Direct medical cost of newly diagnosed stable coronary artery disease in Hong Kong

Vivian W Y Lee,[1] Yat Yin Lam,[2] Amy C M Yuen,[1] Shuk Yan Cheung,[1] Cheuk-Man Yu,[2] Bryan P Y Yan[2]

[1]School of Pharmacy, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong
[2]Department of Medicine and Therapeutics, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong

Correspondence to
Professor Vivian W Y Lee, School of Pharmacy, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; vivianlee@cuhk.edu.hk

Received 16 August 2012
Revised 27 September 2012
Accepted 25 November 2012

ABSTRACT

Background Stable coronary artery disease (CAD) affects approximately 7% of the population of Hong Kong and is associated with substantial healthcare costs.

Objective We aimed to evaluate the first-year direct medical cost for a patient with newly diagnosed stable CAD at a tertiary care public hospital in Hong Kong and to identify CAD-related resource consumption pattern among different patient subgroups.

Methods 89 consecutive patients with newly diagnosed stable CAD at our institution from January 2007 to December 2009 were retrospectively analysed. Direct medical costs including hospitalisation, clinic visits, diagnostic tests, laboratory tests, invasive procedures and medications were calculated for 1 year after diagnosis. Mann-Whitney tests were performed to compare median costs in patients with and without hypertension, diabetes mellitus and hyperlipidaemia, and in patients undergoing coronary intervention and those who were not.

Results The mean first-year total direct medical cost of newly diagnosed stable CAD per patient was US$11 477. Hospitalisation was the dominant cost item accounting for 29.2% of the total cost. The total cost for patients who underwent invasive coronary procedure was higher than those treated medically alone (US$14 787 vs US$6121, p<0.001). Hyperlipidaemia was associated with higher incremental costs than hypertension and diabetes mellitus (p<0.001).
(1US$=7.8HK$).

Conclusions Huge healthcare expenses are incurred in the first year of stable CAD diagnosis from the perspective of the local public healthcare system. Healthcare costs are highest among patients with hyperlipidaemia and those undergoing invasive coronary procedures (even discounting costs for procedural consumables). Strategies for cost saving and preventive measures should be implemented to lower healthcare expenditure associated with CAD.

INTRODUCTION

Heart disease is one of the most prevalent and debilitating chronic illnesses. In Hong Kong, it ranks as the second leading cause of death and constitutes 16.3% of total mortality.[1] Among the various cardiac conditions, coronary artery disease (CAD) accounts for the majority of heart diseases deaths, up to 67.5% in 2008 according to the Centre for Health Protection of Hong Kong.[2] The prevalence of stable CAD in persons aged 15–84 years in Hong Kong was approximately 6.9%.[3] In 2008, ischaemic heart diseases and associated complications (International Classification of Diseases (ICD) 10 I20, I23–25) contributed to 2638 deaths and around 25 000 hospital admissions in Hong Kong.[4]

The most common manifestation of stable CAD is angina (chest pain). Angina that occurs regularly with activity or at other predictable times is termed stable angina (SA) (ICD 10 I20). Angina usually occurs in patients with CAD but can also occur in individuals with valvular heart disease, hypertrophic cardiomyopathy and uncontrolled hypertension. Stable CAD may progress to acute coronary syndrome including unstable angina, myocardial infarction (MI) and death. In addition to the prognostic implications, angina can markedly impair quality of life and functional capacity.

The management of stable CAD consists of medical therapy and invasive coronary intervention such as percutaneous coronary invention (PCI) and coronary artery bypass graft (CABG) surgery which consumes enormous monetary resources and imposes substantial burden on the healthcare financial system. In the UK, economic analysis of stable CAD has been performed to evaluate the annual cost of the disease to the National Health Service in 2000. In a study of 634 000 patients, the total direct cost of stable CAD counting hospitalisation, revascularisation procedures, outpatient visits, general practitioner consultations and pharmacological treatment costs, was estimated to be £669 million (HK$7.9 billion; £1=11.8HK$).[5] In Canada, the annual cost of chronic SA paid by patients plus indirect costs involved found that the average cost of illness was around $C19 000 per patient per year (HK$114 000, 1$C=6HK$).[6] In USA, the annual direct cost of chronic SA in patients with newly diagnosed CAD was US$188 million (HK$14.7 billion, 1$US=7.8HKS).[7] These overseas data have provided good insight to the economic burden that the disease may bring to the diseased individuals as well as the healthcare provider. Although overseas data can provide a general picture of the cost of stable CAD, these data were mostly outdated and may not adequately reflect current local therapeutic and disease management patterns. Cost-of-illness study in the field of CAD is limited in Hong Kong. In 2005, a 1-year cost-of-illness analysis evaluating the annual cost of acute myocardial infarction (AMI) management and resources consumption pattern was conducted.[8] However, there is a lack of local cost-of-illness analysis for stable CAD which can be used to guide quality improvement initiatives and inform medical resource allocation.

This cost-of-illness study therefore aims to estimate the cost incurred by the diagnosis and management of newly documented cases of stable CAD

To cite: Lee VWY, Lam YY, Yuen ACM, *et al*. *Heart Asia* Published Online First: 2 January 2013 doi:10.1136/heartasia-2012-010168

in Hong Kong. The economic evaluation is undertaken from the perspective of the local public healthcare provider, the hospital authority (HA). Comparisons of costs between patients with and without hypertension (HTN), diabetes mellitus (DM) and hyperlipidaemia, and patients undergoing and not undergoing invasive coronary procedures, were evaluated.

METHODS

A retrospective case note review was adopted in this study using the clinical management system (CMS) from the HA. A total of 206 consecutive patients who underwent coronary angiography and 100 consecutive patients with positive cardiac exercise stress test from 1 January 2007 to 31 December 2009 were screened from the Prince of Wales Hospital which is a public tertiary hospital. Of these patients, 89 were eligible subjects with newly diagnosed stable CAD defined by stable chest pain syndromes and either a positive exercise stress test or significant CAD on angiography. Patients were excluded if they had unstable angina, prior history of MI or coronary revascularisation. Patients with active malignancy or a life expectancy <1 year were excluded from this study.

Exercise testing is well-established for the diagnosis of CAD. The definition of a positive exercise test is ≥1 mm of horizontal or down-sloping ST segment depression or elevation for ≥60–80 ms after the end of the QRS complex. Significant CAD on angiography is defined by the presence of ≥50% luminal narrowing in one or more major epicardial coronary artery. Antianginal drugs were defined as drugs intended to alleviate symptoms or ischaemia, such as β blockers, calcium antagonists and nitrates.

Medical events were followed up to 1 year through review of patient records in the CMS. Patient demographics, clinical characteristics, inpatient care, outpatient clinic visits, accident and emergency department admissions, diagnostic procedures, radiological examinations, laboratory tests, therapeutic operations (PCI and CABG) and medications were identified. The Ethics Committee of the Chinese University of Hong Kong approved this study.

DIRECT MEDICAL COSTS

The direct medical costs in this evaluation were defined as the sum of the cost for diagnosis of stable CAD and cost of first-year management of this medical event in public hospitals in the New Territories East Cluster in Hong Kong, comprising hospitalisation, clinic visits, accident and emergency department admission, diagnostic, radiological and laboratory tests, procedures (PCI and CABG) and drugs. The unit costs of medications and all direct medical items were based on the list of drugs cost 2008–2010 from the Prince of Wales Hospital and the Hong Kong Government Gazette 2003 respectively. The medications under consideration were aspirin, clopidogrel, DM drugs, lipid lowering agents, angiotensin-converting enzyme inhibitors, β blockers, nitrates and calcium channel blockers (table 1). Consumables during PCI including angioplasty balloons and stents were self-financed by all patients. Social security and Samaritan Funds are available for subsidy application in patients with financial difficulties. As the perspective of this study was that of HA; the cost for PCI consumables would be neglected in the cost summation.

STATISTICAL ANALYSES

The costs for each direct medical item would be presented in mean±SD and more importantly in median (quartiles) and range, as the data collected were of high possibility of having

Table 1 Summary of healthcare resource cost estimates for patients newly diagnosed with stable angina who were first admitted to the public hospitals (New Territories East Cluster) in Hong Kong between 1 January 2007 to 31 December 2009

Direct medical item	Mean cost (HK$)*
Daily hospital bed	
Public ward	3300
Private ward	3900
Doctor fee	1500
Outpatient clinic	
Public: general outpatient clinic (GOPC)	215
Public: specialist outpatient clinic (SOPC)	700
Private: initial consultation from one specialty	1500
Private: follow-up	1000
Admission	
Accident and emergency department	570
Diagnostic procedures	
Non-invasive (ECG)	300
Cardiological ambulatory: intermediate (24-h Holter ECG, ETT, echocardiogram)	1800
Cardiological ambulatory: major (stress echocardiogram)	3000
Cardiological invasive: intermediate (cardiac catheterisation, coronary angiogram)	14000
Radiology	
Group 1 (Chest x-ray)	895
Group IV(USG)	2150
Group VII (CT)	3275
Group IX (MRI)	6050
Laboratory tests	
Routine haematology (CBC, ESR, RCC, Differential WCC)	130
Coagulation (APTT, PT)	430
Special haematology (HbA_{1c}, folate, B_{12})	355
Troponin (cTnT), cardiac enzymes (CE)	300
Blood chemical pathology (LFT, RFT, LDH, CPK, Glu, FBGlu, TSH, CRP)	300
Blood chemical pathology (miscellaneous-FOBT)	200
Lipid panel (cholesterol, triglycerides)	300
Microbiology: general bacteriology	765
Microbiology: virology	805
Microbiology: serology	290
Therapeutic operations	
Major 1 (PTCA and related procedures)	27550
Ultra-major II (CABG)	63250
Cost of PCI consumables (including balloon, stent, guide wires, etc)†	
Tier 1	12000
Tier 2	18000
Tier 3	25000
Tier 4	36000
Tier 5	48000
Medications‡	
ASA, H_2-antagonists, clopidogrel, antithrombotics, nitrates, β blockers, ACEIs, ARBs, CCBs, diuretics, α_1 blockers, lipid-lowering agents, anti-DM drugs, etc	

*The mean direct medical cost was decided with regard to the List of Charges, Hong Kong Government Gazette 2003.
†The 5-tier system was based on the judgment of physicians with regard to what type of PCI consumables they used.
‡The list of drugs cost 2008–2010 was retrieved from a confidential document from The Prince of Wales Hospital.
ACEI, angiotensin-converting enzyme inhibitors; APTT, activated partial thromboplastin time; ARB, angiotensin receptor blocker; ASA, aspirin; CABG, coronary artery bypass graft; CBC, complete blood count; CCB, calcium channel blocker; CE, cardiac enzymes; CPK, creatinine phosphokinase; CRP, C-reactive protein; DM, diabetes mellitus; ESR, erythrocyte sedimentation rate; FOBT, fecal occult blood test; LFT, liver function test; PT, prothrombin time; PTCA, percutaneous transluminal coronary angioplasty; PCI, percutaneous coronary intervention=PTCA with stenting; RCC, red cell count; RFT, renal function test; TSH, thyroid stimulating hormone; USG, ultrasound guided; WCC, white cell count.

existing outliers, to which the median values are supposed to be less sensitive. Non-parametric Mann-Whitney tests were performed using the Statistics Package for Social Sciences (SPSS for Windows, V.16.0, 2007, SPSS Inc., Chicago, Illinois, USA) in order to compare the medians of individual cost items and the total cost for two sample groups respectively. The null hypothesis (Ho) was that the medians of the two samples were equal. A p value less than 0.05 was considered statistically significant and would reject Ho, implying that a difference was found between the medians. The importance of adopting non-parametric tests rather than parametric independent samples t-tests was that the data did not need to be normally distributed, the sample size was not restricted to be over 30 and the presence of outliers definitely favoured the use of the non-parametric tests.

RESULTS

A total of 89 patients' medical and dispensing records from the CMS were investigated. All study subjects were followed fully for a period of 1 year after the initial diagnosis of stable CAD, with no deaths identified. The demographic summary including the use of drugs in management, baseline laboratory results and hospital stay characteristics of our subjects are listed in table 2.

Table 2 Demographic summary of study subjects

Demographic characteristics	
Number of study subjects; n	89
Gender; n (%)	
Men	63 (69. 2)
Women	26 (28.6)
Mean age at the time of diagnosis±SD (years)	62.3±9.8
Age range (y)	38–88
Social history; n (%)	
Unknown	16 (18.0)
Non-smoker	44 (49.4)
Ex-smoker	14 (15.7)
Smoker	15 (16.9)
Comorbidities; n (%)	
Hypertension*	57 (64.0)
Diabetes mellitus†	36 (40.4)
Hyperlipidaemia†	74 (83.1)
Comorbid with either two of the above diseases	34 (38.2)
Comorbid with all three above diseases	24 (27.0)
Average length of hospital stay±SD (days)	5.4±5.1
Required PTCA; n (%)	46 (51.7)
BMS	18 (39.1)
DES	28 (60.9)
Required CABG; n (%)	10 (11.2)
Use of drugs for SA management	n (%)
Low dose aspirin (75–150 mg four times a day)	82 (92.1)
Clopidogrel	58 (65.2)
ACEIs	40 (44.9)
Lipid-lowering agents	74 (83.1)
β blockers	64 (71.9)
Nitrates	55 (61.8)
CCBs	30 (33.7)

*Deduced from physician' s diagnosis.
†Deduced from the use of medications.
ACEI, angiotensin-converting enzyme inhibitors; BMS, bare metal stent; CABG, coronary artery bypass graft; CCB, calcium channel blocker; DES, drug eluting stent; PTCA, percutaneous transluminal coronary angioplasty; SA, stable angina.

The mean age at the time of diagnosis was 62.3 years. A majority of stable CAD patients were men. In the first year of management, 37.1% were treated medically, 51.7% underwent PCI and 11.2% underwent CABG (p<0.001). Up to 92.1% and 83.1% of patients received antiplatelet (mainly aspirin) and lipid-lowering agents, respectively. Antianginal therapy including nitrates, β blockers and calcium channel blockers were prescribed in 71.9%, 61.8% and 33.7% of subjects, respectively. Some patients were prescribed more than one antianginal therapy. The average blood pressure at the time of CAD diagnosis was 138/77 mm Hg and 45% of patients had suboptimal blood pressure control >140/90 mm Hg. The average baseline HbA1c for diabetic patients was 6.7%. Of all baseline parameters, the control of low density lipoprotein (LDL) level was the worst; the mean LDL level was 2.8 mmol/l and up to 82% of our subjects had LDL >1.8 mmol/l.

The overall average length of stay (LOS) was 5.4 days. There were no significant differences between gender and age group. Patients who underwent PCI and CABG had a longer average LOS of 5.3 and 14.1 days, respectively. Patients treated medically alone had an average LOS of 3.1 days.

The mean first-year direct medical cost per patient for the diagnosis and management of stable CAD in this study between 2007 and 2010 was US$11 477±6663 (table 3). The most dominant direct medical cost was for inpatient care, accounting for 29.2% (US$3350) of the average first-year total cost. The second and third main constituents of the total were costs for invasive procedures and that for diagnostic examinations, contributing to 25.9% (US$2975) and 22.8% (US$2612), respectively. Costs for laboratory tests contributed to 13.0% (US$1497) of the total cost. Pharmaceuticals and emergency room visits cost the least, which were 2.4% (US$276) and 0.3% (US$ 29), respectively. The first-year total cost per patient increased with the complexity of the disease, ranging from US$6121±3439 for patients treated medically alone to US$ 14 787±5991 for patients who underwent invasive cardiac procedures (p<0.001).

The average first-year total cost per stable CAD patient with DM was US$11 724±6867 and that per non-DM patient was US $11 308±6582 (p=0.907). The total cost for non-hypertensive patients (US$12 336±6974; US$10 926) was higher, but not significant, than hypertensive patients (US$10 994±6495; US$10 027) (p=0.334). By comparison, the average first-year total cost for stable CAD patients with hyperlipidaemia was significantly higher (US$12 602±6581) than those without hyperlipidaemia (US$5926±3682, p<0.001).

There was a significantly higher cost for laboratory tests (US$ 1801±1049) in DM compared with non-DM patients (p=0.026). Furthermore, the annual cost for drug consumption for DM patients was also the highest (US$325±374) compared with hyperlipidaemic patients (US$313±331) and hypertensive patients (US$279±328). The mean costs for hospitalisation (p=0.001), diagnostic examinations (p=0.009), laboratory tests (p=0.015), procedures (p<0.001) and pharmaceuticals (p=0.001) were higher in patients with hyperlipidaemia than in those without hyperlipidaemia.

DISCUSSION

In Hong Kong, the healthcare budget is under constant stress. According to the most updated statistics released by the Hong Kong Food and Health Bureau, the total health expenditure amounted to HK$75 billion (US$9.6 billion), contributing to about 5% of the local gross domestic product in 2007.[9] Although the proportion of healthcare expenditure in terms of total gross domestic product seems to be minimal, with the rising

Table 3 First year costs for the management of patients newly diagnosed with stable angina who were admitted to the public hospitals (New Territories East Cluster) in Hong Kong between 1 January 2007 and 31 December 2009 (expressed in HK$)

Direct medical items	Mean (SD)	Percentage of total by mean	Median (quartiles)*	Range (min.–max.)
Inpatient care	26130.3 (24404.2)	29.2	19200 (9600, 28800)	4300–120000
Visits to outpatient clinic	2887.6 (1587.9)	3.2	2800 (2100, 3500)	0–10200
Emergency room visits	224.2 (412.6)	0.3	0 (0, 570)	0–1710
Diagnostic exams	20370.2 (16812)	22.8	15800 (14000, 19075)	1800–154000
Radiological tests	2872.1 (4908.8)	3.2	1790 (895, 2400)	0–42000
Laboratory tests	11677.3 (6903.9)	13.0	10225 (6255, 15380)	1985–37275
Therapeutic operations†	23203.4 (22398.7)	25.9	27550 (0, 27550)	0–90800
Medications	2152.8 (2457.6)	2.4	1084.3 (399.2, 3576.4)	23.7–13228.0
Total cost per patient	89518.0 (51971.6)	100	79962.1 (49609.3, 119803.6)	20475.6–234662.6
			Complexity of SA	
	Mean±SD		Median (quartiles)*	Range (min.–max.)
SA without procedure—total cost	47743.7±26325.7		40818.7 (32172.6, 54040.0)	20475.6–164575.5
Breakdown items				
Inpatient care	15105 (12401)		9600 (9600, 18000)	4800–67200
Visits to outpatient clinic	2771 (1871)		2450(1400, 350O)	0–10200
Emergency room visits	201 (363)		0 (0.428)	0–1140
Diagnostic exams	19104 (24550)		15800 (14000, 15800)	1800–154000
Radiological tests	1635 (1722)		895 (895, 1790)	895–10840
Laboratory tests	8059 (6143)		6050 (4570, 9478)	2285–31295
Therapeutic operations†	/		/	/
Medications	858.4 (1484)		384.4 (145)	23.7–8487
SA with procedure—total cost	115342.1±46732.6		94187.8 (81741.3, 143550.7)	62733.6–234662.5
Breakdown items				
Inpatient care	32945 (27436)		19200 (14400, 39600)	4800–120000
Visits to outpatient clinic	2950 (1399)		2800 (2100, 350O)	700–6300
Emergency room visits	238 (448)		0 (0, 570)	0–1710
Diagnostic exams	21153 (9521)		17600 (1580O, 28000)	1800–49925
Radiological tests	3637 (5991)		1790 (895, 3583}	0–42000
Laboratory tests	13908 (6430)		12905 (8993, 17463)	1985–37275
Therapeutic operations†	37547 (16402)		27550 (27550, 55100)	27550–90800
Medications	2953.1 (2606)		2639 (868.5)	137.6–13228

*(25%, 75%) interquartiles.
†PCI and CABG.
CABG, coronary artery bypass graft; PCI, percutaneous coronary invention; SA, stable angina.

trend of healthcare expenses at 6.3% per year and the emerging problem of an aging population, planning for allocation of efficient and fair medical resources is indispensable. This cost-of-illness analysis of stable CAD gives an estimation of the first-year direct medical cost involved in the management of this condition, which may in turn provide some implications for the resource consumption pattern and possible preventive measures that may lighten the financial burden.

Some features were noted with regard to the demographic characteristics of the stable CAD patients included in our study. The majority of the patients recruited were men (70%). A similar pattern was found in other studies in which over 60–80% of patients were men.[4 5 9] However, a meta-analysis found that women in fact had a similar or slightly higher incidence of SA symptoms than men, which seemed to contradict our findings. A possible explanation is that the diagnosis of SA was more difficult in women than in men, as atypical symptoms like dyspnoea and weakness were more prevalent in women and the perception of the chest pain was not the same in women as in men, resulting in higher incidence of SA diagnosis and admission in the male population.[10 11] The rate of revascularisation was as high as 62% in our study, which is significantly higher when compared with other countries like the UK, which had a rate of only 6%. A reason for this can be our subject retrieval method. In this study, patients were mostly identified from coronary catheterisation (CC) records. In local practice, after CC had shown vessel obstruction, subsequent PCI would usually be immediately arranged and thus, patients receiving CC had a relatively higher potential of subsequent PCI.

An obvious variation in LOS was observed, with the longest average LOS in the CABG group, having over a threefold difference from that of the PCI group and the no procedure group. In general, patients with long hospital stay of over 10 days were seldom observed in patients not receiving any surgical or cardiac catheterisation procedures. Only 3% of patients not undergoing procedures, contrasting with 70% of CABG and 11% of PCI patients, had stayed for over 10 days. Therefore, the longer the hospital stays, the higher the cost. The hospital stay was related to the complexity of the procedures performed.

When compared with cost analysis studies in other countries, the cost contribution pattern demonstrated a few differences. In the UK cost of angina pectoris study, the top two cost contributors were also revascularisation and hospitalisation costs, but the former was 35%, which was slightly higher than the latter one, 32%.[4] The difference in cost patterns may be attributed to the different cost breakdown components included. In this UK study, a coronary angiogram was counted as a part of the procedural cost under revascularisation but in our study, it belonged

to the class of diagnostic procedures. Although the rate of PCI and CABG was only 6% in the UK study, it was 62% in ours; the inclusion of the high-cost coronary angiogram compensated for the low procedural rate. Thus it still had a significant contribution to the total cost. Besides, the average LOS was slightly longer in Hong Kong (5.4 days) than in the UK (3.8 days), resulting in the difference in hospitalisation costs. In addition, the outpatient clinic visits showed the greatest contribution to the cost of newly diagnosed stable CAD in the USA, which accounted for a total cost of US$722 million (38% of the total cost) in 2000.[7] Ranking second was hospitalisation cost, which was largely different from outpatient cost, contributing to 16% of the total cost (US$307 million). The difference seen may be attributed to the different study design and various managements in different geographical locations. In this US study, medical costs under consideration excluded diagnostic exams, radiological tests and coronary revascularisation when compared with our study. Also, the reasons for the less dominant role of outpatient visit costs in our study may partly be caused by the local resources constraint in our healthcare system. In Hong Kong, the public healthcare system is under great stress and most citizens are fully dependent on public services. Over 90% of the total secondary and tertiary care including specialist outpatient clinic follow-up were provided by the public healthcare system.[12] In 2007, 5.5 million consultations were provided by the specialist outpatient clinics and yet, public hospitals were facing a manpower crisis with insufficient numbers of doctors. As a result, outpatient services in the local community are always in a state of saturation and thus follow-up visits are inevitably arranged infrequently for less acute and non-fatal diseases like stable CAD. On the other hand, American citizens are used to private clinic visits and the outpatient visit costs did include private clinic fees, contrary to the inclusion of public spending only in our study. Thus, the different inclusion criteria and different public-private service reliance may account for the difference observed.

Another major finding from this study was that among the three comorbidities concerned, the total annual cost was the highest in patients with hyperlipidaemia, followed by DM and HTN. With regard to the correlation between the cost and the disease state, diverse patterns were observed among the three groups of comorbidities. Hyperlipidaemia was associated with significantly higher total medical costs, as well as in the costs of most individual items like hospitalisation, diagnostic examination, laboratory investigations, medications and procedures. The higher cost in hyperlipidaemia cases can be explained by the increased risk of atherosclerosis in the presence of poor LDL control, which likely increases the chance of revascularisation. Such an increase in the need for invasive therapy directly caused a rise in revascularisation costs, which was confirmed by the high statistically significant difference found in the hyperlipidaemia group, and indirectly increased hospital admissions and inpatient costs. Considering the fact that revascularisation was the second leading contributor to the first-year cost of stable CAD, the higher cost in hyperlipidaemia was understandable. It is reasonable to deduce that aggressive control and management of serum lipid level can be an effective means of minimising the cost by lowering the need for procedures. One piece of supporting evidence from a meta-analysis involving over 90 000 hyperlipidaemia subjects conducted in 2005 showed that for hyperlipidaemia patients, the need for first coronary revascularisation was reduced by 23% with every 1 mmol/l of LDL cholesterol reduction. Lowering LDL cholesterol by 1.5 mmol/l with the use of sustained statin therapy showed a decrease in the incidence of major vascular events by 21%.[13] Hence, the use of lipid-lowering agents like statins in stable CAD patients is warranted. However, the cost-effectiveness of lipid lowering therapy in terms of lowering total medical costs needs further evaluation.

In the case of DM, the statistical significance found in the cost of laboratory investigations between the DM group and non-DM group was expected. As more routine monitoring such as HbA1C, whole blood glucose, random plasma glucose level and fasting blood glucose level were required for assessing the blood glucose control in DM patients, more laboratory tests were needed, thus causing increased expenses in the DM group. Although it has been shown that DM increased the risk of cardiovascular complications,[14] the total cost and other cost components in this study did not reveal a significant difference. This may be due to the fact that medical costs involved in conditions other than those related to CAD were not included in the cost calculation. Therefore, even if complications like AMI arise, the subsequent resources consumption was not taken into account. And, the baseline blood glucose of our study subjects was good in general, the mean HbA1c was 6.7%. Another point is that the costs of DM medications were relatively low when compared with the total cost of CAD, and consequently minimal difference in total cost was reported.

Cost analysis in HTN patients showed a different scenario with a higher total cost in the non-hypertensive group. Such difference may be caused by the uncertainty during the recruitment of the HTN patient group. Contrasting with the cases of DM and hyperlipidaemia, the diagnosis of HTN could not be adequately identified from the medications prescribed or the baseline blood pressure level. Thus, the recruitment was solely dependent on the physicians' diagnosis noted in the patients' medical record. Yet, in practice, chronic illnesses may not be recorded in every admission record and therefore, some of the patients with no marked diagnosis of HTN may be inappropriately classified as non-HTN due to the limitation in accessing actual disease record.

Stable CAD is an early stage disease which may progress to more advanced stages like unstable angina and MI if it is not properly managed. Apart from the more severe symptoms experienced by the individuals, the cost incurred due to AMI was also higher. When compared with our previous finding in AMI patients,[8] a few significant differences were observed. Patients with unstable angina had a longer average hospital stay of 16.4 days, when compared with 5.4 days in stable CAD. Majority of AMI patients required over 8 days of hospitalisation while stable CAD patients mostly required only 1–6 days, thus explaining the much higher inpatient cost in AMI subjects. In addition, the cost of bed stay in the coronary care unit for most MI patients is significantly higher than the cost of a general ward bed for most stable CAD patients. Furthermore, drugs used in the two conditions showed a diverse pattern. The major difference was the use of fibrinolytic agents, which was the usual practice in AMI but not in stable CAD. Thus, the use of high unit-cost fibrinolytics accounted for the one-third higher medication cost in AMI. Third, the cost of emergency services for AMI and stable CAD was 30-fold. As regards the resource consumption pattern characteristics in AMI and SA patients with comorbidities of HTN, DM and hyperlipidaemia, both studies found that patients with hyperlipidaemia had a higher management cost than those with HTN or DM.

In a meta-analysis involving 2950 non-acute CAD patients with half of them received PCI and half of them managed with conservative therapy, those with an absence of recent MI

showed no significant difference from PCI in term of mortality, MI and the need for subsequent revascularisation over the use of drugs alone. It concluded that PCI currently performed in these patients were not reasonably cost-effective.[15] Also, the guidelines on the management of stable CAD published by the European Society of Cardiology 2006[12] and the Scottish intercollegiate Guidelines Network 2007,[16] mentioned certain circumstances when interventional approaches would not offer prognostic gain and the procedures were considered as highly elective without true urgency. Referring to the findings in our study, up to 62% of subjects received either PCI or CABG; there is a possibility that the number of procedures carried out were not justified for their cost-effectiveness. Despite the self-financed nature of PCI consumables, operations would certainly bring about their own costs, additional hospitalisation days and laboratory tests, making up substantial healthcare spending. Given the current budget constraint, risk stratification and cost-effectiveness of invasive versus conservative therapy need to be carefully considered in decision making in the management of stable CAD. Optimal use of medical therapy is likely to be a much more cost-effective initial treatment strategy for most low-risk stable CAD patients without prognostic disadvantage compared with an early invasive strategy.

Since HTN, DM, hyperlipidaemia and progression to AMI have been shown to burden the healthcare system, proper management of general health and care involved in the early stage of disease can definitely help ease the stress. Preventive strategies rather than therapeutic approaches should be of higher priority in the management of most of the chronic diseases. Family doctors, community nurse services, public health education and pharmacists' efforts on drug review, monitoring the progress and control of these diseases are crucial for the overall health management in a society, especially when facing an aging population. A multidisciplinary approach involving various healthcare professionals for disease prevention and management is therefore another measure suggested for cost saving, which can also help share the workload from doctors and nurses in hospital settings.

This study has several limitations. First of all, our study included a small sample pool and was adopting a retrospective way of data retrieval. Therefore, some information may not be accessible and the actual duration of therapy was difficult to assess. Second, this study calculated the direct medical costs incurred in the diagnosis and management of stable CAD in the subsequent year following initial diagnosis. The unit cost data were obtained from the Hong Kong Government Gazette 2003, which lists the costs of various procedures, laboratory investigations, inpatient care, clinic services and emergency admissions at that time. However, as inflation has taken place between 2003 and 2008, the price in 2003 may not truly represent the costs in 2008, making the cost calculation unable to reflect the actual cost involved in the management of CAD in the study period. Third, this study only involved patients from the Prince of Wales Hospital and therefore the usual practice and treatment choice in our cluster may not be representative, making the generalisation of the cost less applicable. Another drawback of this study is that in retrieving data concerning hypertensive patients, the presence of HTN may not have been properly recorded in the patient records and also may not be easily identified from the medications prescribed. Therefore, some hypertensive patients who had no confirmed diagnosis of HTN may be neglected and counted as non-hypertensive, affecting the generation of a reliable correlation between cost and HTN. In addition, this study had taken into account only the direct medical costs involved from the perspective of a public health provider. Intangible costs and other costs incurred by patients like disease-related loss of productivity, impact on patients and family members' quality of life, as well as the tremendous cost of PCI consumables were not addressed, making the study not comprehensive enough to represent the whole cost-of-illness to the society. Therefore, future research may look further into this aspect and evaluate the direct and intangible costs from the societal perspective to complement this current study. Furthermore, investigations on the cost-effectiveness between conservative treatment and interventional therapy in stable CAD in the local setting may be done to provide more guidance on the choice of management.

CONCLUSION

This study of the cost-of-illness showed that the first-year total direct medical cost per patient with newly diagnosed stable CAD was approximately US$ 11 500. Patients who underwent invasive procedures and those with a history of hyperlipidaemia had significantly higher medical costs. This study conveys an important message to the healthcare policy maker on the substantial expenses incurred by stable CAD and the financial impact of comorbidities such as HTN, DM and hyperlipidaemia. Better resources allocation and the strategies for cost saving are warranted to lower healthcare expenditure associated with CAD.

Acknowledgments Technical support was provided by the School of Pharmacy, The Chinese University of Hong Kong.

Competing interests None.

Provenance and peer review Not commissioned; internally peer reviewed.

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