Journal of the Saudi Heart Association

Volume 33 | Issue 2 Article 5

2021

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Recommended Citation

Hoo, Yee Yin; Mazlan-Kepli, Wardati; Hasan, Wan Nurul Huda Wan; Chen, Fan Jie; Devadas, Prashanthini; Chow, Yan Yee; Sow, Qian Yi; Azizan, Azrol Amar; Muizz Abd Malek, Abdul; Seng Kiong Lau, Glendon; and Chua, Ping Lik (2021) "A Quality Improvement Approach to Reduce 30-Day Readmissions and Mortality in Patients with Acute Decompensated Heart Failure," *Journal of the Saudi Heart Association*: Vol. 33 : Iss. 2 , Article 5.
Available at: https://doi.org/10.37616/2212-5043.1247

ORIGINAL ARTICLE

A Quality Improvement Approach to Reduce 30-day Readmissions and Mortality in Patients with Acute Decompensated Heart Failure

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Abstract

Objectives: **Heart failure [HF] hospital readmissions are a continued challenge in the care of HF patients, which contribute substantially to the high costs of the disease and high mortality rate in lower to middle income country. We implemented a quality improvement project to improve patient outcomes and resource utilization.**

Methods: **This study was a prospective cohort design with a historical comparison group. It was conducted to assess the difference in 30-day readmissions and mortality and to assess compliance rate with HF guideline between the historical pre-intervention audit 1 cohort and prospective post-intervention audit 2 cohorts. Audit 1 cohort were recruited from January to February 2019, whereas, audit 2 cohort which received the bundled intervention program were recruited from July to December 2019. Clinical outcomes were compared between cohorts using 30-day readmissions and mortality.**

Results: **A total of 50 and 164 patients were included in audit 1 and audit 2 cohort, respectively. Patients in the audit 2 cohort were younger [63.0 ± 14.5 in audit 1 vs 56.5 ± 12.7 in audit 2, p = 0.003] and majority were male [50.0% in audit 1 vs 72.0% in audit2, p = 0.004]. Thirty-day readmissions were significantly different [36.0% audit 1 vs. 22.0% audit 2, p = 0.045], but the mortality rates were similar [4.0%% audit 1 vs. 5.5% audit 2, p = 0.677] between two cohorts.**

Conclusion: **A significant decrease in 30-day readmissions was observed in the post-intervention audit 2 cohort in our setting. Further study in larger population and prolong study follow-up is warranted.**

Keywords: Congestive heart failure, Left ventricular failure, Heart failure

1. Background

Heart failure [HF] poses significant health and economic challenges. In Malaysia, the disease is an essential cause of hospitalization accounting for 6.7%−9.0% of all acute medical admissions [1,2]. The cost of managing HF is high. In 2012, the estimated overall HF economic cost was $USD108 billion [MYR 462 billion] per annum globally and $USD 194 million [MYR 830 million] for Malaysia [3]. A diagnosis of HF in Asia pacific region is expensive and disastrous to the patients, his family members, society and nation [4].

HF patients are prone to repetitive hospital admissions. To make the matter worse, the pool of potential HF patients is estimated to be expanded due to aging population and by the successes of treating other ischemic heart diseases [5]. Readmission measures are estimates of unplanned readmission for any reason to an acute care hospital in the 30 days after discharge from a hospitalization. High hospital readmission rate is used in certain government as indicators of poor care or missed

Received 3 December 2020; revised 11 March 2021; accepted 16 March 2021.
Available online 03 May 2021

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https://doi.org/10.37616/2212-5043.1247

opportunities to better coordinate care [6]. In the western countries, rates of HF 30-day readmissions range between 19.6% and 24.7% [5,7], while in Asian countries, the rate is between 3.0% and 15.0% and for Malaysia, 30-days HF readmissions is 8.0% [8]. It is of note that readmission range between western and Asian countries are not head to head trial and thus should not be compared directly.

There are many factors accounted for early readmission following HF hospitalization and these were not easily categorized into mutually exclusive reasons. Some of the common cause such as development of new condition or worsening of the underlying chronic diseases [9], was not preventable. On the other hand, some of the factors deemed avoidable include: potentially premature discharge from index admission, inadequate coordinating care transition and discharge planning, underuse of heart failure medications, insufficient patient education and follow-up [10,11]. Increased attention to these factors is important in optimizing HF management.

Multidisciplinary team approach which strengthens the communication between healthcare teams, prompt outpatient follow-up, hospital quality-improvement programs, consistency in implementing evidence-based practice [11–17] were well-documented in reducing HF readmissions. Notably, many of these strategies were translated from interventions tested in controlled environments and complemented with huge manpower and resources. It is thus challenging to implement it in daily practice and scientific publication may not reflect all variables in the real-world setting. Determining factors which may contribute to readmission in own facilities are therefore important and audit is a useful tool in doing so.

This quality improvement project aims to improve patient outcomes and resource utilization. The specific objectives were: To assess the difference in 30-day readmissions and mortality between the historical pre-intervention audit 1 cohort and prospective post-intervention audit 2 cohorts, and to assess compliance rate with HF guideline.

2. Materials and methods

2.1. Study design

This study was a prospective cohort design with a historical comparison group. Hypothesis was made that there was no difference in 30-day readmissions between the 2 audit cohorts. A BIP was implemented as part of the HF usual care from April 2019 onward to address issues arise in audit 1. A six months follow-up audit [Audit 2] was then carried out from July to December 2019. A case report form was used to facilitate data collection. The data collected from the case notes include: baseline characteristics, comorbidities, aetiologies of ADHF and aetiologies of readmissions. The design of the work has been approved by Ministry of Health Malaysia and waiver of informed consent obtained from Medical Research Ethics Committee [MREC] [NMRR-18-3591-44996]. Individual consent for participation was not required as all patients received the BIP as part of their usual care. The study adhered to strict information governance and security protocols.

Abbreviation list

ACEI	Angiotensin-converting enzyme inhibitors
ACS	Acute coronary syndrome
ADHF	Acute decompensated heart failure
ARB	Angiotensin receptor blockers
ARNI	Angiotensin neprilysin inhibitors
BIP	Bundled intervention program
CABG	Coronary artery bypass graft
DM	Diabetes mellitus
HF	Heart failure
IHD	Ischaemic heart disease
LVEF	Left ventricular ejection fraction
MRA	Mineralocorticoid receptor antagonists
MYR	Malaysian ringgit
PCI	Percutaneous coronary intervention
RAAS	Renin angiotensin aldosterone system
USD	U.S. dollar

2.2. Study setting and study population

All ADHF patients admitted to cardiology ward Hospital Serdang Malaysia, a tertiary referral cardiology centre was included in the audit, irrespective of their underlying aetiology. These patients were identified by the confirmed primary diagnosis of ADHF by the auditors. Exclusion criteria were patients below 18-years old, patients who passed away or required inpatient coronary artery bypass graft [CABG] during index admission. CABG patients were excluded because they were transferred to cardiothoracic ward and the HF care will be managed by a different team. The index admissions were defined as the first admission carrying ADHF as a primary diagnosis for a patient from 1st January 2019 to 31st December 2019. ADHF readmissions for the same patient during the audit period, only the first admission for the year was included among index admissions.

2.3. Outcomes

The clinical outcomes of ADHF patients were measured using 30-day readmissions and mortality.

30-day all-cause readmissions were defined as an admission to a hospital within 30 days of discharge from the same or another hospital. Lengths of initial hospitalizations were calculated and 30-day all-cause readmissions were examined via clinical notes. The prespecified period of readmission was within 30 days of discharge with at least 24 h' unplanned stay in hospital. The aetiologies of 30-day readmissions were also recorded.

2.4. Description of audit key indicators

Audit key indicators were adopted and adapted from 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure [18], 2014 Management of Heart Failure 3rd Edition Clinical Practice Guideline 2014 [19] and Target: HF Strategies and Clinical Tools [20]. A total of 7 audit key indicators were established in audit 1. The key indicators include provide immediate care, review by specialists, initiate specific treatment, obtained baseline echocardiography, initiate and up-titrate HF key medications, device therapy referral if indicated and clinic provider follow-up. The compliance with HF guidelines was determined via compliance with the audit key indicators.

2.5. Bundle intervention program [BIP]

A BIP was implemented to address issues arise in baseline audit. This included a multidisciplinary ward round lead by a cardiologist, inclusion of treatment checklist in patients' bed head ticket, inpatient cardiac rehabilitation and dieticians counselling session, medication reconciliation, 30 min standardized patient education and HF management counselling by pharmacist. The standardized education content provided by the multidisciplinary team consist of instructions on medications, daily weight monitoring, diet and sodium intake, exercise, a list of symptoms for patients to report if they experienced; and smoking cessation. Family members and caregivers were included in the educational sessions when available and verbal consent obtained on willing to participate. The standardized educational session was to reduce variances in information provided to HF patients and families, with staff consistently delivering the same message across the continuum of care.

2.6. Statistical analysis

Statistical analysis was performed using IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Descriptive statistics were used for demographic characteristics, determining readmissions and mortality rate. The characteristics of patient cohorts in audit 1 and audit 2 was compared using Chi-square and Fisher's Exact test for categorical variables and Student's t-test for continuous variables. An independent sample Mann-Whitney *U* test was utilized when comparing non-parametric data such as total length of stay and left ventricular ejection fraction [LVEF], as these data violated the assumptions of parametric tests. Further analyses were repeated by excluding patients undergoing PCI. A significance level of $P < 0.05$ was considered statistically significant for all tests.

3. Results

3.1. Baseline characteristics

During the entire audit period, a total of 265 patients were admitted due to ADHF, 214 were eligible for recruitment. Fifty and 164 patients were included in audit 1 and audit 2 cohort respectively. Patients in audit 2 were younger [63.0 ± 14.5 years in audit 1, 56.5 ± 12.7 years in audit 2; $p = 0.003$] and majority were male [50% in audit 1, 72.0% in audit 2; $p = 0.004$] [Table 1]. There was no statistically significant difference in length of hospital stay and LVEF between audit 1 and audit 2 cohorts. Similar baseline characteristics pattern was observed between 2 cohorts before and after PCI patients were excluded [Table 1].

3.2. Audit key indicators

Seven audit key indicators were monitored during audit 1. Audit key indicators such as providing immediate care, review by specialist achieved 100% in all patients in both audit cycle. LVEF was assessed in 58.0% of all audit 1 patients while in the hospital or they had an assessment before hospitalization. This subsequently significantly increased to 81.6% in audit 2, $p = 0.001$. There are also more patients with optimized blood pressure at discharge in audit 2 [60.0% in audit 1 versus 79.9% in audit 2; $p = 0.006$].

In comparison to the audit 1 cohort, the proportion of HF patients in audit 2 cohort prescribed with a beta-blocker [58.0% in audit 1 versus 78.0% in audit 2, $p = 0.006$] increased significantly. Throughout the audit period, several measures were added to reduce readmissions. Of note, the proportion of patients with a documented reason of RAAS [32.1% in audit 1 vs 67.5% in audit 2, $p = 0.002$] and MRA ineligibility [18.2% in audit 1 vs 51.6% in audit 2, $p = 0.001$] increased significantly respectively [Table 2].

Table 1. Baseline characteristics.

Variable	All Patients [N = 214]			Patients with PCI Excluded [N = 196]		
	Audit 1 [n = 50]	Audit 2 [n = 164]	p-value	Audit 1 [n = 50]	Audit 2 [n = 146]	p-value
Age, years	63.0 ± 14.5	56.6 ± 12.7	0.003	63.0 ± 14.5	57.5 ± 12.5	0.01
Male	25 [50.0]	118 [72.0]	0.004	25 [50.0]	104 [71.2]	0.006
Median LVEF, % [IQR]	39 [23.5]	33.5 [20.0]	0.069	39 [23.5]	30.6 [21.0]	0.098
Median length of stay, days [IQR]	6 [7]	7 [8]	0.312	6 [7]	7 [7]	0.332
Comorbidities						
IHD and ACS events	23 [46.0]	98 [59.8]	0.086	23 [46.0]	90 [61.6]	0.053
Arrhythmias	10 [20.0]	23 [14.0]	0.370	10 [20.0]	20 [13.7]	0.285
Past Stroke/TIA events	6 [12.0]	11 [6.7]	0.238	6 [12.0]	11 [7.5]	0.333
Diabetes mellitus	30 [60.0]	103 [62.8]	0.741	30 [60.0]	98 [67.1]	0.361
Hyperlipidaemia	23 [46.0]	39 [23.8]	0.003	23 [46.0]	35 [24.0]	0.003
Metabolic derangements [ex: thyroid disease, Addison disease]	5 [10.0]	6 [3.7]	0.134	5 [10.0]	6 [4.1]	0.118
Immune mediated & inflammatory damage [autoimmune disease]	0 [0.0]	8 [4.9]	0.203	0 [0.0]	8 [5.5]	0.091
Infiltration [cancer, malignancy, amyloidosis, sarcoidosis, pompe disease, connective tissue disorders]	0 [0.0]	2 [1.2]	1.000	0 [0.0]	2 [1.4]	1.000
Peripartum cardiomyopathy	0 [0.0]	0 [0.0]	–	0 [0.0]	0 [0.0]	–
Asthma/COPD	8 [16.0]	14 [8.5]	0.180	8 [16.0]	12 [8.2]	0.117
CKD/ESRF	11 [22.0]	44 [26.8]	0.581	11 [22.0]	42 [28.8]	0.352
Hypertension	36 [72.0]	110 [67.1]	0.604	36 [72.0]	104 [71.2]	0.917
Genetic abnormalities	0 [0.0]	0 [0.0]	–	0 [0.0]	0 [0.0]	–
Valvular heart disease	4 [8.0]	10 [6.1]	0.744	4 [8.0]	9 [6.2]	0.743
Others	10 [20.0]	58 [35.4]	0.056	10 [20.0]	55 [37.3]	0.022
Aetiology of ADHF						
Ischemic, ACS events	2 [4.0]	55 [33.5]	0.001	2 [4.0]	47 [32.2]	0.001
Non-compliant to fluid	0 [0.0]	27 [16.5]	0.001	0 [0.0]	27 [18.5]	0.001
Non-compliant to medication	0 [0.0]	1 [0.6]	1.000	0 [0.0]	1 [0.7]	1.000
Uncontrolled hypertension	2 [4.0]	4 [2.4]	0.626	2 [4.0]	3 [2.1]	0.603
Arrhythmia	2 [4.0]	6 [3.7]	1.000	2 [4.0]	6 [4.1]	1.000
Superimposed infection	7 [14.0]	11 [6.7]	0.142	7 [14.0]	11 [7.5]	0.172
Thyroid disease	0 [0.0]	0 [0.0]	–	0 [0.0]	0 [0.0]	–
Worsening renal disease	0 [0.0]	10 [6.1]	0.121	0 [0.0]	9 [6.2]	0.115
Valvular heart disease	2 [4.0]	2 [1.2]	0.233	2 [4.0]	2 [1.4]	0.269
Other factors [etc. non-ischemic DCM]	0 [0.0]	15 [9.1]	0.025	0 [0.0]	13 [8.9]	0.042
Mixed factors	34 [68.0]	33 [20.1]	0.001	34 [68.0]	29 [19.9]	0.001
ADHF factors not documented	1 [2.0]	10 [6.1]	0.464	1 [2.0]	8 [5.5]	0.452

Data are n [%] unless stated otherwise. Data expressed as mean ± standard deviation for continuous variables. ACS, acute coronary syndrome; ADHF, acute decompensated heart failure; CKD: chronic kidney disease; COPD: chronic obstructive pulmonary disease; DCM, dilated cardiomyopathy; DM: diabetes mellitus; LVEF: left ventricular ejection fraction; TIA: transient ischemic attack.

3.3. Thirty-day readmissions and mortality

The study showed that 30-day readmissions were significantly different [36.0% audit 1 cohort vs. 22.0% for the audit 2 cohort respectively, p = 0.045] [Table 3a]. However, when further analyses repeated by excluding patients undergoing PCI, these results were attenuated [Table 3b]. The mortality rates were similar for both cohorts before and after excluding patients undergone PCI [Table 3a, b]. Among the aetiologies of readmission, non-compliant to fluid was common in audit 1, and was significantly lower in audit 2, [45.0%in audit 1 vs 0.0% in audit 2; p = 0.001, Table 4]. Readmission aetiologies were not significantly different for all other causes [Table 4].

4. Discussion

This quality improvement project improved patients' outcomes and resource utilization in our centre. Thirty-day readmissions were both numerically and statistically reduced in the post-intervention audit 2 cohort in our setting treated with BIP.

Table 2. Audit key indicators.

Audit Standard	Variables	Audit 1 [n = 50]	Audit 2 [n = 164]	p-value
Provide immediate care	Provide immediate care	50 [100.0]	164 [100]	1.000
Review by specialists	Review by specialists	50 [100.0]	164 [100]	1.000
Initiate Specific Treatment	To start appropriate therapy to target & control symptoms	50 [100.0]	164 [100]	1.000
	Optimize BP	30 [60.0]	131 [79.9]	0.006
Perform echocardiography	Availability of echocardiography within the same year	29 [58.0]	133 [81.6]	0.001
Initiate and up-titrate HF key medications	Initiate RAAS	22 [44.0]	84 [51.2]	0.421
	Initiate Beta Blocker	29 [58.0]	128 [78.0]	0.006
	Initiate MRA	17 [34.0]	71 [43.3]	0.256
	Initiate Ivabradine	1 [2.0]	12 [7.3]	0.308
	Patients with documented reason for RAAS ineligibility	n = 28 9 [32.1]	n = 80 54 [67.5]	0.002
	Patients with documented reason for Beta Blocker ineligibility	n = 21 11 [52.4]	n = 36 18 [50.0]	1.000
	Patients with documented reason for MRA ineligibility	n = 33 6 [18.2]	n = 93 48 [51.6]	0.001
	Patients with documented reason for Ivabradine ineligibility	n = 49 0 [0.0]	n = 152 15 [9.9]	0.024
Device therapy referral	Device Therapy Referral	0 [0.0]	8 [4.9]	0.203
HF counselling	HF Management Counselling by Pharmacist	0 [0.0]	144 [87.8]	0.001
	Cardiac Rehabilitation Counselling During Admission	0 [0.0]	68 [41.5]	0.001
	Dietitian Counselling During Admission	0 [0.0]	72 [43.9]	0.001
Follow ups/referrals	Cardiologist follow-up only	50 [100.0]	100 [61.0]	0.001
	Primary care follow-up only	0 [0.0]	4 [2.4]	0.575
	Both cardiologist and primary care follow-up	0 [0.0]	50 [30.5]	0.001
	Follow-up not mentioned	0 [0.0]	10 [6.1]	0.121
Telephone follow up	Nurses Follow-Up Phone Calls	0 [0.0]	78 [47.6]	0.001

Data are n [%] unless stated otherwise.

Table 3a. 30-day Readmissions and Mortality (All patients).

Clinical Outcomes	Audit 1 [n = 50]	Audit 2 [n = 164]	p-value
30-day Readmissions	18 [36.0]	36 [22.0]	0.045
30-day Mortality	2 [4.0]	9 [5.5]	0.677

Data are n [%] unless stated otherwise.

Table 3b. 30-day Readmissions and Mortality of HF patients on medical treatment [repeated analysis by excluding patients with PCI].

Clinical Outcomes	Audit 1 [n = 50]	Audit 2 [n = 146]	p-value
30-day Readmissions	18 [36.0]	33 [22.6]	0.062
30-day Mortality	2 [4.0]	9 [6.2]	0.733

Data are n [%] unless stated otherwise.

Table 4. 30-day readmissions and mortality aetiologies.

Variable	Audit 1 [n = 20]	Audit 2 [n = 45]	p-value
Ischemic, ACS events	3 [15.0]	11 [24.4]	0.521
Non-compliant to medication	0 [0.0]	8 [17.8]	0.051
Non-compliant to fluid	9 [45.0]	0 [0.0]	0.001
Uncontrolled hypertension	0 [0.0]	0 [0.0]	–
Arrhythmia	0 [0.0]	2 [4.4]	1.000
Superimposed infection	4 [20.0]	2 [4.4]	0.067
Thyroid disease	1 [5.0]	0 [0.0]	0.308
Worsening renal disease	1 [5.0]	2 [4.4]	1.000
Valvular heart disease	0 [0.0]	0 [0.0]	–
Other factors [etc. non-ischemic DCM, over-warfarin]	0 [0.0]	3 [6.7]	0.547
Mixed factors	0 [0.0]	4 [8.9]	0.303
ADHF factors not documented	2 [10.0]	9 [20.0]	0.480

Data are n [%] unless stated otherwise.

Our patients were relatively younger, co-morbidities were generally common, compared to other countries [21], and more likely to battle with this chronic disease longer. Thus, reducing readmission is utmost important.

In our study, 30-day readmissions were reduced to 22.0% in audit 2 cohort; where other studies show a substantial variation in 30-day readmissions ranging between 6% and 23% [17,22–24]. The variation of results was due to the different inclusion and exclusion criteria. We found that in one study which obtained good reduction in 30-day readmissions, patients with concomitant illnesses which could influence short term prognosis such as concomitant unstable angina or acute myocardial infarction were excluded [22]. In the additional analyses, the 30-day readmissions were attenuated but

the mortality rate was similar after patients underwent PCI were excluded. We postulated that mortality benefit may be significant if follow up duration was prolonged. This is showed in a Korean acute HF registry which recruited Asia patients with acute ischemic HF; where the rate of death from any cause was lower over a period of 4 years [32].

The decrease in hospital readmissions made additional patient beds available where more patients could be treated. Our program was unique where an existing multidisciplinary service was consolidated and utilized; rather than creating a new resource-intensive service. Combining strength from various healthcare personnel is essential and this was the highlight in a meta-analysis where isolated intervention has small effects and did not associate with a reduced 30-day readmissions while bundled interventions which postulated to change the value in cultural or organization factors have an additive effect [25].

Despite this study showed that 30-day readmissions were reduced in audit 2 cohort, treatment gap and low compliance rate with evidence-based recommendations for ADHF patients among practitioner still exist for a considerable large proportion of patients. This include the availability of echocardiography, initiation of HF key medications, referral to cardiac rehabilitation and nurses phone calls follow up. Echocardiography used less often in audit 1 cohort, highlighting potential opportunities to improve outcomes. Despite the rate increased to 79.9% after BIP was introduced, this still leaves 20.1% of patients not accessing echocardiography in hospital and having no record of a recent echocardiography within the last six months. The use of handheld echocardiography and brain natriuretic peptides [BNP] level was shown to reduce the needs of a time-consuming full scan on every HF patient before discharge. Both methods are also effective to optimize intravascular volume status. Thus these interventions may be considered in future management of HF patients [22].

A lower than recommended rate of prescribing HF key medications before patients discharge was profound when compared to other Asia countries [4,8]. The prescription of beta-blockers improved markedly after the introduction of BIP. Still, the prescribing rate for Renin angiotensin aldosterone system [RAAS] blockers, mineralocorticoid receptor antagonists [MRA] and ivabradine were not significantly increased. Our prescribing rate for RAAS blockers, beta-blockers, MRA after introduction of BIP program was 51.2%, 78.0%, 43.3%, respectively, versus 83.0%, 87.0%, 53.0% in 2016–2017 national heart failure audit in UK [26] and 63.0%, 41.0% and 31.0% in Asia pacific registry [4].

In this study, patients with documented reason for ineligibility increased substantially for both agents after introduction of BIP program. This may suggest the increase of awareness of prescribing key modifying agents. With new evidence involving the introduction of ARNI [27]; and ivabradine pre-discharge without increasing adverse events [28]; achieving higher prescription rates for all these agents during discharge and titration to the maximum tolerated or target dose should be a goal and an area for targeting better practice in the next audit.

BIP programme increased education through infographic and direct counselling to ensure understanding of HF diagnosis, symptom recognition, adherence of medicines, sodium and fluid restriction, weight monitoring, physical activity level and exercise plan. This was done by medical officers, pharmacists, dietician and cardiac rehabilitation physicians. The previous study demonstrated that patients who were not able to recognize HF symptoms delayed for days before reacting [29]. Thus, education is essential and method to increase the counselling rate should be conducted.

This audit cohort captures data on the guideline-based management of HF in the cardiology ward in a single tertiary referral centre, which requires interpretation within certain limitations as multimorbid case-mix our centre attracts may not be entirely generalisable. This study is subject to inherent selection bias as patients who underwent CABG were excluded but patients who underwent PCI were not. In order to overcome this inherent selection bias, the additional analyses were done by excluding patients undergoing PCI.

5. Conclusion

This quality improvement project provides an overview of the current practice. The study demonstrated that increased adherence to guideline-directed HF management could be achieved through clinical audit and agreed intervention program. Project lessons learned suggest that all parties should be actively involved in changing practices at the facilities, and greater collaboration between the multidisciplinary team with consistent mentoring by experienced clinicians is essential to ensure sustainment of the practice change.

Disclosure of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors OR Conflict of interest: none declared.

Disclosures of any conflict of interest

Conflict of interest: none declared.

Author's contribution

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Acknowledgement

The authors would like to thank the Director-General of Health Malaysia for the permission to publish this paper. We would like to express our sincere gratitude for everyone who has involved directly or indirectly in helping us to complete this study.

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