Association of Preanesthesia Hypertension With Adverse Outcomes

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Objective: **To investigate the incidence of preanesthesia hypertension, case cancellation for hypertension, and association with postoperative outcomes.**

Design: **Retrospective descriptive, univariate, and multivariate analyses of electronic anesthesia and hospital records.**

Setting: **A large urban academic medical center.**

Participants: **Adult elective surgical patients with preinduction blood pressure (BP) >140/90 mmHg during calendar years 2002 to 2008.**

Interventions: **None.**

Measurements and Main Results: **Preinduction hypertension was present in 21,126 of 209,985 (10%) patients, and the incidence of adverse outcomes (elevated troponin or in-hospital death) was 1.3% overall and 2.8% for the subset of patients with baseline systolic BP >200 mmHg. Independent predictors of adverse outcome included increased baseline systolic BP, intraoperative diastolic BP <85 mmHg, increased intraoperative heart rate, blood transfusion, and anesthetic technique, controlling for standard risk factors. A total of 69 hypertensive patients (0.3%) had surgery cancelled before the induction of anesthesia; 29 of these cancellations occurred among the 1,330 patients with baseline SBP >200 mmHg (2.2%). Among 42 "cancelled" patients who returned for surgery hours to years later, the average preinduction BP was 192/102 mmHg, and adverse cardiovascular outcomes occurred in 4.8%.**

Conclusions: **The increasing severity of preinduction hypertension was an independent risk factor for postoperative myocardial injury/infarction or in-hospital death. Only a small percentage of cases with patients presenting with severe hypertension were cancelled, and the delay of surgery did not result in interval normalization of blood pressure.**

KEY WORDS: anesthesia, hypertension, cardiovascular risk stratification, surgery cancellation, patient safety

GUIDELINES HAVE BEEN formulated to assist practitioners in deciding how to deal with patients who present for anesthesia and surgery with elevated blood pressure (BP).[1] These guidelines are based on limited data and expert opinion, and practitioners must exercise judgment in specific clinical scenarios. It is unknown to what extent these guidelines are followed. Furthermore, it is unknown whether proceeding with elective surgery, case cancellation, or case postponement is optimal in patients with uncontrolled hypertension for preventing adverse outcomes. The present authors hypothesized that in-hospital adverse outcomes would be associated directly with greater degrees of preinduction hypertension in cases in which elective procedures were performed in hypertensive patients.

METHODS

Local institutional review board approval and waiver of informed consent were obtained for this investigation. Preoperative and intraoperative data (Table 1) were extracted from all elective (ie, nonemergency) adult anesthesia records in an anesthesia information-management system (AIMS; CompuRecord, Philips Medical System, Andover, MA) at a large academic medical from 2002 through 2008. For each case, the average of all preinduction (or, in regional/monitored anesthesia care cases, preprocedure) systolic blood pressure (SBP) and diastolic blood pressure (DBP) were calculated and were considered the baseline BP. Only cases with baseline SBP >140 mmHg and DBP >90 mmHg were included in the analysis. (Isolated systolic or diastolic hypertension was not included.) Data also were extracted from an institutional clinical data warehouse to identify those who expired postoperatively or had elevated (ie, above normal range for the authors' laboratory) serum troponin within 30 days. The occurrence of either mortality or troponin elevation was classified as an adverse outcome.

Baseline BP was grouped into numeric ranges, and the incidence of adverse outcomes was calculated for each range with 95% confidence intervals. The Cochran-Armitage trend test was used to test whether there was an overall trend toward a higher incidence of adverse outcomes with a higher baseline BP. Univariate logistic regression analyses were performed to test for associations between the included parameters in Table 1 and outcomes. Significant factors then were considered in a stepwise logistic regression analysis to create a final prediction model for the adverse outcomes. To explore the possibility of a nonconstant odds ratio (similar to the relative risk for rare events such as these) over the BP range, a quadratic polynomial term for each of the BP parameters was tested in the multivariate model for statistical significance. If detected, piecewise regression analysis was performed to confirm such an association.

All case cancellations in the AIMS were sought by searching for the text string "cancel" in the procedure description or narrative comments (as it is typically documented in such cases), and those that were cancelled for hypertension were identified. For cancelled cases, the authors determined whether the patient returned to the center for surgery at a later date. If so, the baseline BP was compared with that of the preceding (cancelled) case using the Wilcoxon signed-rank test. The incidence of adverse outcomes in this group was compared with the noncancelled cases in similar BP ranges using the Fisher exact test.

RESULTS

Baseline hypertension was present in 21,126 of 209,985 (10%) patients in the AIMS database. Complete data sets as defined in Table 1 were present in 17,967 of these hypertensive patients (85%). In the patients with full datasets, there were 225 adverse outcomes (1.3%).

There was a direct association between an increasing baseline SBP (in the hypertensive ranges) with adverse outcomes that is presented in Figure 1 ($p < 0.001$). The rate of adverse events in the SBP >200-mmHg group was significantly in-

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Table 1. Characteristics of Patients/Cases With Preinduction Hypertension

Parameter	Mean ± Standard Deviation, Median (IQR), or %
Patient age (y)	58 ± 16
Preinduction Hemodynamics (average)	
SBP (mmHg)	167 ± 19
DBP (mmHg)	99 ± 7
HR (beats/min)	80 ± 15
Intraoperative Hemodynamics (average)	
SBP (mmHg)	129 ± 20
DBP (mmHg)	77 ± 12
HR (beats/min)	72 ± 12
Case duration (min)	74 (36-135)
Fluid administration (mL)	1,000 (500-2,000)
Male sex	49
Diabetes	9
Blood transfusion	6
Intraoperative β-blockers	28
American Society of Anesthesiologists classification	
1	9
2	47
3	38
4	5
Admission status	
Ambulatory	45
Inpatient	21
Day of surgery	34
Anesthesia care	
General	63
Monitored	21
Regional	16

Abbreviations: HR, heart rate; IQR, interquartile range (range between the 25th and 75th percentiles).

creased compared with each of the lower SBP ranges (all $p < 0.001$). Similarly, there was a direct association between increasing baseline DBP (in the hypertensive ranges) with adverse outcomes as presented in Figure 2 ($p = 0.01$). The incidence of adverse outcomes for the DBP >110-mmHg

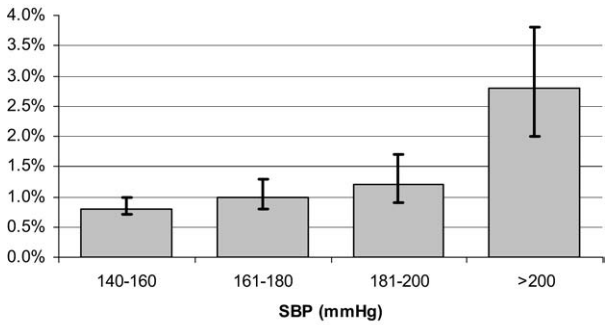

Fig 1. The incidence (and 95% confidence interval) of adverse outcomes (*) by preinduction SBP.

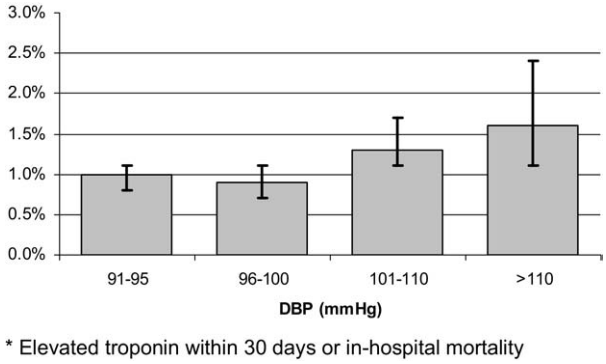

Fig 2. The incidence (and 95% confidence interval) of adverse outcomes (*) by preinduction DBP.

group was increased compared with the 2 groups with baseline DBP ≤100 mmHg (both $p < 0.03$).

All parameters, except sex ($p = 0.38$) and diabetes ($p = 0.09$), were univariate predictors at the $\alpha = 0.05$ level and were considered in the multivariate analysis. Table 2 shows the independent predictors of adverse outcome including an increased baseline SBP, decreased average intraoperative DBP (<85 mmHg), increased average intraoperative heart rate, increased age, blood transfusion, inpatient status, monitored anesthesia care or general anesthesia (*v* regional), and higher American Society of Anesthesiologists classification.

A total of 69 hypertensive patients (0.3%) had surgery cancelled before the induction of anesthesia; 29 of these cancellations occurred among the 1,330 patients with baseline SBP >200 mmHg (2.2%). There was a median of 8 BP measurements obtained over a median of 38 minutes in the

Table 2. Multivariate Analysis of Factors Associated With Adverse Outcome* in Hypertensive Patients

Factor	Odds Ratio	95% Confidence Interval		*p* Value
Preoperative parameters				
ASA class 3 or 4 (*v* 1 or 2)	3.02	1.84	4.94	<.0001
Age (per 10-y increase)	1.35	1.21	1.51	<.0001
Baseline SBP (per 10-mmHg increase)	1.10	1.02	1.19	0.016
DAS status (*v* inpatient)	0.41	0.29	0.59	<.0001
Ambulatory status (*v* inpatient)	0.09	0.05	0.19	<.0001
Intraoperative parameters				
Regional (*v* MAC or general)	0.59	0.36	0.98	0.042
Blood transfusion (*v* no transfusion)	2.38	1.67	3.40	<.0001
Intraoperative heart rate (per 10-beat/min increase)	1.52	1.35	1.71	<.0001
Intraoperative DBP (per 10-mmHg decrease <85 mmHg)	1.26	1.07	1.48	0.005

Abbreviations: DAS, day of admission surgery; MAC, monitored anesthesia care; ASA, American Society of Anesthesiologists.

*Adverse outcome defined as elevated troponin within 30 days or in-hospital mortality.