ORIGINAL ARTICLE

The Development of an Order Set for Adults Admitted for Acute Heart Failure at a National University Hospital in the Philippines

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ABSTRACT

Background and Objectives. Heart Failure (HF) remains a major health concern worldwide. In the Philippine General Hospital (PGH), HF is consistently a top cause of mortality and readmissions among adults. The American College of Cardiology (ACC) and European Society of Cardiology (ESC) published guidelines for interventions that improve quality of life and survival, but they are underused and untested for local acceptability. Hospitals overseas used order sets created from these guidelines, which resulted in a considerable decrease in in-hospital mortality and healthcare costs. We aimed to develop an order set for adult patients with acute heart failure (AHF) admitted to the PGH Emergency Department (ED) to improve care outcomes.

Methods. This study utilized a mixed methods approach to create the AHF order set. ESC and ACC HF guidelines were appraised using the AGREE II tool. Class I interventions for AHF were included in the initial order set. Through focused group discussions (FGD), clinicians and other care team members involved in the management of AHF patients at PGH ED modified and validated the order set. Stakeholders were asked to use online Delphi and FGD to get a consensus on how to amend, approve, and carry out the order given.

Results. Upon review of HF guidelines, 29 recommendations on patient monitoring, initial diagnostic, and therapeutic interventions were adopted in the order set. Orders on subspecialty referrals and ED disposition were introduced. The AHF patient was operationally defined in the setting of PGH ED. The clinical orders fit the PGH context, ensuring evidence-based, cost-effective, and accessible care responsiveness to patients' needs and suitable for local practice. Workflow changes due to COVID-19 were considered. Potential barriers to implementation were identified and addressed. The final order set was adopted for implementation through stakeholder consensus.

Conclusion. The PGH developed and adopted its own AHF order set that is locally applicable and can potentially optimize outcomes of care.

Keywords: acute heart failure, order set, quality improvement, clinical pathway

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INTRODUCTION

Heart Failure (HF) is one of the major diseases of public health concern. It affects about 1-2% of the general adult population in developed countries and 1-2% of total adult hospitalizations.[1] In the Philippines, HF prevalence was at 1.6% and account for 16/1000 adult hospital admissions.[2] In 2014, the total economic burden for HF in the country amounted to Php 691,522,200. Every Filipino hospitalized for HF spent up to Php 28,220 but the national insurance policy (PhilHealth) was only able to cover for Php 16,700. Length of hospital stay was about 7.2 days with an overall in-hospital mortality rate of 8.2%.[3] In the Philippine General Hospital, HF remains in the top five reasons for ward admission among adults.[4] Despite advances in therapy, the overall prognosis of HF is still poor, marked by significant mortality, prolonged length of stay, and high rates of readmissions.[1,5]

Numerous clinical practice guidelines (CPGs) are available that identify the evidence-based, cost-effective practices for patients with heart failure.[6] However, there is still a marked variation in care and underuse of guideline recommendations for heart failure.[5] Among ASEAN countries, the Philippines included, the utilization of key recommendations such as use of ACEI/ARBs, Beta blockers, MRAs and Ivabradine for HF remain suboptimal.[2]

Clinical order sets and clinical pathways are tools developed from CPG recommendations designed to improve clinician adherence to guideline-based therapy in clinics and hospitals.[7] Clinical pathways, when activated in defined clinical scenarios, recommend appropriate clinical actions given at an appropriate time.[8] Clinical order sets are grouped physician orders used to standardize and expedite the management of a common clinical scenario (e.g., HF).[9] A clinical pathway may be used as an instruction for the clinician on when to activate, and how to implement its corresponding order set, ensuring that key clinical assessment and eventually interventions with proven clinical benefit are not missed and are given in a timely manner.[8] The use of clinical order sets and clinical pathways results in lower mortality and morbidity, shorter hospital stay, efficient use of resources, and equity in terms of access and quality of health care.[9-11] However, the implementation of clinical order sets and pathways is challenging. They cannot be simply imposed but must be developed and reconciled with what can be applied clinically given the institutional context and resources.[12]

RATIONALE, OBJECTIVES, AND SCOPE

True to its mandate of being a national referral center, PGH continuously strives to improve the quality of the care it delivers for the public, particularly to the underserved. To this end, the Division of Cardiovascular Medicine (DCVM) and the Department of Medicine of the Philippine General Hospital (PGH) jointly developed a clinical pathway and order set as tools to standardize the inpatient management of patients with heart failure. This is part of the Quality Improvement and Patient Safety Initiative of the Department of Medicine (IM-QuIPS) and is in line with the priority research agenda of PGH. Given the complex nature of care given to patients with heart failure, it was decided to divide the task into phases: Phase I for emergency department (ED) management of Acute Heart Failure (AHF) patients, Phase II for transition care in the wards, and Phase III for outpatient management of stable HF.

This paper will focus on Phase I of order set development, specifically on AHF in the Emergency Department (ED) setting. Our study aims to create a multidisciplinary evidence-based order set for patients presenting with AHF admitted at PGH ED. Specific objectives include the following 1) to review existing CPGs promulgated by ESC and ACC in AHF and 2) to conduct multidisciplinary discussions with stakeholders towards the creation of the AHF order set. A clinical pathway was concurrently developed to guide the implementation of this order set.[13] Furthermore, a separate study is planned in the future to assess the impact of implementing the resulting order set and clinical pathway. Patients referred for AHF in the wards and intensive care units were excluded in our study due to the difference in setting, resources, and care processes.

METHODS

Research Design

This research is a mixed methods study that utilized clinical practice guideline appraisal using the AGREE II tool, qualitative data from focused group discussions, and consensus-building using online Delphi techniques. This research is a component of the IM Quality Improvement and Patient Safety (IM-QuIPS) initiative.

Participant Selection

A core group of investigators composed of cardiologists, internists, fellows, and medical residents was formed to oversee the development of the order set. They identified key stakeholders directly involved in the care of AHF patients in the ED, as enumerated in the appendices. Representatives from these groups were selected to participate in the creation of the order set.

Data Collection

Data collection was done in three parts, detailed in Appendix Figure 1:

1. **Search and appraisal of existing guidelines.** Existing local and international heart failure guidelines were searched. These were independently appraised by three of the authors for quality using the AGREE II tool which has 23 items under six domains namely scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence.[14] Class I recommendations on AHF Care were then extracted and summarized.

2. **Drafting of the initial order set.** An initial order set was drafted from the guideline review results.
3. **Content validation.** Focused group discussions with stakeholders transpired between February 2021 to April 2022. These were done online via Zoom platform to comply with safety standards during the COVID-19 pandemic. These were recorded and transcribed by the study team with utmost confidentiality.
    a. ***Internal validation.*** A panel of cardiologists from PGH DCVM conducted focused group discussions to assess the initial order set for completeness, feasibility, clarity, and clinical applicability. Proceedings from these discussions are detailed in Appendix Table 3.
    b. ***External validation.*** Representatives from key stakeholders reviewed and revised the order set. Accessibility and availability of resources, cost-effectiveness, responsiveness to patient needs, and suitability in the PGH setting were considered. A consensus among stakeholders to revise, then adopt and implement the order set was sought. This was done on two levels:
        i. Independent, asynchronous evaluation of the order set was made by each stakeholder representative online using Delphi technique for the period of February 2022. This ensured that each participating stakeholder group could independently assess and raise their clarifications on the order set, prior to being exposed to the opinions of the other stakeholders who would then be participating in the subsequent focused group discussion. The process is described as follows:
            1. A copy of the order set with the technical approval of the PGH DCVM was emailed independently to each of the stakeholder group through their respective heads. Every component of the order set was evaluated by these stakeholders.
            2. Each stakeholder group was asked if they concur with each order set component, and points for clarification or suggestions were actively sought. The study team encouraged the stakeholders to send an email to the study core group should any clarification or query arise regarding the order set so these can be addressed promptly.
            3. Each stakeholder group was given at least three weeks to send back their responses through direct email to the study core group.
            4. These responses were gathered by the study core group. Points of consensus were identified and upheld. Points of clarification or non-consensus were also identified to be prioritized in the subsequent focused group discussions between the stakeholders. Utmost confidentiality was upheld in the handling of these comments; each stakeholder group independently and anonymously sent their responses online to the study team.
        ii. Focused group discussions between stakeholder group representatives transpired online, via Zoom platform for the period of March to April 2022, following safety protocols for COVID-19 set by the hospital. The focus of these discussions centered on order set items that had concerns and clarifications based on online Delphi to finally reach consensus. Proceedings of the focused group discussions are detailed in Appendix Table 3.
            1. Heads of the stakeholder groups involved sent one representative to the focused group discussion who was tasked to represent and cast votes for their respective offices.
            2. Proceedings began with the presentation of the summary of anonymized responses from the online Delphi. Items that had no consensus and had clarifications were prioritized.
            3. Consensus was sought among the representatives that ultimately led to the final order set, detailed in Appendix Table 4.

Data Management and Analysis

Appraisal for the available CPGs was done using AGREE II criteria. Data gathered during the FGD were organized to capture the themes that have formed the bases for adopting, and/or modifying order set items. Rationale for deviations from established guidelines were documented. These inputs from multidisciplinary consultation were highlighted in the review.

Order Set Creation

The order set was intended to include the minimum set of interventions that should be done for all patients with AHF seen at the PGH ED. The orders were divided into mandatory orders, which were deemed appropriate for all AHF patients regardless of their clinical presentation; and conditional orders, which are triggered when a specific clinical condition, explicitly stated in the order set, is met. During internal and external validations as well as finalization of the order set, interventions were prioritized based on the best available evidence of effectiveness, availability of resources to implement the interventions, and promotion of equity in service delivery.

The orders were written in active form. To ensure clarity, consensus among stakeholders was sought to specify (1) numerical cut-offs that define clinical criteria to activate

conditional orders (e.g., blood pressure, urine output) and (2) specific medication and initial doses to be prescribed by the order set. Finally, a template was prepared to integrate the final order set to the PGH Electronic Medical Record (EMR).

Ethical Considerations

The study protocol was reviewed, approved by, and implemented under strict compliance to the guidelines from the Research and Ethics Board (REB) of UP Manila (UPM REB 2020-612-01).

RESULTS

Review of Guidelines

At the time of writing, the core group found no local heart failure CPG in the Philippines. Two leading CPGs stood out during the review: 1) the HF Guidelines of the European Society of Cardiology (ESC) (2021) and 2) HF Guidelines of the American College of Cardiology - American Heart Association (ACCF/ AHA) (2021 Update to the 2017 ACC Expert consensus decision).[15,16] These CPGs have been prioritized since these guidelines are more established and are more often cited in Philippine clinical practice. Both guidelines have just recently been updated at the start of this study (2021). The past versions of these guidelines (2013 to 2021) were reviewed to compare which guidelines remained unchanged, and which guidelines have been revised through time.[17-19] After undergoing appraisal using the AGREE II tool, the guidelines were found to be of good quality (See Appendix Table 1). After thorough review, the ACCF/AHA 2021 Updated HF guideline document was excluded since there was no recommendation noted for AHF.

Drafting the initial order set

The initial order set was drafted from the selected guideline interventions from the guideline review. For acute HF, twenty-nine (29) key interventions were selected based on relevance to clinical practice, which can be categorized into 1) clinical assessment and monitoring (5 items); 2) laboratory examination and imaging (16 items); and 3) therapeutics (8 items) which covers both pharmacologic and nonpharmacologic management (See Appendix Table 2).

Content Validation

The order set was reviewed by the PGH DVCM (internal validation) and stakeholders involved in care of patients with AHF at PGH ED (external validation). Findings after internal and external validation procedures are summarized in Appendix Table 3. Certain areas in the discussion of the order set needed further clarification and consensus building among stakeholders during the FGDs. The principles and rationale that became the bases to modify and adopt orders were documented. While there were more comments seeking clarification and consensus to common clinical dilemmas expected to be encountered in patients with AHF at the ED, there were also comments that can be flagged pertaining to PGH context, including accessibility and availability of the proposed intervention (A), material and manpower resources required (R), differences in system or workflow, including presence of care pathways, and identified gaps (S), and new technology that could be introduced as an opportunity to improve care (O).

The final order set that was modified and eventually had consensus to adopt for implementation by the stakeholders is detailed in Appendix Table 4.

DISCUSSION

This paper describes the development of the Acute Heart Failure order set which will be an addition to the clinical pathways and order sets that have been successfully used in PGH for Sepsis and ACS, among others.[20] Discussions with cardiology experts, clinicians, and other stakeholders involved in AHF patient care were collegial and consultative, to ensure the timely and smooth implementation of the order set for PGH.

A clinical definition of AHF patient in the PGH ED, solely based on history and PE, was set to help in early recognition of the AHF and to facilitate early referrals to CVS and General Medicine. PGH, being a government end-referral hospital, admits service AHF patients that are complicated with multiple systemic problems. Cardiac and non-cardiac comorbidities presenting similarly with dyspnea and sharing similar risk factors (i.e., COVID pneumonia, CKD in fluid overload, COPD) make diagnosis of AHF in ED very tricky. Even when just contributing to the primary problem of AHF, these concomitant diseases may complicate or worsen the primary AHF. Prompt diagnosis, often without the benefit of diagnostics, is required since misdiagnosis may delay potentially life-saving management for the true underlying cause of the patient's dyspnea.

The lack of available resources or facilities, insufficient staffing, and healthcare costs continue to be a challenge in many facilities including PGH. Every item in the order set was qualitatively evaluated for its impact on patient outcomes balanced against feasibility and cost-effectiveness. High value diagnostics and equipment in AHF management whose benefits strongly justify the costs were adapted (e.g., NT-ProBNP, Troponin I, POCUS 2DE) and turn-around times for these were defined. Lifesaving therapeutic interventions were also adopted including provision of oxygen therapy, diuretic therapy, inotropes, and vasopressors. Available alternatives for interventions labeled as class I recommendations in the guidelines were presented and appraised for the incremental benefit vis-à-vis the resources needed (i.e., corrected calcium). Finally, defined criteria on patient disposition to ICU or wards were laid out. Order set management should be completed within six hours as part of resuscitation measures for an AHF patient in PGH ED.

The expedited shift to EMR from paper-based records was an opportunity to make care more efficient. Harmonizing existing databases reduces redundancy reported in laboratory information systems and optimizes diagnostic and clinical workflow. The use of EMR to facilitate creation of AHF patient databases and generate data for quality improvement must be reviewed.

During discussions held during this project, understaffing and task overload were frequently cited for delays in care delivery and suboptimal care. Implementing the order set is foreseen to generate demand for better quality care and rationalize the need to procure needed equipment and/or reagents and hire additional skilled personnel for the ER health care team who will keep the pathway operational.

The PGH AHF order set was created for and by the stakeholders at the frontlines, and is specifically tailored to the specific needs and characteristics of patients served by PGH. It serves as a standard for all clinicians managing patients with AHF at the PGH Emergency Department but may also be used for patients who develop AHF in other areas of the hospital.

CONCLUSION

The study developed an order set for patients with AHF in the ED that ensures clinical effectiveness and responsiveness to the specific needs of PGH with due consideration to cost, accessibility, and workflow changes due to COVID-19. It features the standardized orders for patient monitoring, initial diagnostic and therapeutic plans, subspecialty referrals, and patient disposition plan for all patients presenting with acute heart failure in the emergency department and other areas of the hospital.

ORDER SET PILOT IMPLEMENTATION, UPDATING, AND FURTHER RESEARCH

Pilot testing of the PGH HF order set and clinical pathway will be done to assess the impact of implementing the resulting HF order set and clinical pathway, and will form a basis for revisions and updates. Specific benchmarks to determine (1) adherence to order set recommendation and (2) measurable process and impact targets such as timing of orders and referrals, overuse and underuse of diagnostics and therapeutics, and user feedback (ease of implementation, clarity, perceived impact to process flow and outcomes) will be covered in a separate manuscript.

Updating of the order set will be done once new HF guidelines or guideline updates from ACC AHA or ESC are published. Otherwise, updates and revisions of the order set will be done based on feedback from users during implementation and upon deliberation by the Order Set Core Team.

It is hoped that this initiative would guide and empower hospitals and facilities, particularly those with limited resources, in developing their own tools to improve heart failure care.

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PGH AHF Order Set Core Team

Project Consultants
- Dr. John C. Anonuevo, Chairman, Dept. of Medicine
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- Dr. Michelle Pipo, Head, Section of Cardiac Rehabilitation, DCVM
- Dr. Lauren Kay Evangelista, Team Leader, PGH HF QuIPs 2023-present
- Dr. Ruth Divine Agustin, Dept. of Health - DPCB, Past Chief Fellow (2020)

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no significant disclosures, including potential conflict and/or competing interests. None of the project participants were involved in the formulation of the ACC AHA and ESC guidelines (which were the bases of the order set) nor have received any financial remuneration from this or related work.

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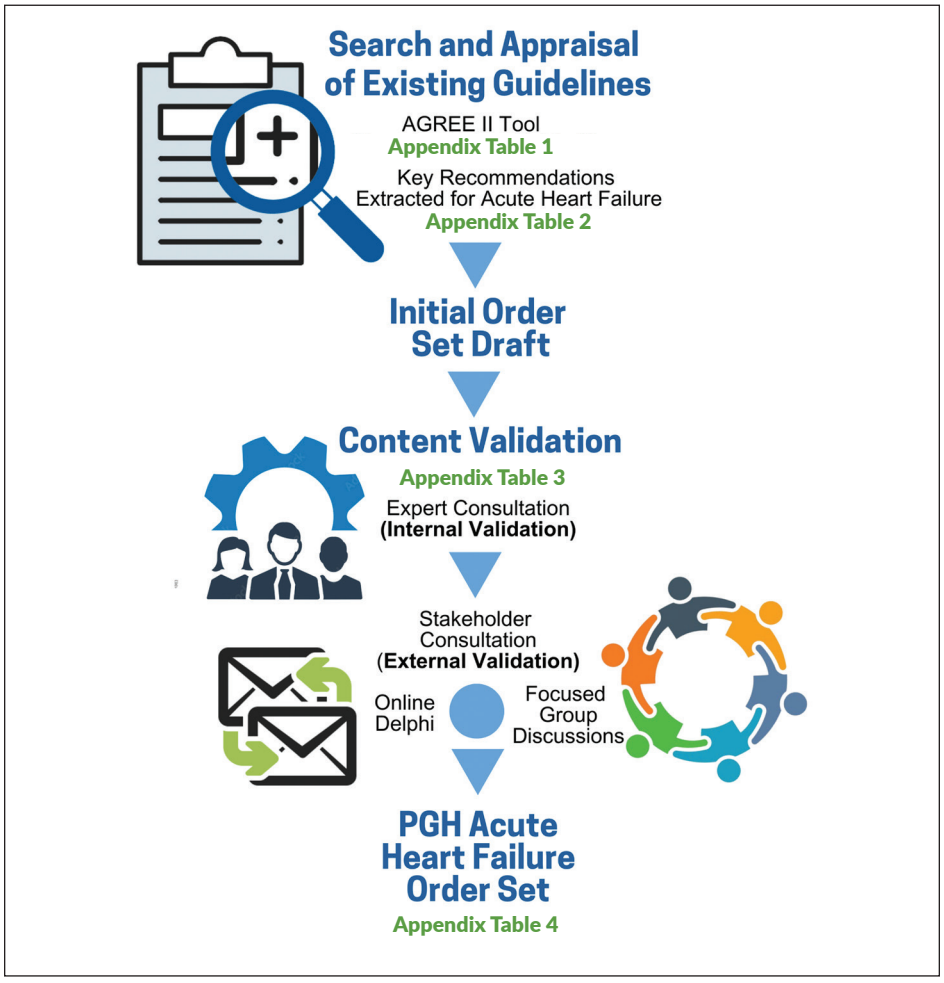
APPENDICES



Appendix Figure 1. Methodology of the PGH Acute Heart Failure Order Set Development.

Appendix Table 1. Guideline Quality Appraisal Using the AGREE II Tool

	Domain 1 Scope & Purpose			Domain 2 Stakeholder Involvement			Domain 3 Rigor of Development								Domain 4 Clarity of Presentation			Domain 5 Applicability				Domain 6 Editorial Independence	
Questions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
ESC 2021	7	7	7	6	7	7	4	4	7	7	7	7	5	7	7	7	7	5	7	4	7	7	7
	7	7	7	6	7	7	4	4	7	7	7	7	5	7	7	7	7	5	7	4	7	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ESC 2016	7	7	7	5	7	7	4	4	7	7	7	7	5	7	7	7	7	5	7	4	7	7	7
	7	7	7	5	7	7	4	4	7	7	7	7	5	7	7	7	7	5	7	4	7	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ACC 2021	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ACC 2017	7	7	7	7	7	7	7	7	7	4	7	7	7	7	7	7	7	4	7	4	4	7	7
	7	7	7	7	7	7	7	7	7	4	7	7	7	7	7	7	7	4	7	4	4	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ACC 2013	7	7	7	7	7	7	7	7	7	4	7	7	7	7	7	7	7	4	7	4	4	7	7
	7	7	7	7	7	7	7	7	7	4	7	7	7	7	7	7	7	4	7	4	4	7	7
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

The authors utilized the AGREE II tool to assess the quality of the appraised guidelines (ACC, ESC, and its revisions) across six domains. Three authors independently reviewed and rated the guidelines, and using the AGREE II tool, deemed these guidelines to be of high quality in all domains, with the benchmark set at >70% Scaled Domain Score per domain. Most comments from the reviewers point on Domain 5, Applicability, and Domain 3, Rigor of Development.

On appraising applicability (Domain 5), both ACC and ESC guidelines stress the importance of clinician judgment in making final decisions on patient treatment. Facilitators and barriers have only been mentioned in passing. Resource implications (i.e., cost) have not been part of the guideline document and are presumed as a separate research agenda. Though not stated in the guideline document, the ACC have developed a set of performance measures that can be used to monitor guideline compliance and patient outcomes.

Both ACC and ESC guidelines were assessed as high-quality on rigor of development. For transparency, citing the literature search methods and specific methods of consensus building was recommended.

Appendix Table 2. Summary of Key Recommendations Based on Review of International Guidelines

Key Intervention	Guideline Recommendation				Key Intervention	Guideline Recommendation			
	ACC/AHA		ESC			ACC/AHA		ESC	
	2013[19]	2017[18]	2016[17]	2021[15]		2013[19]	2017[18]	2016[17]	2021[15]
Vital Signs *Heart Rate *Respiratory Rate *Blood Pressure	I-C		I-C	R	Arterial Blood Gas Procalcitonin D-Dimer Lactate				R R R R
Oxygen Saturation (transcutaneous)	I-C		I-C	R	***Chest X-Ray***	I-C		I-C	C
Continuous ECG monitor			I-C		***Lung Ultrasound***				C
Daily Weight	I-C		I-C		***12L Electrocardiogram***	I-C		I-C	
Fluid Intake/Output	I-C		I-C		***2D Echocardiogram***	I-C		I-C	
Laboratory/ Imaging					***Therapeutics***				
NT-ProBNP	I-A	I-A	I-A	R	VTE Prophylaxis	I-B		I-B	I-A
Cardiac Troponin	I-A	I-A	I-C	R	Inotropes (Dobutamine)	I-C		IIb-C	IIb-C
Ionized Calcium, Magnesium	I-C				Vasopressor (Norepinephrine)			IIb-B	IIb-B
BUN, Creatinine, Sodium, Potassium	I-C		I-C	R	Oxygen Therapy *O_2 Saturation <90			I-C	I-C
Serum glucose	I-C		I-C		*Clinical Dyspnea				M
Complete blood count	I-C		I-C		Loop Diuretics	I-B		I-C	I-C
Liver Function Test	I-C		I-C		Vasodilators (Nitrates)	IIb-A		IIa-B	IIa-B
Thyroid Function Test	I-C		I-C	R					
Urinalysis	I-C				GDMT Continuation	I-B		I-C	I-C

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19. *Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE Jr, Drazner MH, et al; American College of Cardiology Foundation; American Heart Association Task Force on Practice Guidelines. 2013 ACCF/ AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2013 Oct 15;62(16):e147-239.*

Appendix Table 3. Summary of Issues Raised during the Content Validation

Area of Concern	Internal Validation Findings (DCVM/ Cardiology Review)	External Validation Findings (General Stakeholder Review)
Definition of Heart Failure	Definitions of AHF from the ESC and ACC included diagnostics (NT-proBNP, 2D echo) that are problematic in the ED, since the physician should differentiate AHF promptly from the other causes of dyspnea including COVID-19 pneumonia, often without the benefit of diagnostics. Adopt an operational definition of AHF, based solely on history and PE, with the rest of stakeholders.	The operational definition of the AHF patient approved by panel consensus was based on history and PE alone, with a premium on the most common phenotype seen at PGH ED. Including all AHF patients in one single operational definition was difficult. AHF patients present variedly: There are at least four distinct AHF phenotypes based on congestion and perfusion which can even potentially overlap.
Patient Monitoring	Close monitoring is needed in AHF patients, especially for patients on IV diuresis, in shock, and on vasopressor and inotropes. Continuous cardiac monitoring was adapted due to elevated risk for arrhythmias and ACS, regardless of vasopressor requirement. The frequency and resources for monitoring have to be discussed with ED physicians and nursing staff during the FGD **(R)**.	The availability of more cardiac monitors at ED made close monitoring more feasible **(R)**. Telemetry systems that synchronize viewing patients' monitors were recommended **(O)**. Weight monitoring was not adopted yet due to lack of equipment that measures weight especially for bed-bound patients **(R)**. There is a need to hire more healthcare staff and to procure more monitoring equipment **(R)**.
Diagnostic Examinations		
N-Terminal B Natriuretic Peptide (NT-ProBNP)	NT-ProBNP on admission is essential to confirm AHF diagnosis. A negative value prompts the ED physician to look for an alternative diagnosis for the patient's dyspnea.	If NT-ProBNP is normal/low, put a provision to terminate the AHF pathway and tailor the plan according to the more likely diagnosis **(S)**.
Arterial Blood Gas (ABG)	ABG complements NT-ProBNP and CXR to elicit pulmonary/metabolic causes of dyspnea.	ABG is readily available in PGH and results are available in 15 minutes **(A)**.
Ionized Calcium vs Corrected Calcium (Serum Calcium and Albumin); ***Serum Magnesium***	Serum calcium and magnesium determination is important particularly for patients with suspected derangements of electrolytes and renal impairment, which can be associated with arrhythmias.	Serum calcium, albumin, and magnesium are routinely done at ED in AHF for association of hypocalcemia, hypercalcemia, and hypomagnesemia with arrhythmias. Ionized calcium is expensive, tedious to prepare, and is not routinely available in PGH. Corrected calcium (derived from serum calcium and albumin) is a reasonable alternative routinely available in PGH **(A)**.
Troponin I	Though Troponin I has prognostic value in AHF, it is only recommended for those suspected of having ACS. Patients with high likelihood of ACS are referred to the ACS pathway. In this case, ACS pathway supersede the AHF pathway **(S)**.	Baseline, then serial Troponin I are done routinely for AHF in PGH ED practice since absence of chest pain and ischemic ECG findings do not reliably rule out ACS. Request Troponin I if the attending physician clinically suspects ACS.
General concerns on Diagnostic Exams	NT-ProBNP, Troponin I, 12 L ECG, and POCUS 2DE were deemed time-sensitive. Results of NT-ProBNP and Troponin I should be released in 2 hours or less **(S)**. Assure availability of equipment and reagents for these diagnostics, and need for adequate staffing **(R)**. The need for a more efficient communication system for relaying results was emphasized **(S)**. Use of point-of-care testing for critical laboratory exams (i.e., Troponins, electrolytes), is being explored **(O)**.	
12-Lead ECG	A 12L ECG is performed and interpreted within 10 minutes to align AHF to the ACS pathway. AHF can be caused by ACS and time-bound interventions are required to manage ACS **(S)**.	Stakeholders upheld that 12L ECG is to be done and interpreted within 10 minutes.
Point of Care Ultrasound 2D Echocardiogram (POCUS 2DE)	POCUS 2DE is currently done by DCVM for patients with AHF seen within 24 hours of admission. For ED management, POCUS 2DE is deemed adequate for evaluating ejection fraction, systolic function.	The panel clarified that the Cardiology service will be responsible for POCUS 2DE. The panel highlighted the importance of consistent availability of equipment and manpower who do 2DE **(R)**.

Appendix Table 3. Summary of Issues Raised during the Content Validation *(continued)*

Area of Concern	Internal Validation Findings (DCVM/ Cardiology Review)	External Validation Findings (General Stakeholder Review)
Therapeutics		
Oxygen Therapy	DCVM supports the new ESC 2021 recommendation to start oxygen therapy as clinically warranted. Further discussion was suggested during the stakeholder FGD.	No definite oxygen saturation cut-off was recommended by the panel to start oxygen therapy, even with consultation with Pulmonary Medicine.
Furosemide Diuresis	The panel adapted to give Furosemide at 20-40 mg IV bolus and to double the dose (80 mg) if diuretic response is unsatisfactory, defined as urine output of less than 200cc after 2 hours of IV diuretic. Unsatisfactory diuretic response or persistent congestion at 80 mg Furosemide dose may warrant referral to a nephrologist.	The initial dose of Furosemide was left to the ED physician, anticipating higher dose (>40 mg IV of Furosemide) for those on diuretics and with renal impairment. Renal referral was recommended for patients who require high Furosemide doses. Furosemide is deferred if MAP <65 mmHg since many PGH AHF patients come in with borderline BP.
Need for ICU admission	AHF ER order set ends once initial ED resuscitation is completed and need for ICU care is established. ICU-requiring AHF patients require individualized care. Subspecialty co-management may be necessary (i.e., Renal, Pulmonary Medicine)	The need for more ICU beds in PGH to accommodate eligible AHF patients was reviewed **(R)**.

Findings specific for PGH context are marked with the following: A – Accessibility and availability of the proposed intervention; R – Material and manpower resources required; S – Differences in system or workflow, including presence of care pathways, and identified gaps; O – new technology that could be introduced as an opportunity to improve care.

Appendix Table 4. The PGH Acute Heart Failure Order Set (version 2022.1)

The order set will be activated for any adult patient seen in the ER who is suspected to have Acute Heart Failure (AHF), with the following features:
- Typical symptoms of AHF including worsening Dyspnea, on top of Exertional Dyspnea, Orthopnea, and Paroxysmal Nocturnal Dyspnea
- Typical signs such as neck vein engorgement, bilateral pulmonary rales, cardiomegaly (i.e., displaced PMI), S3 gallop, bilateral lower extremity edema +/- signs of hypoperfusion (i.e., hypotension, cool extremities)

Admit to PGH ER

Refer to	• General Medicine (Primary Service)	• Cardiovascular Medicine (CVS)

Patient Monitoring
- Get Baseline Vital Signs (Heart Rate, Respiratory Rate, Blood Pressure, Temperature) and monitor hourly
- Get Baseline Transcutaneous Oxygen Saturation and monitor hourly
- Get Baseline Capillary Blood Glucose and monitor every 4 hours while NPO
- Monitor Urine Output hourly if on IV diuresis (Furosemide), and patients in shock (on inotrope/ vasopressor)
- Monitor Fluid Intake and Output
- Hook patient to Cardiac Monitor at All Times

Diagnostic Examinations and Imaging

Request for the following Routine Diagnostics:

□ 12 Lead ECG within 10 minutes of ER Admission	□ Serum BUN, Creatinine, Sodium, Potassium
□ POCUS 2DE within 24 hours of ER Admission	□ PT/PTT
□ Chest X-Ray	□ Arterial Blood Gas
□ Complete Blood Count	□ Routine Urinalysis
□ NT-ProBNP sent as STAT and followed up in 2 hours	

Request for the following if the patient met the ff conditions:
- □ Troponin HS sent as STAT and follow up in 2H, *if the patient presents with chest pain and with strong clinical/ ECG suspicion of ACS*
- □ Calcium, Albumin, Magnesium, *if baseline chemistry is deranged or with significant renal impairment*
- □ TSH, *if with signs and symptoms of thyroid dysfunction*

Therapeutics: Nonpharmacologic
- NPO temporarily until more stable
- Hook patient to oxygen support, *if clinically dyspneic AND/OR Oxygen Saturation <90%; PaO_2 <60 (ABG), Initiate non-invasive ventilation if with respiratory failure and with no contraindications. Consider intubation if patient cannot be managed noninvasively.*

Therapeutics: Pharmacologic
- □ Start Norepinephrine at 0.2 to 1 mcg/kg/min, *if BP <90/60 with signs of hypoperfusion*
- □ Start Dobutamine at 2 to 20 mcg/kg/min, *if no improvement in BP despite Norepinephrine. Investigate other causes of shock and manage accordingly.*
- □ Start Furosemide ____ mg IV bolus, *if with signs of pulmonary congestion but MAP >65 without signs of hypoperfusion*
- □ Give another Furosemide ____ mg IV bolus. Continue uptitrating diuretic, *if with inadequate improvement in congestion after initial Furosemide IV bolus*[1]
- □ Start Enoxaparin 0.4 cc SC q24H (VTE prophylaxis), *if PT/PTT acceptable and without contraindications*[2]

Disposition from ER
- □ Admit to ICU if the patient meets the following criteria (Check all that apply)
  - □ Shock (BP <90/60 with signs of hypoperfusion) OR with vasopressors
  - □ Refractory Congestion
  - □ Intubated on Mechanical Ventilation
- □ Admit to Wards (Transition Care)

Footnotes:

[1] *ESC 2021 defines satisfactory diuretic response as urine output >100-150 mL/h during the first 6 h after giving the diuretic. A urine output of <200 cc over 2 h indicates unsatisfactory diuretic response. It suggests concurrent intrinsic renal insufficiency. Increasing diuretic dose might help. Consider renal referral for increasing diuretic requirements.*

[2] *Contraindications to VTE prophylaxis include, but are not limited to active bleeding, bleeding diathesis including prolonged INR and severe thrombocytopenia, and concurrent treatment with another anticoagulant such as warfarin or direct oral anticoagulants.*