research	1. Diagnosis 2. Pattern recognition and initial classification 3. Resuscitation, stabilisation and initial management 4. Goals of ED AHF therapy 5. Role of existing biomarkers for diagnostic and prognostic purposes 6. Improved pathophysiological understanding 7. Greater evidence base for therapeutic management including potential for a time-dependent component 8. Development of novel therapies 9. Evaluation of phenotype-driven management and its effect on outcomes 10. Effectiveness of biomarker directed treatment 11. Role of imaging in acute care (i.e. point of care ECHO, lung ultrasound, IVC measurement, CT-coronary, cardiac MR) 12. Risk stratification (use of observation units/status) 13. Role in prevention as well as compliance (assessments of self-care) 14. Patient preferences (e.g. advanced directives, palliative care) 15. Patient-centred research and education 16. Management and integration of implantable devices

ED: emergency department; AHF: acute heart failure; ECHO: echocardiography; IVC: Inferior vena cava; CT: Computed tomography; MR: magnetic resonance.

currently being tested as well as approaches to diagnosis, risk stratification and strategies of care. It is also worth highlighting the ongoing development of novel biomarkers that will aid not only current management, but shed light on the pathophysiology of AHF. Particularly relevant to the ED is organ injury. Whether prevention or protection from organ injury will lead to improved outcomes is an active area of investigation. Organ injury may be time dependent, suggesting a need for early intervention.[35,36] As portable bedside ultrasound (to distinguish from detailed echocardiography) continues to becomes more widespread in the ED, a more direct focus on cardiac structure, function and haemodynamics may occur. Some centres already perform detailed echocardiography assessments of ED patients with AHF. Other imaging modalities or approaches, such as lung ultrasound, are likely to become more widely used. If current research endeavours are successful, integration into existing algorithms as well as new approaches to AHF may be needed. Given the burden of AHF and the role the ED plays in AHF management, dissemination regarding appropriate use will be critical.

Conclusions

The lack of evidence regarding the initial management of patients with AHF, continued poor outcomes and limited therapeutic advances highlight the challenges facing clinicians caring for AHF patients in the ED. At the same time, EDs do not operate in isolation. Their ability to manage chronic diseases during an acute exacerbation, as well as integrate into an overall episode of care, are critical operational considerations and important to the health of an overall system of care. The prevalence of heart failure and the dominance of the ED as an entry point for admissions present a unique opportunity to challenge traditional perspectives of emergency care as a contributor to the overuse of healthcare resources, instead envisioning the ED as a potent partner in the overall management of heart failure.

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Conflicts of interest

Peter Pang is or has been a consultant for Intersection Medical, INSYS, Janssen, Medtronic, Novartis, Trevena, scPharmaceuticals, Cardioxyl, Roche Diagnostics; and has received honoraria from Relypsa and Palatin Technologies.

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Deborah Diercks is a consultant for Novartis and has received research support from NIH, PCORI, Alere and Beckman Coulter.
Salvatore Di Somma works as a consultant for Novartis, Alere, Thermofischer, Cardiorentis, Sphyngotec and Adrenomed.
Veli-Pekka Harjola is a consultant for Novartis, Servier, Orion Pharma and Roche Diagnostics.
Judd Hollander has received research funding from Alere, Roche, Siemens and Trinity.
Ekaterini Lambrinou is a consultant for Novartis.
Phillip Levy is a consultant for Novartis, Cardiorentis, Trevena, Intersection Medical, Celgene, ZS Pharma; has received honoraria from Roche Diagnostics, Otsuka, Beckam Coulter and ThermoFisher; and has received research support from NIH/NIMHD, Novartis, Cardiorentis, Cardioxyl, Trevena, Intersection Medical and Mespere.
Martin Möckel is or has been within the past 2 years: consultant for BRAHMS, Roche Diagnostics, Radiometer, ASTRAZeneca, Novartis, BayerHealthcare and Instrumentation Laboratory.
The remaining authors have no conflicts of interest to disclose.

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