Rapid diagnosis and treatment of meningococcal disease are vital to prevent life-threatening complications and long-term physical and psychological effects.

**Infectious diseases**

**Prevention and treatment of meningococcal disease**

**Keywords:** Meningococcal disease/Meningitis/Septicaemia/Meningococcus/Shock

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In the UK, meningococcal disease (MD) is the leading cause of death from infectious disease in children aged under five years (National Institute for Health and Care Excellence, 2010). The disease can have a rapid onset so nurses must be aware of its signs and symptoms in order to identify patients quickly so prompt treatment can be given to minimise the risk of complications.

In the majority of cases, clinical suspicion of MD based on an assessment of the child will inform the diagnosis. The presence of fever and a non-blanching rash are key clinical indicators, but laboratory diagnosis is vital to identify the causative organism and guide public health management (Nadel and Kroll, 2007). Blood tests are listed in Box 1. However, while laboratory diagnosis is important, the rapid administration of antibiotics and management of shock and/or raised intracranial pressure (ICP) should not be delayed because results are not available (NICE, 2010).

Meningococcal whole-blood polymerase chain reaction (PCR) testing, which indicates the presence of infection, has improved the detection rate of MD and is now considered the gold standard for diagnosis (Visintin et al, 2010). It is important to note that C-reactive protein (CRP) and white cell count, which are usually elevated in the presence of infection, may not be raised initially in MD, so normal blood results should not provide false reassurance if MD is suspected (Nadel and Kroll, 2007).

Obtaining a sample of cerebrospinal fluid (CSF) via lumbar puncture is a diagnostic tool for suspected meningitis but there are important contraindications (NICE, 2010). These include signs of raised ICP, shock, extensive or spreading purpura, seizures, coagulation abnormalities and respiratory insufficiency.

**Treatment and management**

Children with suspected MD need to be urgently transferred to hospital (NICE, 2010), where the priorities are:

» Administration of antibiotics;
» Recognition and treatment of complications;
» Laboratory diagnosis.

Ceftriaxone is the antibiotic of choice for both meningitis and septicaemia, unless the child is younger than three months, when cefotaxime plus either amoxicillin or ampicillin is recommended (NICE, 2010). Thereafter, treatment and management depends on the severity of disease progression and whether the child has symptoms of shock and/or raised ICP (Vyse et al, 2013). The challenge is to...
Nursing Practice

Review

differentiate between children with less serious disease and those who may require more aggressive management (Vyse et al, 2013). For a child presenting with MD without signs of shock or raised ICP, management focuses on monitoring vital signs for possible deterioration (Nadel and Kroll, 2007).

MD with septic shock
A child presenting with MD in septic shock needs aggressive intravenous (IV) fluid therapy (NICE, 2010). An initial fluid bolus of 20mL/kg of 0.9% sodium chloride should be given immediately over 5-10 minutes. If there is no immediate improvement after this, a second bolus of 20mL/kg should be given. If there are signs of shock after this, a third 20mL/kg fluid bolus should be administered and anaesthetic support sought urgently. The child will also require vasoactive drugs to support blood pressure alongside continuing fluid therapy, as large volumes of fluid are often required to restore the circulating blood volume (Visentin et al, 2010).

NICE (2010) recommends that, along with anaesthetic support, the advice of a paediatric intensivist is sought; if this service does not exist locally, protocols for contacting these specialist services should be followed.

Children requiring >40mL/kg fluid who have signs of ongoing shock require intubation and ventilation and transfer to a paediatric intensive care unit (Nadel and Kroll, 2007). Because of their precarious cardiovascular state, children may deteriorate during intubation so senior anaesthetic and intensive care staff should be available. The child must be fully monitored at all times, with regular blood pressure monitoring. Urethral catheterisation is important to guide prescribing of fluid therapy, as urine output provides an indication of cardiac output (Nadel and Kroll, 2007).

Children presenting in shock are likely to be hypoglycaemic, acidic, hypokalaemic (low potassium), hypocalcaemic (low calcium) and anaemic (Nadel and Kroll, 2007). Their clotting will also be deranged and this requires correction with blood products.

Protocols should be followed to manage each of these conditions. Metabolic derangements will further suppress myocardial function and urgent management is needed to prevent cardiac collapse.

Although septicaemic shock is probably the more significant and common complication of MD, meningitis with raised ICP requires urgent and expert management (Nadel and Kroll, 2007; Hart and Thompson, 2006). Neuroprotective strategies should be employed to prevent secondary brain damage. If there are signs of raised ICP coexisting with signs of shock, fluid management can become complex and specialist advice from a paediatric intensivist should be sought. Intravenous dexamethasone is advised for cases of suspected or confirmed bacterial meningitis (NICE, 2010).

Nursing implications
Nurses have a key role in recognising, managing and preventing MD. In hospitals, the triage nurse is often the first health professional to see the child (Paul et al, 2011). It is vital to undress children with symptoms indicating possible MD to allow a full examination for rashes, and perform a complete set of vital signs. Febrile children who are symptomatic must be seen urgently and triaged appropriately.

Since MD is a notifiable disease, key contacts should be identified and prescribed chemoprophylaxis (Paul et al, 2011).

Once MD has been diagnosed, close monitoring is crucial to identify any signs of deterioration quickly (Nadel and Kroll, 2007). Nurses must be aware of the signs of shock and raised ICP and be able to articulate their concerns to medical colleagues. In addition to vital sign monitoring, administration of fluid and other medications, nurses must also care for the child’s family, who will be anxious and distressed (Hart and Thompson, 2006). Nurses also play a vital role in health promotion, vaccination uptake and educating parents about the signs and symptoms of MD.

Complications
The overall MD mortality rate in developed countries is around 5-10% (Vyse et al, 2013), although case fatality ratios (CFR) of up to 50% have been found with meningococcal septicaemia (Nadel et al, 2005); CFR are also affected by serogroup and age (Vyse et al, 2013). Some data reports higher CFR with increasing age, whereas others show evidence of greater CFR in infants (Howitz et al, 2009; Ramsay et al, 1997). Alongside the significant mortality risk, a range of short and long-term complications are associated with MD (NICE, 2010). Box 2 lists complications associated with severe sepsis and multi-organ failure.

Patients with meningococcal meningitis are more likely to develop long-term neurodevelopmental complications (Hart and Thompson, 2006), including hemiplegia, deafness or ongoing seizures. Recognition of long-term psychological problems, such as post-traumatic stress disorder, anxiety, depression and educational/behavioural disturbances, is increasing (Vyse et al, 2013).

Prevention
Guidelines and other measures, including media campaigns to promote awareness of MD among parents and training for health professionals, have improved the recognition and management of MD and led to a reduction in mortality rates. However, cases continue to occur.

BOX 1. BLOOD TESTS FOR SUSPECTED MD
- Whole-blood polymerase chain reaction
- Blood cultures
- Clotting studies
- Full blood count
- C-reactive protein
- Urea and electrolytes
- Blood gas

NICE (2010)

BOX 2. COMPLICATIONS OF SEVERE SEPSIS AND MULTI-ORGAN FAILURE

Respiratory The large volumes of fluid required to manage severe sepsis and capillary leak syndrome mean children are at high risk of pulmonary oedema and acute respiratory distress syndrome.

Renal Due to reduced cardiac output and compensatory mechanisms, children may develop pre-renal failure, requiring renal replacement therapy.

Skin/limb Cardiovascular compromise and the purpuric rash may lead to necrotic digits and gangrenous limbs. Capillary leak and aggressive fluid management combined with renal insufficiency can cause severe oedema, and compartment syndrome poses a risk to limbs. Compartment syndrome involves increased pressure in a muscle compartment and can lead to muscle and nerve damage and problems with blood flow. Fasciotomy (used to relieve pressure) is sometimes required to salvage limbs, and patients will require ongoing surgical care (Fig 1). Approximately 2-5% of patients may require amputation of limbs/digits.
Vaccination programmes have dramatically reduced numbers of cases of MD in the UK (Table 1). Serogroup C meningococcal conjugate vaccine, introduced in the UK in 1999, reduced the incidence of serogroup C MD by 94% in immunised populations and 67% in unimmunised populations (Nadel, 2012). As a result of this success, the leading cause of MD in Europe is now serogroup B (Nadel, 2012).

The Joint Committee for Vaccine and Immunisation recently reviewed a MenB (Bexsero) vaccine but has not recommended its inclusion in the routine childhood vaccination schedule (JCVI, 2013). It found insufficient data on efficacy and cost-effectiveness, and recommended further evaluation (JCVI, 2013b).

Primary prevention of MD acquired through foreign travel is another important measure to consider. Large epidemics have been associated with the annual Hajj pilgrimage to Saudi Arabia and resulted in serogroup A and W135 infections being imported into the UK (Salisbury and Ramsay, 2013). The quadrivalent conjugated ACWY vaccine should be administered to travellers visiting high-risk areas and is a visa entry requirement for Saudi Arabia (Salisbury and Ramsay, 2013).

**Education and training**

Ninis et al (2005) found that significant risk factors for death from MD included not being treated by a paediatrician, not being supervised by a consultant and inadequate inotrope therapy (to improve cardiac output) (Ninis et al, 2005).

Another significant risk is failure to recognise complications (Ninis et al, 2005). This highlights the importance of education and training for professionals who may see children or young people with MD, and is one of the key recommendations by NICE (2010). Although children should ideally be treated only by paediatric staff, this is not always possible as not all hospitals have dedicated paediatric emergency departments.

There are numerous methods to improve the recognition of seriously ill children, one of which is the use of paediatric early warning scores (Pearson, 2008). However, important as these tools are, they should be used in combination with appropriate staff education and training.

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**TABLE 1. INVASIVE MENINGOCOCCAL INFECTIONS, ENGLAND AND WALES BY CAPSULAR GROUP**

<table>
<thead>
<tr>
<th>Year</th>
<th>B</th>
<th>C</th>
<th>W135</th>
<th>Y</th>
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<tbody>
<tr>
<td>1998-99</td>
<td>1,400</td>
<td>955</td>
<td>44</td>
<td>23</td>
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<tr>
<td>1999-00</td>
<td>1,629</td>
<td>892</td>
<td>95</td>
<td>27</td>
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<tr>
<td>2000-01</td>
<td>1,688</td>
<td>412</td>
<td>126</td>
<td>27</td>
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<tr>
<td>2001-02</td>
<td>1,501</td>
<td>210</td>
<td>101</td>
<td>29</td>
</tr>
<tr>
<td>2002-03</td>
<td>1,210</td>
<td>121</td>
<td>46</td>
<td>17</td>
</tr>
<tr>
<td>2003-04</td>
<td>1,297</td>
<td>64</td>
<td>47</td>
<td>28</td>
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<td>2004-05</td>
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<td>65</td>
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<tr>
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<td>34</td>
<td>81</td>
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We recently investigated the effects of simulation training in a clinical area, with the aim of improving nurses’ confidence (Dowson et al, 2013). We found that regular repetitive simulation training improved their confidence in recognising and managing seriously ill children by providing insight and experience as close to real-life situations as possible. Knowledge of and adherence to published protocols and guidelines are also key to improving outcomes in MD (Nadel and Kroll, 2007).

**Conclusion**

MD remains a leading cause of illness in children and young people, with a significant risk of mortality or long-term effects on health. It presents a challenge for health professionals as it is difficult to both recognise and treat. Research into vaccines for group B MD are an exciting development but will not entirely remove the risk for this disease. NT

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**References**


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