

# Reducing maternal mortality: Systolic blood pressure



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**Objective.** To establish whether systolic blood pressure management outlined in hospital guidelines for the management of severe pre-eclampsia and eclampsia is in line with national recommendations.

**Design.** A survey of obstetric unit guidelines for the management of severe pre-eclampsia and eclampsia.

**Sample.** Obstetric units in the UK.

**Methods.** Postal request to all UK obstetric units requesting a copy of their guidelines for management of severe pre-eclampsia and eclampsia. Guidelines were compared with published recommendations with regard to the management and monitoring of blood pressure.

**Results.** A total of 108 units sent guidelines for review (47.6%), and 73 different guidelines were assessed. Four guidelines (5.5%) failed to provide a definition of severe hypertension. There was considerable variation in the level of blood pressure used as a target during treatment with antihypertensive medication and 32 (43.8%) of the guidelines did not specify a target blood pressure. Only 34 (46.6%) guidelines contained clear recommendations on the speed with which blood pressure should be reduced.

**Conclusions.** The danger of high systolic blood pressure continues to be under-acknowledged by clinicians.

The latest triennial report of the Confidential Enquiries into Maternal Deaths in the UK showed a maternal death rate of 5 - 6 per 100 000 maternities.<sup>1</sup> Fourteen deaths were due to pre-eclampsia (PET) and eclampsia; 9 of these women died from intracranial haemorrhage. This contrasts starkly with deaths in the early years of the Enquiry (Fig. 1). In 1952 - 54 there were 246 deaths

due to PET, eclampsia or placental abruption associated with PET. While deaths due to fluid overload have decreased over recent years, presumably as a result of better fluid balance management, we have made little impact on preventing deaths from intracranial haemorrhage (Table I).

As far back as the 1979 - 81 Confidential Enquiries Report, there were recommendations for more widespread use of antihypertensive drugs as a means of reducing the number of deaths from intracranial haemorrhage, secondary to hypertension. Tuffnell *et al.*'s recently published report<sup>2</sup> on the outcome of severe PET/eclampsia in 1 087 women managed using the Yorkshire Obstetric Critical Care Group guideline concluded that the use of a regional guideline may contribute to a low rate of serious complications.

In 2000, the National Institutes of Health-sponsored Working Group on High Blood Pressure in Pregnancy specifically recommended that treatment should lower systolic pressures to less than 160 mmHg.<sup>3</sup> The 2001 Enquiry contained guidelines for the management of

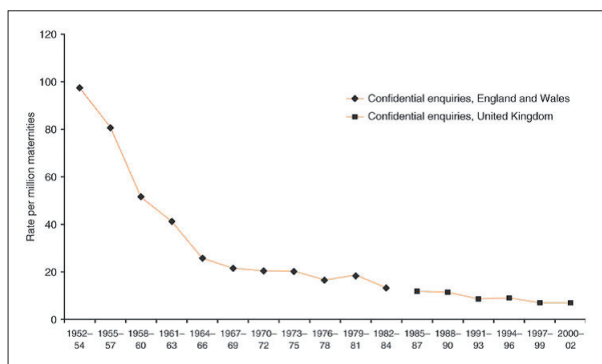


Fig. 1. Maternal mortality from eclampsia and PET: England and Wales 1952 - 84; UK 1985 - 2002.<sup>1</sup>

**Table I. Number of deaths by cause due to eclampsia and PET: UK 1988 - 2002**

Cause of death	Triennia				
	1988 - 90	1991 - 93	1994 - 96	1997 - 99	2000 - 02
Cerebral					
Intracranial haemorrhage	10	5	2	7	9
Subarachnoid	2	0	1	0	0
Infarct	2	0	0	0	0
Oedema	0	0	3	0	0
Subtotal	14	5	7	7	9
Pulmonary subtotal	10	11	8	2	1
Hepatic subtotal	3	4	5	7	4
Total	27	20	20	16	14

severe PET and defined severe hypertension as blood pressure greater than 160/110 mmHg or mean arterial pressure (MAP) greater than 125.<sup>4</sup> The most recent Enquiry highlighted that while diastolic blood pressure is one of a number of useful indices of severity of PET, it is thought to be the pressure during systole that causes intracranial haemorrhage.<sup>1</sup> It recommended that recognition of this concept should be incorporated into clinical guidelines to try to ensure effective reduction of systolic blood pressure and that clinical protocols should identify a systolic blood pressure above which urgent and effective antihypertensive treatment is required. Recent data from the USA provide further evidence for these recommendations. Martin *et al.*<sup>5</sup> reported 28 women who had haemorrhagic strokes associated with severe PET and eclampsia. Over half of the women died and only 3 of the survivors had no disabling neurological morbidity. Analysis of pre-morbid events relating to these strokes, in an admittedly selected cohort, revealed that the constant finding was that systolic blood pressure (SBP) exceeded 155 mmHg, and that in 96% of women it exceeded 160 mmHg.

The methods by which blood pressure is measured have also been under the spotlight in recent years. The last two Confidential Enquiries have emphasised the observation that many automated blood pressure monitoring systems systematically underestimate systolic blood pressure in PET.<sup>1,4</sup> They suggested that mercury sphygmomanometers should be used to establish baseline blood pressure as a reference for automated monitoring in hospital for women with PET, unless the automated system has been validated in pregnancy.

This study aimed to look at how guidelines developed to standardise the management of severe PET and eclampsia compared with best practice recommendations with regard to the measurement and management of severe hypertension.

## Methods

We circulated a letter during September 2003 to 227 obstetric units in the UK asking for a copy of their guideline for management of severe PET/ eclampsia.

A second postal request was sent in January 2004. Data regarding blood pressure measurement and management were extracted and put into a database. Simple descriptive statistics were applied using SPSS 12.0.

## Results

Responses were obtained from 108 units (47.6%). One unit declined to participate in the survey. Two units were midwifery-led and stated that they therefore had no need for a guideline. Thirty-seven units were using one of five regional guidelines: Mersey Region Guideline – 4 units, North West Region Guideline – 15 units, Yorkshire Obstetric Critical Care Group Guideline – 11 units, Leicester Region Guideline – 2 units and Clinical Resource Efficiency Support Team Guideline (CREST) – 5 units.<sup>6</sup> This gave a total of 73 guidelines, which were then assessed.

As can be seen from Table II there was considerable variation in the level of blood pressure used to define severe hypertension, and 4 guidelines (5.5%) failed to provide a definition of severe hypertension at all. There was also considerable variation in the level of blood pressure used as a target during treatment with antihypertensive medication and 32 (43.8%) of the guidelines did not specify a target blood pressure (Table III). Only 34 guidelines (46.6%) contained clear recommendations on the speed with which blood pressure should be reduced. In a further 19 guidelines (26%) the speed of blood pressure drop was implied within the text.

Forty-two (57.6%) of the guidelines made a recommendation with regard to how to measure blood pressure. Of the 38 guidelines recommending use of an automated sphygmomanometer, 32 (84.2%) recommended that either the automated device be calibrated against a mercury sphygmomanometer or the readings obtained with the automated device be compared with manually obtained readings on a regular basis. Five guidelines (13.2%) made no comment with regard to validation of the automated device and 1 guideline recommended that mean arterial pressure (MAP) readings obtained with an automated device

**Table II. Definition of severe hypertension**

Definition of severe hypertension	Number (%)
Systolic $\geq$ 160 mmHg	25 (34.2%)
Systolic $>$ 170 mmHg	19 (26.0%)
Systolic $\geq$ 170 mmHg	19 (26.0%)
Diastolic $\geq$ 110 mmHg	4 (5.5%)
No definition given	4 (5.5%)
MAP $>$ 120 mmHg	1 (2.3%)
MAP $>$ 125 mmHg	1 (2.3%)

**Table III. Blood pressure targets following institution of treatment for severe hypertension**

Blood pressure target	Number of protocols (%)
Systolic $<$ 160 mmHg	4 (5.5)
Systolic $<$ 170 mmHg	6 (8.2)
MAP $<$ 120 mmHg	2 (2.9)
MAP $<$ 125 mmHg	21(28.6)
MAP $<$ 140 mmHg	8 (11)
No comment	32 (43.8)

should have 10 mm subtracted from them to give a true reading.

## Discussion

This study has shown that the importance of the management of systolic pressure in the setting of severe pre-eclampsia and eclampsia is not reflected in the majority of guidelines assessed. While not a truly national audit as responses were not obtained from 119 maternity units (52.4%), this report provides an insight into the extent to which UK guidelines for the management of severe PET and eclampsia reflect knowledge about the risks of an elevated blood pressure. Requests for information by post often meet with a poor response; a recent review of published reports showed a mean response rate of 54%, similar to the 47% obtained in this study.<sup>7</sup> Numerous strategies have been adopted in an attempt to improve survey response rates, including the repeat mailings we used in this study.<sup>7-9</sup> The Royal College of Obstetricians and Gynaecologists was unable to provide us with a list of maternity units in the UK. Our maternity unit list was therefore an amalgamation of information obtained at a regional level and via the National Health Service website.<sup>10</sup> It is probable that some of the maternity units we contacted had merged, thus reducing our response rate. It is also possible that some degree of bias has been introduced into the audit as it can be postulated that units with up-to-date protocols are most likely to respond.

More than any other organ the brain depends on a continuous and adequate supply of oxygenated

blood. A failure of adequate blood supply results in unconsciousness 5 - 10 seconds after onset of asystole.<sup>11</sup> The process of cerebral autoregulation assures a constancy of cerebral blood flow. Cerebral autoregulation consists of a series of baroreceptor and vasomotor reflexes and is a fast-acting mechanism that maintains a relatively constant cerebral blood flow in spite of changes in systemic arterial blood pressure. Studies have shown that cerebral blood flow remains constant even when cerebral perfusion pressure (mean arterial pressure minus intracranial pressure) varies from 50 to 170 mmHg.<sup>12</sup> Generally in hypertensive patients the cerebral circulation retains its ability to autoregulate, but both the upper and lower limits of autoregulation are shifted to higher levels.<sup>13</sup>

In recent years there has been considerable interest in the association between stroke and blood pressure. In the general population the risk of stroke increases continuously above a blood pressure of approximately 115/75 mmHg.<sup>14</sup> Approximately two-thirds of the stroke burden globally occurs in people outside of the reproductive age. However, the evidence that systolic blood pressure plays a significant role in the development of intracranial haemorrhage in the general population is strong.<sup>15</sup> Trials have shown significant benefits from treating isolated systolic hypertension (systolic blood pressure  $>$  150 - 160 mmHg) in terms of reduction in stroke, coronary vascular disease, heart failure and mortality.<sup>16,17</sup>

While age-related physiological changes are different to the physiological changes of pregnancy, it is not unreasonable to hypothesise a role for systolic blood pressure in the development of intracranial haemorrhage in the pregnant population. Indeed, the relationship between eclampsia and haemorrhagic strokes has been described in medical journals since the early 1800s.<sup>18</sup> There are few data addressing normal cerebral autoregulation during pregnancy. In PET vascular autoregulation in the kidney and the middle cerebral artery distribution of the brain appears to be dysfunctional.<sup>19,20</sup> It is thought that in eclampsia the upper limit of autoregulation is reduced and becomes breached by severe systolic blood pressure rises with a consequent forced overdistension of the cerebral vasculature.<sup>21</sup> A number of groups have reported that patients with severe PET have high cerebral perfusion pressures in comparison with controls, thus putting them at increased risk for barotrauma and vessel damage in the cerebral vasculature.<sup>22-24</sup> It is speculated that when cerebral autoregulation is disrupted interstitial extravasation of proteins and fluids results in vasogenic oedema in some vascular beds and rupture and haemorrhage in others.

Given the acknowledged importance of blood pressure in the context of severe PET and eclampsia, it is disappointing that any guidelines for the management of this condition failed to include a definition of severe hypertension. The wide variation in the definitions

given for severe hypertension (Table II) perhaps reflects the variation found in published guidance from national bodies such as the National Institutes of Health Working Group Report on High Blood Pressure in Pregnancy, the Royal College of Obstetrics and Gynaecology and the 2001 Enquiry.<sup>4,25,26</sup> The highest number of guidelines used a systolic blood pressure of  $\geq 160$  mmHg as their definition of severe hypertension in line with the guideline published in the 2001 Enquiry, thus suggesting that this may have influenced individual units. It is disappointing that the importance of using the appropriate equipment to measure blood pressure is not acknowledged in almost half of the guidelines assessed. It is not possible for us to say whether this reflects a lack of awareness that automated sphygmomanometers can fail to reflect true blood pressure readings, a pressure on staffing levels such that use of a non-automated device is not possible, or that manual calibration of automated devices is standard practice and therefore does not warrant inclusion in a guideline.

Given the findings of the 2004 Enquiry the paucity of guidance given on the titration of blood pressure following institution of treatment of hypertension is worrying (Table III).<sup>1</sup> Neilson<sup>1</sup> observes that many of the published guidelines for the management of severe PET and eclampsia have focused on target figures for diastolic blood pressure with treatment of systolic blood pressure implied rather than explicit. Our survey provides evidence for this observation, with only 10 protocols (13.7%) giving a target systolic blood pressure. Moreover, 6 of the 10 specified a target for blood pressure control as systolic blood pressure  $< 170$  mmHg. Martin *et al.*<sup>5</sup> studied the case histories of 28 women who sustained a stroke in association with severe PET and eclampsia. They had pre-stroke data regarding blood pressure for 24 patients. Of these, 96% had a pre-stroke systolic blood pressure  $\geq 160$  mmHg. It is therefore worrying that some guidelines are aiming for a systolic blood pressure of  $< 170$  mmHg with treatment and, perhaps more important still, that 52% of guidelines do not recommend starting antihypertensive medication until systolic blood pressure exceeds 170 mmHg (Table II). The mean MAP pre-stroke was 123.9 ( $\pm 6.6$ ), illustrating that MAP and systolic blood pressure should be considered independently when assessing the woman with severe hypertension. Tuffnell *et al.*<sup>2</sup> recently reported on 1 087 women with severe PET and eclampsia managed using the Yorkshire Obstetric Critical Care Group guideline. In this series no patients were reported as having an intracranial haemorrhage, although 13 patients with eclampsia had neuro-imaging, one of whom had evidence of a recent infarct and another possible ischaemic change. Neither patient had any long-term sequelae. These guidelines use systolic blood pressure  $\geq 160$  mmHg as their definition of severe hypertension and recommend lowering systolic blood pressure over the course of 60 minutes. Their findings provide further circumstantial

evidence that systolic blood pressure is important in the development of intracranial haemorrhage.<sup>2</sup>

It is likely that blood pressure alone, whether systolic, diastolic or a derivative of the two, is not the only, or indeed the dominant factor in intracranial haemorrhage occurrence in the setting of severe PET and eclampsia. This is supported by the fact that intracranial haemorrhage is rare in the setting of severe PET/eclampsia and indeed among pregnant women whose systolic pressures exceed 160 mmHg without any other signs of PET.<sup>2,5,27</sup> In addition, if one looks at the work of Martin *et al.*<sup>5</sup> it is clear that many of the patients who developed intracranial haemorrhage had rapidly worsening conditions with haemolysis, elevated liver enzymes and low platelets consistent with HELLP syndrome suggesting that disorder of vascular-endothelial physiology may also be involved in the pathophysiology. While the evidence suggests that simply lowering blood pressure below a certain systolic threshold may not be protective in certain patients, what data there are suggest that withholding antihypertensive medication in the presence of sustained systolic hypertension because diastolic pressures have not yet reached the required threshold seems to be ill advised. It is important that our guidelines reflect this.

## Conclusions

The danger of high systolic blood pressure continues to be under-acknowledged by clinicians, as evidenced by our findings. Perhaps now is the time to consider the development of a national guideline for the management of severe pre-eclampsia and eclampsia that pays heed to the significance of systolic hypertension and addresses the management of women with this in mind. This would have the added bonus of allowing for audit of management and management outcomes on a national scale, thus providing valuable data on systolic hypertension as a risk factor for intracranial haemorrhage in the pregnant population.

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