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STOCHASTIC MODELING FOR RISK FACTORS OF CARDIOVASCULAR DISEASES IN INDIAN COMMUNITY BASED SETTING

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Abstract

Objective: To assess the cost-effectiveness of implementing screening strategy and management for cardio-vascular diseases risk factors (Hypertension and Diabetes) in Indian community based setting. **Methods:** A stochastic decision tree model was developed to compare the cost effectiveness of screening for cardio-vascular diseases risk factors (Hypertension and Diabetes) and intervention strategy against standard of care for the known diabetes and hypertensive patients in Indian setting. Cost and health outcomes were calculated based on the proportion of health outcomes from our previous studies and literature review. Total costs, life year gained and incremental cost-effectiveness ratio (ICER) of the intervention and comparator strategies were calculated with the stochastic decision tree model. **Results:** Considering the screening for cardio-vascular diseases risk factors and intervention strategy for the diabetes and hypertensive patients in a rural area will result in an incremental cost-effectiveness ratio of INR 41,615. With the life year gain of 216 per lakh population. Life year gain in the intervention arm was 69,244 per lakh population in the intervention arm and 69,028 per lakh population in the control arm. **Conclusion:** Active screening and appropriate intervention for Hypertension and Diabetes patients in the Indian setting could save lives and reduce out-of-pocket expenditures compared to passive screening.

Keywords: Stochastic, Decision Tree, Diabetes, CVD and ICER.

INTRODUCTION

Prevention is better than cure. In public health preventive strategies are always given importance as it is cheap and cost effective. Cardiovascular diseases (CVDs) are the leading cause of mortality at global level as well as in India as per recent World Health Organization (WHO) report.[1] Recent days Non-Communicable Diseases (NCDs) gained larger importance. In India 70% of the population still lives in villages and the NCD management at the rural level needs special attention to ensure equity.[2] By Sustainable Developmental Goals-2030 (SDG), India has committed to achieving one third reduction in the premature mortality caused by NCDs by 2030.[3,4] The National Health Policy of India (NHP-India) introduced in 2017 to fulfil the SDG 2030 goals. By the NHP India-2025 goals, the NCD management has integrated at all levels of health care and the availability of free medications has been ensured.[5] Through the National Programme for Non-Communicable Disease programme (NP-NCD) NCD clinics were established at Community Health Centre (CHC) level. NCDs were managed at the primary care level through these setups.[6] Understanding the importance of NCD screening, diagnosis and management, states like Tamil Nadu has started a special programme where the medical facilities for management of NCDs will reach their home. This included screening, diagnosis and monthly medications were made available at their door step free of cost.[7]

We have also conducted a preventive screening programme for already known hypertensive (high blood pressure) patients and Diabetes patients in a remote rural

area.[8,9] In this paper, we intended to assess the cost effectiveness of one of such a community based programme with the help of available evidences. We aimed to assess the cost-effectiveness of implementing a screening strategy for hypertensive and diabetes patients to prevent Myocardial Infarction (MI) which is one of the major cardio-vascular diseases a risk factors in Indian public health setting.

METHODS

Population: Already diagnosed diabetes and Hypertensive patients from the community were taken as the study population.

Intervention arm: Hypothetical intervention (active screening and management) includes visiting the families in the community by the ASHAs, PHNs or MSWs of the concerned rural health training centers for routine checkups. During this visit the health workers will identify the already known cases of hypertension and diabetes as well as screen the population for hypertension and diabetes and refer them to their clinic for standard of care. Intervention includes minimum one visit in a year for general population and four visits in a year for already diagnosed DM and HT population will be done. During this visit, one time checking of BP and Random Blood Sugars for general population will be done. For the DM and HT patients, appropriate management of disease including diet modification, exercise promotion, counselling to stop smoking and alcohol and pharmacological treatment will be offered. In the control setting (Passive screening and management) the individuals will be approaching the hospital for testing and diagnosis and followed by treatment in diagnosed with disease (DM and HT).

Study design:

Model Setting: A stochastic decision tree model was developed using Microsoft Excel Version 2019. The cost effectiveness of screening and intervention strategy against control setting was compared.

Duration: the model was designed for a period of one year.

Cost: Cost of the programme was hypothetically calculated in INR from our previous experience (Table 1). [8,9] The cost per person on intervention arm was calculated to be INR 100 per person in a population. Cost for passive approach in the control arm per person was calculated to be INR 10 per person.

Outcome measures: Outcome measures of the intervention (Exercise, diet modification and pharmacological treatment) for the Diabetes and Hypertensive patients, which may result in up to 3.8% reduction of heart disease (table 1).[10] Mortality (Death) among DM and HT after developing MI was up to 8.2% per annum.[11] Age specific death rate of India at 60-64 years (18.6%) was taken as reference and the calculated death rate per annum at this age was 3.72.[12] Life year gained with DM and HT was 0.72, whereas life year gained after developing CVD was 0.671.[13] details of model inputs given in Table 1.

Data analysis:

Decision tree model engine was developed in Microsoft Excel Version 2019. Total costs, life year gained and incremental cost-effectiveness ratio (ICER) of the intervention and comparator strategies were calculated with the same model (figure 1).

RESULTS

Considering the screening for cardio-vascular diseases risk factors and intervention strategy for the diabetes and hypertensive patients in a rural area will result in incremental cost effectiveness ratio of INR 41,615. With the life year gain of 216 per lakh population. Life year gain in the intervention arm was 69,244 per lakh population and in the control arm was 69,028 per lakh.

Table 1: Model input parameters

Input parameters	Variables	Values	References
Health Indicators	Annual MI risk after intervention	1%	10
	No MI after intervention	99.0%	10
	Annual MI risk after No intervention	3.8%	10
	No MI after No intervention	96.2%	10
	Annual Death rate after MI	8.2%	11
	Annual Death rate after No MI	3.72%	12
Life Year Gained	MI	0.671 LYG	13
	DM and HT	0.72 LYG	13
	Death	0 LYG	13
Costs	Overall cost with intervention	INR 100	8
	Overall cost with no intervention	INR 10	8

MI –Myocardial Infarction, DM-Diabetes Mellitus & HT - Hypertension

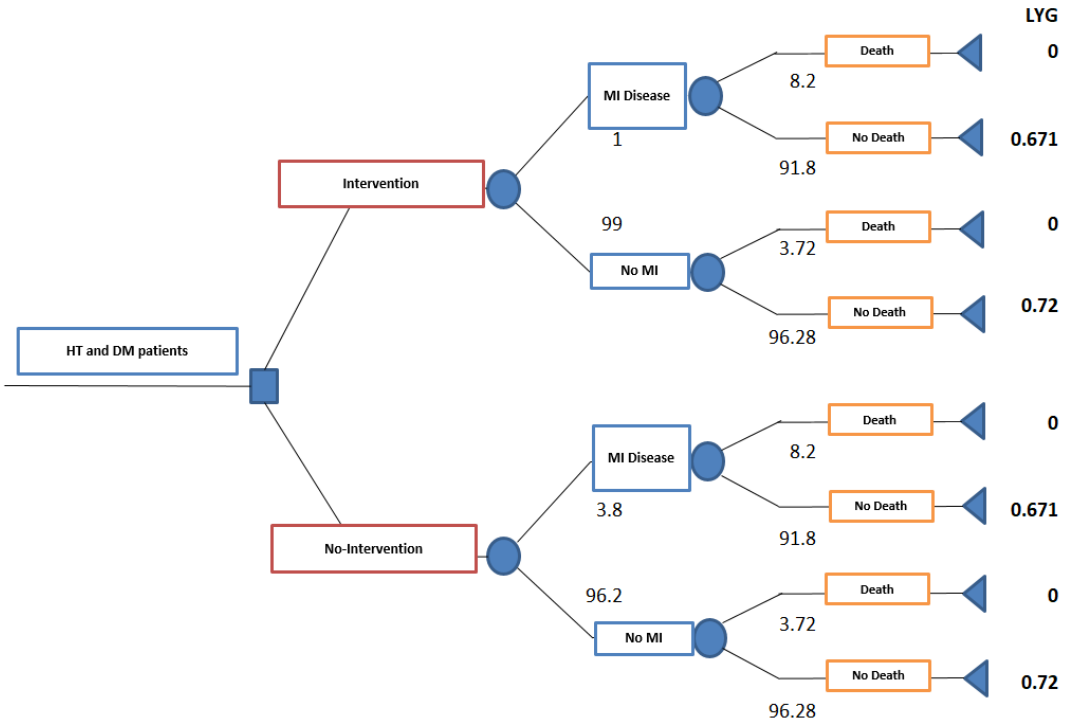

Figure 2: Decision tree model for Cost effectiveness analysis

DISCUSSION

Major finding in our study was, the active community based intervention to screen, diagnose and manage the HT and DM patients at community level could be highly cost effective. Our finding shows INR of 41,615 needed to save one QALY (Quality adjusted life year) which is nearly five times below the Indian per capital income of INR

1.96 lakhs.[14] CVD is the outcome major risk factors like DM and HT leading cause of morbidity and mortality in India. Myocardial Infarction (MI) and Cerebro vascular accidents are responsible for >80% of CVD related deaths. The Global Burden of Disease study estimated of age-standardized CVD death rate of 272 per 100000 population in India. This is more than the global average CVD death rate of 235 per 100000 population.[15] CVD has a wide range of prevalence in India, however CVD deaths occupied the top most reason across state and also across different economic section (rich and poor).[15] Individuals from lower socioeconomic backgrounds frequently do not receive optimal screening for the risk factors (DM, HT & hypercholesterolemia) for CVD and optimal therapy after diagnosis, leading to poorer outcomes. India is often referred as the "the capital of diabetes".[16] Active screening and management of these patients could benefit a lot. Countering the diabetes epidemic requires the development of strategies such as the formulation and effective implementation of evidence-based policy, reinforcement of health systems, and emphasis on prevention, early detection, and treatment with the use of both conventional and innovative techniques.

Several ongoing community-based studies are testing these strategies. But very few had analyzed the CE of the strategy. Many CEA are on newer diagnostic techniques. But ours is on CEA is on well proven basic preventive strategies (Diet, exercise, alcohol & smoking and medical management). We were unable to perform sensitivity analysis due to technical resource constrain. However, our experience has proven it is feasible and much cost effective to implement CVD prevention strategy in the community and in rural areas with the help of existing government health facilities. Government may need adopt appropriate strategies to implement these preventive strategies in the community.

CONCLUSION

Active screening and appropriate basic intervention for the cardiovascular diseases risk factors in the community in the Indian setup and reduce out-of-pocket expenditures compared to the passive approach to the community.

References

1) World Health Organization. Non Communicable Diseases country Profile 2018 [Internet]. [cited 2019 Aug 2]. Available from: https://www.who.int/nmh/publications/ncd-profiles-2018/en/

2) Swaminathan K, Veerasekar G, Kuppusamy S, Sundaresan M, Velmurugan G, Palaniswami N. Noncommunicable disease in rural India: Are we seriously underestimating the risk? the Nallampatti noncommunicable disease study. Indian J Endocrinol Metab. 2017 Jan 1;21(1):90–5.

3) The United Nations Development Programme. sustainable Development goals [Internet]. 2015 [cited 2020 Mar 11]. Available from: https://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

4) World Health Organization. World health statistics 2016: monitoring health for the SDGs sustainable development goals. 1st ed. Geneva: World Health Organization; 2016. 161 p.

5) Ministry of Helath and Family Welfare - Government of India. National Health Policy 2017 [Internet]. 2018 [cited 2019 Dec 21]. Available from: https://mohfw.gov.in/sites/default/files/9147562941489753121.pdf

6) Ministry of Helath and Family Welfare G of I. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS). New Delhi; 2017.

7) Health and Family Welfare - Government of Tamilnadu. Makkalai Thedi Maruthuvam [Internet]. 2021 [cited 2024 Mar 6]. Available from: https://cms.tn.gov.in/sites/default/files/go/hfw_e_340_2021.pdf

8) Newtonraj A, Selvaraj K, Purty AJ, Nanda SK, Arokiaraj MC, Vincent A, et al. Feasibility and outcome of community-based screening for cardiovascular disease risk factors in a remote rural area of South India: The Chunampet rural–Cardiovascular health assessment and management program. Indian J Endocrinol Metab. 2019;23(6):628.

9) Ponraj DS, Gopikrishnan S, Newtonraj A, Arokiaraj M, Purty A, Nanda S, et al. Cardiovascular risk using WHO-ISH chart among Diabetes and Hypertensive patients in a remote rural area of South India. J Fam Med Prim care [Internet]. 2020 [cited 2022 Sep 22];9(8):4145. Available from: https://pubmed.ncbi.nlm.nih.gov/33110823/

10) Stratton IM, Cull CA, Adler AI, Matthews DR, Neil HAW, Holman RR. Additive effects of glycaemia and blood pressure exposure on risk of complications in type 2 diabetes: a prospective observational study (UKPDS 75). Diabetologia [Internet]. 2006 Aug [cited 2024 Mar 4];49(8):1761–9. Available from: https://pubmed.ncbi.nlm.nih.gov/16736131/

11) Xavier D, Pais P, Devereaux P, Xie C, Prabhakaran D, Reddy KS, et al. Treatment and outcomes of acute coronary syndromes in India (CREATE): a prospective analysis of registry data. Lancet (London, England) [Internet]. 2008 [cited 2024 Mar 5];371(9622):1435–42. Available from: https://pubmed.ncbi.nlm.nih.gov/18440425/

12) Office of the Registrar General & Census Commisioner - Ministrty of Home Affairs - Government of India. Sample registration system statistical report 2020 [Internet]. [cited 2024 Mar 20]. Available from: https://censusindia.gov.in/nada/index.php/catalog/44376/download/48048/SRS_STAT_2020.pdf

13) Kaur G, Chauhan AS, Prinja S, Teerawattananon Y, Muniyandi M, Rastogi A, et al. Cost-effectiveness of population-based screening for diabetes and hypertension in India: an economic modelling study. Lancet Public Heal [Internet]. 2022 Jan 1 [cited 2024 Mar 4];7(1):e65–73. Available from: https://pubmed.ncbi.nlm.nih.gov/34774219/

14) Satistics Times. GDP percapita of India. 2024 [cited 2024 Mar 24]; Available from: https://statisticstimes.com/economy/country/india-gdp-per-capita.php#:~:text=Nominal GDP per capita or,115%2C746 INR for 2022-23.

15) Prabhakaran D, Jeemon P, Roy A. Cardiovascular diseases in India: current epidemiology and future directions. Circulation. 2016;133(16):1605–20.

16) Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, et al. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2·7 million participants. Lancet (London, England) [Internet]. 2011 [cited 2024 Feb 23];378(9785):31–40. Available from: https://pubmed.ncbi.nlm.nih.gov/21705069/