Health impact of hypertension control in four countries: an individual-based simulation model calibrated to Global Burden of Disease Study estimates

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INTRODUCTION

- Globally, 218 million disability adjusted life years (DALYs) were lost due to systolic blood pressure (SBP) ≥140 mmHg in 2017.
- The effectiveness of medications is established, but hypertension screening and medication coverage varies widely.

METHODS

- We developed an individual-based model of hypertension risk, treatment, and related disease, calibrated to match GBD estimates at the population level.
- We simulated an opportunistic screening program for hypertension using age-/sex-/location-specific outpatient visits as screening opportunities, couples with fixed-dose combination (FDC) therapy for individuals age 40+ with measured SBP ≥140 mmHg.

Table 1: The treatment strategy was based on 28-day follow-up visits for individuals who were above target (SBP 140 for age below 80, SBP 150 for age 80 and above); up-titration proceeded according to table:

name	arb	calcium_channel_blocker	thiazide_type_diuretic	beta_blocker
FDC (ARB standard plus CCB standard)	1	1	0	0
increase FDC dose (ARB standard plus CCB double standard)	1	2	0	0
add diuretic half standard dose	1	2	0.5	0
increase diuretic to standard dose	1	2	1	0
increase diuretic to double standard dose	1	2	2	0
switch FDC to separate drugs and increase ARB to double-standard dose	2	2	2	0
add beta blocker at half-standard dose	2	2	2	0.5
increase beta blocker to standard dose	2	2	2	1
increase beta blocker to double standard dose	2	2	2	2

- We compared population health under this intervention with the current standard of care.
- Our model includes SBP measurement error, medication-related adverse events that lead to treatment discontinuation, and therapeutic inertia (the lack of intensified antihypertensive treatment for uncontrolled SBP).
- We generated 1,000 replicates of 5 years of simulation for cohorts of 1,000,000 adults representing the population aged ≥35 years in each of four middle-income countries (Brazil, Russia, India, and China)

RESULTS

Difference in SBP between business-as-usual and FTC scenario varied from mean reduction of 6.2 mmHg in India to 8.2 mmHg in Russia, which corresponds to a change in the percent controlled of 14.2 percentage points (pp) in India to 18.4 pp in Russia. DALYs averted with FDC treatment varied from 990 per 100,000 person-years in Brazil to 3,000 in Russia.

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The impact of scaling-up **screening and treatment** for hypertension with fixed-dose combination therapy is large, and varies by country.

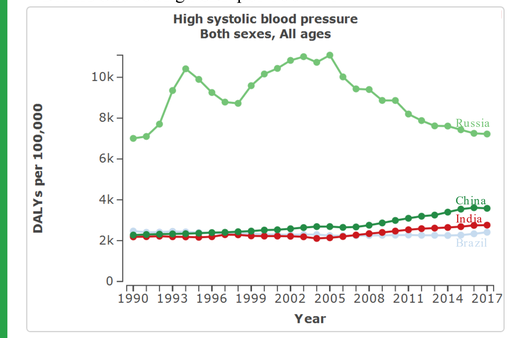
	DALYs Averted (/100k PY)	SBP Shift (mmHG)	Change in % Controlled (pp)	Change in Time to Control (days)
Brazil	991.0	7.4	17.8	55.2
India	1524.2	6.2	14.2	44.7
China	1604.7	6.3	14.3	40.8
Russia	2963.8	8.2	18.4	58.0

Population Studied

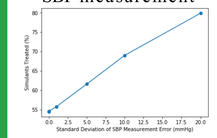
1,000 replicates of cohorts of 1,000,000 adults representing the population aged ≥35 years in each of four middle-income countries.

Simulation Timeframe
2018 to 2023, with a 30 day step size

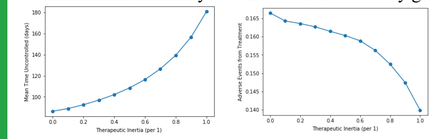
DALYs due to High SBP per 100k PY



Impact of error in SBP measurement



Impact of Therapeutic Inertial (delay in increasing treatment intensity when recommended by guidelines)



Patient profile in multiple alternative scenarios