children under 3 years of age the sternal marrow space is inadequate and there is the risk of mediastinal infusion.^{2 5}

The contraindications are osteogenesis imperfecta, osteoporosis, osteomyelitis, ipsilateral fracture of the extremity, or local skin infection.²

The commonest complication is subcutaneous infusion after failure to enter the marrow cavity. Skin infection has been reported in 0.7% (five out of 694), which is less than that reported with intravascular catheters (3.7%). Osteomyelitis has been reported in 0.6% (27 out of 4270), with an increased risk if the needle is left in situ for a prolonged period. Despite concern about effects on bone growth, no long term side effects have been reported.⁵ The deaths attributed to intraosseous infusion have all followed sternal puncture.^{2 3}

Blood products, fluids, vasoconstrictors, inotropes, and anticonvulsants have all been investigated using animal models and in clinical practice.^{2 6} Although we were reluctant to infuse adrenaline because of fears about the vasoconstrictor effects on the marrow, studies have shown that adrenaline exerts a systemic effect within 20 seconds and atropine exerts its effect more rapidly via the intraosseous route than via the intratracheal route.⁶ Sodium bicarbonate can be infused safely, although an increased risk of osteomyelitis has been reported with hypertonic solutions.^{2 4}

Fluid flow rates under gravity infusion vary between 1 and 25 ml/minute, but at 40 kPa (300

mm Hg) pressure flow can be increased to 40 ml/minute via a 13 gauge needle.⁶

In the UK intraosseous infusion is seldom used despite the extensive literature on the subject. Even for those with experience of paediatric resuscitation intravascular access may be impossible to achieve, and for the trainee called to resuscitate a child the prospect of placing an intravenous cannula rapidly can be daunting. Intraosseous infusion provides reliable access to the circulation even in inexperienced hands and more than justifies the small risk of complications if intravascular access is difficult. However, this route should only be used in extreme emergencies, in cases where no venous access has been achieved, and after adequate ventilation has failed to improve the child's condition. In this case we are in no doubt that the child would have died if we had not used an intraosseous infusion. We believe that bone marrow infusion needles should be stocked on all paediatric resuscitation trolleys.

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Meningitis caused by human herpesvirus-6

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Abstract

Since the discovery of human herpesvirus-6 (HHV-6) the illnesses associated with it have increased steadily. Two infants with meningitis are reported: both suffered a mild meningitis and serological studies confirmed an acute HHV-6 infection. This report supports a role of HHV-6 in nervous system disease.

Human herpesvirus-6 (HHV-6) was first reported by Salahuddin *et al* in 1986.¹ After its discovery illnesses linked to HHV-6 have been reported and include roseola infantum, hepatitis, lymphadenitis, mononucleosis, atypical polyclonal lymphoproliferative disorder, and haemophagocytic syndrome.²⁻⁴ Here we report two cases of roseola infantum with meningitis, which to the best of our knowledge has not been reported before.

Case reports

CASE 1

A 7 month old girl presented with fever of three

days' duration and a mild cough. Physical examination showed only pharyngitis, an appreciably bulging anterior fontanelle, and mild hepatomegaly (3 cm palpable below right costal margin). Lumbar puncture showed 18 mononuclear and 2 polymorphonuclear cells/mm³. Her cerebrospinal fluid protein concentration was 0.35 g/l and glucose 3.05 mmol/l. During her stay in hospital the peripheral white cell counts ranged from 6.9 and 12.0 × 10⁹/l and lymphocytes accounted for 60 to 90% of them. Atypical lymphocytes represented 12% of all white cells initially and reached a peak of 25%.

Serological studies showed no evidence of infection of Epstein-Barr virus, cytomegalovirus, or *Toxoplasma gondii*. Virus culture of cerebrospinal fluid was negative. Antibody to HHV-6 was determined by indirect immunofluorescence assay using HHV-6 (U1102 strain) infected J Jhan cells as antigens. The IgG anti-HHV-6 was tested as reported by Salahuddin¹ and IgM anti-HHV-6 as the method of Niederman *et al*.³ The first serum taken on the fourth day of illness was negative for IgG anti-HHV-6 but positive for IgM anti-HHV-6 (titre 1:10). The second serum taken 11 days later was

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positive for both IgG anti-HHV-6 (1:160) and IgM anti-HHV-6 (1:80). A maculopapular rash appeared over her face, scalp, and neck on the fourth day of illness. She became afebrile soon after the rash eruption. No sequela was noted one month after discharge.

CASE 2

This 4 month old boy presented with cough, poor appetite, and high fever. Four episodes of generalised seizure occurred in the next two days with persistent fever. Examination of his cerebrospinal fluid performed on the third day of illness revealed 8 polymorphonuclear cells and 1 mononuclear cell/mm³. Cerebrospinal fluid protein and glucose concentrations were normal. A peripheral blood smear revealed lymphocytosis (total white cell count was $9.6 \times 10^9/l$, lymphocyte 73%, and atypical lymphocyte 6%). Impaired liver function was noted (aspartate aminotransferase 87 U/l and alanine aminotransferase 50 U/l. His electroencephalogram was normal. A diffuse maculopapular rash appeared over his trunk and lower extremities on the fourth day of illness and his fever soon subsided. Virus culture of throat swab, rectal swab, and cerebrospinal fluid showed no pathogens. The first serum taken on the fifth day of illness was negative for both IgG and IgM anti-HHV-6. The second serum taken 12 days later was positive for both IgG anti-HHV-6 (1:160) and IgM anti-HHV-6 (1:40). The boy recovered well and no sequela was noted two months later.

Discussion

Both cases underwent a typical course of roseola infantum, that is, high fever for three to four days' duration followed by skin rash eruption and lysis of fever and recovery. Case 1 was neurologically normal and case 2 suffered from repeated seizures. Both had pleocytosis and recovered well. HHV-6 has been known to infect glioblastoma cells² and is thought to be a potential cause of nervous system disease. Before the identification of HHV-6 in the aetiology of roseola infantum, encephalitis has been known to occur after roseola infantum.⁵

However, the connection between HHV-6 and these reported cases of encephalitis was not certain as no study on HHV-6 was done and enterovirus was incriminated as a possible aetiological factor as it may cause a roseola-like disease. Although the number of diseases linked to HHV-6 are increasing, the connection of HHV-6 with nervous system illness has been shown only by Irving *et al* who reported a 13 month old girl suffering from encephalitis and experiencing brain atrophy six months later.⁶

Our cases had serological evidence of acute primary HHV-6 infection and a search for other viruses failed. Both cases had lymphocytosis and a certain degree of atypical lymphocytosis; one of them fulfilled the diagnosis of mononucleosis syndrome. From the clinical information we believe that HHV-6 was responsible for the full clinical features of these two children.

Roseola infantum is, in a paediatrician's mind, a benign disease. Seizure is not uncommon and is mostly attributed to a febrile convulsion. Though both our cases experienced mild neurological insults, there is no guarantee that HHV-6 causes only mild nervous system disease. Testing for HHV-6 in unexplained neurological inflammatory diseases is therefore important, especially in infants. An additional point is the occurrence of mononucleosis and hepatitis that we observed; both have been reported before.^{2,3} This finding supports the view that HHV-6 is capable of causing a variety of illnesses.

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Severe nephropathy in three adolescents with cystic fibrosis

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Abstract

Renal involvement has rarely been reported in patients with cystic fibrosis. We describe severe nephropathy with a rapidly fatal outcome in three adolescents with cystic fibrosis, and evaluate the important repercussions that the nephrotic syndrome had on the precarious clinical situation of these patients.

Despite the general consensus that the kidney is spared in cystic fibrosis and does not present specific lesions, mounting evidence suggests that renal involvement occurs. Numerous and even severe anatomical and pathological changes have been reported in the kidney in patients with cystic fibrosis.^{1,2} Glomerular alterations were seen (amyloidosis, glomerulosclerosis, mesangial deposits of immuno-

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