CONTRASTING TRAJECTORIES: A STUDY OF OUT-OF-HOSPITAL CARDIAC ARREST INCIDENCE AND COMMUNITY RESPONSE

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ABSTRACT

With a rapidly ageing population, Singapore faces the challenge of managing rising Out-of-Hospital Cardiac Arrest (OHCA) incidence. Time is of the essence and Community First Responders (CFRs) are necessary in OHCA response. However, CFRs are also members of an ageing society; ageing also affects potential adoption of the CFR role. No public forecast is available either for OHCA incidence or CFR availability in Singapore. We estimated the age-specific incidence of OHCA in Singapore based on historical data from 2010 to 2021. We developed an Agent Based Model (ABM) to simulate the population of Singapore (stratified by age), the incidence of OHCA, and adoption of the CFR role until 2050. Preliminary results from the ABM show that even if CFR adoption follows a successful diffusion curve, there will not be enough CFRs relative to the number of OHCA cases. Our open-source ABM can be an aid for policymakers and researchers.

1   INTRODUCTION

Out-of-Hospital Cardiac Arrest (OHCA), a highly time sensitive medical emergency, poses a serious challenge to the health system. Society needs to provide social, emotional, and financial support for OHCA survivors. Timely response to OHCA necessarily requires the participation of the community. Community First Responders (CFRs) are a caring group of community members that is increasingly engaged in OHCA care in the "golden window during which actions have the highest chance of affecting patient survival (Siddiqui et al. 2023). CFRs are a necessary and critical part of the infrastructure of OHCA management.

Being part of an aging society, CFRs will also experience aging. With increasing OHCA incidence among the elderly and a decreasing segment of population capable of delivering this physically and emotionally demanding intervention. Estimating the future trajectories of OHCA incidence and CFR availability would help to stimulate discussion on this topic as no public forecasts are available for either of these. To address this gap, our study has the following research questions:
- RQ1: What is the estimated number of OHCA incidents per year in Singapore till 2050?
- RQ2: What is the estimated number of CFRs in Singapore till year 2050?

2   METHODS

The logical components of our model include functions to simulate the following: (i) the population of Singapore, stratified by age, from years 2010 through 2050; (ii) incidence of OHCA in Singapore, determined by the age-stratified population and the age-specific incidence of OHCA; (iii) Adoption of the CFR role in Singapore.

The population model has "aging clock" mechanism. Each agent in the population represents 1000 Singapore residents, tagged by age and gender. The time horizon begins in 2010 (the first year for which OHCA incidence data is available) and ends in 2050. Population parameters are based on publicly available census data from the Singapore Department of Statistics. A limitation of the present model is that it does

not take immigration into account. We used non-linear least squares curve fitting to estimate age-specific incidence as a function of time, resulting in exponentially saturating curves per age group. To model the diffusion of CFR role adoption, we applied the theory of the Bass Diffusion Model (BDM, Bass 1969; Mahajan, Muller, and Bass 1990). To estimate values of BDM parameters for Singapore, we fit data for second generation (2G) mobile diffusion (Info-Communications Media Development Authority 2025) to the BDM. The simulation model of OHCA incidence and CFR role adoption is developed in NetLogo version 6.4 (Wilensky 1999).

3   RESULTS

Figures 1(a) and 1(b) show the resulting trends in the number of CFRs and the CFRs per OHCA incident respectively. In Figure 1(a), the classical S-curve of the BDM is subjected to the truncating effect of population ageing on the available pool of CFRs after the number of adopters hits a ceiling. Figure 1(b) shows the resulting worsening of the ratio of registered CFRs relative to the number of OHCA incidents, as the latter increases to more than double its 2025 levels. The higher the number of CFRs per OHCA case, the greater the likelihood of at least one CFR will be nearby to respond.
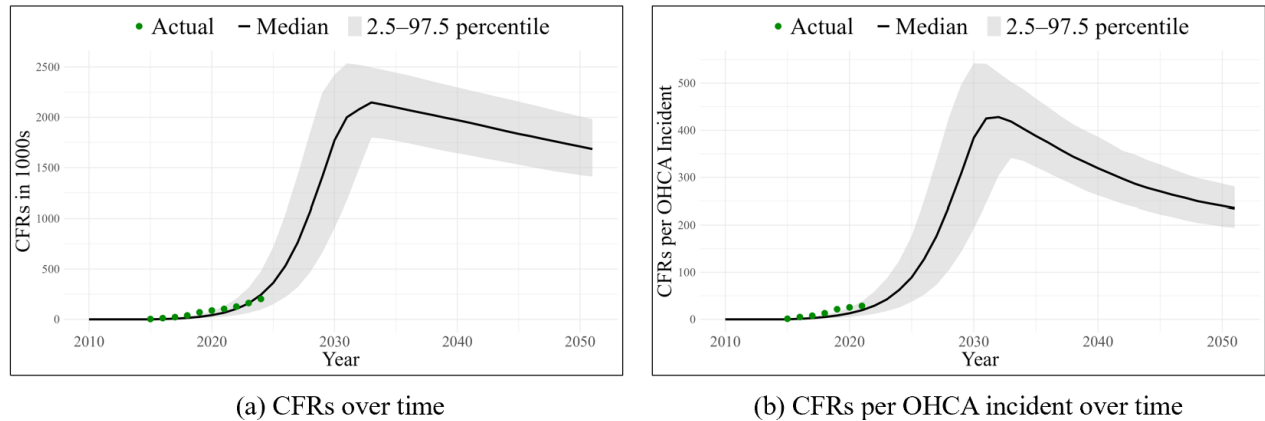

(a) CFRs over time   (b) CFRs per OHCA incident over time

Figure 1: CFR trends.

4   CONCLUSION

Coping with OHCA is a major challenge to health systems and having an adequate reserve of CFRs is essential to meet this challenge. Our open-source approach to modelling the demand for OHCA care and the supply pool of CFRs will help to stimulate further discussion on this subject.

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