

Implanting a baroreceptor stimulation device for resistant hypertension

Interventional procedures guidance

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Your responsibility

This guidance represents the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, healthcare professionals are expected to take this guidance fully into account, and specifically any special arrangements relating to the introduction of new interventional procedures. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer.

All problems (adverse events) related to a medicine or medical device used for treatment or in a procedure should be reported to the Medicines and Healthcare products Regulatory Agency using the [Yellow Card Scheme](#).

Commissioners and/or providers have a responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful

discrimination, advance equality of opportunity, and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties. Providers should ensure that governance structures are in place to review, authorise and monitor the introduction of new devices and procedures.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

1 Recommendations

- 1.1 Current evidence on the safety and efficacy of implanting a baroreceptor stimulation device for resistant hypertension is inadequate. Therefore, this procedure should only be used in the context of research.
- 1.2 Further research on implanting a baroreceptor stimulation device for resistant hypertension should document patient selection in detail and should specify the devices and techniques used, and any adjunctive therapies. It should describe the changes in blood pressure that are considered to result from baroreceptor stimulation, and those that might be caused by other factors. Outcomes should include the duration of effect of baroreceptor stimulation; device durability; and the complications of hypertension, such as myocardial infarction and stroke.

2 Indications and current treatments

- 2.1 Hypertension is usually asymptomatic, but it is a common and preventable cause of premature morbidity and death. It is a major, but modifiable, risk factor for cardiovascular disease (including stroke and myocardial infarction) and chronic kidney disease. The cause of primary hypertension, which is the most common form, is not fully understood. However, it is likely to involve multiple factors including an increase in sodium retention and a reduction in renal blood flow mediated by the sympathetic nervous system. Secondary hypertension, which is less common, is caused by conditions affecting the kidneys, arteries, heart or endocrine system.

- 2.2 The [NICE guideline on hypertension](#) defines resistant hypertension as blood pressure that remains higher than 140/90 mmHg after treatment with the optimal or best tolerated doses of an angiotensin-converting enzyme (ACE) inhibitor or an angiotensin-II receptor blocker (ARB) plus a calcium-channel blocker (CCB) plus a diuretic. First-line treatment of hypertension includes lifestyle changes, such as diet and exercise. Antihypertensive medications are used if high blood pressure persists. Implanting a baroreceptor stimulation device may be considered if hypertension fails to respond adequately to these measures.

3 The procedure

- 3.1 Implanting a baroreceptor stimulation device for resistant hypertension aims to lower blood pressure by electrically stimulating the carotid baroreflex, which controls blood pressure by regulating autonomic nervous activity. Both unilateral and bilateral devices have been used. The unilateral device consists of an electrode placed on 1 of the carotid sinuses and a battery-powered implantable generator. Device programming allows the frequency, amplitude and pulse-width of stimulation to be adjusted and it is programmable by time of day.
- 3.2 The procedure is usually done with the patient under general anaesthesia or conscious sedation. The pulse generator is implanted under the skin near the clavicle. With the unilateral device, a button electrode is sutured to 1 carotid sinus and a thin wire conducts electrical energy from the implantable pulse generator to the carotid sinus. Intraoperative testing is used to determine the optimal placement of the electrode for the best haemodynamic response. An earlier version of the device was bilateral, using 2 leads with electrodes wrapped around both carotid sinuses.
- 3.3 The device is usually activated about a month after implantation. Clinic staff adjust therapy settings, such as the frequency, amplitude and pulse-width of stimulation, using wireless communication when the patient attends hospital for follow-up appointments. The device can be turned off by clinic staff if necessary.

4 Efficacy

This section describes efficacy outcomes from the published literature that the Committee considered as part of the evidence about this procedure. For more detailed information on the evidence, see the [interventional procedure overview](#).

The following outcomes were reported in patients treated by implantation of a bilateral baroreceptor stimulation device:

- 4.1 A randomised controlled trial of 265 patients treated by implantation of a bilateral baroreceptor stimulation device that was either turned on 1 month after implantation (immediate stimulation) or turned on after 6 months (deferred stimulation) was carried out. Response rates at 6 months (defined as a 10 mmHg or more drop in systolic blood pressure at month 6 compared with systolic blood pressure obtained 1 month after implantation) were 54% and 46% respectively ($p=0.97$). Of those patients whose blood pressure responded to active therapy at 6 months, 88% maintained a response at 12 months ($p<0.001$). The mean decreases in systolic blood pressure at 6 months were 16 ± 29 mmHg for immediate stimulation and 9 ± 29 mmHg for deferred stimulation ($p=0.08$). The proportion of patients with systolic blood pressure of 140 mmHg or less at 6 months was 42% for immediate stimulation and 24% for deferred stimulation ($p=0.005$).

- 4.2 A cohort study of 322 patients, which was an open-label follow-up of the randomised controlled trial described in section 4.1 (including all patients who had a device implanted regardless of whether they were subsequently randomised), reported a mean decrease in blood pressure of 35/16 mmHg compared with pre-implantation, after a mean follow-up of 28 months. Among the 244 patients whose blood pressure responded (defined as a 10 mmHg or more drop in systolic blood pressure at month 6 compared with systolic blood pressure obtained 1 month after implantation) 55% reached goal pressures (less than 140 mmHg or less than 130 mmHg in patients with diabetes or kidney disease) throughout follow-up. A case series of 45 patients treated by implantation of a bilateral baroreceptor stimulation device reported that mean blood pressure decreased by 21/12 mmHg in 37 evaluable patients after 3 months of baroreceptor stimulation ($p=0.001$). The mean reduction after 2 years of follow-up was 33/22 mmHg ($n=17$, $p=0.001$ for systolic blood pressure and

p=0.002 for diastolic blood pressure).

- 4.3 The cohort study of 322 patients reported that the mean number of prescribed medications fell significantly between pre-implantation and month 12 in those patients whose blood pressure responded to the device (n=244). These reduced from 5.3±1.9 to 4.7±2.1 and remained lower after a mean follow-up of 28 months (p<0.05).

The following outcomes were reported in patients treated by implantation of a unilateral baroreceptor stimulation device:

- 4.4 A case series of 30 patients treated by implantation of a unilateral stimulation device reported a mean reduction in systolic blood pressure from the pre-implant baseline of 26±3 mmHg at 3-month follow-up (p<0.001). The mean reduction was 26±4 mmHg at 6-month follow-up (p<0.001). The proportion of patients with systolic blood pressure of 140 mmHg or less was 43% at 6-month follow-up. A case series of 25 patients treated by implantation of a unilateral stimulation device reported that the mean blood pressure decreased from 160/83 mmHg at baseline to 143/74 mmHg at 6-month follow-up (p<0.01).
- 4.5 The specialist advisers listed key efficacy outcomes as reduction in blood pressure at 6 and 12 months, reduction in blood pressure variability, reduction in heart rate, and reduction in left ventricular hypertrophy.

5 Safety

This section describes safety outcomes from the published literature that the Committee considered as part of the evidence about this procedure. For more detailed information on the evidence, see the [interventional procedure overview](#).

The following outcomes were reported in patients treated by implantation of a bilateral baroreceptor stimulation device:

- 5.1 Nerve injury with residual deficit was reported in 5% (13/265) of patients and transient nerve injury was reported in 5% (12/265) of patients in a randomised controlled trial of 265 patients (no further details given). Tongue paresis, most

likely caused by intraoperative injury to the hypoglossal nerve, was reported in 1 patient in a case series of 45 patients.

- 5.2 Hypertension-related stroke was reported in 2% (6/265) of patients in the randomised controlled trial of 265 patients (timing and study group not reported). Perioperative stroke with minimal residual effects was reported in 1 patient in the case series of 45 patients.
- 5.3 Hypertensive crisis was reported in 5% (9/181) of patients treated by immediate baroreceptor stimulation and 8% (7/84) of patients treated by deferred stimulation in the randomised controlled trial of 265 patients.
- 5.4 Device removal before activation because of infection was reported in 7% (3/42) of patients in the case series of 45 patients. In 1 patient, the leads were left in and a new device was implanted 12 months later. Infection needing device removal was reported in 1 patient in a case series of 10 patients; the infection occurred after the 4-month follow-up visit.
- 5.5 Respiratory complications (not otherwise described) after device implantation were reported in 3% (7/265) of patients in the randomised controlled trial of 265 patients.
- 5.6 Wound complications (not otherwise described) after device implantation were reported in 3% (7/265) of patients in the randomised controlled trial of 265 patients.
- 5.7 Movement of the implantable pulse generator, needing further surgery to reposition it, was reported in 1 patient in the case series of 45 patients.

The following outcomes were reported in patients treated by implantation of a unilateral baroreceptor stimulation device:

- 5.8 Intermittent pain lateral to the device system was reported within 30 days of device implantation in 1 patient in the case series of 30 patients; the patient recovered with no residual effects.
- 5.9 Device pocket haematoma 3 days after device implantation was reported in

1 patient in a case series of 30 patients; the patient recovered with no residual effects.

- 5.10 In addition to safety outcomes reported in the literature, specialist advisers are asked about anecdotal adverse events (events which they have heard about) and about theoretical adverse events (events which they think might possibly occur, even if they have never done so). For this procedure, specialist advisers considered that the following were theoretical adverse events: traumatic injury to the carotid artery or major neck veins; bleeding; cerebral embolisation causing stroke; wound dehiscence; late damage to the carotid artery; bradycardia; bradypnoea; excessive lowering of blood pressure; orthostatic hypotension; and device failure.

6 Committee comments

- 6.1 The Committee reviewed the evidence separately for bilateral and unilateral implantation. It noted that much of the available evidence was on bilateral implantation, but that unilateral stimulation was often used. It noted that the technology has evolved and unilateral implantation and stimulation is now used.
- 6.2 The Committee noted that non-adherence to medication is an important factor to consider in trials of resistant hypertension.
- 6.3 The Committee was aware of the difficulties in treating patients with drug resistant hypertension and the serious risks these patients face from uncontrolled high blood pressure.

7 Further information

NICE has produced information on this procedure for patients and carers ([information for the public](#)). It explains the nature of the procedure and the guidance issued by NICE, and has been written with patient consent in mind.

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Endorsing organisation

This guidance has been endorsed by [Healthcare Improvement Scotland](#).