Quality of Care among Patients with Acute Heart Failure at the Emergency Room and Adherence of Physicians at the University of the Philippines – Philippine General Hospital to the Division of Cardiovascular Medicine – Heart Failure Pathway: A Retrospective Cohort Study

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ABSTRACT

Background and Objectives. Clinical pathways (CPs) ensure adherence to heart failure (HF) management guidelines. To optimize quality care in a low resource setting, an evidence-based care pathway for the management of acute HF was implemented at the emergency department (ED) of the Philippine General Hospital (PGH), the designated national tertiary hospital and referral center. This study aimed to describe the characteristics of adults with acute HF admitted at the ED and evaluate the quality of care they received, measured using physician adherence to the hospital's acute heart failure CP.

Methods. This was a retrospective, descriptive cohort study. We reviewed the inpatient charts of all adult patients with acute HF admitted to the ED of the PGH and referred to the Division of Cardiovascular Medicine between December 1, 2022 and May 31, 2023. Quality of care was assessed based on adherence to quality indicators adapted from routine and conditional order sets detailed in the pathway. Descriptive statistics was utilized to describe patient characteristics, quality of care, and outcomes.

Results. Two hundred thirty-six (236) patients were included, with a mean age of 51.8 years. Majority were male (53.4%); hypertension (61.4%) and ischemic heart disease (53.8%) were the most common comorbidities, and infection the most common precipitant of decompensation (60.6%). There were optimal adherence rates to routine orders, which included referrals to Internal Medicine and Cardiology, baseline vital signs monitoring, fluid intake and output monitoring, chest radiograph, complete blood count, blood urea nitrogen, sodium, potassium, prothrombin time, partial thromboplastin time, arterial blood gas, urinalysis, and N-terminal pro b-type natriuretic peptide. Conditional orders, such as oxygen support, focused echocardiography, thyroid-

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stimulating hormone, and the use of vasopressors, diuretics, and venous thromboembolism prophylactic agents, were optimally performed when warranted. However, we noted suboptimal adherence to certain resource-intensive conditional orders, such as hourly monitoring of urine output (61.4%), hooking to cardiac monitor (53.8%), and performance of 12-lead ECG within 10 minutes (56.8%). Further, only 43.9% of patients were referred to the intensive care unit. Troponin I, calcium, magnesium, and albumin were ordered in excess.

Conclusion. Overall adherence rate of physicians to the hospital's Acute Heart Failure Pathway was satisfactory. Work is needed to improve adherence to hourly urine output monitoring, consistent hooking to cardiac monitor, and timely performance of 12-lead ECG – an effort that begins with expanding in-hospital diagnostic equipment and human resource supply. We recommend continuous pathway implementation with periodic evaluation and stakeholder feedback to further improve quality of care.

Keywords: acute heart failure, care pathway, emergency room, quality of care, quality improvement, physician adherence, Philippines

INTRODUCTION

Background

Heart failure (HF) represents a complex clinical syndrome characterized by structural or functional cardiac abnormalities, which result in subsequent elevation of intracardiac pressures and occasionally, inadequate generation of cardiac output. Its clinical presentation varies widely, ranging from chronic congestion (e.g., dyspnea, edema) to acute or de-novo HF to acute decompensation of a chronically diagnosed patient.[1] HF affects 1-2% of adults in developed countries, but for people over aged 65 presenting to the primary care setting, this figure increases to nearly 20%.[2] In Singapore and Malaysia, HF prevalence is estimated to be 4.5% and 6.7%, respectively, though data for the rest of the Southeast Asian region remains scarce.[3]

Especially for adults aged 65 years and older, acute heart failure (AHF) represents a common reason for emergency room visits and hospitalization, accounting for over 1 million hospitalizations per year in the United States.[4] In the Philippines, a low to middle-income country in Southeast Asia, HF-related hospitalization was reported to comprise 1,648 cases for every 100,000 patient claims in 2014.[5] AHF, with its considerable prevalence and high potential for morbidity and mortality, confers substantial economic burden to the healthcare system, thus necessitating proper identification and stratification of affected patients.[6-9]

Clinical pathways (CPs) are a popular means to achieve high quality AHF care, incorporating best available practices to standardize multidisciplinary care processes and improve patient outcomes while optimizing resource use. In their 2012 systematic review of in-hospital HF CPs, Kul et al. found that CPs for in-hospital treatment of HF decrease mortality rates and length of stay, with no statistically significant impact on readmission rates and hospital costs; importantly, however, all studies included in the final review were of CPs implemented in high-income settings.[7,10–16] Indeed, to this day, there remains a gap in the literature about the use of CPs for AHF in low- and middle-income countries (LMICs), where inadequate healthcare equipment and limited human resources are common, rendering the efficient utilization of limited resources a significant priority. While quality indicators (QIs) have similarly emerged as a tool to evaluate heart failure quality of care in a standardized, evidence-based manner, their application in LMICs remains understudied.

Located in Manila, Philippines, the Philippine General Hospital (PGH) is a 1,500-bed tertiary government-owned hospital and the designated national government referral center, servicing both charity and private patients. To ensure provision of quality care while promoting the efficient allocation of scarce resources, its Division of Cardiovascular Medicine implemented a CP for patients presenting with acute or decompensated HF at the emergency department (ED); validation of this pathway has been described elsewhere.[17] In accordance with published guidelines for the care of patients with AHF, we developed a standardized order set, which included both routine and conditional orders for necessary diagnostics and therapeutic interventions.[1,17,18] In this study, we described AHF patients admitted in our ED, assessed the adherence of our healthcare team to our CP, and evaluated clinical outcomes and quality of care post-CP implementation utilizing a set of QIs our group adapted from best available evidence to our context. It is our hope that this sheds light on the unique barriers to CP implementation and quality of care for AHF patients in the Philippines, with implications for other LMICs facing parallel challenges.

METHODS

Study Population

We performed a retrospective review of electronic medical records of all adults admitted to the ED of the PGH between December 1, 2022 and May 31, 2023. We included all patients aged 19 years old and above diagnosed with acute or decompensated HF and referred to the Division of Cardiovascular Medicine (DCVM), defined based on the 2021 European Society of Cardiology guidelines.[1] The diagnosis of acute or decompensated heart failure were based on set clinical definition as stated in the DCVM Heart Failure Clinical Pathway. Patients with symptoms that can be better explained with an alternate diagnosis were excluded.

The following patient characteristics were examined: age; sex; baseline vital signs; New York Heart Association (NYHA) functional class; comorbidities; history of smoking,

alcohol, and drug intake; etiology of heart failure; causes of decompensation; and ejection fraction, if available. Ejection fraction was taken from either 1) available prior results, or 2) a physician's visual estimate during bedside focused echocardiography performed within the initial 24 hours of admission. Data on patient outcomes was also collected, including mortality rates, discharge rates, and admission rates to the medical ward and intensive care unit. (see Appendix) All patient information was anonymized and maintained strictly confidential, available only to the investigators. This study was conducted in accordance with the principles of the Declaration of Helsinki and the Philippine National Ethical Guidelines for Health Research, and approved by the University of the Philippines Manila Research Ethics Board (protocol number: 2023-0131-01).

Clinical Pathway, Quality Indicators, and Physician Adherence

First implemented in 2022, the AHF pathway of the PGH consists of a set of routine and conditional orders, with routine orders performed in all patients and conditional orders done for specific patients meeting a predefined clinical condition or indication. Routine orders included referrals to Internal Medicine and Cardiology, nil per os (NPO) until stable, patient monitoring, 12-lead electrocardiogram within 10 minutes of admission, chest radiography, and a prespecified set of blood laboratory tests [complete blood count, serum blood urea nitrogen, creatinine, sodium, potassium, prothrombin time (PT), partial thromboplastin time (PTT), arterial blood gas, urinalysis, and N-terminal pro b-type natriuretic peptide (NT-proBNP)]. On the other hand, conditional orders included oxygen support, point-of-care cardiac ultrasound (POCUS), troponin I, serum calcium, albumin, magnesium, thyroid-stimulating hormone (TSH), and enoxaparin for venous thromboembolism prophylaxis.

Our multidisciplinary group, in collaboration with local cardiologists and stakeholders including representatives from the hospital Quality Improvement and Patient Safety Committee, consultant physicians and fellows from Internal Medicine, Emergency Medicine, Cardiovascular Medicine, Pulmonary Medicine, and the Department of Laboratories, and staff representing the hospital electronic medical record and the Departments of Radiology, Nursing, and Pharmacology, formulated a set of quality indicators (QIs), adapting best available evidence to fit local needs.[1,17,19,20] We subsequently evaluated the adherence of the physicians to these QIs. Outcome measures were assessed by determining the proportion of patients eligible or with an indication for specific diagnostic or therapeutic intervention – and no contraindications – who were actually prescribed said modality.[21] The adherence rate for key QIs was expressed as follows:

$$\text{Adherence Rate (\%)} = \frac{\text{All eligible patients who were prescribed the diagnostic or therapeutic modality}}{\text{All patients with an indication and without contraindication for the modality}}$$

An adherence rate of at least 75% was subsequently used as the threshold for optimal quality of care.[21] Adherence to routine and conditional orders were described. In addition, adherence to the use of intravenous diuretics and vasopressors (e.g., norepinephrine and dobutamine) for eligible patients were determined.

Data Analysis

Descriptive statistics was employed to describe clinical characteristics and outcomes for all patients. Continuous variables were presented as mean and standard deviation, while categorical data was captured as count and percentage. All statistical analyses were performed using Stata Version 17.0 (StataCorp LLC, College Station, TX, USA).

RESULTS

Patient Demographics, Clinical Profile, and Outcomes

Table 1 depicts the baseline characteristics of the 236 patients included in our study. The mean age was 51.8 ± 14.9 years, with the majority (53.4%) of patients being male. The mean blood pressure and heart rate on admission were 129 ± 36 mm Hg and 97 ± 28 bpm, respectively. There was a marked predominance of patients presenting with marked limitation of physical activity (63.6%), with less than ordinary activity precipitating dyspnea, chest pain, palpitations, or fatigue (NYHA Functional Class III).[20,22] Common co-morbidities included hypertension (61.4%), ischemic heart disease (53.8%), chronic kidney disease (46.6%), diabetes mellitus (32.2%), and valvular heart disease (17.8%), and among patients with hypertension, most (55.2%) exhibited poor control. Importantly, majority (46.5%) had reduced left ventricular ejection fraction.

In our study, the majority of patients had de novo heart failure (58.5%), defined as acute worsening of heart function without known underlying heart disease while the remaining proportion of patients had acute decompensation of chronic heart failure.[23] Among those with prior diagnosis of heart failure, 24.5% experienced recent admission within the preceding 30 days while 33.3% had a heart failure-related hospitalization within the previous 90 days. The most common identified cause of decompensation was infection (60.6%), followed by nonadherence to dietary or fluid restrictions (40.3%), and nonadherence to medications (33.1%).

Among eighty-two patients eligible for intensive care unit admission, only thirty-six patients were admitted with an adherence rate of 43.9%. The most common identified indications for ICU admission were shock (20.3%) and need for mechanical ventilation (17.4%). Meanwhile, among 152 eligible patients for ward admission, only 113 (74.3%)

were transferred for transition care, while 40 (16.9%) were discharged directly from the ED.

In our cohort, the mortality rate within 24 hours of admission was 8.1%. The clinical pathway was terminated in 20 (8.5%) patients, as they were either deemed to have stable heart failure without signs of decompensation or acute coronary syndrome.

Adherence to Routine Orders

Figure 1 describes physician adherence to both routine and conditional order sets developed for our pathway.

Table 1. Demographic and Clinical Profile of Patients (N=236)

Variable	All Patients (n=236)
Age (years) (mean ± SD)	51.8 ± 14.91
Sex	
Male	126 (53.4%)
Female	110 (46.6%)
Systolic blood pressure (mmHg) (mean ± SD)	129 ± 35.6
Heart rate (bpm) (mean ± SD)	97 ± 27.9
NYHA functional class	
I	0 (0%)
II	43 (18.2%)
III	150 (63.6%)
IV	42 (17.8%)
Comorbidities	
Hypertension	145 (61.4%)
Controlled	65 (44.8%)
Uncontrolled	80 (55.2%)
Ischemic heart disease	127 (53.8%)
Chronic kidney disease	110 (46.6%)
Diabetes mellitus	76 (32.2%)
Valvular heart disease	42 (17.8%)
Cerebrovascular disease	24 (10.2%)
Lifestyle risk factors	
Alcohol use	115 (48.7%)
Smoking	99 (41.9%)
Illicit drug use	24 (10.2%)
Ejection Fraction (n=230)	
≤40%	107 (46.5%)
41-49%	36 (15.7%)
≥50%	87 (37.8%)
Cause of decompensation	
Infection	143 (60.6%)
Dietary/fluid restriction non-adherence	95 (40.3%)
Medication non-adherence	78 (33.1%)
Disposition	
Admitted to ICU	36 (15.3%)
Admitted to ward	113 (47.9%)
Outcome	
Expired within 24 hours of admission	19 (8.1%)
Discharged from ED	40 (16.9%)
Home against medical advice	10 (4.2%)

Referrals to Internal Medicine and Cardiology were carried out for all patients. Similarly, adherence to baseline monitoring of vital signs, oxygen saturations, and capillary blood glucose had adherence rates over 75%. However, only 53.8% of patients were hooked to a cardiac monitor on admission. Monitoring of fluid intake and output was optimally done in 80.5% of patients who entered our CP. However, among patients receiving intravenous diuresis, only 61.4% had intake and output monitored hourly.

A 12-lead electrocardiogram (12L-ECG) was ordered in all patients; however, only 56.8% of patients received one within ten minutes of ED admission. In contrast, adherence to the performance measure of chest radiography was achieved in almost all patients (98.7%). Similarly, we found physician adherence to ordering of routine laboratory tests satisfactory; these included complete blood count, blood urea nitrogen, creatinine, serum sodium, serum potassium, PT, PTT, arterial blood gas, urinalysis, and NT-proBNP.

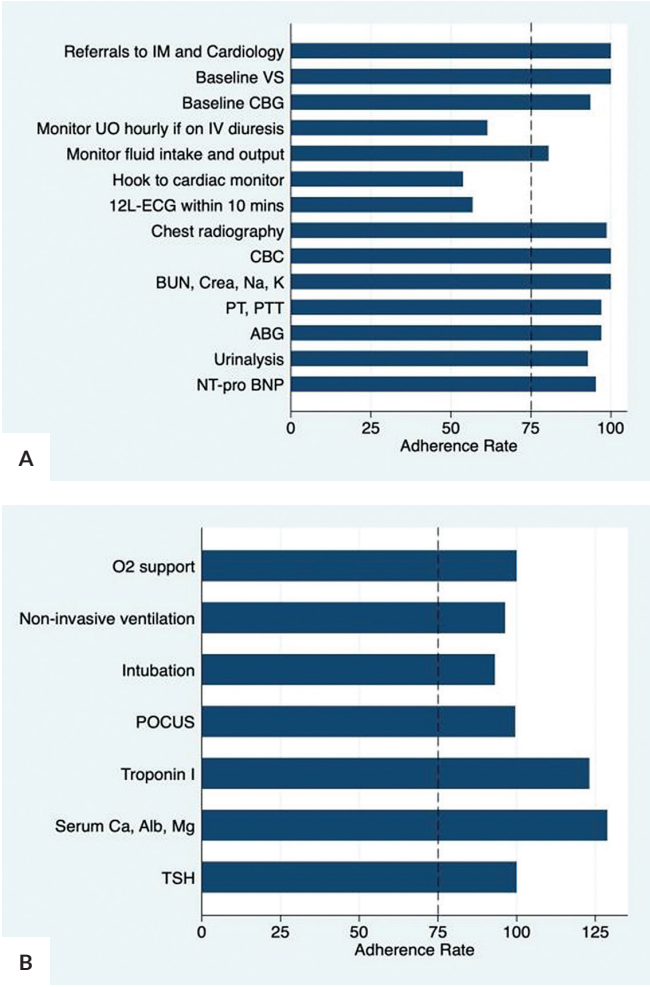

Figure 1. Adherence rates to the quality indicators set by the heart failure pathway; Routine orders **(A)** and conditional orders **(B)**.

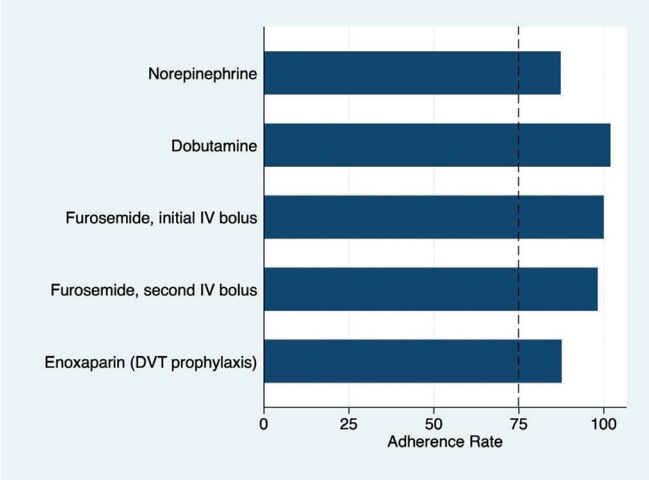

Figure 2. Adherence rates to pharmacologic management.

Adherence to Conditional Orders

In patients with a clinical indication, orders for nil per os (NPO), oxygen support, non-invasive ventilation, and intubation were optimally performed.

In terms of diagnostic tests, we found that point-of-care cardiac ultrasound (POCUS) and thyroid stimulating hormone (TSH) were optimally ordered when indicated. However, Troponin I was ordered excessively, as it was ordered in 149 patients despite only 121 patients demonstrating clear eligibility for the test. Serum calcium, albumin, and magnesium were also ordered excessively.

Adherence to Pharmacologic Management

Figure 2 demonstrates physician adherence to administration of pharmacologic agents for eligible patients. All congested patients requiring diuresis were given intravenous furosemide boluses. Notably, we observed variations in dosing, with some physicians opting to initiate furosemide drip from the beginning, instead of an initial bolus as recommended by the clinical pathway. Deep vein thrombosis prophylaxis (e.g., low molecular weight heparins), as well as vasopressors and inotropes (e.g., norepinephrine and dobutamine), were optimally ordered among eligible patients.

DISCUSSION

Baseline Characteristics and Clinical Profile

In this study of 236 patients with AHF from the PGH ED spanning December 2022 to May 2023, we contribute novel Philippine clinical data and identify critical differences in characteristics between our study population and other registries of AHF. Overall, our study population was younger compared to previous Asian-Pacific and Western registries, such as Asian Sudden Cardiac Death in Heart Failure (ASIAN-HF) (61.6 years), Korean Acute Heart Failure Registry (Kor-AHF) (68 years), Prospective Comparison of ARNI with ARB Global Outcomes in HF with Preserved Ejection Fraction (PARAGON-HF) (72 years), and Prospective Comparison of ARNI with ACEI to Determine Impact on Global Mortality and Morbidity in Heart Failure (PARADIGM-HF)(58 years).[24–27] This is a finding consistent, however, with other recent surveys in the Philippines.[5,28] Furthermore, while previous local studies have identified hypertension as the most prevalent comorbidity, blood pressure control in the AHF population was not explored.[5,28] In our study, we found that most hypertensive patients in our cohort had inadequate blood pressure control. Indeed, beyond atrial fibrillation and myocardial ischemia, uncontrolled hypertension is a recognized significant factor precipitating heart failure-related rehospitalization.[29] The safety and efficacy of optimal blood pressure targets among hypertensive patients with heart failure remains an evidence gap in the management of such patients.[20] More studies are needed to identify prevalent comorbidities of AHF patients in the Philippine setting and assess how various aspects of blood pressure control and renal disease relate to HF outcomes.

Existing registries of AHF in low- and middle-income countries are generally hospital-based and include only patients admitted for AHF, without distinguishing de novo HF from ADHF.[30] Clinically, this distinction is critical given their varying clinical characteristics and prognosis.[31] Our study, the first in the Philippines to disaggregate the AHF ED population into de novo HF versus ADHF, found that the majority of patients had acute de novo heart failure (58.5%). Furthermore, among those with acute decompensation of chronic heart failure, a 30-day rehospitalization rate of 24.5% was observed; about a third (33%) had heart failure-related re-hospitalization within the past three months. Our patients experienced a significantly higher rate of heart failure-related readmission in comparison to international registries, such as in Effect of Nesiritide in Patients with Acute Decompensated Heart Failure (ASCEND-HF) (6% at 30 days), Effects of oral tolvaptan in patients hospitalized for worsening heart failure (EVEREST) (12% at 30 days), Serelaxin, recombinant human relaxin-2, for treatment of acute heart failure (RELAX-AHF) (9% at 60 days), Effect of Ularitide on Cardiovascular Mortality in Acute Heart Failure (TRUE-HF) (7% at 30 days), Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF) (30% at 60-90 days), and the Sub-Saharan Africa Survey of Heart Failure (9% all cause re-hospitalization at 60 days).[32-37] As HF readmissions significantly impact the morbidity, mortality, and overall cost of HF management, our findings underscore the importance of identifying at-risk groups and formulating targeted clinical interventions accordingly.[38] Work is required to further substantiate the mechanisms underlying such disparities.

Infection was the most common identified precipitating factor for decompensation in our study. Medical and dietary nonadherence, which are well-established triggers for heart failure decompensation, were also common in our cohort, but remain lower compared to existing literature, where non-

adherence rates as high as 60% and 80% have been reported for treatment regimen and lifestyle changes, respectively.[38,39] As top contributors to decompensation have been shown to vary across populations, identifying a group's most prevalent precipitants is key to galvanizing effective preventive interventions and preventing future episodes of decompensation.

There are no standard guidelines for intensive care unit admission in patients with heart failure.[40] In our study, the ICU admission rate was 15.3%. Nonetheless, the optimal quality of care of ICU admission was not achieved (43.9% adherence rate) due to limited bed availability, provider decisions based on patient prognosis, and lack of consent for ICU care. In our institution, ICU admissions are triaged by physicians based on clinical status, bed availability, and hospital policies. ICU admission rates for heart failure in the US range from 8% to 32% but are not significantly associated with in-hospital mortality.[40]

Our study cohort had lower mortality rate (8.1%) compared with the study of Tago et al. (13.46%).[28] In a more recent, larger Philippine study of 636 patients, the overall in-hospital mortality rate in HFrEF was 3.9%.[41] Interestingly, these rates are all lower than some Western registries, which document up to a 23.5% mortality rate for acute heart failure.[42] Several reasons for variations in mortality rates have been suggested, including differences in facilities used for patient management and discrepancies in healthcare costs; however, further comparative studies are needed to elucidate the mechanisms that underlie these differences.[5]

Adherence to Routine Orders

The PGH Division of Cardiovascular Medicine AHF pathway was implemented last December 2022. We found that despite optimal adherence rates to most routine orders, there remained suboptimal adherence to hourly urine output monitoring among patients receiving intravenous diuretics, which may present challenges in the evaluation of diuretic responsiveness and acute kidney injury. Several factors may account for this: 1) lack of physician orders, 2) understaffing of ED nurses, and 3) inconsistent documentation of urine output.[43] Further studies are recommended to properly characterize the local in-hospital challenges associated with diuresis and accordingly, the diuretic responses of Filipino patients with AHF.

The 12-lead electrocardiogram is another standard diagnostic test that should be done in all patients presenting with acute heart failure.[39] 12-lead ECG was done in all patients enrolled in the pathway, which was markedly improved compared with data prior to implementation of the pathway (91.35%).[28] However, performance of this diagnostic within the recommended 10 minutes of admission was suboptimal, done in only 56.8% of patients, primarily attributable to low equipment availability. With myocardial ischemia representing an established trigger of heart failure decompensation, early 12-lead ECG is crucial to rule out acute coronary syndrome (ACS); indeed, in our study cohort, ten patients (4.24%) were eventually diagnosed with ACS, leading to termination of the AHF pathway.[39] We propose providing continuous feedback to the stakeholders of the pathway and recommend provision of an ECG machine in the emergency room dedicated to our cardiac patients, with the aim of improving the quality of care for these patients.

In our study population, routine diagnostic tests, which encompass complete blood count, blood urea nitrogen, creatinine, serum sodium, serum potassium, arterial blood gas, and urinalysis, were optimally ordered. Furthermore, the utility rate of the cardiac biomarkers, NT-proBNP and cardiac troponins, showed marked improvement compared before pathway implementation.[28] NT-proBNP has a pivotal role in the differential diagnosis of patients presenting with acute dyspnea, and its role as prognostic marker is well established.[1,39] Within our study cohort, for instance, 4.24% of patients referred for pathway activation were deemed not in decompensation upon the assessment of Cardiology service, due in part to the utility of NT-proBNP. We recommend the continued optimized use of this diagnostic tool in the emergency department.

Adherence to Conditional Orders

Specific, conditional laboratory tests such as serum calcium, albumin, and magnesium, were ordered in excess, despite the fact that they are only indicated in patients with renal impairment and/or initial electrolyte derangements. We also observed that compared to prior studies, serum troponin I was ordered in excess, even among patients with no clear indication for the test.[28] In the setting of ACS, Troponin I has an established diagnostic utility; however, although it has prognostic utility in AHF, it does not aid in the diagnosis and does not constitute a change in management of the disease.[1] Given that the PGH is a resource-limited government hospital, the HF order set was designed with core group members and stakeholders considering the clinical value of diagnostic tests weighed against cost and availability; the group also explored cost-effective alternatives when selecting diagnostics to be included as routine orders.[17] It is for this reason that these tests were recommended to be conditional. Efforts to remind and educate clinicians to practice judicious ordering of diagnostic tests should be upscaled, to minimize unnecessary costs.

Adherence to Pharmacologic Management

Norepinephrine is the preferred vasopressor and dobutamine the preferred inotrope in heart failure patients presenting with significant hypotension.[1,39] The adherence rates on the use of these agents in our study was generally optimal, with dobutamine ordered in excess. This may be attributed to differences in physician discretion and clinical judgment, with some opting to initiate dobutamine over norepinephrine, despite the clinical pathway's recommendation. In addition, some providers opted to administer dobutamine even in the absence of shock, with the intent of supporting

the blood pressure in order to facilitate diuresis. Similarly, although all eligible patients presenting with congestion were given diuretics, some variation in dosing was observed, with some physicians opting to start furosemide drip at the onset instead of the initial intravenous boluses as recommended by the pathway. According to the Diuretic Strategies in Patients with Acute Decompensated Heart Failure (DOSE-AHF Trial), there was no difference in terms of primary outcome of global assessment of symptoms, change in renal function and serious adverse events between continuous infusion and bolus infusion of diuretics.[44,45] More studies are needed to characterize physicians prescribing practices among Filipino AHF patients in shock.

Our thromboembolism prophylaxis rates are optimal and comparable to the results of previous local studies.[28] The use of thromboembolism prophylaxis is recommended in all patients with acute heart failure to reduce the risk of venous thromboembolism unless there are clear contraindications.[1,39] Concomitant use of other anti-thrombotic medications (i.e., therapeutic anticoagulation, typically with vitamin K antagonist or direct oral anticoagulants), as well as a perceived, individualized high risk for bleeding, may contribute to physician non-ordering.

Limitations

CPs are designed to improve the quality of care and outcomes for specific patient groups.[46] Quality of care studies and registries on performance improvement have also been shown to improve the initiation of HF therapies, improve the quality of care and outcomes of heart failure patients.[47] Our study evaluates the state of quality of care of AHF patients in our emergency department following implementation of our AHF CP and by doing so, characterizes the status of and challenges to AHF care in resource-limited settings. However, this study was limited only to the initial identification, diagnosis, and initial medical stabilization of heart failure patients at the emergency department within 24 hours of admission. The adherence rates to the clinical pathway do not entirely reflect the clinical outcomes of the involved participants.

Further, it is important to note that due to the retrospective, descriptive nature of the study, potential sources of bias may affect its results. Selection bias can arise from non-random sampling, while information bias (i.e., recall by patients or misclassification by physicians) can influence the accuracy of exposure and outcome data. Such limitations must be considered when interpreting our study's findings.

Future Directions

More studies are needed to assess the impact of the PGH DCVM Heart Failure Pathway on patient outcomes. Upon reviewer suggestion, we recommend a future study describing baseline clinical characteristics in more depth (e.g., percentage of ED consultations that are for AHF, ECG findings on presentation), as our study focused primarily on quality of care. In addition, to better quantify in delays in care (e.g., ECG performance) for AHF patients in the emergency room, a future time and motion study is recommended, in order to provide detailed insights into workflow inefficiencies and more specific time intervals contributing to delays. Lastly, to understand the long-term clinical impact of the hospital CP (e.g., overall in-hospital mortality, 30- and 90-day hospitalization), we suggest undertaking a cohort study with longer follow-up times, spanning admission to the ward, subsequent discharge to outpatient care, and long-term follow-up.

CONCLUSION

A total of 236 patients were included in our study cohort. Hypertension, ischemic heart disease, and chronic kidney disease are amongst the most common comorbidities. The mortality rate within twenty-four hours of admission was 8.1%. The adherence of the physicians to the Heart Failure Pathway was generally optimal. Identified areas of improvement include: 1) accurate hourly urine output monitoring among those receiving intravenous diuresis, 2) consistent hooking to cardiac monitor, and 3) timely performance of 12-lead ECG – an effort that begins with expanding in-hospital diagnostic equipment and human resource supply. Furthermore, a more selective, judicious approach should be instituted in ordering diagnostic tests (e.g., serum calcium, albumin, magnesium, and troponin I) to optimize cost-effectiveness. We recommend continuous pathway implementation with periodic evaluation and stakeholder feedback to further improve quality of care.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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APPENDIX

Data Collection Sheet

PATIENT'S IDENTIFIER NUMBER:	**Age:** _____ □ Male □ Female	**Weight:** _____ kg **Height:** _____ cm	**NYHA Functional Class:** □ I □ II □ III □ IV
Comorbidities			
• Hypertension	• Acute Kidney Injury	• Cerebrovascular Disease	• Smoking
• Ischemic Heart Disease	• Diabetes Mellitus	• Dyslipidemia	• Alcohol use
• Valvular Heart Disease	• Chronic Kidney Disease	• Cancer	• Illicit drug use

HISTORY			
worsening dyspnea exertional dyspnea paroxysmal nocturnal dyspnea orthopnea angina			
PHYSICAL EXAMINATION			
Vital signs: BP: _____ HR: _____ RR: _____ O_2 sat: _____ JVP: _____ **Chest:** Rales: basal mid pulmonary edema wheezes decreased breath sound Others: _____ **Heart:** distinct heart sounds S3 gallop Rhythm: regular irregular murmur _____ displaced PMI thrills heaves Others: _____		**Abdomen:** positive fluid wave hepatomegaly _____ **Extremities:** pulses: full thready Bipedal edema grade: _____ cool extremities poor CRT Others: _____ **Neuro:** altered sensorium Others: _____	
Referred to:	**Done:**	**Not done:**	**Variance:**
• Internal Medicine			
• Cardiology			
Patient Monitoring:	**Done:**	**Not done:**	**Variance:**
• 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			
Routine Diagnostics	**Done:**	**Not done:**	**Variance:**
• 12L ECG within 10 minutes of ER admission			
• Chest X-ray			
• Complete Blood Count			
• Serum BUN, Creatinine, Sodium Potassium			
• PT/PTT			
• Arterial blood gas			
• Urinalysis			
• NT-proBNP			

Conditional Diagnostics	**Done:**	**Not done:**	**Variance:**
Considering the following: • cardiac tamponade • pulmonary embolism or • other indications • POCUS echocardiography			
• With symptoms or ECG changes suggestive of Acute Coronary Syndrome • Troponin I			
• Deranged electrolytes and with significant renal impairment • Serum Ca, Alb, Mg in next blood extraction			
• With symptoms and signs of thyroid dysfunction • TSH			
Therapeutics: Nonpharmacologic	**Done:**	**Not done:**	**Variance:**
• NPO temporarily until hemodynamically stable			
• Hook to O_2 support for SpO_2 <90% on pulse oximetry or PaO_2 <60 mm Hg on ABG, or based on the clinician's judgment for patients with dyspnea			
• Initiate non-invasive ventilation if with respiratory failure and with no contraindications			
• Intubate if respiratory failure cannot be managed non-invasively			
Therapeutics: Pharmacologic	**Done:**	**Not done:**	**Variance:**
• If with MAP <65 mm Hg with signs of hypoperfusion, start Norepinephrine at 0.2 to 1 mcg/kg/min			
• If unable to reach MAP of >65 mm Hg despite Norepinephrine, start Dobutamine at 2 to 20 mcg/kg/min			
• Investigate other causes of shock and manage accordingly			
• If with signs of pulmonary congestion but MAP >65 mm Hg without signs of hypoperfusion, start Furosemide _____ mg IV bolus			
• If with inadequate improvement in congestion after initial Furosemide IV bolus, give another Furosemide _____ mg IV bolus. Continue uptitrating diuretics.			
• Enoxaparin 40 mg SC as DVT prophylaxis, if there are no contraindications			
Disposition:	**Done:**	**Not done:**	**Variance:**

• Admit to ICU if with presence of any of the following (check what applies):
  • Shock (MAP <65 mm Hg with signs of hypoperfusion) OR with vasopressors
  • Refractory congestion
  • Intubated on mechanical ventilation			

• Admit to wards (transition care)			
• Home against medical advice			
• Expired			
• Discharged from ED			