Heart Failure Reviews (2020) 25:1089–1097
https://doi.org/10.1007/s10741-020-10025-1

A manifesto of collaborative longitudinal cardiovascular care in heart failure

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Accepted: 31 August 2020 / Published online: 6 October 2020

Abstract
In this document, we outline the challenges faced by patients and clinicians in heart failure, specifically centered around the needed coordination of care among the various subspecialties within cardiovascular medicine. We call for a more organized and collaborative effort among clinicians in primary care, general cardiology, electrophysiology, interventional cardiology, cardiothoracic surgery, cardiac imaging, and heart failure—all caring for mutual patients. Care is contextualized within the framework of two phases: a cardiomyopathy phase and an advanced heart failure phase, each of which lends to different considerations in therapy. Ultimately multidisciplinary coordinated care within cardiovascular medicine may lead to greater patient and clinician satisfaction as well as improved outcomes, but this remains to be investigated.

Keywords Cardiovascular medicine · Heart failure · Cardiomyopathy · Advanced therapies · Multidisciplinary

Introduction

> Man, that inveterate dreamer… ~ Andre Breton Manifesto of Surrealism, 1924

> Andre Breton's Manifesto of Surrealism inspires to go beyond the "imperative practical necessity" of everyday reality to the perception of a higher realm. By freeing the mind from established constructs, we are unlimited in the design of an ideal model and effect a paradigm shift.

Heart failure (HF) is a worldwide epidemic of growing proportions with 26 million affected in an increasing aging population. Acute decompensation of HF is the most common cause of hospitalization in the USA and in Europe, accounting for over 1 million admissions respectively [1]. While guideline-directed medical therapy (GDMT) and device-based therapies have significantly improved symptoms and

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survival in patients with advanced heart failure, penetration is still highly variable within the USA and internationally [2].

Challenges for the modern-day heart failure patient

The contemporary HF patient often has more than one cardiovascular (CV) issue, requiring optimal management to extend beyond pharmacotherapy alone. Rather, comprehensive management lies at the intersection of multiple subspecialties within CV medicine in addition to other organ systems. For example, a stable patient with newly diagnosed heart failure with reduced ejection fraction (HFrEF) routinely undergoes an ischemic evaluation to understand the etiology of reduced left ventricular function and as such may require diagnostic procedures from an interventional cardiologist and then potential consideration of revascularization from a cardiothoracic (CT) surgeon. Once GDMT is optimized, this same patient may be referred for implantation of a primary prevention defibrillator or cardiac resynchronization therapy as appropriate by an electrophysiologist, who then follows longitudinally for management of arrhythmias; ablation of supraventricular or ventricular arrhythmias, if present, may ensue. Should the patient develop refractory symptoms due to ischemia and/or valvular disease, (re-)counsel of a cardiothoracic surgeon or interventional cardiologist for consideration of appropriate interventions may then be necessary. Throughout this course, a number of imaging studies will be performed, requiring the input of a cardiac imaging specialist. Thus, the longitudinal journey of a HF patient may entail exposure to 4 or more cardiology specialists, as well as at least one cardiothoracic surgeon.

The past 3 decades have yielded prodigious advances in the treatment of HF which once consisted of only digoxin and diuretics. Table 1 summarizes many of the key discoveries made in pharmacology and device-based therapies. Treatment options now span pharmacotherapy, ablations, coronary revascularization, percutaneous structural heart interventions, implantation of devices, valvular surgeries, durable ventricular assist devices, and transplantation. This increasingly complex web of therapies requires impeccable communication among physicians and healthcare practitioners to deliver optimal, coordinated, longitudinal care. The reality, however, is that care is often fragmented and episodic, leaving patients confused and frustrated with suboptimal outcomes.

Current state of the management of the patient with HF patient

Different models of multidisciplinary care have been developed in many centers to improve outcomes in HF patients, whether they are to address complex dyspnea, prevent readmissions, manage cardiogenic shock, and transition from hospital to home, or for coordinating care of extracardiac complications [7–10]. Optimal outcomes must start with coordinated care within the CV team itself. From there, some teams involve specialists from other specialties, while others involve ancillary staff, nurse practitioners, social work, pharmacy, and nutrition.

To better gauge perceptions of intra-disciplinary care within CV medicine and surgery in the management of HF patients, an 8-question survey was administered to general cardiologists, electrophysiologists, interventional cardiologists, HF specialists, CT surgeons, CV nurse practitioners (NP), physician assistants (PA), and registered nurses across 9 tertiary care centers. These included St. Vincent Heart Center, The Mount Sinai Hospital, Hospital of the University of Pennsylvania, Columbia University Irving Medical Center, Kansas University Medical Center, University of North Carolina Health Center, Tufts Medical Center, Florida Hospital Center, and Cleveland Clinic.

Voluntary participation in this multicenter survey resulted in nearly 400 respondents, almost half of whom were advanced practice providers (NPs or PAs) and registered nurses (Fig. 1). All CV subspecialties and CT surgery were well represented. Approximately 70% of participants stated that cross-collaboration was "good" or "excellent," with a similar proportion stating that care was delivered in a mostly coordinated, time-efficient manner. However, nearly 95% of respondents believed that improved communication in CV medicine would result in improved HF care. Less than one-third of clinicians endorsed participation in routine intra-disciplinary discussions, and only 43% reported regular review of practice guidelines in subspecialties other than their own. Despite the inclusion of only tertiary care, largely academic hospitals with specialized HF centers, the results of this survey corroborate the need for improved intra-disciplinary partnerships and coordination for delivery of optimal care to patients with advanced CV disease.

So, if one were to apply Breton's ideology to the management of intra-disciplinary patients today and move from current practice to ascend through an ideal and more present-time model of care, what would it look like?

The "surreal" or ideal approach to HF management

Deconstructing the linear model

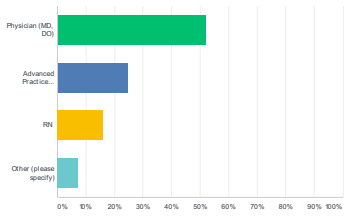
In the iconic schema of HF management by stages, care is depicted as a stepwise ladder with the patient becoming progressively sicker and in need of escalating therapies as they reach the top (Fig. 2). This approach however often results in the involvement of subspecialists within cardiology only once patients reach end-stage levels. Too often, appropriate therapies are considered too late, potentially leading to unfavorable outcomes.

Table 1 Key discoveries made in pharmacology and device-based therapies

Heart failure–related therapy	Year	Key clinical trials	HF guideline recommendation (AHA/ACC) [3, 4]
Pharmacotherapy			
ACE inhibitors	1991	SOLVD, ATLAS, AIRE	Class I, LOE A
Beta blockers	1996	COPERNICUS, MERIT-HF, CIBIS-II	Class I, LOE A
Mineralocorticoid receptor antagonists	1999	RALES, EMPHASIS-HF	Class I, LOE A
Digoxin	1997	DIG trial	Class IIa, LOE B
Angiotensin receptor blockers	2001	Val-HEFT, CHARM	Class I, LOE A
Hydralazine/nitrates	1986, 2004	V-HEFT, A-HEFT	Class I, LOE A
Ivabradine	2010	SHIFT	Class IIa, LOE B
Sacubitril/valsartan	2014	PARADIGM-HF	Class I, LOE B
Sodium–glucose cotransporter 2 (SGLT-2) inhibitors	2019 [5], 2020 [6]	DAPA-HF, EMPEROR Reduced	not yet incorporated in guidelines
Cardiovascular implantable electronic devices			
Implantable defibrillators	1996	SCD-HeFT, MADIT, MADIT II, MUSTT	Class I, LOE A
Cardiac resynchronization therapy	2002	MIRACLE, COMPANION-HF, MADIT CRT	Class I, LOE A-B (LBBB with QRS ≥ 150 ms) Class IIa, LOE A-B (non-LBBB QRS ≥ 150 ms or LBBB with QRS 120–149 ms)
Arrhythmia management			
Ventricular tachycardia ablation	2016	VANISH	None
Atrial fibrillation ablation	2017	CASTLE-AF	None
Coronary revascularization			
Percutaneous coronary revascularization	1995	CASS	Class Ia, LOE C (angina) Class IIa, LOE B (mild to moderate LV dysfunction) Class IIb, LOE B (severe LV dysfunction)
Surgical revascularization	2011	STICH, BARI, BARI 2D	
Valvular heart disease interventions			
TAVR	Ongoing	TAVR UNLOAD	Class IIa, LOE B
Mitral valve repair versus replacement	2014	MMR, SMR trials	Class IIb, LOE B
MitraClip	2011	EVEREST-II, COAPT	
Mechanical circulatory support			
LVAD destination therapy (pulsatile flow)	2001	REMATCH	Class IIa, LOE B
LVAD destination therapy (continuous flow)	2009	HEARTMATE2, MOMENTUM3, ENDURANCE	Class IIa, LOE B
Ambulatory monitoring			
CardioMEMS	2011	CHAMPION	None

Q1 Which best describes your position as a care team member?

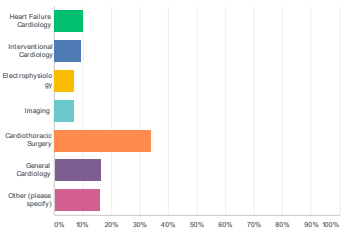
Answered: 392 Skipped: 5



ANSWER CHOICES	RESPONSES	
Physician (MD, DO)	51.79%	203
Advanced Practice Provider (NP, PA)	24.74%	97
RN	16.07%	63
Other (please specify)	7.40%	29
TOTAL		392

Q2 Which of the following best describes your specialty?

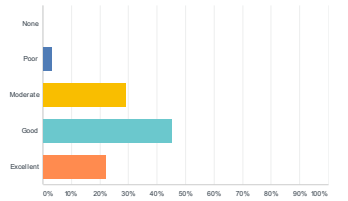
Answered: 390 Skipped: 7



ANSWER CHOICES	RESPONSES	
Heart Failure Cardiology	10.26%	40
Interventional Cardiology	9.49%	37
Electrophysiology	6.92%	27
Imaging	6.92%	27
Cardiothoracic Surgery	34.10%	133
General Cardiology	16.41%	64
Other (please specify)	15.90%	62
TOTAL		390

Q3 How would you rate quality and intensity of collaboration among disciplines in the management of heart failure?

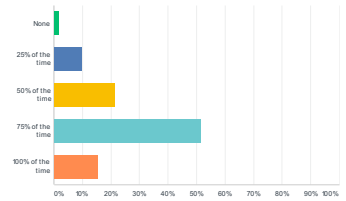
Answered: 396 Skipped: 1



ANSWER CHOICES	RESPONSES	
None	0.00%	0
Poor	3.28%	13
Moderate	29.29%	116
Good	45.20%	179
Excellent	22.22%	88
TOTAL		396

Q4 How frequent do you experience timely and efficient coordination in heart failure care?

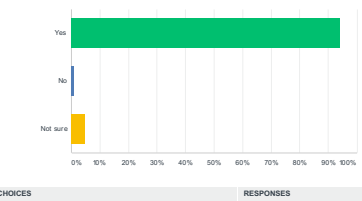
Answered: 396 Skipped: 1



ANSWER CHOICES	RESPONSES	
None	1.77%	7
25% of the time	9.85%	39
50% of the time	21.46%	85
75% of the time	51.52%	204
100% of the time	15.40%	61
TOTAL		396

Q5 Do you think that improved communication among disciplines in cardiovascular medicine would improve heart failure care?

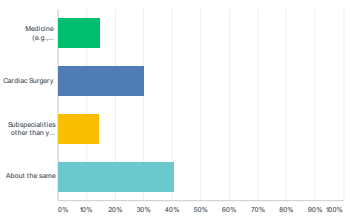
Answered: 396 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	94.19%	373
No	1.01%	4
Not sure	4.80%	19
TOTAL		396

Q6 Which disciplines, do you think are more connected on a daily basis as part of multidisciplinary team approach?

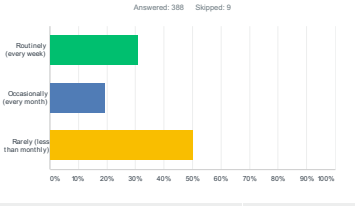
Answered: 396 Skipped: 1



ANSWER CHOICES	RESPONSES	
Medicine (e.g., nephrology, neurology, infectious disease, pulmonary)	14.90%	59
Cardiac Surgery	30.05%	119
Subspecialities other than your own within Cardiology	14.39%	57
About the same	40.66%	161
TOTAL		396

Q7 How often are you involved in intra-disciplinary discussions at meetings (e.g. at the weekly meeting(s) of the transplant/VAD programs) or at the bedside that relate to the care of complex cardiac patients?

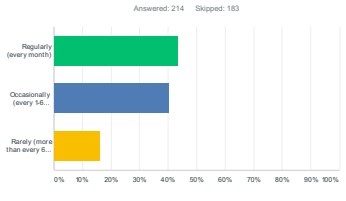
Answered: 388 Skipped: 9



ANSWER CHOICES	RESPONSES	
Routinely (every week)	30.67%	119
Occasionally (every month)	19.33%	75
Rarely (less than monthly)	50.00%	194
TOTAL		388

Q8 If you are an HF, Imaging, EP or Interventional specialist, please answer the following question:How often do you review the scientific literature to look for changes in clinical practice guidelines that relate to cardiology disciplines other than your subspecialty?

Answered: 214 Skipped: 183



ANSWER CHOICES	RESPONSES	
Regularly (every month)	43.46%	93
Occasionally (every 1-6 months)	40.19%	86
Rarely (more than every 6 months)	16.36%	35
TOTAL		214

Fig. 1 Responses provided by physicians, advanced practice providers, registered nurses, and other healthcare providers to questionnaire regarding heart failure care

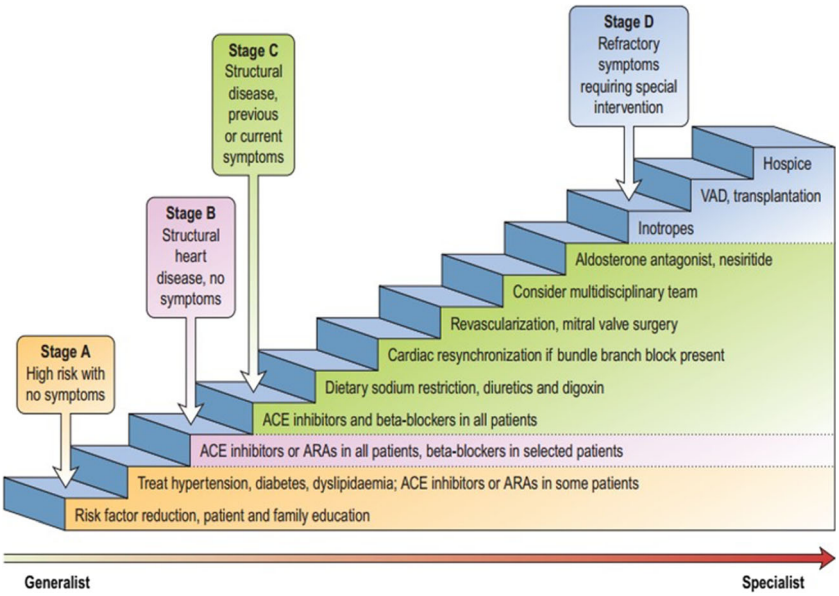


Fig. 2 The American College of Cardiology/American Heart Association stages of systolic heart failure and treatment (adopted from Jessup M. *NEJM*. 2003; 348. 2007–2018)

We propose therefore, moving from the linear, stepwise ladder to a "jungle gym" construct (Fig. 3) allowing for both vertical and lateral movement to denote progression. At times, patients may proceed laterally between CV specialists such when an EP refers a CRT non-responder to CT surgery for epicardial LV lead placement; other times patients move vertically such as when present in decompensated heart failure requiring hemodynamic-guided therapy before moving back down to the care of their community cardiologists. Rather in the present era, heart teams are required to ensure the appropriateness of an intervention. Consideration of MitraClip is an example wherein the patient is evaluated by a HF specialist, a CT surgeon, and an interventional cardiologist to proceed or not proceed with the procedure. These teams have evolved in accordance with how the clinical trial was conducted and allowed for excellent outcomes.

Phases of disease

Within this cardio-centric and team-based framework, two phases of care are recognized: (a) the chronic HF phase and (b) the advanced HF phase. With respect to terminology, the "chronic HF phase" is replaced with a "cardiomyopathy" phase [11]. Adaptation of this terminology allows a reframing of our lexicon to better represent the patients who enjoy long periods of stability with good quality of life, often protesting

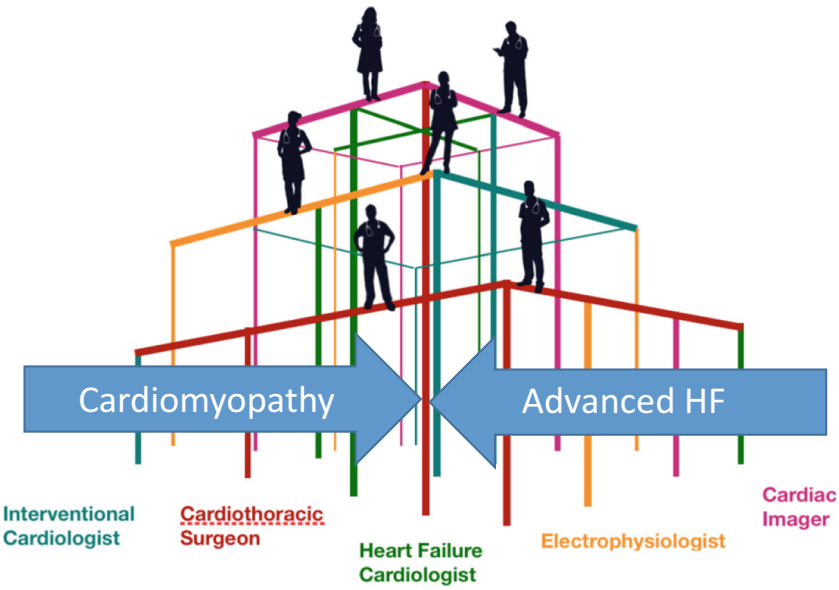


Fig. 3 "Jungle gym" construct which allows for horizontal as well as vertical movement to denote progress in the management of heart failure patients

they do not feel like they "are failing." The subsequent phase of disease would accordingly be referred to simply as "heart failure" in lieu of "*advanced* heart failure," reflecting progression to a phase characterized by refractory symptoms and clinical deterioration. Using the current blanket term of "heart failure" across phases of disease often dilutes a sense of urgency needed to identify clinical decline. Rather, applying the term "failure" exclusively to the latter phase conveys a more selective and appropriate sense of urgency for patients and providers to escalate care as needed.

Cardiomyopathy phase

In the cardiomyopathy phase, the primary CV provider (who may be the primary care physician, internist, nurse practitioner, or general cardiologist) serves as the principal champion for the patient (Fig. 4). Standard CV procedures are performed for evaluation of hemodynamic stability, myocardial function, valvular heart disease, arrhythmias, coronary disease, end-organ function, and functional capacity as indicated. An initial evaluation followed by annual (or biennial in asymptomatic patients) assessment by a HF specialist is recommended for diagnostic purposes (particularly in non-ischemic cases, e.g., rule out amyloid, sarcoid, and other infiltrative diseases) to review response to treatment and for risk stratification. This specialized HF assessment should become routine practice and embedded in providers' minds similar to how mammography and colonoscopy screenings are reflexively considered standard of care. Importantly, this approach is also in line with and further expands the recommendations of the Consensus Decision Pathway for Optimization of HF Treatment [12]. The present model of collaborative care distinctly focuses on the web of providers within CV medicine and surgery that is designated to deliver optimal and coordinated care to HF patients. The HF specialist serves to ensure conventional therapies are exhausted before advanced options are considered and, if so, shepherds patients to the next phase of care.

Table 2 Criteria that define advanced HF

HF with high-risk features, such as development of 1 or more of the following risk factors:

- Need for Chronic IV inotropes
- Persistent NYHA functional class III–IV symptoms of congestion or profound fatigue
- Systolic blood pressure ≤ 90 mmHg or symptomatic hypotension
- Creatinine ≥ 1.8 mg/dL or BUN ≥ 43 mg/dL
- Onset of atrial fibrillation or ventricular arrhythmias or repetitive ICD shocks
- Two or more emergency department visits or hospitalizations for worsening HF in prior 12 months
- Inability to tolerate optimally dosed beta blockers and/or ACEI/ARB/ARNI and/or aldosterone antagonists
- Clinical deterioration as indicated by worsening edema, rising biomarkers (BNP, NT-proBNP, others), worsened exercise testing, decompensated hemodynamics, or evidence of progressive remodeling on imaging
- High mortality risk using validated risk model for further assessment and consideration of advanced therapies (http://www.onlinejacc.org/content/62/16/e147/T10)

Heart failure phase

If and when a patient meets any criteria that define advanced HF (Table 2), he/she will be confronted with advanced therapeutic options utilizing the expertise of the same CV subspecialties that contributed to his/her care during the chronic HF (cardiomyopathy phase) [4, 12].

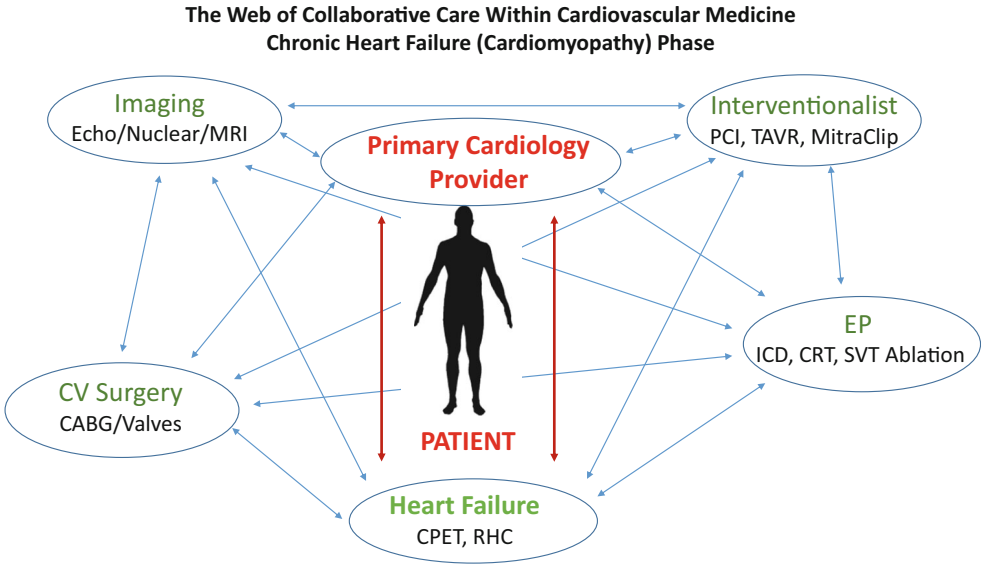


Fig. 4 The web of collaborative care within cardiovascular medicine chronic heart failure (cardiomyopathy) phase

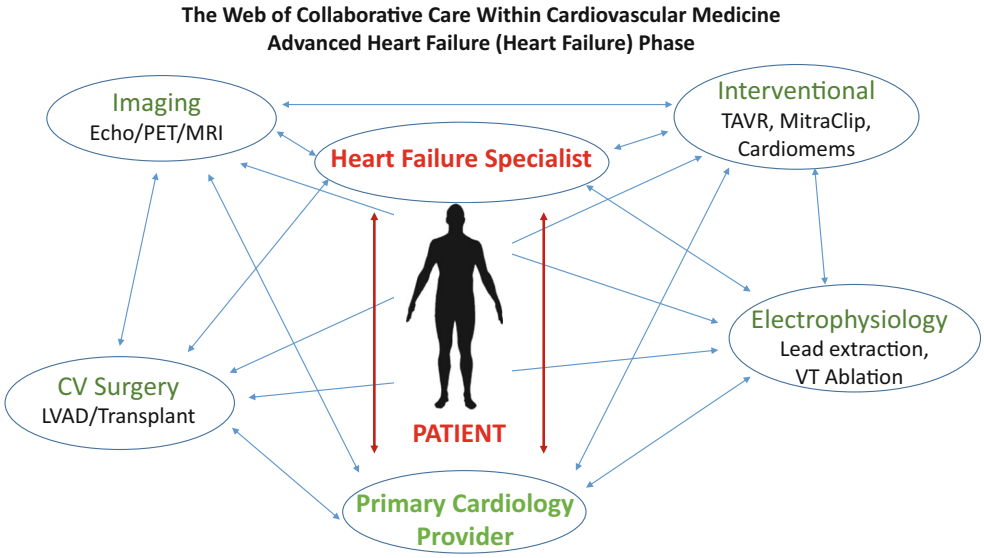


Fig. 5 The web of collaborative care within cardiovascular medicine advanced heart failure (heart failure) phase

The primary patient champion in this advanced phase shifts from the general cardiology provider to the HF specialist. For appropriate patients, conversations with patients and families about advanced treatment options, including left ventricular assist device (LVAD) and transplant, eligibility assessment, and interventions to overcome potential barriers, deserve early consideration.

In view of the severity and complexity of this (advanced) HF phase (Fig. 5), each discipline including interventional cardiology, CT surgery, electrophysiology, and cardiac imaging will serve as integral members of the HF team. This team will also be joined by pharmacy, social work, palliative care, infectious disease, cardiac surgery, and other pertinent specialists for the purposes of integrating multidisciplinary patient care [13]. Once bonds within the collaboration are strengthened for this purpose, communication with other subspecialists in medicine, general surgery, and other departments will be also more streamlined and effective.

Once patients are stabilized and return back to the "cardiomyopathy" stage either with medical or device therapy, it may be entirely appropriate for their care to return back to their primary CV provider.

Translating the surreal into reality

What are the practical ways in which this surreal model of care can be integrated into everyday practice? What are the necessary tools? What are the barriers?

Technology

Communication, connectivity, and access on both the patient and provider team levels are integral to the collaborative care of HF patients. The novel coronavirus disease (COVID-19) pandemic has taught us how effective communication can be with the appropriate use of technology. Timely provider correspondence has improved with mobile device technology. Remote providers from different centers can log in for teleconferences. Radiology, labs, and notes can be shared between centers' EMR. For patients with geographic barriers to intra-disciplinary care, virtual visits may be the solution [14]. Remote diagnostic imaging is also feasible and may expedite patient care [15]. Use of such modes of evaluation may effectively limit costs (both in terms of time and lost productivity) to patients who would benefit from seeing multiple providers for their CV care. Reimbursement for virtual visits is evolving, but is gaining acceptance among both government and private payers [16].

As internet access has become nearly ubiquitous, remote patient monitoring is bringing patients closer to their providers. Electrophysiologists routinely monitor device performance and arrhythmic complications for HF patients via implantable devices. Implantable pulmonary artery pressure sensors can provide accurate ambulatory hemodynamic data, which can be used to effectively manage HF patients at home and identify patients beginning to decompensate. LVADs will also have the capabilities for remote monitoring in the future. The arena of remote monitoring is ripe for synergistic collaboration among CV subspecialists and machine learning can further develop algorithms to identify failing patients. The remote and virtual needs of our patients during the pandemic may highlight this need more than ever.

Educating the workforce

Maintaining competency in the current era of evolving technologies and increasing patient complexity is a challenge, and

our survey results demonstrate that even in a cohort largely composed of academic institutions, less than half of respondents regularly review literature outside of their CV subspecialty. However, since few practitioners have the time or resources to attend multiple conferences per year, multidisciplinary educational rounds and conferences are effective platforms for CV subspecialties to understand one another's diagnostic and therapeutic technologies, decision-making priorities, and clinical guidelines. For example, a structural heart interventionalist featured at an HF meeting for the management of valvular disease can provide insight into different approaches to complex patients. Finally, novel pathways for post-graduate education have been and are being developed. A 2004 manuscript by Adamson and colleagues has proposed a formal training program wherein HF trainees would gain proficiency in the cognitive and technical aspects of device implantation, and now serves as a guiding principle for these budding dual-fellowship options [17].

Recently, growing interest and clinical demand have led to the development of interventional HF programs, whereby interventional cardiologists fulfill training requirements for advanced HF, thereby allowing them to *think* like an HF specialist, while *operating* like interventional cardiologists [18–20].

Conclusions

The modern-day HF patient is increasingly complex and requires highly specialized knowledge across CV disciplines. Simultaneously, GDMT and devices are yielding dramatically better clinical outcomes in symptomology and survival. This commentary challenges current constructs of care and suggests a paradigm shift wherein communication and collaboration and ownership of patients flow freely from primary cardiology providers to subspecialists and back. The ultimate goal is for every HF patient, regardless of geography to receive evidence-based, cost-effective, coordinated care at the right time by the right providers.

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