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## Editorials

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### Brain injury and ocular motor abnormalities in surviving preterm infants

Advances in neonatal care over the past 10 years have resulted in increased survival of very immature preterm infants but there has not been a corresponding improvement in neurodevelopmental outcome.<sup>1</sup> Serious neonatal morbidity is associated with decreasing gestational age. The survival of infants of extremely low birth weight and gestational age is associated with an increased incidence of brain injury in the survivors. The immature central nervous system of premature infants is particularly susceptible to cerebrovascular damage.<sup>2–4</sup> Intracranial, particularly intraventricular, haemorrhage is common, especially in smaller infants and may be associated with post-haemorrhagic hydrocephalus and with focal infarction of the white matter. The haemorrhage arises from the subependymal germinal matrix, a fine vascular gelatinous structure lying beneath the ependyma of the ventricular system and containing cells which will form mature glial cells that will later populate the cortex.<sup>2–4</sup> The germinal matrix is present from 10 weeks' gestational age and has disappeared by term. Most haemorrhage occurs in the first 72 hours after birth and may break through into the intraventricular space. Bleeding may also occur into the brain parenchyma. Between 24 and 32 weeks' gestational age the risk of white matter damage is particularly high. It is during this period that the brain is undergoing time limited maturational changes including myelogenesis.<sup>3</sup> The cause of the haemorrhage and the mechanism of white matter necrosis are not entirely clear but, like retinopathy of prematurity, are probably multifactorial.<sup>3–4</sup>

Intraventricular haemorrhage is common in preterm infants; it occurs in about 40% of those weighing <1500 g at birth. It is often silent but a large haemorrhage may be associated with loss of visual responses, the development of dilated unresponsive pupils, and ocular motor signs including large angle esotropia and tonic downgaze.<sup>5</sup> Although most of the signs may resolve the convergent strabismus usually persists.<sup>5–6</sup> Large haemorrhages may also be complicated by post-haemorrhagic hydrocephalus which may in itself be a cause of ocular morbidity.

Periventricular leucomalacia (PVL) is a separate ischaemic lesion of white matter that is often associated with intraventricular haemorrhage.<sup>3–4</sup> It occurs in a characteristic distribution in the white matter dorsal and lateral to the outer angle of the lateral ventricles and commonly affects the optic radiations. Until the advent of imaging techniques, particularly ultrasound, these white matter changes

could only be studied pathologically. Postmortem studies of premature infants have demonstrated a close link between white matter damage and neurological handicap.<sup>4–7</sup> Now intraventricular haemorrhage and parenchymal abnormalities can be detected in the neonatal period and their natural history followed using serial ultrasound. Two types of parenchymal changes are seen on ultrasound—periventricular echodensities and cystic lucencies; both may represent ischaemic damage to the white matter. In longitudinal studies the cystic lesions are preceded by echodensities and are thought to represent more severe ischaemic necrosis with cyst formation.

Several studies<sup>8–10</sup> have investigated the relation between findings on cerebral ultrasound and neurological and ophthalmological morbidity. There is a clear association between the finding of cystic lesions on ultrasound and adverse neurological outcome and ophthalmological abnormality, particularly the development of convergent strabismus. The more posterior the cystic PVL the worse the prognosis.<sup>8</sup> Non-cystic PVL is associated with less ophthalmological morbidity.<sup>8–9</sup>

It is clear that a neurological insult to the developing brain may result in a number of ophthalmological abnormalities including high (predominantly hyperopic) refractive errors, gaze palsies, strabismus, nystagmus, and visual pathway abnormalities. Strabismus is much more common in preterm infants than in the normal childhood population.<sup>11–13</sup> Pennefather and colleagues in a careful prospective study reported in this issue of the *BjO* (p 514) demonstrated that 12% of preterm infants born before 32 weeks' gestation had evidence of strabismus by 2 years of age and the incidence rose to 52% in infants with cerebral palsy. This is in contrast with the incidence of about 2% in the normal population. There was an increased risk of strabismus in children with refractive error and family history of strabismus, which are also prominent risk factors in the normal population.<sup>14</sup> Cicatricial retinopathy of prematurity was also found to be an independent risk factor confirming the findings of other recent studies.<sup>12–13</sup>

Strabismus in infants who were born prematurely is usually convergent and of early onset.<sup>6–11–12</sup> The angle of strabismus is usually large and there may also be dissociated vertical deviation and inferior oblique overaction.<sup>15</sup> The findings are similar to those found in normal infants with early onset esotropia suggesting that the major site of dysfunction in normal infants with strabismus is likely to be

cortical. Even in preterm infants where brain injury plays a significant role other factors such as the genetic background of the child, failure of normal emmetropisation, and retinal abnormalities which interfere with normal sensory fusion are important.<sup>12 13</sup> (Pennefather *et al*, p 514) The aetiology of strabismus is multifactorial but the careful study of infants with brain injury with newer imaging techniques should improve our understanding of the cortical mechanisms controlling ocular alignment and ocular motor function.

ANTHONY T MOORE

Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ

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## Criteria for cataract surgery: the role of visual acuity and visual function

The paper presented by Crabtree *et al* in this issue of the *BJO* (p 519) represents yet another contribution to the growing literature on the assessment of visual function in ophthalmic patients from a variety of different settings.<sup>1–8</sup> To date, the majority of such studies have centred on comparing the postoperative gains in visual function and visual acuity as a result of cataract surgery.<sup>9–13</sup> Not unexpectedly, such studies have suggested that a strong correlation between visual acuity, a largely objective measure, and visual function, a relatively more subjective measure of vision, exists. For the most part too, such studies have found that visual function questionnaires are highly setting and population dependent, and that what might work in the United States just about works in England, but doesn't work at all in India, even though they are all rooted in vision. But what to do with the resulting information contained in the burgeoning plethora of visual functioning indices?

Both the current (p 519) and previous authors have raised the question of utilising such visual function questionnaires in conjunction with traditional visual acuity measures, as a means of prioritising who gets listed for cataract surgery.<sup>6 8–11</sup> Underpinning the much contested and hotly debated subject of who should receive cataract surgery is, of course, the magnitude of the cataract backlog operating within any one country. Globally it is estimated that cataract accounts for at least 17 million blind people.<sup>14</sup> In the United States, however, with one of the highest number of ophthalmologists per population, the cataract surgical threshold is lower than in countries with distinct shortages of ophthalmologists. Under such circumstances of limited resources which can be devoted to reducing the backlog of unoperated cataract, the prioritisation of cataract surgery assumes that patients with some, as yet undefined, combination of poor visual acuity and low visual function scores will be given cataract surgery first. The difficulty of this approach is apparent—namely, overestimation of a patient's visual functioning

status. In fact, if such a system were to be implemented, there would be tremendous incentive for patients to artificially suppress their own visual function scores to ensure a place on the cataract surgery list. Any effort to maintain fairness in the delivery of publicly sponsored cataract surgery should seriously reconsider any attempt to prioritise cataract surgery upon the basis of patient perceived valuations of their own visual capabilities. Rather, the whole area of vision function requires much more refinement and study as to how it might be used, if at all, in any attempt to prioritise cataract surgery either in whole or in part in the place of clinical measures, most notably visual acuity. Although efforts to uncover the ways in which visual function measures might be used to prioritise cataract surgery are laudable goals, equal if perhaps not more substantive gains might be derived by increasing the existing number of people capable of performing cataract surgery, a course of action which prepares ophthalmology to meet its biggest challenge of the coming millennium—the sustained provision of high quality, cost effective, cataract surgery on a global scale.

ANDREW F SMITH

Nuffield Laboratory of Ophthalmology, University of Oxford, Oxford OX4 6AW and Department of Internal Medicine, Division of General Medicine, University of Michigan, Ann Arbor, Michigan, USA

Correspondence to: Center for Practice Management and Outcomes Research, Veterans Affairs Health Services Research and Development Field Program, PO Box 130170, Ann Arbor, MI 48113-0170, USA.

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### Contributors please note:

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ANTHONY T MOORE

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