

Supplementary materials to: Fletcher DB, Loh GL, Chang GS et al. Advancing cardiology pharmacy practice: A position paper on physician-led, pharmacist-enabled model for sustainable cardiovascular care. *Ann Acad Med Singap* 2025;54:721-84.

DOI: <https://doi.org/10.47102/annals-acadmedsg.2025147>.

Appendix S1. Emerging cardiology pharmacist services in Singapore.

Clinic Element	NHCS Post-MI	NHCS HF	KTPH Combined	CGH Post-MI	CGH HF / CVRF	TTSH Post-MI / PCI	TTSH HF	TTSH Gen Card	NTFGH Post-PCI	NTFGH HF	NUH Post-MI	NUH HF MTMC	WH Gen Cardio Clinic	SKH
Optimize guideline-directed medical therapy (GDMT) for:	MI, CVRF	HF	MI, HF, AF, CVRF, OAC	MI, CVRF	HF, CVRF	MI, HF, AF, CVRF	MI, HF, AF, CVRF	MI, HF, AF, CVRF	Post-PCI, CVRF	HF	MI + complications	HF, CVRF	MI, HF, AF, CVRF, OAC	HF
Patients seen per session	4 - 10	4 – 10	6 – 7	5 -6 (up to 10)	4 – 5 (up to 10)	8-10	7-8	8-10	10-15	25-35 (shared pool)	8-12	8-10	6-8	2-5
Scope outside of drug titrations E.g. devices, TTE and other investigations as instructed by doctor (Dr)	No	No	Order ECG / TTE if needed (collaboration with Dr)	No	No	Order ECG / TTE / stress testing for vocational licensing	Order ECG if needed	Order ECG if needed	Order ECG, stress testing (in collaboration with Dr)	Discuss ischemic workup, echo, device, (in collaboration with Dr)	May order and interpret post-MI MPI or ECG, Clear for vocational driving.	No	Order ECG / TTE (in collaboration with Dr)	No
Patient Referrals & Status: Newly discharged (DC) (high risk), from SOC or Both	Newly DC	Both	Both, majority newly DC	From SOC	Both	Mostly newly DC, or SOC abnormal results	Both	Both	Post-PCI, after SOC Dr & Nurse review	Both	Both, majority newly DC	Both	Both	Both
Situations escalated to the Dr	Initiation of medication (per CPA)	Initiation of medication (per CPA)	Concurrence with Dr on plan, or per escalation criteria	For angina	Concurrence with Dr unless mild overload	For angina with un-revascularized lesions for coronary angiogram, non-cardiac symptoms e.g. stroke, bleed	If requires admission or incongruent clinical picture	If worsening or unable to manage outpatient	For angina	Concurrence with Dr on plan, refer if unsure of management	Per escalation criteria or red flags	Specific red flags: Chest pain, NYHA III, Cr > 30%, K > 5.5mmol/L	Red flag / escalation criteria / for admission, when in doubt for concurrence with Dr	Red Flag
Reviews patients post-DC, before patients see their primary Drs	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes, original intent was to review within one month from discharge but lead time is too long now.	Mostly no	Yes	Yes
Formulates and executes pharmacotherapy plan without need to clear with Dr	Yes	Yes	Yes (with CPA); No (no CPA)	Yes	Yes	Yes	Yes (with CPA); No (no CPA) till Drs comfortable	Yes	Yes	Yes	Yes. Complexity of patient mix is high.	Yes	Yes (with CPA); No (no CPA)	Yes

Clinic Element	NHCS Post-MI	NHCS HF	KTPH Combined	CGH Post-MI	CGH HF / CVRF	TTSH Post-MI / PCI	TTSH HF	TTSH Gen Card	NTFGH Post-PCI	NTFGH HF	NUH Post-MI	NUH HF MTMC	WH Gen Cardio Clinic	SKH
MOH APF Pharmacy Practitioner Quadrant	B	B	C, D	B, C	B, C	C, D	B, C, D	C, D	B, C	B, C	D	B, C	B, C, D	B, C
Key: <u>Institutions:</u> CGH: Changi General Hospital, KTPH: Khoo Teck Puat Hospital, NHCS: National Heart Centre, Singapore, NTFGH: Ng Teng Fong General Hospital, NUH: National University Hospital, SKH: Sengkang General Hospital, TTSH: Tan Tock Seng Hospital, WH: Woodland Health Campus. <u>Services:</u> AF: Atrial Fibrillation, CVRF: Cardiovascular Risk Factors, Gen Card: General Cardiology, HF: Heart Failure, MI: Myocardial Infarction, MTMC: Medication Therapy Management Clinic, PCI: Percutaneous Coronary Intervention, OAC: Oral Anticoagulant Clinic <u>Other abbreviations:</u> APF: Advanced Practice Framework, CPA: Collaborative prescribing agreement, SOC: Specialized Outpatient Clinic														

Note: Information updated as of August 2024.

Appendix 2A. Projection of the cardiovascular disease burden in Singapore

Estimated Disease Burden of Acute Myocardial Infarction, Heart Failure, and Atrial Fibrillation in Singapore in Years 2024, 2030, and 2035[^]

Year	2024	2030	2035
Acute Myocardial Infarction (Incidence, per 100,000 people)	482	598	742
Heart failure (Prevalence, per 100,000 people)	369–400	417–452	457–495
Atrial fibrillation (Prevalence, per 100,000 people)	1989–2029	2775–2831	3486–3556

[^] Based on data from the National Registry of Disease Office¹ & Ministry of Health Singapore (Resources and Statistics).²

Derivation of Estimated Disease Burden of Acute Myocardial Infarction (AMI)

Disease burden for AMI	Incidence of AMI (Per 100,000 people) *
Current prevalence	482 (based on 2025 projection)
Estimate by 2030	598
Estimate by 2035	742

* Extracted from a Singapore study by Chew *et al.* (2023),³ Supplementary Table 1: Projected incidence of acute myocardial infarction per 100,000 population from 2025 to 2050 for each metabolic risk factor, stratified by sex and ethnicity.

Derivation of Estimated Disease Burden of Heart Failure (HF)

Disease burden for HF	Per 100,000 people	Per 100,000 people*
Current prevalence	369	400
Estimate by 2030	417	452
Estimate by 2035	457	495

- Extrapolated based on the prevalence reported by Feng *et al.* (2024),⁴ Epidemiology and burden of HF in Asia.
- According to Goh *et al.* (2024),⁵ it is postulated that heart disease shows a linear increase in prevalence over time, unaffected by confounders, with a specified rate of increase annually or every five years. The crude prevalence is primarily attributed to heart failure as a significant contributing factor.
- Age group of patients that have significant contribution to the overall prevalence rates are from 40 or above 40 years old.

* As per MOH data in 2017, diabetes mellitus (DM) without AMI is the major contributor to incidence of HF. Based on the MOH website,² the prevalence of DM is about 8.5% in 2021-2022.

Derivation of Estimated Disease Burden of Atrial Fibrillation (AF)

Disease burden for AF	Per 100,000 people (45–64 years old)	Per 100,000 people (≥65 years old)	Per 100,000 people overall	Per 100,000 people overall *
Current prevalence	1,171	9,120	1,989	2,029
Estimate by 2030	1,386	10,570	2,775	2,831
Estimate by 2035	1,564	11,780	3,486	3,556
- Extrapolated based on of the prevalence reported by Yap <i>et al.</i> (2008).⁶ - Number of individuals in the respective age groups were extracted from the data from the Department of Statistics Singapore.⁷ - The numbers were forecasted to estimate the numbers of 2030 and 2035. - The total number of patients living with AF were estimated based on the number of residents in each age group and the number of patients living with AF in each age group. Assumptions: - Linear increment without confounders from other factors. - Number of patients who have AF in the age group of below 45 years is not significant in contributing to the overall prevalence rates.				* Assumptions: - Obesity rates continue to increase, - Obesity contributes about 2% of disease burden,

Appendix 2B. Projection of the cardiovascular disease burden in Singapore.

Cardiovascular disease	Phase of patient care	Distribution of care for disease burden (in %)	Workload based on disease burden	Pharmacist level of skill and competencies	
				Ratio of specialist pharmacist to patient numbers	Ratio of general pharmacist (pegged at R1 residency or DFP Domain 1 at Advanced Level) to patient numbers
Acute and Chronic Coronary Syndrome	Acute phase	20	13000 a year (35 a day, 178 admitted at any one time based on LOS 5 days)	1:20 (CCU/Cardiac HD / General Ward Rounds) = 8-9 specialist pharmacists	-
	Early discharge phase	20	13000 a year (35 a day, 245 a week)	8 patients for half day clinic session, 5 sessions a week = 40 patients per pharmacist = 6-7 specialist pharmacists	-
	Long term care phase	60	60000-80000 (1538 per week if seen once a year)	-	80 patients per pharmacist per week = 20 pharmacists
Heart Failure	Acute phase	20	4800 (13 a day, 92 admitted at any one time based on LOS 7 days)	1:15 (CCU/Cardiac HD / General Ward Rounds) = 6-7 specialist pharmacists	-
	Early discharge phase	20	4800 (13 a day, 92 a week, 368 based on each requiring 4 follow up visits)	8 patients for half day clinic session, 5 sessions a week = 40 patients per pharmacist = 9-10 specialist pharmacists	-
	Long term care phase	60	14400 (1107 per week if seen 4 times a year)	-	80 patients per pharmacist per week = 14 pharmacists
Atrial Fibrillation	Acute phase	100	4000-6000 (present at hospital a year)	1:15 (CCU/Cardiac HD / General Ward Rounds) = 4-5 specialist pharmacists	-
	Early discharge phase	-	-	8 patients for half day clinic session, 5 sessions a week = 40 patients per pharmacist = 2-3 specialist pharmacists	-
	Overall burden	-	~83000 (1596 a week if seen once a year)	-	80 patients per pharmacist per week = 20 pharmacists
Combined	-	-	-	20 to 30 specialist pharmacists	50 to 60 pharmacists

CCU: coronary care unit; Gen Cardio: general cardiology; LOS, length of stay.

References

1. National Registry of Diseases Office, Health Promotion Board. Singapore Myocardial Infarction Registry: Annual Report 2021, Sep 2023. Available at: [https://www.nrdo.gov.sg/docs/librariesprovider3/default-document-library/smir-annual-report-2021-\(web\)_final.pdf?sfvrsn=3418ed95_0](https://www.nrdo.gov.sg/docs/librariesprovider3/default-document-library/smir-annual-report-2021-(web)_final.pdf?sfvrsn=3418ed95_0). Accessed on 14 October 2025.
2. Epidemiology & Disease Control Division, Ministry of Health, Singapore and Institute for Health Metrics and Evaluation (2019) *The Burden of Disease in Singapore, 1990–2017: An overview of the Global Burden of Disease Study 2017 results*. 31 May. Available at: <https://www.moh.gov.sg/others/resources-and-statistics/singapore-burden-of-disease-report-2017> Accessed on 14 October 2025.
3. Chew, N.W.S., Chong, B., Kuo, S.M. *et al.* (2023) ‘Trends and predictions of metabolic risk factors for acute myocardial infarction: findings from a multiethnic nationwide cohort’, *Lancet Regional Health – Western Pacific*, 37, p. 100803. doi:10.1016/j.lanwpc.2023.100803.
4. Feng, J., Zhang, Y., & Zhang, J. (2024). Epidemiology and burden of heart failure in Asia. *JACC: Asia*, 4(4), 249–264. <https://doi.org/10.1016/j.jacasi.2024.01.013>
5. Goh, Z. M., Javed, W., Shabi, M., Klassen, J. R. L., Saunderson, C. E. D., Farley, J., Spurr, M., Dall’Armellina, E., Levelt, E., Greenwood, J., Halliday, B., Plein, S., & Swoboda, P. (2023). Early prediction of left ventricular function improvement in patients with new-onset heart failure and presumed non-ischaemic aetiology. *Open Heart*, 10(2), e002429. <https://doi.org/10.1136/openhrt-2023-002429>
6. Yap, K. B., Ng, T. P., & Ong, H. Y. (2008). Low prevalence of atrial fibrillation in community-dwelling Chinese aged 55 years or older in Singapore: A population-based study. *Journal of Electrocardiology*, 41(2), 94–98. <https://doi.org/10.1016/j.jelectrocard.2007.03.012>
7. Singapore Department of Statistics. SingStat Table Builder: Singapore Residents By Age Group, Ethnic Group And Sex, At End June, 24 Sep 2024. Available at: <https://tablebuilder.singstat.gov.sg/table/TS/M810011>. Accessed on 24 Sep 2024.