

## CLINICAL INVESTIGATION

# Association between preoperative ambulatory heart rate and postoperative myocardial injury: a retrospective cohort study

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## Abstract

**Background:** Resting heart rate is well established as a predictor of morbidity and mortality in the general population. However, the relationship between preoperative heart rate and perioperative outcomes, specifically myocardial injury, is unclear.

**Methods:** This retrospective cohort study included patients undergoing elective major non-cardiac surgery from 2008 to 2014 at a multisite healthcare system. The exposure was ambulatory heart rate measured during the outpatient preoperative clinic visit, whereas the outcome of interest was myocardial injury (peak postoperative troponin I concentration  $>30 \text{ ng L}^{-1}$ ). Covariates included patient characteristics, comorbidities, and preoperative medications. We constructed several multivariable regression models that each modelled heart rate in a different manner, including as a simple continuous variable, categories, and fractional polynomials.

**Results:** The cohort included 41 140 patients, of whom 4857 (11.8%) experienced myocardial injury. Based on pre-specified heart rate categories thresholds, a heart rate  $\geq 90 \text{ beats min}^{-1}$  was associated with an elevated odds of myocardial injury compared with a heart rate  $<60 \text{ beats min}^{-1}$  (adjusted odds ratio, 1.22; 95% confidence interval, 1.06–1.39;  $P=0.005$ ). This result was consistent regardless of the method used for categorisation. When fractional polynomials were used to model heart rate, a 'J-shaped' relationship between heart rate and odds of myocardial injury was observed.

**Conclusions:** This cohort study found that both very high preoperative heart rates, and possibly also very low heart rates, are associated with increased risk of myocardial injury. Whether heart rate is a modifiable risk factor, or rather simply a marker of underlying cardiac pathology, needs to be determined in further research.

**Keywords:** Troponin I; Risk factors; Heart rate; Retrospective studies; Morbidity

**Editor's key points**

- A higher-than-normal resting heart rate is an indicator of reduced cardiac reserve.
- Cardiorespiratory fitness is a key determinant of perioperative outcome.
- This study found higher heart rates were associated with perioperative myocardial injury and mortality.
- Whether or not heart rate control could reduce severe perioperative complications is unclear.

Myocardial injury is a prognostically important complication of non-cardiac surgery that affects 8%–22% of patients after elective procedures.<sup>1–3</sup> Even when asymptomatic, myocardial injury is highly associated with increased morbidity and mortality.<sup>4</sup> Thus, finding ways to mitigate myocardial injury has important implications for the millions of patients undergoing surgery worldwide every year.

In current conceptual frameworks of cardiovascular physiology, heart rate is considered to be a key determinant of the balance between myocardial oxygen supply and demand. Although in theory lowering heart rate before operation using negative chronotropic agents such as beta blockers should reduce perioperative complications, the evidence regarding the efficacy of this approach is equivocal.<sup>5</sup> One possible explanation is that previous studies used preset doses of medications that were not titrated to a target heart rate threshold. A challenge with implementing such an approach is that the optimal preoperative heart rate to minimise the risk of myocardial injury is not currently known.

Several previous studies have elucidated the relationship between intraoperative heart rate and outcomes<sup>6–8</sup>; however, there are very limited data examining the connection between preoperative heart rate and postoperative myocardial injury. The single previous study that investigated this association used the heart rate recorded immediately before the induction of anaesthesia, which is likely not indicative of true preoperative heart rate.<sup>9</sup> We therefore conducted a retrospective cohort study in a multihospital healthcare system to evaluate the link between preoperative ambulatory heart rate and postoperative myocardial injury.

**Methods****Study population**

This retrospective cohort study was conducted at the University Health Network, a quaternary-care multisite healthcare system located in Toronto, Ontario, Canada. Data were obtained from linked institutional databases including the preoperative evaluation clinic database, surgical procedure database, and an electronic data warehouse containing administrative and laboratory data. Consecutive patients undergoing elective non-cardiac surgery from 2008 to 2014 with a prior preoperative anaesthesiology consultation at the institutional preoperative evaluation clinic were included in the cohort. Patients with missing data and those with an ASA Physical Status (ASA-PS) Classification 5 were excluded from the analysis. Institutional Research Ethics Board approval was obtained before the initiation of the data set assembly and analysis.

**Exposure and outcome definitions**

The preoperative heart rate was defined as the ambulatory value documented during the preoperative evaluation clinic visit and measured in beats per minute. Heart rate values less than 40 beats  $\text{min}^{-1}$  or greater than 140 beats  $\text{min}^{-1}$  were excluded from the primary analysis as these values were likely to fall outside the expected physiologic range for ambulatory heart rates, and therefore likely related to data entry error. Records with missing heart rate information were also excluded from the study cohort.

Myocardial injury was defined as a peak postoperative troponin I concentration exceeding 30 ng  $\text{L}^{-1}$  or an International Classification of Disease 10th Edition diagnostic code for

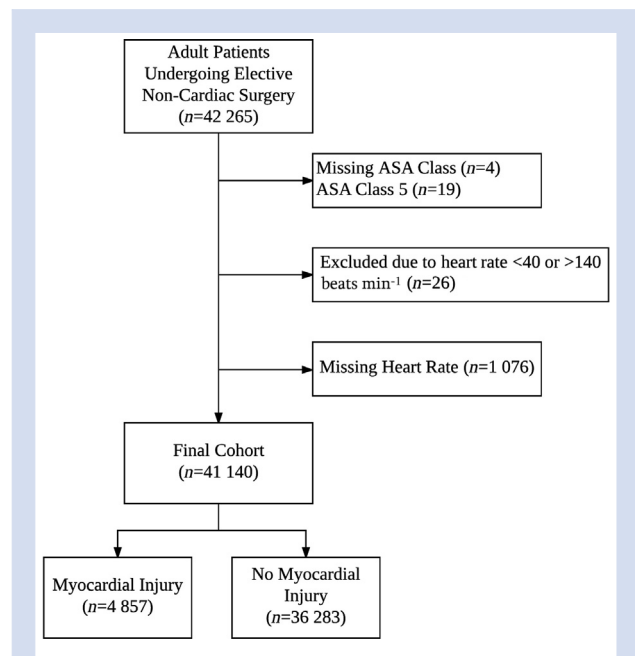


Fig 1. Flowchart of cohort formation.

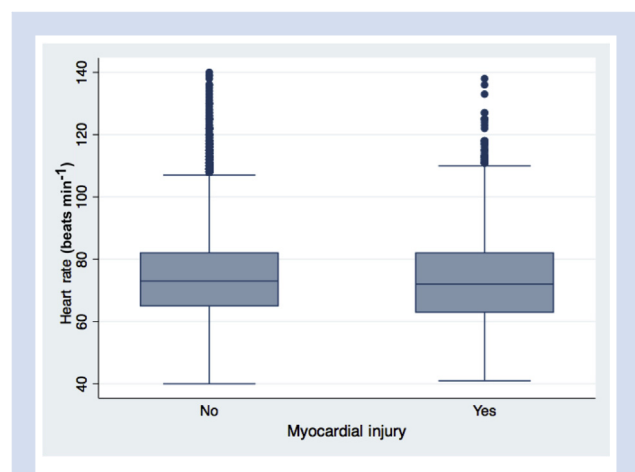


Fig 2. Box plot displaying the distribution of preoperative heart rate among patients without and with myocardial injury.

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