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Cost-effectiveness analysis of intensive hypertension control in China

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ABSTRACT

China has the largest population of adults with hypertension in the world. Recent clinical trials have shown that intensive hypertension control can help patients achieve lower blood pressure and reduce the incidence of major cardiovascular disease (CVD) events, but this level of hypertension control also incurs additional costs to patients and society and may result in a substantial increase in adverse events. The objective of this study is to assess the cost-effectiveness of intensive hypertension control to inform health policymakers and health care delivery systems in China in their decision-making regarding hypertension treatment strategies. We developed a Markov based simulation model of hypertension to assess the impact of intensive and standard hypertension control strategies for the Chinese population who are diagnosed with hypertension. Model parameters were estimated based on the best available data and the literature. We projected that intensive hypertension control would avert about 2.2 million coronary heart disease events and 4.4 million stroke events for all hypertensive patients in China in 10 years compared to standard hypertension control. The incremental cost-effectiveness ratio (ICER) for intensive hypertension control was estimated at 7876 CNY per quality-adjusted life year (QALY) compared to standard hypertension control. Intensive hypertension control would be more cost-effective than standard hypertension control in China. Our findings indicated that China should consider expanding intensive hypertension control among hypertensive patients given its great potential in preventing CVD.

1. Introduction

China is facing an enormous population health challenge due to the high prevalence of hypertension among adults (Wong & Franklin, 2016; Lewington et al., 2016; Li et al., 2016; Y. Wang et al., 2016). Approximately 320 million people—nearly 30% of the population 18 years of age and older—have hypertension in China and < 5% of adults with hypertension have their blood pressure (BP) under control (i.e., systolic BP < 140 mmHg and diastolic BP < 90 mmHg) (Lewington et al., 2016; Y. Wang et al., 2016). Even among adults with a prior history of cardiovascular disease (CVD), the hypertension control rate is only 13% (Lewington et al., 2016). As a result, uncontrolled hypertension accounted for as many as 750,000 CVD deaths a year; a 25% reduction in the prevalence of hypertension could potentially avert 130,000 CVD deaths (Lewington et al., 2016).

After taking into account population aging and growth, the projected trends in the prevalence of hypertension as well as the trends in other risk factors such as high cholesterol, diabetes, and smoking could result in a cumulative increase of about 21 million CVD events and 7 million CVD deaths from 2010 to 2030 (Moran et al., 2010). Thus, even modest decreases in systolic BP could have a substantially large effect at the population level when it comes to the progression of CVD in China (Moran et al., 2010).

Despite the growing burden of hypertension, only about one third of adults with hypertension are receiving treatment to control it and, among those receiving treatment, more than one third rely on traditional (non-Western) medicine for blood pressure management (Li et al., 2016). A recent study showed that expanding hypertension treatment in China using low-cost medications is cost-saving for treating hypertensive adults with a history of CVD and may be borderline cost-effective for treating all hypertensive adults compared to treating only stage-two hypertensive adults (systolic BP ≥ 160 mmHg and diastolic BP ≥ 100 mmHg) (Gu et al., 2015). In addition to treating hypertension with medication, even a moderate reduction in sodium

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intake—which has been linked to reductions in systolic BP—could result in a significant reduction in CVD incidence and substantial savings in medical costs (M. Wang et al., 2016).

The burden of disease and trends described above are making it necessary that public health leaders and health care providers in China consider new strategies that can be applied consistently and aggressively among adults with hypertension. The Systolic Blood Pressure Intervention Trial (SPRINT) found that an intensive hypertension control strategy that lowers systolic BP to 120 mmHg rather than the standard 140 mmHg for patients with high CVD risk reduced CVD events by 25% and all-cause mortality by 27% (The SPRINT Research Group, 2015). A more recent systematic review and meta-analysis (19 trials, including 44,989 participants) further confirmed that intensive hypertension control can help patients achieve lower BP and reduce the incidence of major CVD events (Xie et al., 2016). Specifically, compared to patients receiving less intensive hypertension control, patients receiving intensive hypertension control experienced 14% fewer CVD events, 13% fewer myocardial infarction (MI) events, and 22% fewer stroke events during a follow-up mean of 3.8 years among the reviewed studies (Xie et al., 2016). Although the cost of intensive hypertension control is usually higher than standard hypertension control and more adverse events may take place with higher intensive treatment, several studies have shown that intensive hypertension control is cost-effective compared to standard hypertension control for most target populations in the United States (Moise et al., 2016; Richman et al., 2016).

This study assesses the cost-effectiveness of intensive hypertension control for adults with hypertension in China. We use a validated computer simulation model to project the consequences and cost-effectiveness of intensive hypertension control compared to standard hypertension control over 10 and 20 years, respectively. We report results for the entire population as well as for different age and gender groups.

2. Methods

2.1. Model structure

We developed a Markov (state-transition) model of hypertension and its consequences for the adult population with hypertension in China 35 to 84 years of age. The selection of this age group is based on the evidence from existing clinical trials (The SPRINT Research Group, 2015; Xie et al., 2016). Fig. 1 shows the conceptual structure of the model. In the model, a patient with hypertension can be put on one of two different hypertension control strategies: intensive hypertension control and standard hypertension control. The patient can then move to a health state that is defined by one of four major CVD events caused by hypertension—revascularization, angina, MI, and stroke. Instead of experiencing a CVD event, the person can also have adverse events (i.e., hypotension, syncope, electrolyte abnormalities, and acute kidney injury or failure) due to the use of hypertension medication (The SPRINT Research Group, 2015). Those experiencing a CVD or other adverse event may die immediately if the event is fatal, or survive and stay in the CVD event state. It is worth noting that although smoking is an important risk factor for hypertension, we did not include it because our model focuses on medication intervention rather than lifestyle intervention. Each health state in the model has an annual cost and quality-of-life utility which accumulate over time. Movement between any two health states is defined by a transition probability, which varies based on population characteristics and the hypertension control strategy adopted. These parameters were calibrated following the same procedures used in a recent study based on the Chinese population (Gu et al., 2015). We used one year as the basic simulation cycle. The model was developed using TreeAge Pro software (TreeAge Software, Inc., Williamstown, MA, USA).

2.2. Parameter estimation

We include all the model parameters and assumptions in the Supplementary Appendix (Table SA1). Specifically, we estimated model parameters that determine disease transitions and the effects of treatment based on recent published epidemiological and modeling studies (Gu et al., 2015; Xie et al., 2016; Law et al., 2009; Moran et al., 2015; Gu et al., 2008). For example, relative risks that capture the effects of intensive hypertension control were estimated from a recent systematic review and meta-analysis (Xie et al., 2016). Annual rates of adverse events under standard and intensive hypertension control were also estimated from the same meta-analysis (Xie et al., 2016). Medication adherence rates for standard and intensive hypertension control were estimated from the Prospective Urban Rural Epidemiology (PURE) study (Yusuf et al., 2011). Parameters regarding the natural history of hypertension and CVD events were estimated from China National Hypertension Survey Epidemiology Follow-up Study and Chinese Multi-Provincial Cohort Study (Gu et al., 2008; Liu et al., 2004). In addition, age- and gender-specific mortality rates were estimated based on the Chinese National Sample Survey (Office of the Second China National Sample Survey on Disability, 2007).

We categorized cost parameters into monitoring, antihypertensive drug, and annual treatment costs (Gu et al., 2015). We obtained the frequency of laboratory tests and hypertension treatment through communication with experts from the China Hypertension Control Program and the Beijing Municipal Commission of Development and Reform. Antihypertensive drug costs were estimated by averaging the median costs of four standard antihypertensive classes of drugs (i.e., thiazide diuretics, angiotensin converting enzyme inhibitors, beta

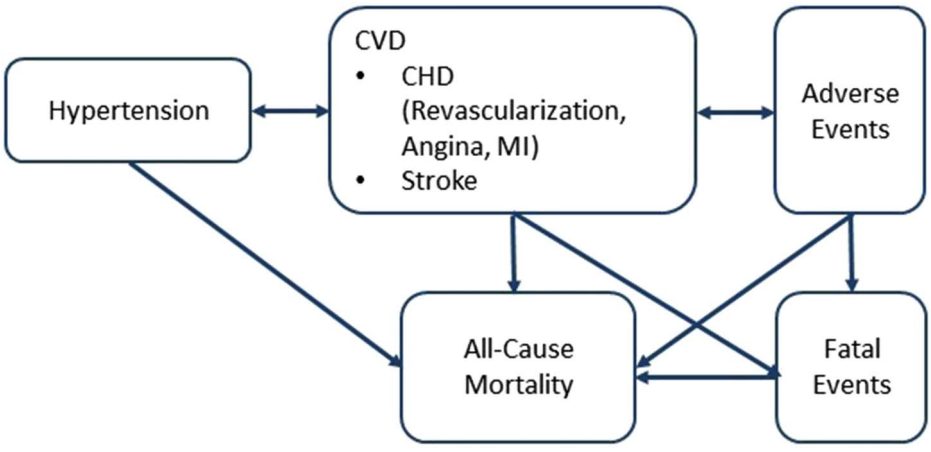

Fig. 1. Conceptual structure of the hypertension model.