# Prognostic scores for use in African meningococcal epidemics*

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*Current WHO guidelines for the case management of meningococcal infections during epidemics in developing countries often cannot be applied, largely because of the limited health resources in such countries. Several scoring scales based on clinical and laboratory features in numerous combinations have been developed for the management of meningococcal infections in developed countries, and these have facilitated early identification of patients with fulminant disease and thus early intervention and reduction in mortality. Unfortunately such scoring scales are not appropriate for use in developing countries. We identified hypotension, tachycardia, tachypnoea, delay in capillary refill time, coma, absence of neck stiffness and petechiae and/or purpura as simple prognostic factors of meningococcal disease. Two scores were developed: score I, which includes all seven prognostic factors, had a sensitivity and specificity of 80% and 94%, respectively. Score II, which excluded hypotension, had a sensitivity and specificity of 73.3% and 89.7%, respectively. Quick and simple scoring scales are therefore not only applicable but useful for the case management of patients in meningococcal epidemics in developing countries.*

## Introduction

Meningococcal infections are endemic in the northern savanna region of tropical Africa, and approximately every 10 years severe epidemics occur (*1–4*). This area is traditionally called the meningitis belt of Africa and extends from the Gambia, in the west, to Ethiopia, in the east. It is characterized by annual rainfall of 300–1100 mm. Epidemics occur at the start of the long, dusty dry season, which is associated with very low humidity, and end abruptly at onset of the rains.

Meningococcal case fatality rates (CFRs) are variable during African epidemics, ranging from as low as 8.3%, when there is a high level of community awareness, early diagnosis and treatment with antibiotics, to as high as 100%, when no treatment is given (*5, 6*).

Despite relatively low CFRs, large numbers of people die because of the high meningococcal attack rates in Africa. Several prognostic scoring scales for meningococcal disease have been devised in developed countries from various combinations of clinical and laboratory prognostic factors such as hypotension, absence of cerebrospinal fluid pleocytosis, leukopenia, hyperthermia, thrombocytopenia, purpura, petechiae, coagulopathy, stupor or coma, myocardial dysfunction (by echocardiography), acidosis, hyperkalaemia, absence of neck stiffness, delay in capillary refill time, and a skin/rectal temperature difference >3 °C (*7–10*). The consequent early detection and management of patients with severe disease have led to a reduction in mortality. Such scoring scale combinations require settings with highly trained personnel and advanced technology and thus are inappropriate for use in the management of patients in African epidemics, where health resources are limited and attack rates high.

## Materials and methods

The study was carried out in the Infectious Disease Hospital, Kano, Nigeria, from 29 February to 25 April 1996. A total of 132 patients were randomly selected during this period and their clinical symptoms and signs on presentation recorded.

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### Case definition

For the analysis we defined a case of meningitis as a patient who presented with fever and a stiff neck (with or without headache), seizures, a bulging anterior fontanelle, and vomiting. A case of meningococcal septicaemia was defined as a patient with fever and petechiae and/or purpura (with or without headache), myalgia, lethargy, and a toxic appearance. Meningitis with meningococcal septicaemia was defined as a case presenting with fever, a stiff neck and petechiae and/or purpura (*11*).

Level of consciousness was assessed using the modified paediatric coma score (*12*) or the Glasgow coma scale where applicable; and hypotension was defined as a systolic blood pressure (BP) ≤75 mmHg (≤10 kPa) in a child aged <4 years or ≤85 mmHg (≤11.3 kPa) in a child aged ≥4 years. Tachycardia was defined as a pulse rate ≥140 per minute or a feeble pulse, and tachypnoea as a respiratory rate ≥50 per minute or an irregular rate. A delay in a capillary refill of more than 3 sec was significant, and hyperpyrexia was defined as a temperature ≥40 °C. Lumbar punctures were not performed routinely during the epidemic, but 216 cerebrospinal fluid samples were analysed to confirm the *Neisseria meningitidis* serotype A.

### Treatment

Patients with meningitis were given an immediate dose of intramuscular oily chloramphenicol (dose according to age), which was repeated after 48 hours if symptoms did not subside. Patients below 3 months of age, pregnant women, and patients with septicaemia were given intravenous ampicillin (200 mg/kg) or intravenous crystalline pencillin (400 000 IU/kg) in four divided doses for 4 days. Any patient in shock received rapid intravenous infusions of Ringer's lactate. Intravenous or intramuscular diazepam was given for seizures; intravenous frusemide for pulmonary oedema; and intramuscular sodium metamizale and paracetamol as an analgesic and antipyretic, respectively. Dexamethasone was given to some patients with meningitis prior to receiving antibiotics in order to reduce the incidence of deafness.

### Statistical methods

Categorical variables were compared using $\chi^2$ tests or Fisher's exact tests, as appropriate, and the sensitivity and specificity of the prognostic scores were calculated using Epi Info version 6 software. The free and informed verbal consent was obtained from the parent or guardian of each patient enrolled in the study.

## Results

During the study period over 6000 patients were seen and 3032 were admitted to the Infectious Disease Hospital, Kano. The overall admission CFR was 7.8% and the male: female ratio was 1.94:1 (male: female ratio of the Kano population, 1.17:1) (*13*). The predominant age group was 6–15 years, which accounted for 50% of all cases. The age of the 132 cases analysed ranged from 3 months to 60 years, with the mean age being 9.25 years. A total of 69 were males and 63 females. The overall mortality rate was 11.36% (15 deaths). Of these deaths, 9 individuals (60%) died within 2 hours of admission, 12

Table 1: **Presenting clinical features of survivors and nonsurvivors with meningococcal disease**

| Variable | Survivor ($n$ = 117) | Nonsurvivor ($n$ = 15) | $P$-value | Odds ratio | Risk ratio |
|---|---|---|---|---|---|
| Fever | 117 | 15 | — | — | — |
| Headache | 90 | 9 | >0.1 | 0.2 (0.02–0.5)[a] | 0.8 (0.55–1)[a] |
| No neck stiffness | 21 | 11 | <0.001 | 12.4 (3.2–52.7) | 3.1 (1.3–7.1) |
| Petechiae | 34 | 13 | <0.001 | 15.9 (4.6–55.0) | 2.9 (1.8–4.7) |
| Vomiting | 71 | 9 | 0.81 | 0.7 (0.3–0.9) | 0.8 (0.3–0.9) |
| Diarrhoea | 6 | 5 | 0.001 | 9.2 (3–28) | 6.5 (2.5–17) |
| Seizures | 43 | 9 | 0.14 | 2.6 (2.5–7.5) | 1.6 (1–2.8) |
| Hyperpyrexia ≥ 40 °C | 7 | 5 | 0.004 | 9.4 (1.2–73) | 3.4 (1.1–10) |
| Hypotension | 8 | 11 | <0.001 | 37.5 (12–111) | 12.7 (5.9–27) |
| Tachycardia/feeble | 17 | 13 | 0 | 37.9 (7.0–272) | 6.4 (1.7–23) |
| Tachypnoea/irregular | 31 | 12 | <0.001 | 18.6 (3.6–129) | 5.5 (1.5–20) |
| CRT[b] > 3 sec | 9 | 10 | <0.001 | 15.9 (4.0–65.8) | 2.3 (1.2–4) |
| Coma < 8 | 21 | 13 | <0.001 | 29.4 (5.5–208) | 6.1 (1.7–22) |
| Pulmonary crepitations | 0 | 6 | <0.001 | — | — |

[a] Figures in parentheses are the 95% confidence interval.
[b] Capillary refill time.

Table 2: **Prognostic scoring scales for use in meningococcal epidemics in Africa**

| Variable | Score I | Score II |
|---|---|---|
| Hypotension[a] | 3 | — |
| Tachycardia[b] | 1 | 1 |
| Tachypnoea[c] | 1 | 1 |
| CRT[d] > 3 sec | 1 | 1 |
| Coma score < 8[e] | 3 | 3 |
| No neck stiffness | 2 | 2 |
| Petechiae/purpura | 1 | 1 |
| Total | 12 | 9 |

[a] Hypotension: systolic BP ≤ 10 kPa (≤75 mmHg) if below 4 years of age; ≤11.3 kPa (≤85 mmHg) if ≥4 years of age.
[b] Defined as ≥140 beats/min and/or feeble.
[c] Defined as ≥50 breaths/min and/or irregular.
[d] Capillary refill time.
[e] Modified paediatric coma scale (see ref. *12*).

(80%) within 6 hours and 14 (93.3%) within 8 hours. Six of the patients who died had pulmonary oedema, five of them at presentation (prior to treatment with crystalloid volume expanders). There were 85 cases of meningitis (CFR, 2.35%), 32 cases of septicaemia (CFR, 34.3%), and 15 cases of meningitis + septicaemia (CFR, 13.3%).

Hypotension, tachycardia, tachypnoea, coma, absence of neck stiffness, petechiae or purpura and a delay in capillary refill were selected as simple and quick clinical predictors of mortality (Table 1). Two scoring scales were developed, as shown in Table 2. On the score I scale, which included all seven variables, a score ≥9 out of 12 indicated a fatal outcome (sensitivity, 80%; specificity, 94%). On the score II scale, where hypotension was not included, a score ≥6 out of 9 indicated a fatal outcome (sensitivity, 73.3%; specificity, 89.7%).

## Discussion

The pattern of meningococcal infections in African epidemics is similar to that in developed countries, where meningitis is by far the commonest presentation and where the mortality is very much lower than the 2.35% reported in the present study (*7*). Septicaemia contributes largely to the overall CFRs in meningococcal infections and in the present study the CFR for septicaemia was 34.3%. In Zaria, Nigeria, Lewis reported a similar CFR (43%) in 1977 (*14*).

The aim of this study was to design a prognostic scoring scale that would be appropriate for patient case management under epidemic situations in developing countries. For this purpose, two scoring scales were developed using seven simple clinical prognostic features. Score I incorporated all seven clinical features (hypotension, tachycardia, tachypnoea, delay in capillary refill time, coma, absence of neck stiffness, and petechiae or purpura). The clinical features of meningococcal infections can readily be characterized even when blood pressure measurements cannot be made because of the lack of sphygmomanometers or of adequately trained personnel or because of a high patient load. The score for the other six variables in score II compares well with score I. This is probably because tachycardia, tachypnoea, and a delay in capillary refill time are signs of shock and are excellent proxies for hypotension.

Although score II is less sensitive and specific than score I, it may be more useful in African epidemics, where limited resources are available. It is hoped that this score can be simplified even further for health workers by using a simpler coma score, such as the Blantyre coma score employed in cerebral malaria if this proves to be applicable to meningococcal infections (*15*).

Finally, we believe that the simple scoring scales which we have described in this article will become useful tools for planning and organizing the case management of meningococcal infections during epidemics in developing countries. It should be noted that no measuring instruments are required to obtain the data for the score II scale. Such scoring scales may ultimately help in further reducing the mortality rate in hospitals and treatment camps during meningococcal epidemics.

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## Résumé

### Scores pronostiques dans les épidémies de méningococcies en Afrique

Les épidémies de méningococcies sont fréquentes dans la ceinture de la méningite de l'Afrique subsaharienne, et bien que les taux de létalité parmi les cas hospitalisés soient comparables à ceux des pays développés, les taux d'atteinte très élevés dans cette région entraînent un grand nombre de décès. Dans la présente étude, le taux de létalité parmi les 3032 cas admis à l'Infectious Disease Hospital de Kano (Nigéria) était de 7,8% (238

décès). Le sex-ratio était de 1,94:1 et 50% des malades étaient âgés de 6 à 15 ans. Un échantillon de 132 cas a été constitué par tirage au sort et étudié. A l'examen clinique, on dénombrait 85 cas de méningite, 32 cas de septicémie et 15 cas de méningite associée à une septicémie. Les taux de létalité étaient respectivement de 2,35%, 34,40% et 13,30% pour ces trois groupes. Le taux global de mortalité était de 11,4% (15 décès).

Les critères cliniques suivants: hypotension, tachycardie, tachypnée, retard du remplissage des capillaires, coma, absence de raideur de la nuque, pétéchies et/ou purpura, ont été retenus pour leur identification simple et rapide en tant que facteurs prédictifs de la mortalité et ont été associés à une note de 3, 1, 1, 1, 3, 2 et 1 respectivement. A partir de ces notes nous avons élaboré deux échelles de cotation. La première inclut les 7 paramètres cliniques et un score >8 sur 12 avait une sensibilité de 80% et une spécificité de 94%. La deuxième inclut tous les paramètres sauf l'hypotension et un score >5 sur 9 avait une sensibilité de 73,3% et une spécificité de 89,7%. Ces deux échelles ont été conçues pour les épidémies de méningococcies dans les pays en développement où les ressources sanitaires sont limitées. L'échelle II en particulier ne nécessite aucun appareillage, un avantage manifeste en situation d'épidémie et là où le manque de personnel qualifié rend problématique une simple mesure de la tension artérielle. Nous estimons que ces deux échelles aideront à améliorer la prise en charge des malades pendant les épidémies de méningococcies dans les pays en développement, notamment en Afrique.

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