An evaluation of clinical indicators for severe paediatric illness

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To help reduce paediatric morbidity and mortality in the developing world, WHO has developed a diagnostic and treatment algorithm that targets the principal causes of death in children, which include acute respiratory infection, malaria, measles, diarrhoeal disease, and malnutrition. With this algorithm, known as the Sick Child Charts, severely ill children are rapidly identified, through the presence of any one of 13 signs indicative of severe illness, and referred for more intensive health care. These signs are the inability to drink, abnormal mental status (abnormally sleepy), convulsions, wasting, oedema, chest wall retraction, stridor, abnormal skin turgor, repeated vomiting, stiff neck, tender swelling behind the ear, pallor of the conjunctiva, and corneal ulceration.

The usefulness of these signs, both in current clinical practice and within the optimized context of the Sick Child Chart algorithm in a rural district of western Kenya, was evaluated. We found that 27% of children seen in outpatient clinics had one or more of these signs and that pallor and chest wall retraction were the signs most likely to be associated with hospital admission (odds ratio (OR) = 8.6 and 5.3, respectively). Presentation with any of these signs led to a 3.2 times increased likelihood of admission, although 54% of hospitalized children had no such signs and 21% of children sent home from the outpatient clinic had at least one sign. Among inpatients, 58% of all children and 89% of children who died had been admitted with a sign. Abnormal mental status was the sign most highly associated with death (OR = 59.6), followed by poor skin turgor (OR = 5.6), pallor (OR = 4.3), repeated vomiting (OR = 3.6), chest wall retraction (OR = 2.7), and oedema (OR = 2.4). Overall, the mortality risk associated with having at least one sign was 6.5 times higher than that for children without any sign.

While these signs are useful in identifying a subset of children at high risk of death, their validation in other settings is needed. The training and supervision of health workers to identify severely ill children should continue to be given high priority because of the benefits, such as reduction of childhood mortality.

Introduction

The reduction of child mortality rates in developing countries, which are about 5–15 times higher than those in developed countries (*1–3*), is one of the greatest public health challenges faced by developing countries. In many countries attempts to achieve this goal are hampered by difficulties in access to health services that provide correct standard case management, or ignorance among families of the signs of severe disease in children or of the most appropriate place to go for treatment (*3*). At the international level, therefore, several organizations have sought to improve the quality of paediatric health care in developing countries by encouraging the use of standardized approaches to diagnosis and treatment. For some diseases, these recommendations have been simplified and promoted as algorithms.[a,b] These algorithms, which were designed to be used by clinical workers at first-level health facilities, encourage a standard approach to clinical diagnosis based on the duration and severity of the patient's symptoms and on the detection of simple signs by physical examination.

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[a] **World Health Organization.** *Technical bases for the WHO recommendations on the management of pneumonia at first-level health facilities.* Unpublished document WHO/ARI/91.20, 1991 (available upon request from Division of Child Health and Development, World Health Organization, 1211 Geneva 27, Switzerland).

[b] **World Health Organization.** *A manual for the treatment of diarrhoea.* Unpublished document WHO/CDD/SER/80.2 Rev. 2, 1990 (available upon request from Division of Child Health and Development, World Health Organization, 1211 Geneva 27, Switzerland).

Algorithms for management of single disease entities such as diarrhoea or acute respiratory infections have been successfully instituted in many countries (*4*).[c,d] However, children often suffer from multiple disease processes simultaneously, and the use of disease-specific algorithms may inadvertently make health care workers focus attention on only one disease (*5*, *6*). To overcome this problem WHO has recently developed a composite algorithm, known as the Sick Child Charts, to integrate previous algorithms aimed at the main causes of preventable paediatric morbidity and mortality in the developing world (*7*). These causes include acute respiratory infection, malaria, measles, diarrhoeal disease, malnutrition, and otitis media, which are estimated to cause 70% of deaths among children in the developing world.

This algorithm is organized so that severely ill children can be rapidly identified and managed. Children with any one of 13 clinical signs of severe illness are to be given initial therapy and referred for more intensive health care. These signs were taken from disease-specific algorithms and were combined by WHO with the aid of expert clinical opinion.[e] The signs are presumed to identify children at high risk of death or serious disability and include the inability to drink, abnormal mental status (defined as being abnormally sleepy or difficult to rouse), convulsions (from the carer's history), evidence of malnutrition (wasting, oedema), respiratory distress (chest wall retraction, stridor), severe dehydration (abnormal skin turgor, repeated vomiting), meningitis (stiff neck), mastoiditis (tender swelling behind the ear), severe anaemia (pallor of the conjunctivae), and corneal ulceration or clouding.

The usefulness of this system to identify children with severe illness has not been assessed. As part of an evaluation of a preliminary version of the Sick Child Assess and Classify Chart, we examined the clinical utility of these 13 signs. We recorded the prevalence of the signs among children seen in outpatient clinics, assessed their current role in determining hospital admission, and determined the risk of in-hospital mortality associated with each sign.

Methods

Study site. The outpatient evaluation was conducted from August to December 1993 in four clinics in Siaya District, western Kenya, and in the paediatric outpatient department of Siaya District Hospital, which is the referral hospital for the district. The inpatient study was conducted from mid-June to mid-November 1993 in the inpatient ward of Siaya District Hospital. This inpatient service admits children from both its own outpatient department and other facilities in the district.

Study population and survey methods. The investigators selected prospective health workers with a minimum of secondary school education to be trained to identify the 13 signs of severity. The training, over a period of several weeks, involved classroom instruction with draft training materials from WHO and examination of hospitalized children under the tutelage of a CDC (U.S. Centers for Disease Control and Prevention)-employed paediatrician. Trained health workers examined every child aged 2–60 months seen at these sites during the study periods, and administered a questionnaire to the child's guardian. Information collected included the child's age and sex, symptoms during the current illness (including presence and duration of cough, fever, ear pain, diarrhoea, and rash), and the presence on physical examination of each of the 13 signs. Children admitted to the inpatient ward underwent a more extensive examination that included determination of haemoglobin concentration and inspection of Giemsa-stained thick blood smears to diagnose malaria.

Each child was independently examined by the staff physician or a paramedical clinical officer who had not been trained in the recognition of the signs of severity. The staff physician or a medical officer provided clinical care and made all the diagnoses and treatment decisions. The outcome for each outpatient (discharged, admitted, transferred, or absconded) and each hospitalized patient (discharged alive, died, transferred, absconded) was recorded.

Each sign of severe illness was evaluated as a predictor of hospitalization (outpatient portion of the study) and as a predictor of in-hospital death (inpatient portion), using both univariate and multivariate logistic regression analysis. Epi Info version 5 (*8*) and SAS® software (*9*) were used to analyse the data.

[c] **World Health Organization.** *Programme for the Control of Acute Respiratory Infections: fifth programme report 1990–1991.* Unpublished document WHO/ARI/94.33, 1994 (available upon request from Division of Child Health and Development, World Health Organization, 1211 Geneva 27, Switzerland).

[d] **World Health Organization.** *Programme for the Control of Diarrhoeal Diseases: ninth programme report 1992–1993.* Unpublished document WHO/CDD/94.46, 1994 (available upon request from Division of Child Health and Development, World Health Organization, 1211 Geneva 27, Switzerland).

[e] **World Health Organization.** *An integrated approach to management of childhood illness: Development and research priorities.* Unpublished document WHO/CDR/94.7, 1994 (available upon request from Division of Child Health and Development, World Health Organization, 1211 Geneva 27, Switzerland).

The protocol for this evaluation was approved by the Human Subjects Review Board of CDC and by the Kenya Medical Research Institute.

Results

Outpatient evaluation

Questionnaires were completed for 3013 children (49.4% female; median age, 13 months). The outcome for 214 children (7% of the total) was not known because the child absconded either before examination by the staff physician or medical officer or before the findings were recorded. The records of these children were excluded from further analysis after it had been verified that they did not differ from the remaining population in age, sex, or frequency of the 13 signs of severe illness.

The most frequently cited reasons for seeking care were fever (87%), cough (73%), and diarrhoea (38%). Repeated vomiting was the most frequently reported sign of severity, which was present in 13% of children evaluated (Table 1). Overall, 28% of children in the outpatient department had at least one sign of severe illness. Of the 2799 children for whom complete information was available, 779 (28%) were referred for hospitalization. Children with any of the 13 signs had a 3.2 times higher odds of hospitalization than children without such signs (Table 1). However, among the 779 admitted, 424 (54%) had none of the 13 signs of severity. Of the 2020 children who were sent home from the outpatient department, 415 (21%) had at least one of the 13 signs of severe illness.

In univariate analyses, the signs among outpatients most highly associated with hospitalization included pallor (odds ratio (OR) = 8.6), abnormal mental status (OR = 7.9), chest wall retraction (OR = 5.3), oedema (OR = 3.8), and wasting (OR = 3.5)) (Table 1). In a multivariate logistic regression model, pallor remained the danger sign most highly associated with hospital admission (OR = 5.7), followed by chest wall retraction (OR = 4.4), oedema (OR = 3.1), convulsions (OR = 2.1), abnormal skin turgor (OR = 1.7), and repeated vomiting (OR = 1.6). Inability to drink, abnormal mental status, and wasting were not associated with hospitalization in the multivariate model.

Inpatient evaluation

Forms were completed for 1262 children (48.4% female; median age, 11 months) who were admitted to the inpatient ward of Siaya District Hospital during the survey. Almost 10% of these children (123) absconded from the hospital after physical examination on admission. The prevalence of signs of severe illness was similar among the children who absconded and those who did not, with the following exceptions: absconders were more likely to have malnutrition (OR = 3.5, $P < 0.005$) or severe dehydration (OR = 1.9, $P < 0.05$), and were less likely to have had convulsions (OR = 0.36, $P < 0.05$) than non-absconders.

Table 1: **Likelihood of referral for hospitalization from the outpatient clinics in Siaya District, by 13 physical signs of severe illness**

Sign	No. among outpatients (n = 2799)	No. among hospitalized children (n = 779)	Odds ratio (95% CI)
Pallor	112 (4)[a]	84 (11)	8.6; *5.5–13.6*[b]
Abnormal mental status	12 (0.4)	9 (1)	7.9; *2.0–36.6*
Chest wall retraction	166 (6)	107 (14)	5.3; *3.8–7.5*
Oedema	44 (2)	26 (3)	3.8; *2.0–7.4*
Wasting	55 (2)	31 (4)	3.5; *2.0–6.1*
Inability to drink	55 (2)	30 (4)	3.2; *1.8–5.7*
Abnormal skin turgor	163 (6)	82 (11)	2.8; *2.0–3.9*
Convulsions	128 (5)	61 (8)	2.5; *1.7–3.6*
Repeated vomiting	358 (13)	140 (18)	1.8; *1.4–2.3*
Stiff neck	0	0	—
Stridor	0	0	—
Corneal ulceration	0	0	—
Tender swelling behind the ear	0	0	—
Any of the 13 signs	770 (28)	355 (46)	3.2; *2.7–3.9*

[a] Figures in parentheses are percentages.
[b] Figures in italics are the 95% confidence intervals.

Table 2: **Risk of death during hospitalization among inpatients in Siaya District Hospital, by 13 physical signs of severe illness**

Sign	No. among hospital inpatients (n = 1139)	No. among children who died (n = 75)	Odds ratio (95% CI)
Abnormal mental status	9 (1)[a]	6 (8)	30.8; *6.7–159*[b]
Inability to drink	25 (2)	15 (20)	23.9; *9.9–58.7*
Repeated vomiting	22 (2)	9 (12)	11.0; *4.2–12.1*
Wasting	23 (2)	6 (8)	5.4; *1.8–15.0*
Abnormal skin turgor	119 (10)	25 (33)	5.2; *3.0–9.0*
Pallor	297 (26)	42 (56)	4.0; *2.4–6.7*
Chest wall retraction	252 (22)	34 (45)	2.9; *1.9–28.8*
Oedema	65 (6)	9 (12)	2.5; *1.1–5.4*
Convulsions	136 (12)	7 (9)	0.8; *0.3–1.7*
Stiff neck	2 (0.02)	1 (1)	—[c]
Stridor	1 (0.001)	0	—[c]
Corneal ulceration	6 (0.05)	1 (1)	—[c]
Tender swelling behind the ear	2 (0.02)	1 (1)	—[c]
Any of the 13 signs	666 (58)	67 (89)	6.5; *3.0–14.8*

[a] Figures in parentheses are percentages.
[b] Figures in italics are the 95% confidence intervals.
[c] Odds ratio invalid.

After excluding the 123 absconders, the records of 1139 children were analysed.

Among hospitalized children, fever was the commonest complaint (94%), followed by cough (81%) and diarrhoea (43%). Pallor was the most frequently identified sign of severe illness, followed by chest wall retraction and convulsions (Table 2). Of the 1139 hospitalized children, 666 (58%) presented with at least one sign and 75 died (7%), 67 (89%) of whom had at least one of the 13 signs at the time of admission. Common symptoms and signs identified in children who died included pallor (56%), chest wall retraction (45%) and abnormal skin turgor (33%). In the univariate analysis, abnormal mental status (OR = 30.8) and inability to drink (OR = 23.9) carried the highest risk of death, although only 27 children (2.4%) were admitted with these signs. There was no increased risk associated with a history of convulsions. In the final multiple logistic regression model, with adjustments for confounding among the signs of severity, abnormal mental status remained the sign most highly associated with death (OR = 59.6), followed by poor skin turgor (OR = 5.6), pallor (OR = 4.3), repeated vomiting (OR = 3.6), chest wall retraction (OR = 2.7), and oedema (OR = 2.4). Too few children presented with stridor, stiff neck, mastoiditis, or corneal clouding to draw any conclusions about their associated mortality risks. Overall, the risk of dying while hospitalized was 6.5 times greater for children with at least one sign of severe illness, compared with children without any such sign.

Eight children, 11% of those who died, had none of the signs of severity. We reviewed again their admission records for symptoms, signs, and laboratory examinations not incorporated in the Sick Child Charts and were unable to find any sign or combination of signs that reliably distinguished them from children who did not die. Their only common symptom was fever, which was present in over 90% of hospitalized children.

Discussion

During their clinical training, health workers learn about signs and symptoms that suggest serious, potentially life-threatening disease which, especially in children, may require immediate and intensive care. WHO's Sick Child Charts have incorporated these clinical signs into a functional algorithm for use at first-level health facilities in developing countries. Our study shows that the system used in these charts to identify severely ill children did identify those at high risk of death in hospital. We also observed that, within the context of current clinical practice in a rural district of Kenya, children presenting with one or more of these signs were more likely to be referred for inpatient care than children who did not have them. However, current practice did not result in the referral and hospitalization of all children with one or more signs of severe illness, nor did all the referred children have these signs.

The risk of death during hospitalization was more than six times higher among children admitted with at least one sign of severe illness than those without such signs. Among non-absconding children, the four signs most highly associated with death were inability to drink, abnormal mental status, repeated vomiting, and wasting. A history of convulsions was not associated with increased risk of death in this study; if further investigation shows that conditions causing convulsions can be managed without hospitalization, convulsions might be removed from the list of signs of severe illness.

As currently formulated, the signs of severity in the Sick Child Charts appear to be comprehensive. They identified 89% of children who subsequently died during hospitalization, and we were unable to detect any other clinical indicators that would have reliably identified the few children who died without any of the 13 signs of severity.

The Sick Child Charts algorithm therefore appears to be consistent with and probably improves current practice. From this evaluation we know that these signs were more commonly observed in children who were selected by the staff physician or clinical officer for hospitalization compared with children not admitted, which suggests that these signs are already being used. However, over half (424/779, 54%) of all children admitted from the outpatient clinic had none of the signs of severity, and 415 children with these signs were discharged from the clinic against 355 who were admitted (Table 1). Children admitted without signs of severe illness, but with the staff physician's or clinical officer's assessment that hospitalization was required, must be more carefully evaluated; if such children are not to be admitted, we need to be assured that they are not at risk of death or serious morbidity. Similarly, before recommending hospitalization for the large number of children who had signs of severe illness but were sent home from the outpatient department, we need to be sure that they required hospitalization to avert serious morbidity or death.

Because of higher hospitalization costs and limited health care resources, the implications of increased rates of admission of children with signs of severity must be examined. A simple evaluation of our data from western Kenya suggests that if all children with a sign of severe illness and no children without such signs were referred for inpatient care, 28% of all children attending outpatient departments would be admitted, the same proportion as under current practice. However, in view of the striking difference in mortality rates between children admitted with and without signs of severity (67/666 versus 8/473, Table 2), we expect that the adoption of this system would more than double the number of children at high risk of death who are admitted, at the same time halving the number of children at high risk who are discharged from the outpatient department.

Our evaluation of the system proposed in the Sick Child Charts to identify high-risk children in need of more intensive health care is encouraging. We were, however, unable to identify additional signs or symptoms from the inpatient component of our study that would have improved the recognition of additional children at risk. We are also encouraged by the fact that the proposed signs are currently being used, at least partially, in clinical practice to refer children for further care. Additional validation of the signs to identify children at risk of severe morbidity, death, and disability in other settings is needed. The current study highlights the importance of continuing to include the clinical judgment of health workers as part of this assessment of severity. In the current Sick Child Assess and Classify Chart, health workers are encouraged to refer "any sick children whose illness you cannot manage." The training and supervision of health workers in identifying severely ill children should continue to be given high priority because of its potential to reduce substantially childhood mortality.

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Résumé

Evaluation des indicateurs cliniques de maladies pédiatriques graves

Pour aider à réduire la morbidité et la mortalité chez l'enfant dans les pays en développement, l'Organisation mondiale de la Santé a établi un algorithme de diagnostic et de traitement axé sur les principales causes de décès chez l'enfant — infections respiratoires aiguës, paludisme, rougeole, maladies diarrhéiques et malnutrition. A l'aide de cet algorithme, (*Sick Child Charts*), les enfants gravement malades sont rapidement identifiés par la présence de l'un quelconque de 13 signes indicateurs, et sont orientés sur un établissement spécialisé pour y recevoir des soins plus intensifs. Les signes indicateurs sont: incapacité de boire, état mental

anormal (somnolence anormale ou inconscience), convulsions, émaciation, œdème, tirage respiratoire, stridor, sécheresse anormale de la peau, vomissements à répétition, raideur de la nuque, tuméfaction douloureuse derrière l'oreille, pâleur de la conjonctive, et ulcération cornéenne.

L'utilité de ces signes a été évaluée dans la pratique clinique actuelle et dans le contexte optimisé d'utilisation de l'algorithme dans un district rural de l'ouest du Kenya. Nous avons observé que 27% des enfants vus dans les services de consultations externes présentaient un ou plusieurs de ces signes et que la pâleur de la conjonctive et le tirage respiratoire étaient les signes les plus souvent associés à une hospitalisation (odds ratio (OR) = 8,6 et 5,3 respectivement). La présence de l'un quelconque de ces signes augmentait de 3,2 fois la probabilité d'hospitalisation, bien que 54% des enfants hospitalisés n'aient présenté aucun de ces signes et que 21% des enfants renvoyés chez eux après la consultation aient présenté au moins un signe. Parmi les cas hospitalisés, 58% de l'ensemble des enfants et 89% des enfants décédés présentaient un signe à l'hospitalisation. L'état mental anormal était le signe présentant la plus forte association avec le décès (OR = 59,6); venaient ensuite la sécheresse anormale de la peau (OR = 5,6), la pâleur de la conjonctive (OR = 4,3), les vomissements à répétition (OR = 3,6), le tirage respiratoire (OR = 2,7) et l'œdème (OR = 2,4). Globalement, le risque de mortalité associé à la présence d'au moins un signe était 6,5 fois plus élevé que chez les enfants ne présentant aucun signe.

Bien que ces signes soient utiles pour identifier un sous-groupe d'enfants à haut risque de mortalité, leur validation dans d'autres contextes est nécessaire. La formation et la supervision des agents de santé en vue de l'identification des enfants gravement malades doivent rester prioritaires en raison de leurs avantages, notamment en ce qui concerne la réduction de la mortalité juvéno-infantile.

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