

CLINICAL PRACTICE

Cohort study of preoperative blood pressure and risk of 30-day mortality after elective non-cardiac surgery

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Abstract

Background: Preoperative blood pressure (BP) thresholds associated with increased postoperative mortality remain unclear. We investigated the relationship between preoperative BP and 30-day mortality after elective non-cardiac surgery.

Methods: We performed a cohort study of primary care data from the UK Clinical Practice Research Datalink (2004–13). Parsimonious and fully adjusted multivariable logistic regression models, including restricted cubic splines for numerical systolic and diastolic BP, for 30-day mortality were constructed. The full model included 29 perioperative risk factors, including age, sex, comorbidities, medications, and surgical risk scale. Sensitivity analyses were conducted for age (>65 vs <65 years old) and the timing of BP measurement.

Results: A total of 251 567 adults were included, with 589 (0.23%) deaths within 30 days of surgery. After adjustment for all risk factors, preoperative low BP was consistently associated with statistically significant increases in the odds ratio (OR) of postoperative mortality. Statistically significant risk thresholds started at a preoperative systolic pressure of 119 mm Hg (adjusted OR 1.02 [95% confidence interval (CI) 1.01–1.02]) compared with the reference (120 mm Hg) and diastolic pressure of 63 mm Hg [OR 1.24 (95% CI 1.03–1.49)] compared with the reference (80 mm Hg). As BP decreased, the OR of mortality risk increased. Subgroup analysis demonstrated that the risk associated with low BP was confined to the elderly. Adjusted

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analyses identified that diastolic hypertension was associated with increased postoperative mortality in the whole cohort.

Conclusions: In this large observational study we identified a significant dose-dependent association between low preoperative BP values and increased postoperative mortality in the elderly. In the whole population, elevated diastolic, not systolic, BP was associated with increased mortality.

Key words: blood pressure; mortality; surgery

Editor's key points

- There remains some uncertainty about the relationship between preoperative blood pressure and perioperative mortality, particularly for hypotension.
- In this large UK cohort study, blood pressure values <119 mm Hg systolic and 63 mm Hg diastolic were independently associated with a progressive increase in postoperative mortality.
- The increased risk with hypotension was confined to elderly patients.
- There was no independent relationship between systolic hypertension and mortality, but diastolic blood pressure >84 mm Hg was associated with an increased risk of death after adjustment for covariables.
- These data have implications for perioperative risk stratification.

Community control of blood pressure (BP) exerts profound effects on cardiovascular outcomes with J-shaped risk curves, indicating risks at either end of the BP spectrum.^{1–3} The optimal BP remains unclear due to the complexity of the relationship between hypertension, cardiovascular disease, age, and other risk factors.^{4–5} Excessive reduction of BP may increase cardiovascular risk, especially in the elderly or patients with diabetes or coronary artery disease,^{2,4,6} perhaps due to impaired diastolic coronary perfusion.² Hence recent guidelines recommend relaxed BP targets in these populations. However, the recent SPRINT study challenged these recommendations: lowering systolic BP to a mean value of 121 mm Hg (vs 136 mm Hg) was associated with reduced cardiovascular events in the community.⁷

While there is strong evidence for the longitudinal control of BP to reduce incident vascular events,⁷ guidance for the optimization of preoperative BP lacks a strong evidence base.^{8–10} Recent guidelines sensibly emphasize the need to focus on primary care readings,¹⁰ however, they acknowledge that ‘whether or not these [community] thresholds and targets should be rigorously applied in the perioperative setting is not clear’. In the perioperative period, anaesthesia and surgery lead to hemodynamic changes, an exaggerated stress response, hypercoagulability, and inflammation. Hence the optimal preparation for the physiological strain of anaesthesia and surgery is unlikely to be the same as reducing long-term vascular risk in the community. Recent studies stress how perioperative hypotension leads to increased postoperative mortality.^{11,12} In particular, the hypothesis that preoperative low BP may be a risk factor for postoperative mortality requires evaluation. Conceptually this hypothesis is supported by evidence that preoperative low BP is a predictor of intraoperative hypotension¹³ and intraoperative hypotension is a predictor of postoperative mortality.^{14,15}

The recent guidelines do not mention the potential impact of preoperative low BP on postoperative outcomes.¹⁰

Similarly, the contribution of comorbid hypertension to postoperative mortality is unclear despite its prevalence in the community and the established effects on multiple vascular outcomes.⁵ In 2004, a meta-analysis found an association between the diagnosis of preoperative hypertension and increased postoperative cardiac events; however, we were unable to identify numerical BP thresholds associated with increased risk.¹⁶ Moreover, the diagnosis of preoperative hypertension (or elevated pulse pressure^{17,18}) is not universally considered important in determining postoperative risk,^{19,20} as suggested by its omission from the widely used revised cardiac risk index.²¹ Despite the lack of clarity on this issue, in the UK ~1% (~100 patients per day) of elective surgical patients have surgery delayed for further primary care management of BP.¹⁰

To date, no large study has attempted to identify BP thresholds associated with increased postoperative mortality in elective non-cardiac surgery. Herein we analysed primary care data from an elective non-cardiac surgery cohort to identify preoperative numerical BP thresholds associated with increased postoperative mortality in all patients and in the elderly. Our aim was to identify preoperative BP thresholds beyond which the odds of postoperative mortality increase through analysis of BP as a continuous measure.

Methods

Data source and study design

This research study was approved by the Independent Scientific Advisory Committee for the Medicines and Healthcare Products Regulatory Agency, UK (number 11_034). We extracted longitudinal data from the Clinical Practice Research Datalink (CPRD), a primary care database including a representative sample of ~6% of the UK population. Patients who underwent specific non-cardiac surgical procedures between January 1, 2004 and December 31, 2013 were identified using medical codes (Appendix 1). We retained only adult patients (≥18 years of age) who had been registered with their general practitioner (GP) for at least 1 year prior to the date of elective non-cardiac surgery (see STROBE diagram, Supplementary Fig. 1). Our internal audit has identified a <1% discrepancy in the CPRD and HES coding of operations.

Patient involvement

Patients were not involved in the design of this study.

Exposure variables

The latest BP measurement recorded before surgery was the exposure variable.

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