

REVIEW ARTICLE

Management of Chronic Coronary Syndromes in Resource-Constrained Settings in India: An Expert Opinion With a Proposed Algorithm

Vijay Shah,¹ Saumitra Ray,² Devanu Ghosh Roy,³ Samir Kubba,⁴ Sarita Rao,⁵ Jabir Abdullakutty,⁶ K. P. Suresh Kumar⁷

VT Shah Diagnostic Centre & Clinic,¹ Mumbai – India
 AMRI Hospital Dhakuria,² Kolkata, West Bengal – India
 Peerless Hospital and B K Roy Research Center,³ Kolkata – India
 Dharamshila Hospital and Research Centre,⁴ Delhi – India
 Rajashree Apollo Hospital,⁵ Indore – India
 Lisie Hospital,⁶ Cochin, Kerala – India
 Kauvery Hospital,⁷ Chennai – India

Abstract

Cardiovascular diseases (CVDs) are associated with considerable morbidity and mortality across the world. The global financial burden caused by CVD emphasizes the importance of preventive strategies and appropriate management. Chronic coronary syndrome (CCS) is a new term recently introduced for stable coronary artery disease (CAD), which is associated with the highest cause-specific mortality in the Indian population. CCS adversely affects the quality of life (QoL) due to anxiety, fatigue, and prolonged disease course. Risk factor modification, adaptation to lifestyle changes, and pharmacotherapy are the optimal treatment options for CCS. Despite the guidelines proposed by numerous groups and societies, such as the European Society of Cardiology (ESC), the American College of Cardiology/American Heart Association (ACC/AHA), and the Taiwan Society of Cardiology, managing CCS in resource-limited situations remains challenging. Lack of awareness about CCS among patients and healthcare professionals (HCPs), limited resources, accessibility and affordability of lifesaving therapies, poor transport facilities for patients, and asymmetrical distribution are among the challenges identified. In India, the scenario of CCS is no different in rural areas and among urban

poor populations due to resource constraints. The current expert opinion review based on 48 experts in the field of cardiology from eastern, western, northern, southern, and pan-India regions highlights the management of CCS in resource-constrained settings with a focus on diagnostic modalities, risk stratification, referral pathways, and medical management. Based on expert opinions and a thorough literature search, an algorithm for the management of patients with CCS in resource-constrained settings in India is also proposed.

Introduction

Cardiovascular diseases (CVDs) account for one-third of the deaths occurring worldwide.^{1,2} Globally, India ranks second in CVD-related deaths.¹ The fact that Indians experience CVDs a decade earlier than people in Western countries reiterates the severity of this condition.^{3,4} Among the CVDs, coronary artery disease (CAD) shares the major disease burden.² A stable CAD, also known as stable ischemic heart disease (IHD), is a condition of repeated, transient episodes of angina pectoris representing an imbalance between demand and supply. As per the Global Burden of Diseases (GBD) 2019 data, India has the highest cause-specific mortality rate (i.e., 110.95 deaths per 100,000 people), with a prevalence of IHD ranging from 2.49% to 3.09%.^{5,6} To improve the diagnosis and prevention of IHD, the term “stable coronary syndrome” was proposed, which encompasses abnormalities of microvessels and endothelium along with the heterogeneous pathophysiology of the

Keywords

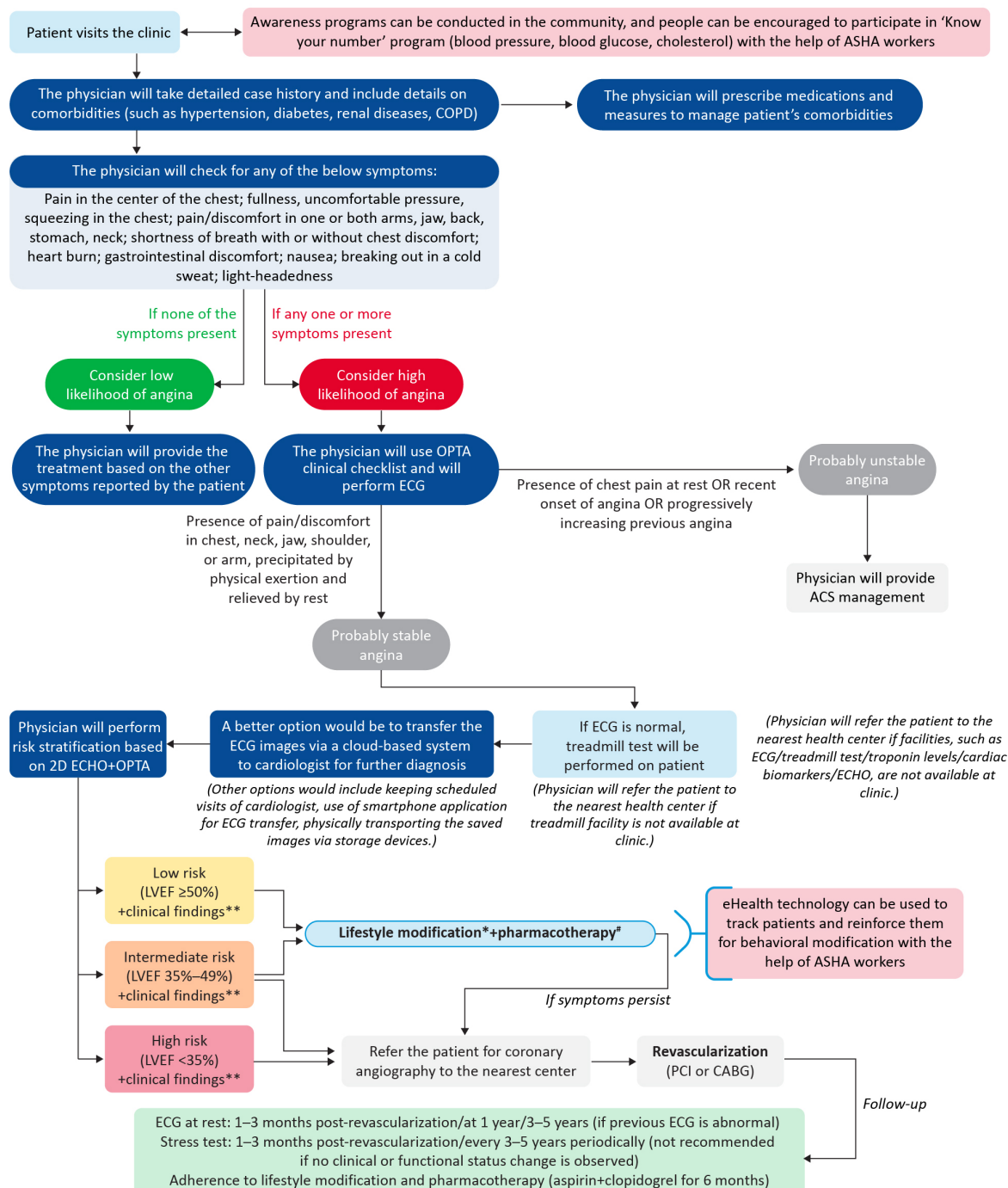
Algorithms; Coronary disease; India; Disease management; Resource-Limited Settings

Mailing Address: Vijay Shah

VT Shah Diagnostic Centre & Clinic. Kopol Niwas, 590, Dr Baba Saheb Ambedkar Rd, Matunga East. Postal code: 400019. Mumbai, Maharashtra – India
 E-mail: drvtshah19@gmail.com
 Editor responsible for the review: Alexandra Arias-Mendoza

Central Illustration: Management of Chronic Coronary Syndromes in Resource-Constrained Settings in India: An Expert Opinion With a Proposed Algorithm

INTERNATIONAL JOURNAL OF
Cardiovascular
SCIENCES



*Tobacco cessation (Using 5As, behavioral intervention+long- and short-acting nicotine replacement therapy), physical activity (≥150 minutes/week, moderate-intense aerobic+muscle-strengthening exercises for ≥2 days/week), healthy diet (fruits, vegetables, whole grains, nuts, lean protein, and dietary fiber and less intake of meat, salt, saturated fats, alcohol, and sugar), controlled weight (BMI <25 kg/m²), control of comorbidities (diabetes mellitus, hypertension, obesity, deranged lipid profile), and good mental health (nonpharmacological or pharmacological therapies).

**Clinical findings may comprise dyspnea, edema, fatigue, persistent coughing or wheezing, lack of appetite, nausea, increased heart rate, weight changes, and impaired thinking. The low-risk patients may present normal function or may have any of the symptoms, intermediate-risk patients may experience symptoms during physical activity, while high-risk patients may experience symptoms even at rest.

*Antiplatelet drug (aspirin), if heart rate is slow (nitrates+dihydropyridine calcium channel blockers+nicorandil), if heart rate is high (beta-blockers+diltiazem/verapamil+ ivabradine), if left ventricular dysfunction+heart failure (beta-blockers if not controlled+ ivabradine+trimetazidine), if hypertension is present (beta-blockers+dihydropyridine calcium channel blockers), if hypotension is present (ranolazine/trimetazidine), if diabetes is present (trimetazidine+ranolazine+carvedilol/nebivolol), if CKD is present (drugs other than ranolazine and trimetazidine), if hyperthyroidism is present (nonselective beta-blockers, such as propranolol+diltiazem+verapamil+ivabradine), if COPD is present (bisoprolol+ivabradine/diltiazem/verapamil to reduce heart rate, colchicine drug to reduce recurrent cardiac events, and COVID-19 vaccination to reduce COVID complications).

epicardium.⁷ The term “stable CAD” is now replaced with “chronic coronary syndrome (CCS)” to cover a wider scope of pathophysiological, clinical, and pharmacological aspects.⁸

The condition is concerning, as managing CCS presents a significant challenge in areas with resource-limited settings in India.⁹ CCS is characterized by atherosclerotic plaque development in the lumen of coronary blood vessels, thereby impeding the blood flow to the myocardium.¹⁰ The etiology of the condition can be modified based on changes in lifestyle, controlling psychological variables and comorbidities. However, age, genetics, gender, and ethnicity remain as nonmodifiable risk factors.¹⁰⁻¹² Despite a significant decrease in the occurrence of the condition by controlling modifiable risk factors, only two-thirds of the patients receive medications for controlling these factors.¹² A meta-analysis reported a moderate-to-poor quality of life (QoL), indicating a negative impact of CCS due to anxiety, fatigue, and prolonged disease course, leading to increased hospital visits and mortality rates and imposing an economic burden.^{13,14}

The European Society of Cardiology (ESC) guidelines and the American College of Cardiology/American Heart Association (ACC/AHA) have highlighted the importance of physical and laboratory testing, risk modification, guideline-directed medical therapy, and revascularization for managing CCS.^{15,16} For CCS, beta-blockers and calcium channel blockers (CCBs) are the first-line treatments; statins and angiotensin-converting inhibitors are the secondary treatments. In high-risk patients, the updated guidelines stress the long-term use of antiplatelet medications with a modest dosage of rivaroxaban or a combination of aspirin and P2Y12 inhibitor.¹⁷

Managing CCS in settings with limited resources in India can be problematic due to several issues that affect patients, healthcare professionals (HCPs), and the healthcare system. Primary care is scarce in the healthcare system. In addition, there are insufficient resources available, and patients have limited access to facilities for transportation and life-saving therapies. Task sharing is not well understood at the HCP level, and physician inertia is a problem. Patient poverty, medication costs, and lack of knowledge about the condition's symptoms impact the standard care and management of CCS.⁹ These challenges highlight the need to review the Indian healthcare system. Furthermore, there is an uneven distribution of healthcare resources between urban and

rural areas in India. Although the majority of people live in peri-urban areas, and villages, urban residents have access to a wider variety of public and private healthcare facilities. In contrast, rural residents have fewer choices for health centers.¹⁸ Moreover, these health centers work with a shortage of nurses and specialist doctors, thereby increasing the gap in need and availability.¹⁹ The disparity is also noted in terms of the availability of hospitals, hospital beds, regulation of spurious pharmaceutical sales, and availability of chronic and acute therapies with rural and semi-urban populations.²⁰

With a threefold increase in CVD from 1.2% to 4.1% due to an increase in risk factors, managing CCS in a rural population with inadequate healthcare resources is challenging and calls for an urgent national effort.²¹ Nevertheless, the scenario is no different in the urban poor population, and access to affordable and high-quality healthcare remains severely restricted despite the higher number of HCPs, institutes, and health indicators over the rural population.²² Currently, there is a lack of data regarding guidelines on managing CCS in areas with resource-constrained settings in India. Hence, this document aims to provide expert opinions on the management of CCS in resource-constrained settings in India with a proposal of an algorithm for the management of patients with CCS in such settings, based on expert opinion and a literature search.

Expert Panel

A comprehensive electronic database search was undertaken to explore available evidence on managing CCS in resource-constrained settings in India. The discussion agenda was finalized based on the identified literature gap. Forty-eight cardiology experts from eastern (n = 8), western (n = 10), northern (n = 11), southern (n = 9), and pan-Indian (n = 10) regions participated in the focused group discussions, each led by a moderator to represent the CCS scenario in their respective regions. The discussions centered around four main areas: resource-constrained settings in India, managing CCS and CVDs in resource-constrained settings, and simplifying CCS management tools (Table S1).

Resource-Constrained Settings in India

Any setting that lacks basic critical care resources, such as hospital wards, emergency rooms, intensive care units, and trained personnel to treat patients with life-threatening illnesses, is considered a resource-

constrained setting. This is irrespective of the setting's location.²³ The government's minimal expenditure on healthcare, lack of infrastructure in rural and peri-urban areas, high out-of-pocket costs, low awareness of diseases, their diagnosis and treatment, subpar and inadequate living conditions, and poor hygiene practices are the main obstacles faced in these settings.^{20,23-26} Despite the proposed universal healthcare coverage by the World Health Organization (WHO), an imbalance in the penetration of healthcare facilities in India has failed to close the gap in resource-constrained and adequate resource settings.^{20,27}

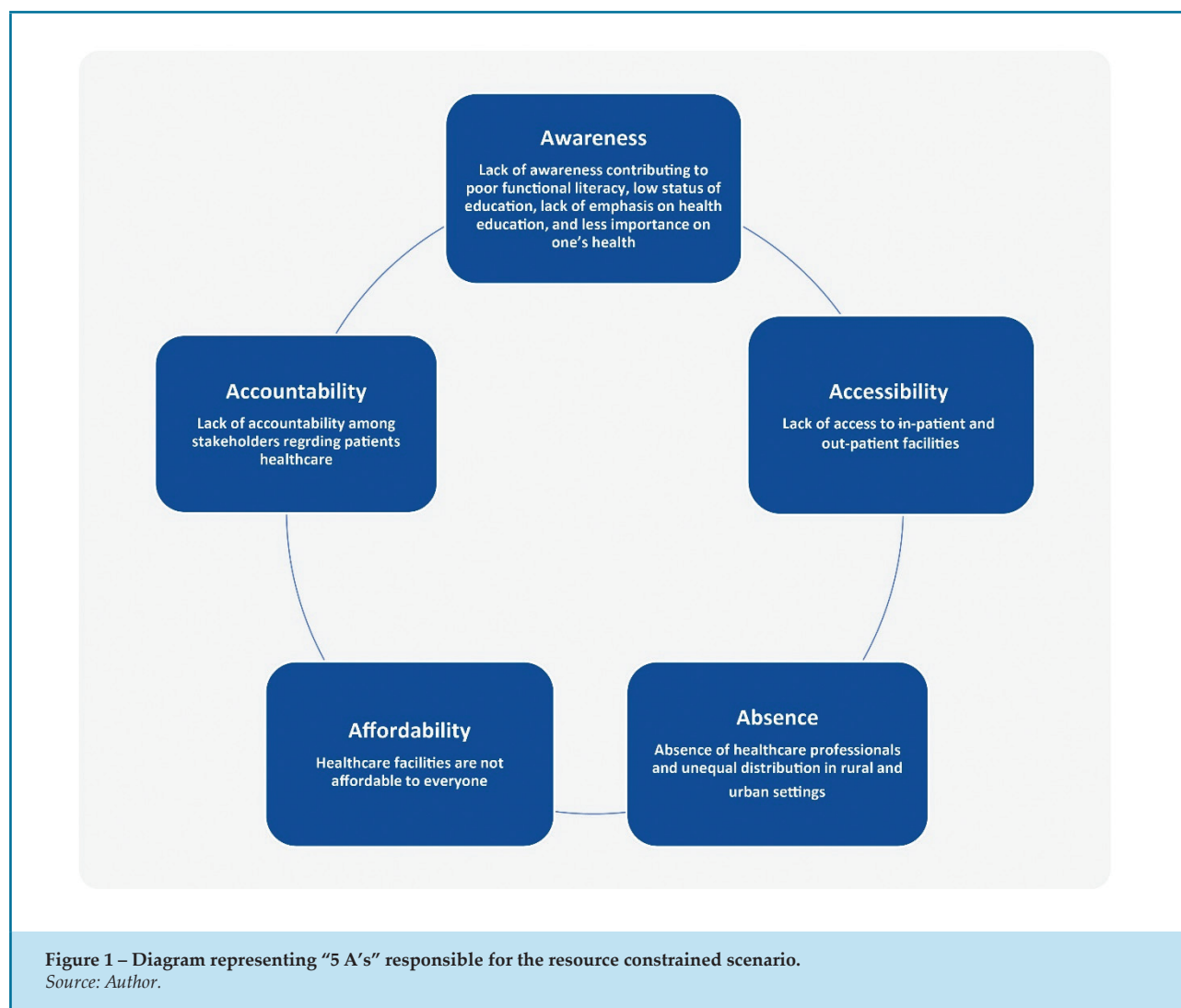
Around 67% of the Indian population resides in villages, 13% in peri-urban areas and the remaining (20%) population in towns and cities. However, resources are not allocated correspondingly, which significantly affects the healthcare system. The areas demanding higher resources compared to areas demanding less resources are confined to the limited number of hospitals (31% vs. 69%), hospital beds (20% vs. 80%), doctors (8% vs. 92%), recommended doctor/population ratio (5% vs. 50%), and spurious sale of pharmaceuticals (75%-80% vs. 20%-25%).²⁰ The lower importance given to resource allocation causes resource imbalance at the regional level, thereby causing disparities in the population's health conditions. Furthermore, inadequate and unoptimized resource allocation to the growing population puts additional pressure on the healthcare system.²⁸ A study highlighted the scenario of insufficient testing, leading to inaccurate disease burden assessment and, eventually, inaccurate resource allocation. Thus, the focus should be on simple yet plausible tailored measures in accordance with the diagnosis and management needs in a real-life scenario.²⁹

A study highlighted the "5 A's" responsible for the resource-constrained scenario in India (Figure 1). First, there is a lack of healthcare awareness among the Indian population.³⁰ Disease awareness changes patients' attitudes and practices, increases treatment adherence and reduces the prevalence and frequency of complications.³¹ Second, there is a dearth of healthcare access; in rural areas, just 37% of the population has access to inpatient facilities and 68% to outpatient facilities. Third, the absence or unequal distribution of HCPs in both urban and rural areas, where more than 25% of physician positions at primary health centers remain vacant, is a significant cause for worry. Fourth, not everyone has access to affordable healthcare

facilities. With 75% of the expense coming from household budgets, the private sector's dominance in the healthcare industry has led to higher healthcare expenses. Finally, there is a lack of accountability among various healthcare stakeholders, including the state health ministry, district health department, advocates, legislators, HCPs, and beneficiaries.^{3,30,32} Furthermore, a large "know-do gap," representing the gap in the care provider's knowledge (know) and the care provided (do) to the population, is reported in the literature, leading to poor quality of healthcare in resource-constrained settings.³³

Expert opinions on resource-constrained settings and the challenges faced:

1. Resource-constrained settings comprise areas with limited diagnostic and management facilities due to access, financial scarcity, or political unwillingness, irrespective of the urban/rural setting.
2. Two types of resource constraints were put forward: resource constraints for HCPs (infrastructure, investigation tool, tests, echocardiogram [ECHO] machines, training, lack of storage facilities for special drugs) and resource constraints for patients (affordability, inaccessibility).
3. There is a noticeable disparity between the availability and use of infrastructure, which can be attributed to the general public's ignorance of diseases, which causes them to seek medical attention only after the illness has advanced significantly and reached a complex stage, making treatment more difficult.
4. Despite multiple health insurance schemes from government and private providers, its uptake in the population is low due to a lack of willingness and acceptability to pay the premiums and limited coverage of specific needs, particularly for elderly patients with disabilities and chronic diseases.
5. There is an urgent need to train more general practitioners in a rural settings, seeking support from the government to improve facilities offered in resource-constrained settings.
6. There is an increased trend of chronic diseases among the younger population and children due to changes in food habits, sedentary lifestyles, increased screen time, obesity, hypertension, chronic kidney disease, dyslipidemia, and metabolic syndrome.³⁴ The disability-adjusted life years (DALYs) due to non-communicable



diseases (NCDs) increased from 30% in 1990 to 55% in 2016.³⁵

7. Experts have noted that the genetics of the population is one of the contributing risk factors for the increase in the incidence of developing CAD.
8. Southern state governments provide free or low-cost common medication for chronic diseases. Despite this, patients often discontinue the regimen upon experiencing short-term improvements, risking harm, increased mortality, and higher treatment costs.
9. Low-cost and easily available spurious drugs are yet another challenge in the resource-constrained settings of India. The intake of these drugs leads to serious health issues due to their substandard quality.

Challenges in the Management of CCS in Resource-Constrained Settings

CVDs account for one-fifth of the total deaths worldwide (CAD rate being the highest); there has been a surge in CVD deaths from 1.3 million in 1990 to 2.8 million in 2016 and an increased crude mortality rate (by 34.3%) from 1990 to 2016 in the Indian population. The concern lies in the early onset of CVDs, high mortality, and rapid progression among Indians.^{3,36} The early/premature onset of CAD (from 30 to 56 years) in Indians is likely due to environmental factors and genetic predisposition. Indians have a low level of antiatherogenic high-density lipoprotein cholesterol (HDL-C) and a high level of atherogenic lipoprotein (independent risk factor of CAD) in comparison with other ethnic groups, thereby prompting early screening initiation.^{37,38} Literature reports smoking, alcohol consumption, dyslipidemia

with a high apolipoprotein B/apolipoprotein A1 ratio, unhealthy diet, psychological stress, high waist/hip ratio, sedentary lifestyle, hypertension, and diabetes as the standard nine risk factors for heart diseases.³⁹

Managing patients with CCS is associated with various challenges. The condition is associated with comorbidities like chronic kidney failure, peripheral arterial disease, type 2 diabetes, and obstructive lung disease with high prevalence among Indians and presents additional challenges in managing CCS.⁴⁰⁻⁴² Hence, a thorough evaluation of these conditions is warranted, considering the deterioration of the patient's health, increased impairment, and functional challenges arising from comorbidities.⁴³ The atypical presentation of the condition is another challenge faced by clinicians. Although angina has the characteristic features of CAD, most patients also present with atypical angina (any two features of typical angina) or no angina, leading to missed diagnoses.^{15,44} In addition, patients tend to deny the existence of their symptoms, avoid visiting HCPs until after they become incapacitated and need emergency care, and prefer to use over-the-counter drugs.^{45,46}

A gap exists in the evidence and the actual practice followed in resource-constrained settings for cardiac diseases. Regarding pharmacotherapy, only 81% of patients with IHD were prescribed aspirin, 30% with statins, 40% with angiotensin-converting enzyme inhibitors, around 48% with beta-blockers by the HCPs, while 75% of the patients were not taking any medications for secondary prevention.⁴⁷ Furthermore, nonadherence to the regimen impedes treatment success. A significant inverse relationship is reported between adherence and adverse outcomes. The main reasons for nonadherence assessed by Morisky's instrument were forgetfulness (63%), carelessness (42%), discontinuation due to a short symptom-free period (43%), and discontinuation due to worsening of symptoms (58%).⁴⁸ WHO emphasizes prioritizing drug adherence over treatment therapies. Thus, HCPs must develop strategies to enhance medication adherence as it is associated with fewer hospitalization days, fewer emergency clinic visits, and lower pharmacy expenditure.⁴⁹ Despite improved accessibility to specialists through newer technology, there is a recognized gap in utilizing telehealth and mobile applications in resource-constrained settings.^{50,51}

Expert opinion on the challenges faced with CVDs with emphasis on CCS:

1. Infrastructure-related:

The nonavailability of diagnostic tests (electrocardiogram [ECG], treadmill test [TMT], two-dimensional echocardiogram [2D-ECHO]), medications, and increased dependence on the private sector are the major challenges faced in diagnosing CCS. However, few experts have noted that as per the ESC guidelines, ECHO is not essential for every patient and may increase stress on the already-stressed infrastructure.

2. HCP-related:

It was discovered that HCPs in the peripheral setup were unaware of the difference between CAD and CCS. Acute coronary syndrome (ACS) and CCS have unusual presentations; hence, it was determined that continuing medical education sessions and AI-based applications would be essential in educating HCPs, primary care physicians, and paramedical staff about CCS. The growing need for improved communication channels between the HCPs in the peripheries and specialists in urban areas was emphasized. This could be facilitated through standard risk questionnaires and detailed case record maintenance.

Experts have noted that ischemia and myocardial infarction with no obstructive CAD are commonly reported in patients with migraine or vascular diseases and perimenopausal females, which leads to significant morbidity if left untreated and poses great challenges in diagnosis, even for the experienced clinician.

3. Patient-related:

Poverty in resource-constrained settings has promoted quackery and faith in quacks among patients. The loss of many patients with chronic disease to alternative therapies was reported to be disastrous in the long run. Furthermore, social media platforms were reported to spread false information about the disease.

Comorbidities such as anemia, chronic obstructive pulmonary disease, thyroid functions, and diabetes lead to adverse outcomes in patients with CCS and predispose them to the conversion of CCS to ACS, which requires intervention and higher treatment modality with additional cost (Table 1).

Table 1 – Expert opinions on overcoming the challenges of CCS management in resource-constrained settings

Challenges	Solutions
Lack of awareness	- Obtaining endorsements from well-known personalities, propagating awareness via mass media, distributing booklets and pamphlets with awareness material in regional languages, and projecting awareness messages on television in the OPD - Initiating a “know your number” (blood pressure, blood glucose, and cholesterol — strong indicators of CVDs) campaign across the settings to make people aware of their health status and take charge, recognize undiagnosed and uncontrolled patients, and take necessary management action - Organizing patient and HCP education programs
Lifestyle	Lifestyle modifications right from childhood by updating the curriculum along with the involvement/ guidance of pediatricians
Advanced/ alternative avenues	- Telemedicine applications through tie-ups with the nearest medical college - Creating an algorithm for the diagnosis and management of CCS in resource-constrained settings (Figure 2)
Public-private partnership	- Early prevention policy by public-private partnerships (government, pharmaceutical companies) specifically charted for a resource-constrained setting - Proposing a norm for HCPs to render services in resource-constrained settings by providing them with incentives - Providing incentives to patients to ensure adequate follow-up - Conducting mass screening camps by HCPs with public-private partnerships and village panchayats to provide minimum investigation tools and cost-effective medications in resource-constrained settings

CCS: Chronic coronary syndrome; CVD: Cardiovascular disease; HCP: Health care professional; OPD: Outpatient department. Source: Author

Management of CCS in Resource-Constrained Settings

Various guidelines have been put forward for the diagnosis and management of patients with CCS.^{15,16,52} The ECS guidelines recommend basic first-line tests, biomechanical testing, ambulatory monitoring, resting ECG, ECHO, and magnetic resonance imaging (MRI) at rest, as well as chest X-ray for suspected CAD patients. The emphasis is made on categorizing ACS and CCS patients and ruling in/out CAD based on risk factors.¹⁵ The ACC/AHA discussed the importance of invasive techniques in suspected patients with stable IHD for diagnosing CAD.⁵³ According to the Taiwan Society of Cardiology, the first-line diagnostic test comprises coronary computed tomography (CT) angiography for the detection of both obstructive and nonobstructive plaques. Invasive procedures are reserved for patients with high-risk anatomies, refractory symptoms, hemodynamically significant lesions, and high ischemic burden.⁵⁴

Management of CCS comprises lifestyle modification, pharmacotherapy, and surgical intervention. Lifestyle modification, the first step for preventing and reducing the subsequent mortality rate, focuses on smoking

cessation, a balanced diet, moderate physical exercise (30 minutes/day), and maintaining a healthy weight (body mass index of < 25 kg/m²).^{15,54} The importance of lifestyle modification with significant improvement in cardiovascular risk factors was also supported by the PREvencion con DIeta MEDiterránea (PREDIMED)-Plus trial.⁵⁵

Pharmacotherapy emphasizes the use of short-acting nitrates for immediate relief from angina symptoms. The first-line treatment remains the CCBs/beta-blockers that are replaced by beta-blockers+dihydropyridine CCBs in case of uncontrolled symptoms. The second-line treatment comprises nitroglycerine/isosorbide mononitrates/dinitrates with replacement by nicorandil/ranolazine/trimetazidine in cases with contraindication to the previous drugs, poorly tolerated drugs, or uncontrolled symptoms. Dual antiplatelet therapy (DAPT) with the combination of aspirin and oral P2Y12 inhibitor is prescribed post-percutaneous coronary intervention (PCI) to reduce the risk of ischemic events.¹⁵ A modeling study on the cost-effectiveness of treating CVDs in India reported that covering primary prevention through pharmacotherapy alone in universal healthcare

coverage would prove to be cost-effective and save around 3.6 million DALYs per year, even in the case of 50% adherence. Although this benefit was significantly lower than encompassing all treatment levels (primary, secondary, and tertiary), it would still be sensible to incorporate it in areas with resource-constrained settings where coverage of all treatments is unaffordable.⁵⁶

Combining pharmacotherapy with surgical intervention (coronary artery bypass graft or PCI) significantly reduces rehospitalization and mortality rates, improves angina symptom relief, eliminates myocardial ischemia, limits antianginal drug use, lowers cardiovascular death rate, and improves overall QoL of patients with CCS.⁵⁷⁻⁵⁹

However, managing CCS in resource-constrained settings in developing nations like India poses challenges due to limited paramedical staff, scarcity of advanced life support systems, and inaccessibility of hospitals capable of performing revascularization treatments.^{60,61} In such a situation, alternative approaches include utilizing mobile applications via accredited social health activist

(ASHA) workers and linking tele-ECG with teaching hospitals to record ECGs and transferring them to nearby cardiologists for interpretation.^{60,62,63}

Expert opinion on the management of CCS in resource-constrained settings:

1. The experts noted that thorough history taking followed by simple diagnostic tests are necessary first steps in the diagnosis of CCS. The ECG and ECHO were minimum requirements in the health centers.
2. Male patients and those with comorbidities were advised to undergo TMT for a regular assessment; patients with a moderate or high likelihood of disease should be considered for invasive angiography, while those with a low or intermediate probability should be considered for CT angiography.
3. Lifestyle modification and pharmacotherapy (DAPT) were emphasized for preventing complications and further cardiac events. The expert opinions are summarized further in Table 2.

Table 2 – Expert opinions on the management of CCS in resource-constrained settings

Challenges	Solutions
Screening/diagnosis	<i>Clinical history/examination</i>
	• A thorough clinical history should be taken • Simple tests such as physical BP monitoring, finger prick for glucose monitoring, biomarker testing, and perfusion scans should be performed to increase the likelihood of a definite diagnosis
	<i>Noninvasive test</i>
	• ECG and ECHO should be considered as the bare minimum requirement, and calcium scoring should be considered for identifying patients with obstructive CAD with a high likelihood • TMTs for male patients and patients with diabetes should be routinely considered in fitness programs to provide functional capacity • CT angiography should be considered only in the low and intermediate probability of disease
Management	<i>Invasive tests</i>
	• Invasive angiography should be considered in those with moderate or high likelihood of disease
	<i>Lifestyle modification</i>
	• A healthy diet, physical exercise, and good hygiene practices remain the first steps to be taken against CCS
	<i>Pharmacotherapy</i>
Management	• Use of nitrates for symptomatic relief and delay the onset of complications • Dual pathway inhibitors and dual platelets were reported to be less effective, and the use of a combination of antiplatelets and anticoagulants was emphasized. A fixed-dose combination of atorvastatin and ezetimibe was also noted to be beneficial among Indian patients
	<i>Others</i>
	• Creating a checklist with rigid preset criteria comprising one hemodynamic agent, one metabolic agent, and symptomatic treatment • Allocating separate resources for ACS and CCS

ACS: Acute coronary syndrome; BP: Blood pressure; CAD: Coronary artery disease; CCS: Chronic coronary system; CT: computed tomography; ECHO: Echocardiogram; ECG: Electrocardiogram; TMT: treadmill test. Source: Author

Simplifying Management Tools for CCS

Considering the lack of resources, cost and availability of healthcare, and logistic challenges, the treatment for patients in resource-constrained settings may not necessarily follow the standard guidelines.⁴⁴ Various methods can be opted for diagnosis in resource-constrained settings. The recently developed optimal treatment for chronic angina (OPTA) tool, a clinical checklist tailored for the Indian setting considering the areas with resource constraints, assists HCPs in accurate diagnosis and prognosis of suspected patients by categorizing them into having stable and unstable angina, providing a combination of antianginal drugs, and giving due consideration to the comorbidities considering its prevalence in the Indian population.^{44,64} The Indian consensus on OPTA discussed patients with chronic stable angina, microvascular angina, angina in women, and chronic stable angina in a diabetic patient with failed graft encountered in the Indian settings. It emphasized a shift in paradigm from the traditional strategy of first- and second-line agents to a strategy that considers the use of various antianginal drugs and their combinations depending on each case and associated comorbidities.⁶⁴

The involvement of ASHA workers has been advantageous in these situations, as specialists are not easily accessible. An improvement in blood pressure control and a greater decline in both systolic and diastolic blood pressure were observed in study participants who received multiple health education sessions from ASHA workers. The sessions focused on medication adherence, physical activity, lifestyle changes, and choosing a healthy diet. The research was conducted in resource-constrained areas of India.⁶⁵ Medical artificial intelligence (AI) can alleviate urban-rural healthcare inequalities by increasing HCP efficiency, improving healthcare quality, lowering medical expenses, and also educating paramedical professionals and nurses to compensate for the shortage of HCPs.⁶⁶ A study demonstrated improved accuracy in the interpretation of stress ECHOs by automated analysis using AI.⁶⁷ Furthermore, community health workers (CHWs) in resource-constrained settings anticipate a positive outlook from AI, expecting improved work efficiency, time-saving for themselves and patients, and assistance in training and reinforcing their skills.⁶⁸

Telehealth is another domain that has proved to be effective in remote monitoring of patients wherein the ECG images were transferred to a cardiologist for diagnosis and further referral via the use of portable ECG and Android tablet connection.⁶² Similar results were reported in a study by Dwivedi et al.,⁶⁹ with the use of a telemedicine model in transmitting ECG and

ultrasound images to telemedicine centers for the diagnosis of CVDs.⁶⁹ A telehealth-based model for cardiac patients in the resource-constrained settings of Australia comprising face-to-face, web-based, telephone-based, or a combination of these involving all the stakeholders was proposed and can be studied further for its usage in the Indian resource-constrained settings.⁷⁰ A smartphone application additionally demonstrated promise in monitoring behavioral changes and medication adherence, lowering the risk of hospitalization and the relative risk of mortality for patients with cardiac diseases.⁷¹⁻⁷⁵

Expert opinion on the use of simplified management tools for CCS in resource-constrained settings:

1. The experts proposed an algorithm that would aid in the diagnosis and management of CCS in resource-constrained settings (Figure 2).
2. The OPTA approach was approved for use in such settings. The use of the OPTA checklist and combination drug therapy in patients with CCS was stressed.
3. The development of a native language OPTA questionnaire for outpatient use was suggested to ensure optimal treatment for chronic stable angina.
4. Digital technology, including sharing ECG readings via cloud/instant messaging, electronic intensive care units for remote monitoring, and AI for diagnosis of CCS, can significantly impact patient diagnosis and management.
5. Considering the expert opinions and extensive literature search, an algorithm has been proposed for CCS management. It involves detailed history, clinical examination, noninvasive/invasive tests, telehealth confirmation from a cardiologist, lifestyle modification aided by ASHA workers, pharmacotherapy tailored to comorbidities, and timely revascularization referrals. Furthermore, patient management is categorized based on risk severity: the low-risk emphasizing lifestyle modification, intermediate-risk combining lifestyle management and pharmacotherapy, and high-risk situations prioritizing revascularization (Central Illustration).

Conclusion

This article highlights the opinions of experts on challenges in resource-constrained settings in India, including infrastructure issues, HCPs' understanding and patient awareness, comorbidities among the

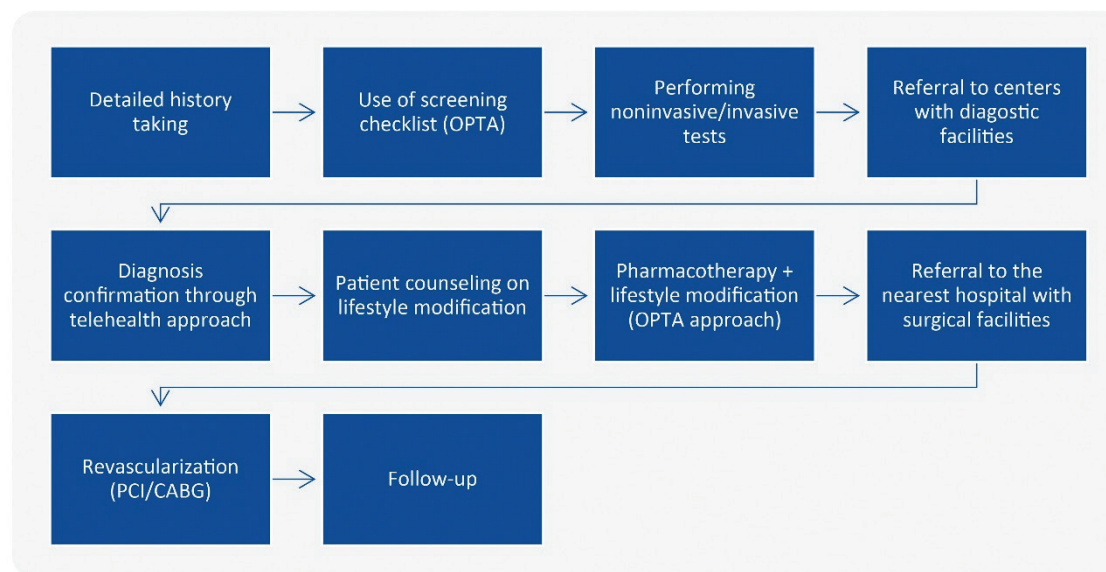


Figure 2 – Flow diagram representing the key points in the management of patients with CCS in resource constrained settings.
 CABG: Coronary artery bypass graft; OPTA: Optimal treatment of angina; PCI: Percutaneous coronary intervention. Source: Author.

Indian population aggravating the CCS risk, and limited adherence toward lifestyle modification and pharmacotherapy. Spreading awareness via mass media, adoption of healthy lifestyles, telemedicine use, and encouraging public-private partnership programs on mass screening and CCS awareness were recognized as the ways to overcome challenges. The proposed algorithm involves ASHA workers in spreading awareness, employing an OPTA checklist for patient screening, timely referral for ECG/ECHO tests, adopting a telehealth model for diagnosis confirmation, and managing the condition according to risk levels. Although the algorithm shows promise for accurate diagnosis and optimal treatment, future studies are recommended to evaluate its utility among patients with CCS in resource-constrained settings.

Acknowledgements

We hereby acknowledge BioQuest Solutions Pvt. Ltd., Bangalore, for providing medical writing and editorial support in the preparation of this manuscript.

Author Contributions

Conception and design of the research, acquisition of data, analysis and interpretation of the data and critical

revision of the manuscript for intellectual content: Shah V, Ray S, Roy DG, Kubba S, Rao S, Abdullakutty J, Kumar KPS.

Potential Conflict of Interest

The authors participated in focused group discussions sponsored by Abbott Healthcare Pvt. Ltd., on which the content of this article is based. The views expressed in the discussion are solely those of the panel members and do not reflect those of Abbott Healthcare Pvt. Ltd.

Sources of Funding

The focused group discussions and manuscript writing support were funded by Abbott Healthcare Pvt. Ltd

Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

References

- Roth GA, Mensah GA, Fuster V. The Global Burden of Cardiovascular Diseases and Risks: A Compass for Global Action. *J Am Coll Cardiol*. 2020;76(25):2980-1. doi: 10.1016/j.jacc.2020.11.021.
- Olvera Lopez E, Ballard BD, Jan A. Cardiovascular Disease. Treasure Island: StatPearls Publishing; 2023.
- Kumar AS, Sinha N. Cardiovascular Disease in India: A 360 Degree Overview. *Med J Armed Forces India*. 2020;76(1):1-3. doi: 10.1016/j.mjafi.2019.12.005.
- Prabhakaran D, Jeemon P, Roy A. Cardiovascular Diseases in India: Current Epidemiology and Future Directions. *Circulation*. 2016;133(16):1605-20. doi: 10.1161/CIRCULATIONAHA.114.008729.
- Institute of Health Metrics and Evaluation. GBD compare [Internet]. Washington: Institute of Health Metrics and Evaluation; 2023 [cited 2023 Dec 16]. Available from: <https://vizhub.healthdata.org/gbd-compare/#>.
- World Health Organization. Global Health Estimates: Leading Causes of Death [Internet]. Geneva: World Health Organization; 2023 [cited 2023 Apr 14]. Available from: <https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghle-leading-causes-of-death>.
- Ford TJ, Corcoran D, Berry C. Stable Coronary Syndromes: Pathophysiology, Diagnostic Advances and Therapeutic Need. *Heart*. 2018;104(4):284-92. doi: 10.1136/heartjnl-2017-311446.
- Hussain S, Al Rashed M, Rajan R, Al-Jarallah M, Brady PA, Soman B, et al. Chronic Coronary Syndrome: A Review of the Literature. *Ann Clin Cardiol*. 2021;3(1):3-7. doi: 10.4103/ACCJ.ACCJ_21_20.
- Gupta R, Yusuf S. Challenges in Management and Prevention of Ischemic Heart Disease in Low Socioeconomic Status People in LLMICs. *BMC Med*. 2019;17(1):209. doi: 10.1186/s12916-019-1454-y.
- Shahjehan RD, Bhutta BS. Coronary Artery Disease. Treasure Island: StatPearls Publishing; 2023.
- Regmi M, Siccardi MA. Coronary Artery Disease Prevention. Treasure Island: StatPearls Publishing; 2023.
- Brown JC, Gerhardt TE, Kwon E. Risk Factors for Coronary Artery Disease. Treasure Island: StatPearls Publishing; 2023.
- Moradi M, Daneshi F, Behzadmehr R, Rafiemanesh H, Bouya S, Raeisi M. Quality of Life Of Chronic Heart Failure Patients: A Systematic Review and Meta-analysis. *Heart Fail Rev*. 2020;25(6):993-1006. doi: 10.1007/s10741-019-09890-2.
- Sajobi TT, Wang M, Awosoga O, Santana M, Southern D, Liang Z, et al. Trajectories of Health-related Quality of Life in Coronary Artery Disease. *Circ Cardiovasc Qual Outcomes*. 2018;11(3):e003661. doi: 10.1161/CIRCOUTCOMES.117.003661.
- Knuuti J, Wijns W, Saraste A, Capodanno D, Barbato E, Funck-Brentano C, et al. 2019 ESC Guidelines for the Diagnosis and Management of Chronic Coronary Syndromes. *Eur Heart J*. 2020;41(3):407-77. doi: 10.1093/eurheartj/ehz425.
- Dababneh E, Goldstein S. Chronic Ischemic Heart Disease Selection of Treatment Modality. Treasure Island: StatPearls Publishing; 2023.
- Kurdi H. Chronic Coronary Syndrome: A New Era for the Diagnosis and Management of Stable Coronary Artery Disease. *BCS Editorial*. 2020:1-5.
- Barik D, Thorat A. Issues of Unequal Access to Public Health in India. *Front Public Health*. 2015;3:245. doi: 10.3389/fpubh.2015.00245.
- Nair A, Jawale Y, Dubey SR, Dharmadhikari S, Zadey S. Workforce Problems at Rural Public Health-centres in India: A WISN Retrospective Analysis and National-Level Modelling Study. *Hum Resour Health*. 2022;19(Suppl 1):147. doi: 10.1186/s12960-021-00687-9.
- Confederation of Indian Industry. Capitalising on India's Growth Potential - PWC [Internet]. New Delhi: PWC; 2010 [cited 2023 Apr 14]. Available from: https://www.pwc.in/assets/pdfs/publications-2011/pwc_cii_pharma_summit_report_22nov.pdf
- Krishnan A, Asadullah M, Roy A, Praveen PA, Singh K, Amarchand R, et al. Change in Prevalence of Coronary Heart Disease and its Risk between 1991-94 to 2010-12 among Rural and Urban Population of National Capital Region, Delhi. *Indian Heart J*. 2020;72(5):403-9. doi: 10.1016/j.ihj.2020.08.008.
- Priya R, Singh R, Das S. Health Implications of Diverse Visions of Urban Spaces: Bridging the Formal-informal Divide. *Front Public Health*. 2019;7:239. doi: 10.3389/fpubh.2019.00239.
- Geiling J, Burkle FM Jr, Amundson D, Dominguez-Cherit G, Gomersall CD, Lim ML, et al. Resource-poor Settings: Infrastructure and Capacity Building: Care of the Critically ill and Injured During Pandemics and Disasters: CHEST Consensus Statement. *Chest*. 2014;146(4 Suppl):e156S-67S. doi: 10.1378/chest.14-0744.
- Agyekum EO, Kalaris K, Maliqi B, Moran AC, Ayim A, Roder-DeWan S. Networks of Care to Strengthen Primary Healthcare in Resource Constrained Settings. *BMJ*. 2023;380:e071833. doi: 10.1136/bmj-2022-071833.
- Saliu F, Behera S, Qadeer A. Healthcare Analytics in Resource-Constrained Settings: Opportunities and Challenges. *J Adv Anal Healthc Manag*. 2022;6:1-8.
- van Zyl C, Badenhorst M, Hanekom S, Heine M. Unravelling 'Low-resource Settings': A Systematic Scoping Review with Qualitative Content Analysis. *BMJ Glob Health*. 2021;6(6):e005190. doi: 10.1136/bmjgh-2021-005190.
- Sharma MG, Popli H. Challenges for Lower-middle-income Countries in Achieving Universal Healthcare: An Indian Perspective. *Cureus*. 2023;15(1):e33751. doi: 10.7759/cureus.33751.
- Jain R, Ajmera H, Rao B. Reducing resource disparity in healthcare resource allocation of laboratories in countries with limited resources by empowering policy-making and implementation. *Current Science*. 2018;115(6):1049-55. doi: 10.18520/cs/v115/i6/1049-1055.
- Alhalaseh YN, Elshabrawy HA, Erashdi M, Shahait M, Abu-Humdan AM, Al-Hussaini M. Allocation of the "Already" Limited Medical Resources Amid the COVID-19 Pandemic, an Iterative Ethical Encounter Including Suggested Solutions From a Real Life Encounter. *Front Med*. 2021;7:616277. doi: 10.3389/fmed.2020.616277.
- Kasthuri A. Challenges to Healthcare in India - The Five A's. *Indian J Community Med*. 2018;43(3):141-3. doi: 10.4103/ijcm.IJCM_194_18.
- Boateng D, Wekesah F, Browne JL, Agyemang C, Agyei-Baffour P, Aikins AD, et al. Knowledge and Awareness of and Perception Towards Cardiovascular Disease Risk in Sub-Saharan Africa: A Systematic Review. *PLoS One*. 2017;12(12):e0189264. doi: 10.1371/journal.pone.0189264.
- Priyadarshi M, Kumar S. Accountability in Healthcare in India. *Indian J Community Med*. 2020;45(2):125-9. doi: 10.4103/ijcm.IJCM_224_19.
- Mohanam M, Hay K, Mor N. Quality Of Health Care In India: Challenges, Priorities, And The Road Ahead. *Health Aff*. 2016;35(10):1753-8. doi: 10.1377/hlthaff.2016.0676.
- Riner WF, Sellhorst SH. Physical Activity and Exercise in Children with Chronic Health Conditions. *J Sport Health Sci*. 2013;2(1):12-20. doi: 10.1016/j.jshs.2012.11.005.
- Thakur JS, Paika R, Singh S. Burden of Noncommunicable Diseases and Implementation Challenges of National NCD Programmes in India. *Med J Armed Forces India*. 2020;76(3):261-7. doi: 10.1016/j.mjafi.2020.03.002.
- India State-Level Disease Burden Initiative CVD Collaborators. The Changing Patterns of Cardiovascular Diseases and their Risk Factors in the States of India: The Global Burden of Disease Study 1990-2016. *Lancet Glob Health*. 2018;6(12):e1339-e1351. doi: 10.1016/S2214-109X(18)30407-8.
- Bansal SK, Agarwal S, Daga MK. Conventional and Advanced Lipid Parameters in Premature Coronary Artery Disease Patients in India. *J Clin Diagn Res*. 2015;9(11):BC07-11. doi: 10.7860/JCDR/2015/14818.6844.

38. Kumbhalkar SD, Bisne VV. Clinical and Angiographic Profile of Young Patients with Ischemic Heart Disease: A Central India Study. *J Clin Prev Cardiol.* 2019;8(1):6-12. doi: 10.4103/JCPC.JCPC_22_18.
39. Iyengar SS, Gupta R, Ravi S, Thangam S, Alexander T, Manjunath CN, et al. Premature Coronary Artery Disease in India: Coronary Artery Disease in the Young (CADY) Registry. *Indian Heart J.* 2017;69(2):211-6. doi: 10.1016/j.ihj.2016.09.009.
40. Atre S, Deshmukh S, Kulkarni M. Prevalence of Type 2 Diabetes Mellitus (T2DM) in India: A Systematic Review (1994-2018). *Diabetes Metab Syndr.* 2020;14(5):897-906. doi: 10.1016/j.dsx.2020.05.040.
41. Shrestha N, Gautam S, Mishra SR, Virani SS, Dhungana RR. Burden of Chronic Kidney Disease in the General Population and High-risk Groups in South Asia: A Systematic Review and Meta-analysis. *PLoS One.* 2021;16(10):e0258494. doi: 10.1371/journal.pone.0258494.
42. Daniel RA, Aggarwal P, Kalaivani M, Gupta SK. Prevalence of Chronic Obstructive Pulmonary Disease in India: A Systematic Review and Meta-analysis. *Lung India.* 2021;38(6):506-13. doi: 10.4103/lungindia.lungindia_159_21.
43. Moroz GZ, Hidzyska IM, Kravchenko AM, Lasysia TS, Dzizinska OO. Comorbidity in Patients with Chronic Coronary Syndromes: Prevalence and Assessment. *Wiad Lek.* 2020;73(3):462-5.
44. Jadhav U, Pinto B, Jayagopal PB, Nair T, Kumar P, Sahoo PK, et al. Indian Consensus on Optimal Treatment of Angina (OPTA). *J Assoc Physicians India.* 2018;66(12):95-103.
45. Taghaddosi M, Dianati M, Bidgoli JFG, Bahonaran J. Delay and its Related Factors in Seeking Treatment in Patients with Acute Myocardial Infarction. *ARYA Atheroscler.* 2010;6(1):35-41.
46. Kwok CS, Burke H, McDermott S, Welsh V, Barker D, Patwala A, et al. Missed Opportunities in the Diagnosis of Heart Failure: Evaluation of Pathways to Determine Sources of Delay to Specialist Evaluation. *Curr Heart Fail Rep.* 2022;19(4):247-53. doi: 10.1007/s11897-022-00551-4.
47. Schwalm JD, McKee M, Huffman MD, Yusuf S. Resource Effective Strategies to Prevent and Treat Cardiovascular Disease. *Circulation.* 2016;133(8):742-55. doi: 10.1161/CIRCULATIONAHA.115.008721.
48. Santra G. Assessment of Adherence to Cardiovascular Medicines in Rural Population: An Observational Study in Patients Attending a Tertiary Care Hospital. *Indian J Pharmacol.* 2015;47(6):600-4. doi: 10.4103/0253-7613.169573.
49. Saeed A, Amin QK, Saeed R, Yousafzai ZA. Comparing Medication Non-adherence in Cardiovascular Disease Patients at Public and Private Hospitals in Peshawar: A Cross-Sectional Study of Prevalence and Contributing Factors. *Cureus.* 2023;15(3):e36345. doi: 10.7759/cureus.36345.
50. Thompson SC, Nedkoff L, Katzenellenbogen J, Hussain MA, Sanfilippo F. Challenges in Managing Acute Cardiovascular Diseases and Follow Up Care in Rural Areas: A Narrative Review. *Int J Environ Res Public Health.* 2019;16(24):5126. doi: 10.3390/ijerph16245126.
51. Gajarawala SN, Pelkowski JN. Telehealth Benefits and Barriers. *J Nurse Pract.* 2021;17(2):218-21. doi: 10.1016/j.nurpra.2020.09.013.
52. Virani SS, Newby LK, Arnold SV, Bittner V, Brewer LC, Demeter SH, et al. 2023 AHA/ACC/ACCP/ASPC/NLA/PCNA Guideline for the Management of Patients with Chronic Coronary Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. *Circulation.* 2023;148(9):e9-e119. doi: 10.1161/CIR.0000000000001168.
53. Fihn SD, Blankenship JC, Alexander KP, Bittl JA, Byrne JG, Fletcher BJ, et al. 2014 ACC/AHA/AATS/PCNA/SCAI/STS Focused Update of the Guideline for the Diagnosis and Management of Patients with Stable Ischemic Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, and the American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *J Am Coll Cardiol.* 2014;64(18):1929-49. doi: 10.1016/j.jacc.2014.07.017.
54. Ueng KC, Chiang CE, Chao TH, Wu YW, Lee WL, Li YH, et al. 2023 Guidelines of the Taiwan Society of Cardiology on the Diagnosis and Management of Chronic Coronary Syndrome. *Acta Cardiol Sin.* 2023;39(1):4-96. doi: 10.6515/ACS.202301_39(1).20221103A.
55. Salas-Salvadó J, Díaz-López A, Ruiz-Canela M, Basora J, Fitó M, Corella D, et al. Effect of a Lifestyle Intervention Program with Energy-Restricted Mediterranean Diet and Exercise on Weight Loss and Cardiovascular Risk Factors: One-year Results of the PREDIMED-Plus Trial. *Diabetes Care.* 2019;42(5):777-88. doi: 10.2337/dc18-0836.
56. Basu S, Bendavid E, Sood N. Health and Economic Implications of National Treatment Coverage for Cardiovascular Disease in India: Cost-effectiveness Analysis. *Circ Cardiovasc Qual Outcomes.* 2015;8(6):541-51. doi: 10.1161/CIRCOUTCOMES.115.001994.
57. Laukkanen JA, Kunutsor SK. Revascularization versus Medical Therapy for the Treatment of Stable Coronary Artery Disease: A Meta-analysis of Contemporary Randomized Controlled Trials. *Int J Cardiol.* 2021;324:13-21. doi: 10.1016/j.ijcard.2020.10.016.
58. Navarese EP, Lansky AJ, Kereiakes DJ, Kubica J, Gurbel PA, Gorog DA, et al. Cardiac Mortality in Patients Randomised to Elective Coronary Revascularisation Plus Medical Therapy or Medical Therapy Alone: A Systematic Review and Meta-analysis. *Eur Heart J.* 2021;42(45):4638-51. doi: 10.1093/eurheartj/ehab246.
59. Shaik TA, Chaudhari SS, Haider T, Rukia R, Al Barznji S, Kataria H, et al. Comparative Effectiveness of Coronary Artery Bypass Graft Surgery and Percutaneous Coronary Intervention for Patients With Coronary Artery Disease: A Meta-analysis of Randomized Clinical Trials. *Cureus.* 2022;14(9):e29505. doi: 10.7759/cureus.29505.
60. Singh M, Agarwal A, Sinha V, Kumar RM, Jaiswal N, Jindal I, et al. Application of Handheld Tele-ECG for Health Care Delivery in Rural India. *Int J Telemed Appl.* 2014;2014:981806. doi: 10.1155/2014/981806.
61. Bashar H, Matetić A, Curzen N, Mamas MA. Invasive Management and In-Hospital Outcomes of Myocardial Infarction Patients in Rural Versus Urban Hospitals in the United States. *Cardiovasc Revasc Med.* 2023;46:3-9. doi: 10.1016/j.carrev.2022.08.023.
62. Shetty R, Samant J, Nayak K, Maiya M, Reddy S. Feasibility of Telecardiology Solution to Connect Rural Health Clinics to a Teaching Hospital. *Indian J Community Med.* 2017;42(3):170-3. doi: 10.4103/ijcm.ijcm_368_16.
63. Raghu A, Devarsetty P, Peiris D, Clifford G, Tarassenko L. Mobile Health for Cardiovascular Disease Risk Screening and management in resource-constrained environments [Internet]. Berlin: ResearchGate; 2013 [cited 2023 Apr 14]. Available from: https://www.researchgate.net/publication/259702832_Mobile_health_for_Cardiovascular_disease_risk_screening_and_management_in_resource-constrained_environments.
64. Shah VT, Zachariah G, Lakshmanan S, Babu S, Suresh K, Roy DG et al. Patient Profile Based Management Approach for Optimal Treatment of Angina: A Consensus from India Cases. *Int J Adv Med.* 2019;6(2):551-61.
65. Gamage DG, Riddell MA, Joshi R, Thankappan KR, Chow CK, Oldenburg B, et al. Effectiveness of a Scalable Group-based Education and Monitoring Program, Delivered by Health Workers, to Improve Control of Hypertension in Rural India: A Cluster Randomised Controlled Trial. *PLoS Med.* 2020;17(1):e1002997. doi: 10.1371/journal.pmed.1002997.
66. Guo J, Li B. The Application of Medical Artificial Intelligence Technology in Rural Areas of Developing Countries. *Health Equity.* 2018;2(1):174-81. doi: 10.1089/hecq.2018.0037.
67. Upton R, Mumith A, Beqiri A, Parker A, Hawkes W, Gao S, et al. Automated Echocardiographic Detection of Severe Coronary Artery Disease Using Artificial Intelligence. *JACC Cardiovasc Imaging.* 2022;15(5):715-27. doi: 10.1016/j.jcmg.2021.10.013.
68. Okolo CT, Kamath S, Dell N, Vashishtha A. "It Cannot do All of My Work": Community Health Worker Perceptions of AI-enabled Mobile Health Applications in RURAL INDIA. Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems; 2021 May 1-20. Yokohama: CHI; 2021.

69. Dwivedi S, Sharma V, Roy K. Importance of Imaging in Work up of Cardiovascular Diseases by Using Telemedicine in Rural India. *J Assoc Physicians India*. 2021;69(11):11-12.
70. Beleigoli A, Champion S, Tirimacco R, Nesbitt K, Tideman P, Clark RA. A Co-designed Telehealth-based Model of Care to Improve Attendance and Completion to Cardiac Rehabilitation of Rural and Remote Australians: The Country Heart Attack Prevention (CHAP) Project. *J Telemed Telecare*. 2021;27(10):685-90. doi: 10.1177/1357633X211048400.
71. Düsing P, Eckardt I, Schirmer SH, Sinning JM, Werner N, Bönner F, et al. A Prospective, Randomized, Controlled, Multicentre Trial for Secondary Prevention in Patients with Chronic Coronary Syndrome Using a Smartphone Application for Digital Therapy: The CHANGE Study Protocol. *Eur Heart J Digit Health*. 2023;4(3):207-15. doi: 10.1093/ehjdh/ztad012.
72. Gallagher R, Chow CK, Parker H, Neubeck L, Celermajor DS, Redfern J, et al. The Effect of a Game-based Mobile App 'MyHeartMate' to Promote Lifestyle Change in Coronary Disease Patients: A Randomized Controlled Trial. *Eur Heart J Digit Health*. 2022;4(1):33-42. doi: 10.1093/ehjdh/ztac069.
73. Davoudi M, Ghezeljeh TN, Aghouee FV. Effect of a Smartphone-Based App on the Quality of Life of Patients with Heart Failure: Randomized Controlled Trial. *JMIR Nurs*. 2020;3(1):e20747. doi: 10.2196/20747.
74. Brørs G, Pettersen TR, Hansen TB, Fridlund B, Hølvold LB, Lund H, et al. Modes of E-health Delivery in Secondary Prevention Programmes for Patients with Coronary Artery Disease: A Systematic Review. *BMC Health Serv Res*. 2019;19(1):364. doi: 10.1186/s12913-019-4106-1.
75. Del Toro MR, Leaño NMH, Barahona-Correa JE, Velandia OMM, Ávila DGF, Peña ÁAG. Effectiveness of Mobile Telemonitoring Applications in Heart Failure Patients: Systematic Review of Literature and Meta-analysis. *Heart Fail Rev*. 2023;28(2):431-52. doi: 10.1007/s10741-022-10291-1.

*Supplemental Materials

For additional information, please [click here](#).

