Surgical cancellation rates due to peri-operative hypertension: implementation of multidisciplinary guidelines across primary and secondary care*

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Summary

Patients with uncontrolled hypertension are at increased risk of complications during general anaesthesia but the number of patients whose surgery is delayed or cancelled due to hypertension remains unknown. Prospective, regional multicentre service evaluations were performed on consecutive patients undergoing elective surgery before and after the publication of new guidelines from the Association of Anaesthetists and the British Hypertensive Society. The aim was to quantify the number of operations cancelled due to hypertension alone and to assess impact of the guidelines on cancellation rates. In October 2013 (before the publication of the guidelines), 1.37% (95%CI 0.69–2.11%) of patients listed for elective surgery were cancelled solely due to raised blood pressure. This reduced significantly to 0.54% (95%CI 0.20–0.92%, p < 0.001) in 2018. There was a significant reduction in inappropriate cancellations for stage 1 or 2 hypertension from 2013 to 2018 (72 vs. 14, respectively, p < 0.001) in keeping with the recommendations in the guidelines. Furthermore, the number of patients being referred back to primary care for the management of hypertension reduced from 2013 to 2018 (85 vs. 30, respectively, p < 0.001). Our data suggest achievement of three major outcomes: reduced surgical cancellations due to hypertension alone; improved detection of significant hypertension before elective surgery; and reduced referral back to primary care from hospital for hypertension management. To the best of our knowledge, this is the first time the successful implementation of guidelines from the Association of Anaesthetists has been assessed on such a broad scale. Our data indicate that these guidelines have been effectively implemented in both primary and secondary care, which is likely to have made a positive psychosocial, physical and economic impact on patients and the NHS.

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Introduction

Hypertension (defined as a systolic blood pressure (BP) equal to or greater than 140 mmHg or a diastolic blood pressure equal to or greater than 90 mmHg) is a common problem. Over a quarter of the UK’s adult population are considered to have hypertension which is either controlled with medication, uncontrolled on medication or entirely untreated [1]. It is well recognised that chronic uncontrolled hypertension remains one of the most important preventable causes of premature morbidity and mortality in the UK [2].

The association between uncontrolled hypertension and adverse peri-operative outcomes has been known since the 1950s [3, 4]. Patients with uncontrolled hypertension undergoing anaesthesia have increased rates of complications such as myocardial ischaemia [5], whilst a pre-operative history of uncontrolled hypertension is strongly associated with peri-operative cardiovascular death [6], renal dysfunction [7] and cerebral vascular disease [8]. Increased postoperative mortality is seen with diastolic hypertension [9] and raised pre-operative pulse pressure is associated with an increased risk of myocardial injury, even when systolic BP is controlled [10]. There is a paucity of data regarding the degree of hypertension and subsequent risk of peri-operative mortality but it has been suggested that systolic BP of less than 180 mmHg or diastolic BP less than 110 mmHg (i.e. stage 1 or 2 hypertension) may be associated with a reduced risk of peri-operative complications compared with those patients with higher blood pressures [11].

In order to mitigate the potential significant peri-operative harm associated with uncontrolled hypertension, patients found to have unacceptably high blood pressures before elective surgery are often cancelled or postponed. However, until recently, it was unclear what constituted a ‘safe’ high blood pressure threshold for planned anaesthesia and surgery. Therefore, general practitioners, peri-operative physicians, anaesthetists and surgeons were often left to rely on their own clinical judgement regarding the management of hypertensive patients, leading to gross variations in practice, not only between regions but also within departments.

The measurement of adult BP and management of hypertension before elective surgery’ [12] guidelines were jointly released by the Association of Anaesthetists and the British Hypertension Society (BHS) in 2016. The fundamental objective of the guidelines was to prevent the diagnosis of significant hypertension being the reason for delay or cancellation of elective surgery. To achieve this, the guidelines recommended that patients in the primary care setting were referred for elective surgery with an systolic BP of less than 160 mmHg and a diastolic BP of less than 100 mmHg. Furthermore, once patients had entered the secondary care pathway, elective surgery should proceed if their systolic BP is below 180 mmHg and their diastolic BP is less than 110 mmHg.

In order to assess the impact of the guidelines on cancellation rates related to pre-operative hypertension, we performed prospective, regional multicentre service evaluations before and after the publication of the guidelines. To the best of our knowledge, the effectiveness of any Association of Anaesthetists peri-operative guidelines has not been previously assessed on such a broad scale.

Methods

Two large prospective, multicentre service evaluations were performed, assessing clinical practice over a 1 month period during October 2013 and then again in November 2018. Formal ethical approval was not deemed necessary for these service evaluations by the clinical governance department at Imperial College NHS Trust. The project was registered with the local audit department. Methods and data are presented in keeping with strengthening the reporting of observational studies in epidemiology (STROBE) guidelines and all data were processed in keeping with local and national recommendations along with the standards of the Declaration of Helsinki.

We evaluated all patients undergoing elective surgery across six hospital trusts within north-west London (Fig. 1). Patients aged 18 years and over were eligible for inclusion. Patients undergoing emergency, cardiac, renal, endocrine, vascular, neurosurgical and obstetric surgery were not included as their underlying pathology may contribute directly to the management of their hypertension.

The initial survey was undertaken during the entire month of October 2013 [13]. In keeping with local policy, patients were either pre-assessed in a pre-operative assessment clinic or assessed for theatre on the day of surgery by their anaesthetist. Anonymised data were collected for patients whose procedures were cancelled or postponed due to hypertension alone including age, the type of operation and surgical speciality. Initial blood pressure and repeated measurements were recorded. We also collected information about whether any further action was taken (e.g. whether the patient’s procedure was cancelled or postponed, whether the patient was referred...
back to their GP or to an inpatient speciality and whether the patient received any antihypertensive treatment).

We repeated the data collection at the same hospitals following the publication of the guidelines, during the entire month of November 2018. In addition to the previously collected data, we also recorded what had guided the decision-making (e.g. guidelines, clinical judgement) for each of these cancellations.

Shapiro-Wilk normality tests were carried out using IBM SPSS (Version 19.0. Armonk, NY, USA). Comparisons between groups were performed by t-tests for parametric data and by Mann-Whitney U-tests or Kruskal-Wallis test (with Dunn’s multiple comparison) for non-parametric data. Categorical data analyses were made using Chi-square test with Fisher’s correction. All data were analysed on GraphPad Prism (version 8.00, GraphPad Software, San Diego, CA, USA). A p < 0.05 was defined as the minimal threshold for statistical significance.

Results

All six hospital Trusts collected patient data and more than 7000 patients were screened in each of the two service evaluations. During October 2013, a total of 105 (1.37% (95%CI 0.69–2.11%)) patients had their procedure cancelled due to hypertension alone whereas during November 2018, 38 patients (0.54% (95%CI 0.20–0.92%)) had their procedures cancelled (p < 0.001, Table 1, Fig. 2). Characteristics of the patients whose procedures were cancelled due to hypertension alone are described in Table 1.

The median (IQR [range]) initial systolic BP for those patients whose procedures were cancelled in the 2013 group was 167 (158–180 [138–225]) mmHg and 179 (164–198 [152–250]) mmHg in the 2018 group (p = 0.003, Table 1, Figs. 3 and 4). Median (IQR [range]) initial diastolic BP was 98 (92–105 [72–137]) mmHg in the first evaluation compared with 99 (91–108 [61–122]) mmHg in the second evaluation. We also recorded the lowest repeat blood pressures in both service evaluations in an attempt to limit the potential influence of ‘white coat hypertension’. In 2013, the median (IQR [range]) lowest repeat systolic BP was 161 (150–180 [135–217]) mmHg and 180 (162–197 [150–210]) mmHg in the 2018 group (p < 0.001, Table 1, Figs. 3 and 4). The lowest repeat diastolic BP was 95 (90–101 [66–120]) mmHg in 2013, whilst in 2018 it was 99 (92–107 [69–115]) mmHg, p = 0.04, Table 1, Figs 3 and 4).

Figure 1 Flow diagram describing the hospitals taking part and patient recruitment.
We found a significant reduction in the number of patients who had their procedure cancelled being referred back to their GP (85 patients in 2013 compared with 30 in 2018, \( p < 0.001 \)) or to an anaesthetist (37 patients in 2013 compared with 16 in 2018, \( p = 0.012 \)). In 2018, we also enquired about how decisions regarding cancellations were made, and in 75% of patients, the decisions were made in direct reference to the Association/BHS guidelines.

We assessed the inter-hospital differences and variations in median blood pressures deemed unsafe for surgery in the 2013 and 2018 groups (Figs 3 and 4). The Association/BHS guidelines recommend that elective surgery should not be postponed or cancelled in patients whose systolic BP is below 180 mmHg and diastolic BP below 110 mmHg. Applying the guidelines retrospectively to the 2013 data, the median BPs in four out of six hospital Trusts were high but below this threshold limit set by the Association/BHS and therefore deemed to be cancelled unnecessarily. In 2018, only two out of the six hospital trusts had median BPs below the threshold.

We examined the total number of patients whose systolic BP and/or diastolic BP were below the ‘safe’ limits set out in the guidelines and therefore needlessly had their procedure cancelled. In the 2013 data, 64 patients in the pre-assessment clinic whose blood pressure was high but within the guideline limits were cancelled and nine patients were cancelled on the day of surgery (73 patients in total inappropriately cancelled, 70% of the cancellations in the 2013 group, Table 2). In 2018, 13 patients in the pre-assessment clinic whose blood pressure was within the guideline limits were cancelled and one patient’s procedure was cancelled on the day of surgery (14 patients in total

### Table 1 Characteristics of the patients cancelled due to hypertension alone during both evaluations. Values are number (proportion) or median (IQR[range]).

|                      | 2013        | 2018        | \( p \) value |
|----------------------|-------------|-------------|---------------|
| Total number of patients screened | 7673        | 7100        | n/a           |
| Number of patients cancelled due to hypertension alone | 105 (1.37%) | 38 (0.05%)  | < 0.001       |
| Number of patients cancelled in pre-assessment clinic | 89 (1.16%)  | 21 (0.29%)  | < 0.001       |
| Number of patients cancelled on day of surgery | 16 (0.20%)  | 17 (0.24%)  | 0.730         |
| Age of cancelled hypertensive patients; years | 57 (48–68 [23–92]) | 65 (53–74 [36–86]) | 0.103         |
| Male                  | 48 (45.71%) | 21 (55.26%) | 0.203         |
| Female                | 57 (54.28%) | 17 (44.73%) | 0.203         |
| Initial systolic blood pressure; mmHg | 167 (158–180 [138–225]) | 179 (164–199 [152-250]) | 0.003         |
| Initial diastolic blood pressure; mmHg | 98 (92–105 [72–137]) | 99 (91–108 [61–122]) | 0.999         |
| Lowest repeat systolic blood pressure; mmHg | 161 (150–180 [135–217]) | 180 (162–197 [150–210]) | < 0.001       |
| Lowest repeat diastolic blood pressure; mmHg | 95 (90–101 [66–120]) | 99 (92–107 [69–115]) | 0.041         |
| Action taken          |             |             |               |
| Referred back to GP   | 85 (1.10%)  | 30 (0.42%)  | < 0.001       |
| Referred to anaesthetist | 37 (0.48%) | 16 (0.22%)  | 0.012         |
| Referred to inpatient specialty | 4 (0.05%)  | 4 (0.05%)  | > 0.999       |
| Given treatment at time | 9 (0.11%)  | 10 (0.14%)  | 0.819         |

![Figure 2](https://example.com/figure2.png)

**Figure 2** Comparison of systolic (□) and diastolic (■) blood pressures deemed unsafe for surgery in each evaluation. The hashed lines refer to 180 systolic and 110 mmHg diastolic, which is the safe limit set out in the Association/BHS guidelines. **\( p < 0.01 \).**
inappropriately with procedures cancelled, 37% of cancel-
ations in the 2018 group, p < 0.001, Table 2, Fig 5). There-
fore In 2018, the vast majority of patients with procedures
cancelled due to hypertension had blood pressure
measurements above 180 mmHg systolic and/or 110
mmHg diastolic as set out in the Association/BHS guidelines
(30% vs. 63% in 2013 and 2018 respectively, p < 0.001).

Discussion
In this study, we have demonstrated a significant reduction
in the number of pre-operative cancellations due to
hypertension alone from 2013 to 2018. Our observational
data suggests that this effect is likely to be attributable to the
Association/BHS guidelines published in 2016, which
provide clear direction in an area lacking robust evidence
regarding hypertension and its management before
elective surgery in the primary and secondary care setting.
The guidelines have helped to reduce variations in practice
and raised awareness about what constitutes a ‘safe’ blood
pressure threshold to proceed without associated adverse
peri-operative outcomes. To the best of our knowledge, this
is the first time the successful implementation of the
Association of Anaesthetists guidelines has been assessed
on such a broad scale.

Table 2  Cancelled patients according to whether cancellation was compliant with guidelines, values are number (proportion).

| Category                                      | 2013    | 2018    | p value |
|-----------------------------------------------|---------|---------|---------|
| Total cancellations compliant with guidelines | 32 (30%)| 24 (63%)| < 0.001 |
| Total cancellations not compliant with guidelines | 73 (70%)| 14 (37%)| < 0.001 |
| Cancellations in pre-assessment clinic compliant with guidelines | 25 (28%)| 8 (38%)  | 0.133   |
| Cancellations in pre-assessment clinic not compliant with guidelines | 64 (72%)| 13 (62%)| 0.133   |
| Cancellations on day of surgery compliant with guidelines | 7 (44%) | 16 (94%)| < 0.001 |
| Cancellations on day of surgery not compliant with guidelines | 9 (56%) | 1 (6%)  | < 0.001 |
In October 2013, we found that 105 out of 7673 (1.37%) of patients had their surgery delayed or cancelled due to hypertension alone. Of these patients, 70% had procedures cancelled with blood pressures that would be considered to be stage 1 or 2 hypertension, which although high, were within safe limits and therefore unnecessarily cancelled. This finding was particularly concerning since the overall peri-operative cancellation rate in UK hospitals is approximately 14%, of which one-third are due to clinical reasons [14]. Our data suggest that pre-operative hypertension would account for a significant proportion of these cancellations, incurring significant yet avoidable psychosocial, physical and economic costs to patients and a substantial monetary expense to the NHS, since operative cancellations are estimated to cost £400 million per year [15].

In November 2018, there was an improvement and only 38 out of 7100 (0.54%) patients had their surgery delayed or cancelled due to hypertension alone. Of these patients, 70% had procedures cancelled with blood pressures that would be considered to be stage 1 or 2 hypertension, which although high, were within safe limits and therefore unnecessarily cancelled. This finding was particularly concerning since the overall peri-operative cancellation rate in UK hospitals is approximately 14%, of which one-third are due to clinical reasons [14]. Our data suggest that pre-operative hypertension would account for a significant proportion of these cancellations, incurring significant yet avoidable psychosocial, physical and economic costs to patients and a substantial monetary expense to the NHS, since operative cancellations are estimated to cost £400 million per year [15].

In conclusion, we have demonstrated a significant reduction in the number of pre-operative cancellations due to hypertension alone between 2013 and 2018, which is likely attributable to the publication of the Association/BHS guidelines in 2016. The guidelines set out to reduce the number of cancellations of elective surgery due to hypertension alone, improve detection of significant hypertension before elective surgery and reduce the number of patients referred back to primary care for the management of hypertension. Our data support the achievement of these ambitious aims.
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