Quality of in-hospital care for adults with acute bacterial meningitis: a national retrospective survey

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Summary

Background: Most adults with bacterial meningitis and meningococcal septicaemia present to junior doctors who have limited experience of these conditions. In contrast to paediatric practice, data from industrialized countries with regard to current hospital management practice are lacking.

Aim: To examine whether current practice meets recommended standards in hospital management of community-acquired bacterial meningitis and meningococcal septicaemia among adults.

Design: National audit of medical records.

Methods: We conducted a survey of all patients with acute bacterial meningitis and meningococcal septicaemia admitted to 18 randomly selected acute hospitals in England and Wales between 1 January 2000 and 31 December 2001. All stages of care, including pre-hospital management, initial hospital assessment, record keeping, and ongoing hospital and public health management, were assessed.

Results: We identified 212 cases of bacterial meningitis and meningococcal septicaemia; 190 cases remained in the final analysis. Clinical record keeping did not meet acceptable standards in 33% of cases. Parenteral antibiotics were given within 1 h of hospital arrival in 56% of cases, increasing to 79% among those with an initial differential diagnosis that included bacterial meningitis or meningococcal septicaemia. A full severity of illness assessment was made in 27%. The quality of clinical practice varied widely between hospitals. This was most pronounced in the timeliness of consultant review (p < 0.0005).

Discussion: The quality of adult clinical practice for bacterial meningitis and meningococcal septicaemia needs improvement. This study provides a tool for developing targeted interventions to improve quality of care and outcome among adults with life-threatening infections, both in the UK and in other countries.

Introduction

Early recognition, assessment of disease severity, and institution of specific therapy are crucial to the outcome of bacterial meningitis and meningococcal septicaemia.1–3 In many industrialized countries, most adults with bacterial meningitis or meningococcal septicaemia are managed initially by clinicians, often junior doctors who have limited experience of these conditions. To date, most clinical and research effort has focused on paediatric practice, where prompt diagnosis in the
community, the formulation of management algorithms, targeted postgraduate training and a greater willingness to refer critically ill patients to specialist centres are thought to have had a significant impact on mortality, particularly amongst patients with meningococcal septicaemia. This encouraging trend contrasts with the persistently higher mortality associated with bacterial meningitis and meningo-coccal sepsis among otherwise fit young adults. The overall mortality associated with bacterial meningitis in adults has remained approximately 20% over the last 20 years, and for pneumococcal meningitis is as high as 30%. Although there is a perception that early recognition and initial in-hospital management of meningitis in adults are suboptimal, large-scale data from industrialized countries are lacking with regard to whether current practice meets recommended standards, or whether the quality of clinical practice varies between centres.

We therefore set out to assess current clinical practice focusing on key elements of the process of care that are thought to influence clinical outcome and that are highlighted in several practice guidelines. We have collected nationally representative data that are relevant to health systems from a range of different environments, with the aim of identifying specific areas for targeted intervention.

Methods

Cases of bacterial meningitis and meningococcal septicaemia

We reviewed the medical records of all patients aged ≥16 years with a diagnosis of acute bacterial meningitis and/or meningococcal septicaemia presenting to 18 acute NHS healthcare trusts (each consists of one or more hospitals) in England and Wales, between 1 January 2000 and 31 December 2001. Cases were identified by discharge diagnoses with ICD 10 codes A39 (all meningococcal infection) or G00 (all bacterial meningitis). Cases with previous neurosurgery (last 6 months), known immunodeficiency (e.g. HIV infection, long-term steroid therapy, chemotherapy, splenectomy), or where the onset of illness was ≥2 weeks after hospital admission were excluded.

Sampling of cases nationwide and data collection

The study was approved by the South West Multi-Centre Research Ethics Committee. The primary sampling unit was the NHS healthcare trust. Two trusts were randomly selected from each of nine regions: the eight NHS regions of England (as in 2000/2001) and the single region of Wales. In trusts with more than one acute hospital, one hospital was randomly selected. A maximum of 16 cases was taken from each hospital. If more than 16 eligible cases were identified, we randomly selected 16. Eligible patients and their notes were identified by local medical records managers in liaison with the hospital Caldicott Guardian. Data were collected by a single clinical research fellow using a standardized case report form, which was revised following a pilot study in four hospitals. Data collected included demographics, indicators of standards of care, disease severity, outcome and note recording (see below). Each patient and hospital data set was given an encrypted unique identifier, to maintain anonymity but enable record linkage.

Assessment of clinical practice, disease severity and outcome

Standards of clinical practice were formulated by an expert panel convened for the study, based on the BIS guidelines, and included disease severity assessment and recording of clinical data (see ‘Standards and Indicators’, available from the QJM website [http://www.qjmed.oxfordjournals.org]). The standards relate to multiple steps in the diagnosis and management process from first assessment, management in the first hour through to follow-up; they provide an analysis framework for the study (Figure 1). We determined the quality of data recording in the clinical notes, classifying it as good if >75% of essential information (see website document) was recorded; medium if 50–75% was recorded and poor if <50% was recorded.

We assessed disease severity using parameters associated with an adverse outcome and likely to be recorded in the case-notes (based on the pilot study). There were insufficient data in the case-notes to determine severity scores such as the Glasgow Meningococcal Septicaemia Prognostic Score. A case of meningococcal septicaemia was considered severe if either the admission systolic blood pressure was <90 mmHg or Glasgow Coma Scale was <10; or if three or more of the following were present: absence of neck stiffness, WCC >10×10⁹/l, platelets <100×10⁹/l or HCO₃ ≤15 mmol/l. Meningitis cases were considered severe if at admission they had any of: a marked depressed conscious level (GCS <10); focal seizures; papilloedema; bradycardia (<60 bpm) plus hypertension (>140 mmHg); or absence of neck stiffness accompanied by a WCC <1×10⁹/l and a platelet count <100×10⁹/l were present.
(see website document). We used the following endpoints to assess outcome: death, length of hospital stay, and long-term sequelae (deafness, neurological deficit, major skin grafting or amputation).

**Data analysis**

We measured clinical practice against the study standards. Confidence intervals were adjusted to allow for the clustering of the sample within trusts, but typically the degree of within-trust correlation was small, and confidence intervals were only widened a little by this adjustment. We included a weighting for the total number of cases reported in England and Wales in 2000 (Table 1). As the regional distribution of the sample was close to the regional distribution of the national data, there was little difference between weighted and unweighted numbers. All other results were therefore reported unweighted. Unrecorded data were omitted from the calculations unless otherwise stated. The analysis was done using Stata.16

**Results**

**Characteristics of the patient population and NHS healthcare trusts**

We identified 212 cases of bacterial meningitis or meningococcal septicemia admitted to the 18 acute NHS healthcare trusts (median beds 600, IQR 375–650). The NHS trusts included five university teaching hospitals (30% of all cases). The median number of cases enrolled per hospital was 13 (range 7–14). All the study hospitals had an intensive care unit (ICU) and 28% (5/18) had an infectious disease unit. Medical records were not available for five cases. Seventeen cases met study exclusion criteria (see Methods), leaving 190 for analysis (Table 1). All the medical records reviewed had been coded correctly, and no apparent alternative diagnoses were documented in any of the records. Of the 190 patients, 107 (56%) were recorded as having meningitis alone, 37 (20%) septicemia alone and 46 (24%) a combination of both.

**Clinical practice**

Multiple elements of the diagnostic and management process from first assessment, early management through to prevention of secondary cases did not meet the recommended clinical practice standards (Table 2). There was incomplete recording of clinical information across a range of parameters (Tables 2 and 3). Information recording was classified as good in 67% (128/190) of cases.

**Pre-hospital management**

Parenteral benzylpenicillin was recorded as given to 17 (20%) (95%CI 11–33) of 85 cases seen
by a GP. Where bacterial meningitis or meningococcal septicaemia were diagnosed, benzylpenicillin was recorded as given to 84% (Table 2).

First assessment in secondary care

One hundred and fifteen cases (60%) were initially assessed in emergency departments; the remainder were admitted directly to medical assessment units or other wards. The time to medical assessment, appropriate diagnosis and prompt administration of parenteral antibiotics varied considerably (Table 2). For example, the IQRs for the time from arrival to first assessment and the time from arrival to IV antibiotics were 15 min to 1 h 50 min, and 15 min to 3 h, respectively.

Severity of illness assessment

Although 81% of cases underwent some form of severity assessment (Table 2), only 27%, (43/162) underwent a full severity assessment. Overall, the IQRs for time to assessment by an ICU team were highly variable (35 min to 8 h 30 min) but varied less where bacterial meningitis or meningococcal septicaemia had been diagnosed initially (35 min to 2 h 35 min).

Lumbar puncture and CT brain scan

A lumbar puncture (LP) was done in 65% (120/185; 95%CI 54–75) of patients overall and in 79% (117/149; 95%CI 70–85) of patients with bacterial meningitis, with or without septicaemia, while of patients with meningitis alone, 11 (10%) did not undergo LP.

Of the 35 cases where all the relevant information was available, 14 underwent LP in the presence of either papilloedema, GCS <10, and/or focal neurology. Where the information was available (n = 126), 81 cases (65%, 95%CI 55–82) underwent CT brain scan before LP. As the exact time of CT was not generally recorded, it was not possible to assess whether CT contributed to the delay in administration of antibiotics.

Treatment, notification and antibiotic prophylaxis

In the 179 cases where the antibiotic administered was recorded, cefotaxime or ceftriaxone were the most common first-choice parenteral antibiotics (117, 65%), followed by a combination of benzylpenicillin and cefotaxime (44, 25%). None of the four cases with a recent history of travel to high-prevalence antibiotic-resistant countries, including Spain and the US, was prescribed vancomycin. Notification of the consultant for communicable disease control (CCDC, the physician responsible for surveillance, prevention and control of communicable disease in the community) was recorded in 64 cases (Table 2). Fifty-eight cases received rifampicin, and an additional 23 received ceftriaxone as part of treatment alone: overall, 76% (95%CI 62–87%) of meningococcal meningitis or meningococcal septicaemia cases (n = 106) received recommended antibiotics to eradicate carriage before discharge.17

Variation in clinical practice between hospitals

Figure 2 illustrates the variation in clinical practice between hospitals in four key areas. This variation was most marked with respect to ‘review by a consultant within 12 h of arrival’ (p < 0.0005).

Outcomes

The median length of stay in hospital was 10 days (IQR 7–16 days). The overall mortality was 11% (95%CI 7–17). Mortality was highest (38%) among individuals aged ≥75 years, vs. 9% for those aged 16–74 years. Of the 190 patients, 34% had long-term sequelae at discharge: hearing

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### Table 1 Characteristics of patients and diagnosis

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Unweighted</th>
<th>Weighteda</th>
</tr>
</thead>
<tbody>
<tr>
<td>16–24</td>
<td>71 (37%)</td>
<td>69 (37%)</td>
</tr>
<tr>
<td>25–64</td>
<td>87 (46%)</td>
<td>87 (46%)</td>
</tr>
<tr>
<td>65+</td>
<td>32 (17%)</td>
<td>34 (18%)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>94 (49%)</td>
<td>98 (52%)</td>
</tr>
<tr>
<td>Male</td>
<td>96 (51%)</td>
<td>92 (48%)</td>
</tr>
<tr>
<td>Co-morbidityb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>165 (87%)</td>
<td>164 (86%)</td>
</tr>
<tr>
<td>Yes</td>
<td>25 (13%)</td>
<td>26 (14%)</td>
</tr>
</tbody>
</table>

**N. meningitidis**

- Serogroup B       | 26 | 30 |
- Serogroup C       | 9  | 9  |
- Serogroup Y       | 0  | 0  |
- Serogroup not recorded | 25 | 24 |
- Total             | 60 (32%) | 63 (33%) |

**S. pneumoniae**

- 25 (13%) | 27 (14%) |
- Other     | 3 (2%)   | 3 (1%)   |
- Clinical diagnosis alonec | 102 (54%) | 98 (52%) |
- Total     | 190      | 190      |

Data are numbers (percentages). aSee methods. bChronic heart, lung, kidney or liver disease cFifteen patients (14%) with meningitis alone did not have a laboratory-confirmed diagnosis, the rest of 102 cases (87) where had a clinical diagnosis of septicaemia.
impairment ($n=30$), other neurological impairment ($n=34$), severe scarring or plastic surgery ($n=8$), loss of digits or limbs ($n=6$) and other sequelae such as renal failure, behavioural change, chronic arthritis or peripheral ischaemia ($n=16$).

**Discussion**

This is the first national study to evaluate the quality of care in adults with acute bacterial meningitis and meningococcal septicaemia. Previous studies have focused on children or have described the epidemiology and clinical characteristics but have not focused on the process of care.$^{17–19}$ These serious infections are not common in adults, yet in many countries including the UK, they have a high public profile and cause devastating effects in otherwise healthy people.

We found that recommended standards were not widely achieved in a number of key areas throughout the diagnostic and management process. These included prompt assessment and initiation of treatment, adequate disease severity assessment and timely prevention of secondary cases. The UK General Medical Council (GMC) states that clear, accurate and contemporaneous patient record can improve doctors’ clinical performance and patient outcomes.$^{20}$ Our data highlight the view that

### Table 2  Standards of clinical practice

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not recorded</th>
<th>Total</th>
<th>%Yes (95%CI)$^b$</th>
<th>Median (IQR) time to the specified event</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(a) Primary care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seen by GP</td>
<td>85</td>
<td>79</td>
<td>26</td>
<td>190</td>
<td>52% (41–62%)</td>
<td></td>
</tr>
<tr>
<td>If seen by GP, penicillin given</td>
<td>17</td>
<td>3</td>
<td>65</td>
<td>85</td>
<td>85% (57–96%)</td>
<td></td>
</tr>
<tr>
<td>If seen by GP, diagnosis suspected</td>
<td>20</td>
<td>27</td>
<td>38</td>
<td>85</td>
<td>43% (28–58%)</td>
<td></td>
</tr>
<tr>
<td>If seen by GP and diagnosis suspected, penicillin given</td>
<td>16</td>
<td>3</td>
<td>1</td>
<td>20</td>
<td>84% (56–96%)</td>
<td></td>
</tr>
<tr>
<td><strong>(b) Secondary care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis and initial management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First medical assessment within 1 h of arrival</td>
<td>60</td>
<td>42</td>
<td>88</td>
<td>190</td>
<td>59% (45–71%)</td>
<td>45 min (15 min, 1 h 50 min) ($n=102$)</td>
</tr>
<tr>
<td>Diagnosis of meningitis within 1 h of arrival</td>
<td>46</td>
<td>36</td>
<td>108</td>
<td>190</td>
<td>56% (43–68%)</td>
<td>55 min (15 min, 1 h 50 min) ($n=82$)</td>
</tr>
<tr>
<td>IV antibiotics within 1h of arrival</td>
<td>55</td>
<td>43</td>
<td>92</td>
<td>190</td>
<td>56% (45–66%)</td>
<td>55 min (15 min, 3 h) ($n=98$)</td>
</tr>
<tr>
<td>Assessment of severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reviewed by critical care team within 6 h of arrival (if severely ill)</td>
<td>15</td>
<td>5</td>
<td>28</td>
<td>48</td>
<td>75% (45–92%)</td>
<td>1 h 30 min (35 min, 2 h 35 min) ($n=17$)</td>
</tr>
<tr>
<td>Reviewed by a consultant within 12 h of arrival</td>
<td>29</td>
<td>34</td>
<td>127</td>
<td>190</td>
<td>46% (27–67%)</td>
<td>12 h 30 min (3 h 20 min, 22 h) ($n=59$)</td>
</tr>
<tr>
<td>Fully or partially assessed for severity of illness</td>
<td>131</td>
<td>31</td>
<td>28</td>
<td>190</td>
<td>81% (74–87%)</td>
<td></td>
</tr>
<tr>
<td>If bacterial meningitis (without septicaemia)</td>
<td>61</td>
<td>18</td>
<td>0</td>
<td>79</td>
<td>77% (64–87%)</td>
<td></td>
</tr>
<tr>
<td>If meningococcal septicaemia</td>
<td>70</td>
<td>13</td>
<td>0</td>
<td>83</td>
<td>84% (71–92%)</td>
<td></td>
</tr>
<tr>
<td>Notification and prophylaxis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index case received rifampicin</td>
<td>58</td>
<td>51</td>
<td>81</td>
<td>190</td>
<td>53% (37–69%)</td>
<td></td>
</tr>
<tr>
<td>Reported to public health the same or following day</td>
<td>64</td>
<td>10</td>
<td>116</td>
<td>190</td>
<td>86% (76–93%)</td>
<td></td>
</tr>
<tr>
<td>(c) Follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up review (survivors only)</td>
<td>100</td>
<td>42</td>
<td>27</td>
<td>169</td>
<td>70% (58–81%)</td>
<td></td>
</tr>
<tr>
<td>Hearing test (during or after hospital stay) (survivors only)</td>
<td>29</td>
<td>96</td>
<td>44</td>
<td>169</td>
<td>23% (16–32%)</td>
<td></td>
</tr>
</tbody>
</table>

Data are numbers unless otherwise indicated. $^a$For all cases seen by a GP; see text. $^b$Of cases with recorded information.
Table 3  Recording of clinical features, vital signs and investigations

<table>
<thead>
<tr>
<th></th>
<th>Recorded (n or present/absent)</th>
<th>Not recorded</th>
<th>Of all cases, % with recorded information (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) At first assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical features</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck stiffness</td>
<td>103/47</td>
<td>40</td>
<td>79% (70–86%)</td>
</tr>
<tr>
<td>Neurological examination</td>
<td>123/11</td>
<td>56</td>
<td>71% (62–78%)</td>
</tr>
<tr>
<td>Fundus examination</td>
<td>104/12</td>
<td>74</td>
<td>61% (57–70%)</td>
</tr>
<tr>
<td>Rash</td>
<td>91/82</td>
<td>17</td>
<td>91% (86–95%)</td>
</tr>
<tr>
<td>Vital signs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consciousness level (GCS)</td>
<td>143/21</td>
<td>47</td>
<td>75% (67–82%)</td>
</tr>
<tr>
<td>Pulse</td>
<td>174/16</td>
<td>16</td>
<td>92% (86–95%)</td>
</tr>
<tr>
<td>Temperature</td>
<td>159/31</td>
<td>31</td>
<td>84% (77–88%)</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>177/13</td>
<td>13</td>
<td>93% (88–96%)</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>88/96</td>
<td>102</td>
<td>46% (34–59%)</td>
</tr>
<tr>
<td>Capillary refill time</td>
<td>5/185</td>
<td>185</td>
<td>3% (1–7%)</td>
</tr>
<tr>
<td>(b) Microbiological investigations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood culture</td>
<td>150/3</td>
<td>37</td>
<td>81% (74–86%)</td>
</tr>
<tr>
<td>Throat swab</td>
<td>56/71</td>
<td>63</td>
<td>67% (58–75%)</td>
</tr>
<tr>
<td>Lumbar puncture</td>
<td>120/65</td>
<td>5</td>
<td>97% (94–99%)</td>
</tr>
</tbody>
</table>

Data include both meningitis and meningococcal septicaemia cases.

even for life-threatening conditions, clinical records frequently do not contain essential information required for optimal patient management, potentially increasing the risk of error.\textsuperscript{21,22} The absence of a consistent approach to the management of conditions is reflected in considerable variation in the quality of care in relation to ‘best practice’. Although in most elements of management, this variation did not reach statistical significance, the magnitude of the differences emphasizes that there are opportunities for improving the management process.\textsuperscript{23}

A differential diagnosis of bacterial meningitis or meningococcal septicaemia was recorded in fewer than half of those seen by a GP, and as reported previously,\textsuperscript{24,25} parenteral antibiotics were recorded as given to only 20% of these patients. The value of giving parenteral antibiotics to patients with suspected bacterial meningitis or meningococcal septicaemia has been difficult to substantiate, due to several confounding factors, but nonetheless remains the advice of the UK Chief Medical Officer.\textsuperscript{26,27} It can be difficult to make a diagnosis in primary care, as the early clinical features of bacterial meningitis or meningococcal septicaemia are often non-specific and a high index of suspicion is needed.\textsuperscript{1} Also, general practitioners place less importance on making a definitive diagnosis than discriminating between self-limiting and potentially serious illnesses.\textsuperscript{28,29}

Figure 2. Variations in medical practice between hospitals. In ascending order of cases per hospitals (from 4 to 16 cases). If all outcomes unknown for a hospital, no bar is shown.
Once a patient reaches hospital, early recognition is essential to guide appropriate intervention. Only about 60% of patients with bacterial meningitis or meningococcal septicaemia were assessed within 1 h of arrival in hospital, and a quarter did not have an appropriate differential diagnosis. Over 40% of cases did not receive antibiotics within 1 h of arrival in hospital. We did not specifically assess the reasons for this delay but, when an early diagnosis had been made, initiation of antibiotic treatment was more likely. This highlights the need for early recognition of these conditions. In hospital care, stabilization and institution of specific therapeutic measures are crucial to patient management, as patients with bacterial meningitis or meningococcal septicaemia may appear relatively well at presentation, but deteriorate rapidly without warning. Our data suggest that prompt appropriate assessment and a heightened diagnostic awareness in adult clinical practice should be emphasized to encourage early and appropriate treatment.

In our study, a full severity assessment was carried out in only 27% of patients. Only half of the patients were reviewed by a supervising consultant within 12 h, with substantial variations between hospitals. A severity assessment should be made in any patient with suspected bacterial meningitis or meningococcal septicaemia, documenting warning signs of shock, respiratory compromise or raised intracranial pressure. Depending on whether meningococcal septicaemia or bacterial meningitis predominates, the clinical management problems may differ considerably. Such decisions require early senior input and involvement of the critical care team. The standard of care received by acutely ill medical in-patients in the UK, US and elsewhere has previously been shown to be sub-optimal. The variation in management observed between hospitals probably indicates a lack of appropriate clinical training and supervision. For example, we found that lumbar puncture was still undertaken in the presence of specific contraindications. Despite an emerging consensus that brain CT does not rule out raised intracranial pressure, CT was still undertaken in 65% of cases. These findings are in line with a recent UK study showing that reported clinical practice in the investigation and management of meningitis by secondary care clinicians does not follow current published guidance.

Nearly 90% of cases were notified promptly to public health authorities for contact tracing, but a significant proportion did not receive a course of antibiotics to eradicate carriage. National guidance in the UK and elsewhere recommends that antibiotic prophylaxis should be initiated in all probable cases of meningococcal meningitis or septicaemia. This is important, as the patient may otherwise pose a continuing risk to close contacts after discharge from hospital. Penicillin is not effective at eradicating carriage.

Our data has a number of strengths and limitations. The study was a randomized sample drawn from all over the country. Medical records, emergency department records and nursing notes were reviewed on-site, there were few missing files, and data extraction was done by one individual. The age and gender distributions of cases in our study were similar to those in national surveillance data (data not shown). A nationally representative prospective study was not feasible, and therefore our findings were limited by the quality of medical note keeping and the retrospective acquisition of data. For example, our ability to assess disease severity was restricted, as was our ability to accurately determine the timing of some medical interventions. However, our observational design allowed for the assessment of patient care likely to reflect real-world medicine, rather than the artificial world of data collected in a prospective research setting.

Efforts to address the quality of care should focus on record keeping, prompt diagnosis, initiation of treatment and assessment of disease severity (Box 1). Improvements in the process of care will be achieved through a multifaceted approach involving close collaboration between those working in acute medicine, infection specialties (microbiology and infectious diseases) and critical care, together with the introduction of intensive care unit (ICU) outreach services. Consensus guidelines should be made readily available and be simple, practical and useful in a range of clinical situations. Such guidelines are evidence-based wherever possible, but further efforts to systematically assess the effectiveness of critical care assessments and interventions are required. Junior doctors form the front line of the clinical management process. The educational curriculum for all newly-qualified doctors in the UK, for example, includes the management of 'severe sepsis' and 'meningism'. Our data suggest that there should be an even greater emphasis on training in the diagnosis and management of severe infection. Experience in paediatric meningitis and adult pneumonia suggests that clinical behaviour change is possible. Data from epidemiology show that these conditions continue to cause considerable morbidity and mortality amongst adults, and there probably is a potentially greater burden than indicated by routine
surveillance.12,46 This study provides insights that will facilitate improvement in the quality of care and outcome of adults with life-threatening infections, both in the UK and in hospital settings worldwide.47

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References


