Identifying sick children requiring referral to hospital in Bangladesh

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The object of this study was to evaluate and improve the guidelines for the Integrated Management of Childhood Illness (IMCI) with respect to identifying young infants and children requiring referral to hospital in an area of low malaria prevalence. A total of 234 young infants (aged 1 week to 2 months) and 668 children (aged 2 months to 5 years) were prospectively sampled from patients presenting at a children's hospital in Dhaka, Bangladesh. The study paediatricians obtained a standardized history and carried out a physical examination, including items in the IMCI guidelines developed by WHO and UNICEF. The paediatricians made a provisional diagnosis and judged whether each patient needed hospital admission. Using the paediatrician's assessment of a need for admission as the standard, the sensitivity and specificity of the current and modified IMCI guidelines for correctly referring patients to hospital were examined.

The IMCI's sensitivity for a paediatrician's assessment in favour of hospital admission was 84% (95% confidence interval (CI): 75–90) for young infants and 86% (95% CI: 81–90) for children, and the specificity was, respectively, 54% (95% CI: 45–63) and 64% (95% CI: 59–69). One fourth or more in each group had a provisional diagnosis of pneumonia, and the IMCI's specificity was increased without lowering sensitivity by modifying the respiratory signs calling for referral. These results show that the IMCI has good sensitivity for correctly referring young infants and children requiring hospital admission in a developing country setting with a low prevalence of malaria. The guidelines' moderate specificity will result in considerable over-referral of patients not needing admission, thereby decreasing opportunities for successful treatment of patients at first-level health facilities. The impact of the IMCI guidelines on children's health and the health care system must be judged in the light of current treatment practices, health outcomes and referral patterns.

Introduction

Since pneumonia and diarrhoea account for the majority of deaths in <5-year-old children in developing countries, Ministries of Health have implemented national disease control programmes to improve the diagnosis and treatment of these illnesses. Disease-specific case management guidelines have been developed to aid health auxiliaries working at first-level facilities, a vital component of which is the identification and referral to hospital of severely ill children. Recognizing that diseases, such as pneumonia and malaria may present with similar symptoms, and that many severely ill children have more than one condition needing treatment, WHO and UNICEF recently developed guidelines for the Integrated Management of Childhood Illness (IMCI). These guidelines enable primary health workers to diagnose and manage illnesses which are thought to be responsible for 70% of childhood deaths in developing countries (*1*).

The IMCI guidelines, which are organized separately for 7–59-day-olds and 2–59-month-olds, use simple clinical signs to classify the illness and its severity. Where the same signs are presented by more than one disease, they are managed by the treatment instructions for the relevant illness classifications. Owing to the nonspecific nature of disease presentation in young infants, most clinical signs of severe illness in this age group are included in a single condition, "possible serious bacterial infection", with other categories covering diarrhoea, malnutrition, and feeding problems. Older infants and children are checked for respiratory and febrile conditions, diarrhoea, ear problems, malnutrition and anaemia, with different instructions for febrile illnesses in areas of high and low malaria risk. The immunization status of all patients is checked, needed immunizations are given, and treatments and instructions are provided to the caregiver.

The IMCI algorithm is designed for use in first-

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level outpatient health facilities which have limited diagnostic and treatment capabilities, and health auxiliary staff with limited training. Many developing countries now have a policy on essential drugs for primary care (*2*), and better-stocked health facilities will carry the nationally approved one oral antibiotic for pneumonia and one for dysentery, a parenteral antibiotic for severe disease, an antimalarial (in malarious areas), paracetamol, oral rehydration packets, vitamin A, and iron. Some may also carry an antibiotic eye ointment and gentian violet for oral lesions. These are the treatments prescribed by the IMCI algorithm, together with instructions to the mothers for home care.

Hospitals and other inpatient facilities are staffed by physicians, often have more advanced diagnostic (including X-ray and laboratory) facilities, and usually have a greater range of drugs. However, the nearest hospital may be far from a first-level facility, transportation may be limited, and care is more expensive. The IMCI guidelines are designed to be highly sensitive on the referral of patients with a possible severe illness, and ideally they would exclude those whose illness does not require care at a hospital. Previous studies have examined the validity of clinical signs of respiratory illness severity (*3–6*) and identified signs of severe illness due to other conditions (*7–9*), which are included in the IMCI guidelines. Because of the need to assess the updated algorithm's performance using these signs, particularly with young infants, we compared the IMCI recommendation for referral with the judgement of an expert clinician on the need for hospitalization.

Patients and methods

We carried out a prospective study of <5-year-old children presenting for medical care at the outpatient or emergency department of the Dhaka Shishu (Children's) Hospital in Dhaka, Bangladesh. Because we sought to validate the content of the IMCI referral guidelines, rather than the ability of health auxiliaries to use the instructions, all clinical data were collected by the study physicians. Two experienced Bangladeshi paediatricians evaluated the enrolled patients, using a standardized history and physical examination form covering the signs included in the field-test version of the IMCI guidelines, other clinical signs found in the current version of the IMCI algorithm (see Table 1 for details), and several other signs familiar to paediatricians. Separate forms, corresponding to the IMCI format, were used for young infants aged 1 week to 2 months and children aged 2 months to 5 years.

The paediatricians' use of medical terminology, such as "crepitations", was standardized in clinical sessions conducted by one of the investigators (*J.A.S.*) who is a paediatrician. The term "chest indrawing" followed the WHO definition: "inward movement of the bony structures of the lower chest wall during inspiration in a calm child". For young infants, in whom increased chest wall pliability and abdominal excursions are part of normal breathing, the WHO definition also requires that the chest indrawing be severe. The sessions on standardization ensured that the study paediatricians included these factors in their evaluation of chest wall indrawing in young infants.

Patients were enrolled from September 1994 through February 1995. We took all young infants aged 1 week to 2 months presenting at the outpatient or emergency department. To increase the chance of including severely ill young infants, those assigned to the emergency room by the admissions clerk were preferentially enrolled if the paediatrician's time was limited. We took a systematic sample of children aged 2 months to 5 years, and enriched our study population for more severe illness by preferentially selecting patients admitted to the emergency room and by taking all children with a chief complaint of fever who had a measured rectal temperature of >38 °C. Young infants and children presenting for immunizations, well-child care, and scheduled or referred visits were excluded from enrolment.

After obtaining informed consent, the enrolled patients were seen by a nurse who measured the height, weight and rectal temperature, and then by a study paediatrician. Laboratory tests were ordered by the paediatrician based on clinical indications and as specified by study criteria; they included the children's haemoglobin levels, which were determined by the HemoCue method (*10*). Weight-for-age *Z*-scores (WAZ) were calculated by comparison with the U.S. National Center for Health Statistics reference population (*11*). The study paediatricians were asked to formulate an "expert clinician's provisional diagnosis" before learning the results of the laboratory or radiological investigations. In addition, they were asked to judge whether each child needed admission to hospital, and to detail their reasons for admission.

A "sampling survey" was also performed on a different day each week, using a standardized data collection form, on which the caregivers' answers about the presenting complaints and the IMCI screening signs for their children were recorded together with the recommended triage assignment. The final study sample was compared to the entire patient population, as reflected by the sampling survey, to assess the influence of our sampling methodology on the study results.

Table 1: **Diagnostic classifications and clinical signs for which the Integrated Management of Childhood Illness (IMCI) guidelines recommend referral of young infants (aged 1 week to 2 months) and children (aged 2 months to 5 years) to hospital**

Young infants

- Possible serious bacterial infection
  Convulsions (by history), fast breathing (≥60 breaths/minute), severe chest indrawing, nasal flaring, grunting, bulging fontanelle, pus draining from ear, umbilical redness extending to the skin, rectal temperature ≥38 °C or <36 °C or feels hot or feels cold, many or severe skin pustules, difficult to wake up,[a] cannot be calmed within one hour,[a] or less than normal movement[b]
- Diarrhoea (by history) *with* severe dehydration[c]
  ≥2 of the following signs: abnormally sleepy or difficult to wake up,[a] sunken eyes, skin pinch goes back very slowly
- Severe persistent diarrhoea (≥14 days)
- Not able to feed — possible serious bacterial infection
  Not able to feed (by history), no attachment to nipple,[b] or not sucking at all[b]

Children

- General danger signs[c]
  Not able to drink or breastfeed, vomits everything, or convulsions (all by history), or abnormally sleepy or difficult to wake up[a]
- Very severe febrile disease
  Fever (by history, feels hot, or rectal temperature ≥38 °C) *and* any general danger sign, or stiff neck
- Severe pneumonia or very severe disease
  Cough or difficult breathing (by history) *and* any general danger sign, chest indrawing, or stridor in a calm child
- Diarrhoea (by history) *with* severe dehydration[c]
  ≥2 of the following signs: abnormally sleepy or difficult to wake up,[a] sunken eyes, not able to drink or drinking poorly,[b] skin pinch goes back very slowly
- Severe persistent diarrhoea (≥14 days, by history *and* dehydration present)
  ≥2 of the following signs: restless/irritable, sunken eyes, drinks eagerly/thirsty,[b] skin pinch goes back slowly
- Severe complicated mealses
  Fever (by history, feels hot, or rectal temperature ≥38 °C) *and* generalized rash *and* cough, runny nose, or red eyes, *and* any general danger sign, clouding of cornea, or deep or extensive mouth ulcers
- Mastoiditis
  Ear problem (by history) *and* tender swelling behind the ear
- Severe malnutrition or severe anaemia
  Visible severe wasting, severe palmar pallor, or oedema of both feet

[a] Following the study, "lethargic or unconscious" replaced these signs in the IMCI.
[b] These signs were excluded from the analysis because they were added to the IMCI after the study, or because it was not feasible to collect the data in the context of the study examinations.
[c] If severe dehydration is present alone or with danger signs, but no other severe classification, rehydration may resolve the severe problem and the need for referral.

To measure the sensitivity and specificity of the IMCI guidelines for identifying young infants and children "needing referral", a computer program used the paediatrician-collected data to generate IMCI diagnoses and referral decisions (Table 1), and compared these to a paediatrician's judgement of a "need for hospital admission". To gain a better understanding of the factors limiting the guidelines' sensitivity, we examined the paediatricians' provisional diagnoses and reasons for admitting patients when the algorithm did not recommend referral. We also examined the provisional diagnoses and IMCI signs of patients referred for hospital admission by the algorithm but not by the paediatricians, in order to better understand the factors limiting the guidelines' specificity. Lastly, changes in the IMCI algorithm that might improve its performance were explored by incorporating data on other historical and clinical signs gathered by the study. The data were analysed using Epi Info computer software (*12*). Sensitivities and specificities with 95% exact binomial confidence intervals, percent change and rate ratios with Taylor series 95% confidence intervals, and χ^2 and Fisher exact tests were calculated.

The study was approved by the ethical review committees of the Dhaka Shishu Hospital, the Johns Hopkins School of Hygiene and Public Health, and the U.S. Centers for Disease Control and Prevention.

Results

A total of 234 young infants (aged 1 week to 2 months) and 668 children (aged 2 months to 5 years) were enrolled in the study. The median age of young infants was 32 days (range, 7–59 days); 72% were male. The median age of the children was 390 days (range, 60–1817 days); 62% were male. Pneumonia was the most common provisional diagnosis in both age groups (Tables 2 and 3). Several young infants and children had multiple diagnoses, most often pneumonia with either diarrhoea or a local bacterial infection. There were also many severe illnesses

Table 2: **Provisional diagnoses by an expert clinician of 234 sick young infants (aged 1 week to 2 months)**

	No.
Pneumonia: alone (84), with diarrhoea (7), or local bacterial infection (10)	101
Upper respiratory tract infection	23
Local bacterial infection	19
Septicaemia: with no known focus (11), with local bacterial infection (4), or upper respiratory tract infection (1)	16
Watery diarrhoea (15), or dysentery (1)	16
Malnutrition[a] and/or feeding problem alone	12
Congenital defect	12
Neonatal jaundice	7
Colic	5
Meningitis: alone (1), with pneumonia (2), or local bacterial infection (1)	4
Tumour	3
Neonatal tetanus: alone (1), or with meningitis (1)	2
Lower respiratory tract infection: alone (1), or with local bacterial infection (1)	2
Other	12

[a] Overall, 14% (33/234) of the young infants had a provisional diagnosis of malnutrition.

Table 3: **Provisional diagnoses by an expert clinician of 668 sick children (aged 2 months to 5 years)**

	No.
Pneumonia: alone (150), with diarrhoea (13), or dysentery (4)	167
Other respiratory conditions[a]	140
Watery (75) or persistent (14) diarrhoea	89
Dysentery (2 with persistent diarrhoea, 1 with haemolytic uraemic syndrome)	59
Meningitis: alone (24), with pneumonia (5), dysentery (2) and/or persistent diarrhoea (1)	31
Viral syndrome	30
Septicaemia: with no known focus (18) or local bacterial infection (10)	28
Local bacterial infection	20
Malnutrition and/or anaemia alone[b]	18
Convulsions (8 febrile)	11
Otitis media	10
Acute glomerulonephritis (4) and/or nephrotic syndrome (2 with diarrhoea, 1 with dysentery)	9
Dermatitis (8), or oral candidiasis	9
Enteric fever	8
Intestinal parasites	8
Congenital defect	5
Acute renal failure (2 due to post-diarrhoea anuria and 1 haemolytic uraemic syndrome)	4
Measles (1 with pneumonia)	2
Other	20

[a] Upper (83) or lower (13) respiratory tract infection, bronchiolitis (28), asthma (16).
[b] Overall, 29% (192), 24% (163), and 16% (110), respectively, of the 668 children had a provisional diagnosis of malnutrition, anaemia, or both.

in both groups, including meningitis, severe pneumonia, and septicaemia with no known focus of infection.

The study population also had a number of nutritional problems; 12% (29/233) and 29% (196/665), respectively, of young infants and children had a WAZ of <-3, signifying severe malnutrition, and 18% (43/233) and 25% (167/665), respectively, were moderately malnourished with a WAZ from -3 to -2. Of the 483 children whose haemoglobin level was measured, 10 (2%) were severely anaemic (haemoglobin <5 g/dl) and 80 (17%) had moderately severe anaemia (haemoglobin from 5 to 7 g/dl).

The paediatricians judged 45% (105/234) of the young infants and 34% (226/668) of the children to need hospital admission. Patients with more than one major provisional diagnosis (meningitis, pneumonia, diarrhoea and/or local bacterial infection in the young infants; meningitis, pneumonia, diarrhoea and/or measles in the children) were more often assessed to require admission than those with one or no major diagnosis (young infants: RR = 1.5, 95% confidence interval (CI): 1.1–2.2; children: RR = 2.2, 95% CI: 1.7–2.9), as were young infants and children with a WAZ of <-2 (young infants: RR = 2.2, 95% CI: 1.7–2.8; children: RR = 1.7, 95% CI: 1.3–2.2), a Young Infant Observation Scale (YIOS) (*13*) score ⩾7 (young infants: RR = 2.8, 95% CI: 2.3–3.5; children: RR = 3.2, 95% CI: 2.7–3.8), or a haemoglobin <8 g/dl (children: RR = 1.8, 95% CI: 1.4–2.3).

The IMCI referral signs had good sensitivity compared with the paediatrician's assessment of a need for hospital admission, but only low to moderate specificity (Table 4). They would have referred 46% (59/129) of the young infants and 36% (159/442) of the children in our study population who, the paediatricians felt, did not need admission. The IMCI's sensitivity tended to be increased, and its specificity decreased, in both young infants and children with multiple provisional diagnoses; however, these findings were not statistically significant. Nutritional status also did not affect the guidelines' performance.

Only 60% (88/147) of the young infants and 55% (195/354) of the children who would have been referred by the IMCI algorithm actually required hospital admission (Table 4). Because positive predictive value is determined by the prevalence of the condition as well as by sensitivity and specificity, and because the study was conducted in a setting that might have attracted more severe illnesses and oversampled for the more severely ill patients seen, it was expected that the study would overestimate the IMCI's predictive value in a first-level health care setting. Predictive value would have been much lower among a random sample of the hospital

Table 4: **Sensitivity, specificity, and positive predictive value in different settings, of the current and modified IMCI guidelines calling for referral to hospital, compared to a physician's judgement of a need for hospital admission, among 234 young infants (aged 1 week to 2 months) and 668 children (aged 2 months to 5 years)**

IMCI signs for referral of:	Admission by physician		Sensitivity (%)	Specificity (%)	Positive predictive value (%)		
					Hospital sample		First-level facility[c]
	Yes	No			Enriched[a]	Random[b]	
Young infants:							
All young infants	105	129					
IMCI guidelines			84	54	60	51	16
Modified guidelines[d]			79	69[f]	67	60	23
With provisional pneumonia	61	42					
IMCI guidelines[e]			100	5	60	38	10
Modified guidelines[d]			90[g]	43[h]	70	48	15
Children:							
All children	226	442					
IMCI guidelines			86	64	55	47	21
Modified guidelines[d]			83	74[f]	62	54	27
With provisional pneumonia	90	83					
IMCI guidelines[e]			97	25	58	32	13
Modified guidelines[d]			89[g]	63[h]	72	47	21

[a] More severely ill children: prevalence of need for admission = 45% in young infants and 34% in children.
[b] Prevalence of need for admission = 37% in young infants and 27% in children.
[c] Prevalence of need for admission = 10% in young infants and children.
[d] Intercostal or suprasternal retractions required in young infants or children with chest indrawing.
[e] "Possible serious bacterial infection" in young infants; "severe pneumonia or very severe disease" in children.
[f] $P \leq 0.01$.
[g] $P < 0.05$.
[h] $P < 0.001$.

outpatients or in a typical first-level facility (Table 4).

The 17 young infants and 31 children who would not have been referred by the IMCI algorithm but were felt by the paediatricians to need hospital admission had a variety of provisional diagnoses (Table 5). Several had conditions the algorithm is not designed to detect, notably neonatal jaundice and orthopaedic problems in young infants and acute glomerulonephritis in children. On the other hand, 41% (7/17) of the young infants had IMCI conditions, including three with septicaemia; 81% (25/31) of the children were likewise diagnosed with IMCI conditions, including four with septicaemia and three with pneumonia.

Of the young infants and children in this group with diarrhoea or dysentery, 47% (9/19) were judged by the paediatrician to be malnourished or anaemic, 58% (11/19) were considered to be dehydrated, and 32% (6/19) were assessed to be both malnourished and dehydrated. Six of the eight children with provisional diarrhoea and malnutrition had a WAZ of <-3, but would not have been referred by the IMCI algorithm because they lacked "visible severe wasting". Similarly, while none of the four children with persistent diarrhoea met the IMCI dehydration criteria, which would have required referral by the algorithm, the paediatricians judged two to be malnourished and/or anaemic.

The paediatricians gave a variety of reasons for admitting the patients with IMCI conditions who would not have been referred by the algorithm. Four of the seven young infants and 16 of the 25 children were admitted for rehydration and/or nutritional therapy. One of these four young infants plus one other, and six of the 16 children plus three others, needed intravenous antibiotics, while one child also required a transfusion for severe anaemia. The paediatricians listed "severe illness" as a reason for admitting two of the seven young infants and seven of the 25 children.

Of the young infants and children referred by the algorithm but judged by the paediatricians not to need hospitalization, the paediatricians made a provisional diagnosis of pneumonia in 68% (40/59) and 41% (65/159), respectively; an additional 25% (39/159) of the children had another respiratory condition (Table 6). Of these 40 young infants with a provisional diagnosis of pneumonia, 36 had severe chest indrawing noted, 12 also had fast breathing, and 10 had an additional IMCI sign that calls for referral. The other four young infants with pneumo-

Table 5: **Provisional diagnoses by an expert clinician of 17 young infants (aged 1 week to 2 months) and 31 children (aged 2 months to 5 years) judged to need hospitalization by the clinician but not referred to hospital by the IMCI guidelines**

	No.
Young infants	
Congenital defect	6
Septicaemia: with no known focus (2) or upper respiratory tract infection (1)	3
Neonatal jaundice	3
Local bacterial infection (1 with acute renal failure)	2
Watery diarrhoea	1
Malnutrition and/or feeding problem alone	1
Umbilical granuloma	1
Children	
Watery diarrhoea (4 with persistent diarrhoea)	10
Acute glomerulonephritis (3) and/or nephrotic syndrome (2 with diarrhoea, 1 with dysentery)	6
Septicaemia: with no known focus (1), enteric fever (1), or local bacterial infection (2)	4
Dysentery (1 with haemolytic uraemic syndrome, 1 with severe anaemia)	4
Pneumonia, alone (2) or with diarrhoea (1)	3
Malnutrition and/or anaemia alone	1
Other[a]	3

[a] Submandibular abscess (1), Hirschsprung's disease (1), and viral syndrome with benign intracranial hypertension (1).

Table 6: **Provisional diagnoses by an expert clinician of 59 young infants (aged 1 week to 2 months) and 159 children (aged 2 months to 5 years) referred to hospital by the IMCI guidelines but judged not to need hospitalization by the clinician**

	No.
Young infants	
Pneumonia: alone (35), with diarrhoea (2) or local bacterial infection (3)	40
Upper (4) or lower respiratory tract infection with local bacterial infection (1)	5
Local bacterial infection	4
Watery diarrhoea	2
Malnutrition and/or feeding problem alone	2
Other[a]	6
Children	
Pneumonia: alone (60), with diarrhoea (3) or dysentery (2)	65
Other respiratory conditions[b]	39
Watery diarrhoea (12), dysentery (7) or persistent diarrhoea (2)	21
Septicaemia: with no known focus (5), enteric fever (3), or local bacterial infection (2)	10
Viral syndrome	9
Convulsions (3 febrile)	4
Local bacterial infection	3
Congenital defect	3
Otitis media	1
Malnutrition and/or anaemia alone	1
Other[c]	3

[a] Laryngomalacia (2), colic (2), spasmodic cough (1), constipation (1).
[b] Bronchiolitis (15), upper (12) or lower (4) respiratory tract infection, asthma (8).
[c] Vomiting (2, 1 with food poisoning), ascariatic crisis (1).

nia had fast breathing, either alone or with one other IMCI referral sign. Of the children with a provisional diagnosis of pneumonia or another respiratory condition, 93% (97/104) would have been referred on the basis of the IMCI classification, "severe pneumonia or very severe disease"; 79% (77/97) of these children had chest indrawing, while 33% (32/97) had a general danger sign including nine with reported convulsions. Five children with "severe pneumonia or very severe disease" plus two others had bipedal oedema. All 40 infants and 93% (97/104) of the children with a provisional diagnosis of pneumonia or another respiratory condition were treated with oral or intramuscular antibiotics and sent home.

Other young infants and children without a provisional diagnosis of pneumonia or another (expert clinician) respiratory diagnosis had a variety of signs that call for IMCI referral, yet were judged by the pediatricians not to need hospital admission. Three young infants had a measured fever and four others were felt to be hot. Seven children with a provisional diagnosis of septicaemia met the IMCI criteria for "very severe febrile disease", including four with reported convulsions. In addition to these four and the nine children with a provisional diagnosis of respiratory illness and convulsions, nine more children had a history of convulsions with their illness. Sixteen children would have been referred for severe malnutrition, including nine with bipedal oedema and eight with visible severe wasting.

Potential modifications of the IMCI algorithm

The specificity of the IMCI's recommendation for referral of young infants to hospital, compared with a paediatrician's assessment of a need for admission, was increased from 54% to 62% by raising the threshold for fast breathing from 60 to 70 breaths per minute, but this was not statistically significant ($P = 0.21$).

The requirement of intercostal or suprasternal retractions to accompany lower chest wall indrawing increased the specificity of IMCI referral from 54% to 69% in young infants (27% increase, 95% CI: 8–49) and from 64% to 74% in children (16% increase, 95% CI: 6–27), while maintaining sensitivity in both age groups (Table 4). This change also increased the guidelines' specificity for a provisional diagnosis of pneumonia requiring admission compared to less severe pneumonia, but decreased the sensitivity for this diagnosis. The predictive value of the modified guidelines was increased in all prevalence settings. The increases in specificity of the modified guidelines were due mostly to retractions having higher specificity than indrawing for the provisional diagnosis of severe pneumonia.

In young infants, the specificities of severe chest indrawing and retractions (intercostal or suprasternal), compared to a paediatrician's assessment of a need for hospital admission, were 68% and 94%, respectively. In young infants with a provisional diagnosis of pneumonia, the specificities of severe chest indrawing and retractions were 14% and 83%. In children aged 2 months to 5 years, the specificities of chest indrawing and retractions were 74% and 90%, respectively, while in children with a provisional diagnosis of pneumonia the specificities of indrawing and retractions were 35% and 80%.

The specificities of chest indrawing and retractions were influenced by their associations with each other and with other signs of respiratory distress. Retractions were accompanied by severe indrawing in 98% (48/49) of the young infants and by indrawing in 85% (99/117) of the children in whom they occurred; 44% (8/18) of the children with retractions, but no indrawing, had at least one more sign of respiratory distress. By contrast, only 59% (61/103) of the young infants with severe indrawing and 39% (42/109) of the children with indrawing had retractions or another sign of respiratory distress. The specificity of indrawing with retractions, 94% in young infants, 84% in young infants with a provisional diagnosis of pneumonia, 92% in children, and 82% in children with provisional pneumonia, was similar to that of any retractions. The relationship between indrawing and retractions was not confounded by age or nutritional status.

The specificity of chest indrawing in children aged 2 months to 5 years varied by age, being lowest (49%) in 2–5-month-old infants, moderate (72%) in 6–11-month-olds, and highest (85%) in children from 12 to 59 months of age. The corresponding specificities for retractions were 83%, 91% and 93%. The age trends in the specificity of the IMCI algorithm for referral of all children and those with severe pneumonia (respectively, 45%, 62% and 71%, and 13%, 33% and 33%), paralleled the levels for indrawing. The specificity of the IMCI algorithm, as modified by the addition of retractions, was higher and more uniform across the three age groups (all children: 70%, 73% and 76%; children with severe pneumonia: 63%, 63%, 62%).

The specificity of chest indrawing, compared to a paediatrician's assessment of a need for hospital admission, was also somewhat lower in better nourished than malnourished children (WAZ of ≥ -2 vs. < -2, 69% vs. 79%, $P = 0.05$), while the specificity of any retractions was equally high in both nutritional strata (91% and 90%). This resulted in equal specificity for the current and modified IMCI referral guidelines in malnourished children (current vs. modified IMCI, 65% vs. 71%, $P = 0.18$), but greater specificity for the modified guidelines in all better nourished children (current vs. modified IMCI, 63% vs. 77%, $P = 0.001$) and those with a provisional diagnosis of pneumonia (current vs. modified IMCI, 22% vs. 64%, $P < 0.001$). The specificity of the modified guidelines was also higher in all young infants with a WAZ of ≥ -2 (current vs. modified IMCI, 53% vs. 68%, $P = 0.03$) and those with provisional pneumonia (current vs. modified IMCI, 3% vs. 39%, $P < 0.001$). There were no statistically significant differences in the sensitivities of the current and modified IMCI guidelines for any of the age or nutritional groups.

Discussion

The IMCI guidelines have good sensitivity for referring young infants and children with a severe illness requiring admission to hospital in the judgement of a paediatrician. The most frequent provisional diagnoses in patients whose need for admission was missed by the algorithm were diarrhoea and dysentery. Many of these referrals may have been missed because the IMCI guidelines rate the severity of illness for each individual condition, while the study paediatricians apparently assessed the overall condition of each child. Half of these patients were judged by the paediatrician to be malnourished or anaemic, and this seems to have influenced the decision to admit. Malnutrition interacts with diarrhoea and other diseases to increase the duration (*14*), severity and mortality (*15, 16*) of the illness, which suggests that nutritional status should be considered in referring or admitting a sick child to hospital. Increased sensitivity of the IMCI algorithm to severe malnutrition would also have increased the referral rate, even without better integration of the information for each child.

The IMCI algorithm has low to moderate specificity for correctly identifying and not referring young infants and children who do not require hospitalization in the judgement of a paediatrician. The most frequent provisional diagnosis in patients needlessly referred by the algorithm was pneumonia. While the study paediatricians used criteria similar to those included in the IMCI to arrive at their diagnoses, they decided that these children were not sick enough to need admission; 21 (13%) in this group had a provisional diagnosis of upper respiratory tract infection or viral syndrome and 14 (9%) would have been referred for febrile convulsions or convulsions alone, further suggesting that the IMCI algorithm will refer some children with a relatively minor illness.

Case management guidelines such as the IMCI's are purposely designed to be sensitive to increase the likelihood that sick children receive the care they need. This strategy is likely to result in relatively low specificity and, for conditions with low to moderate prevalence, low positive predictive value. A recent study in Africa found that 10–11% of children presenting at a rural health centre with an acute respiratory infection were severely ill and that 6% needed urgent referral to hospital (*17*). Even if 10% had actually required admission, our data suggest that if the IMCI algorithm had been used in this setting to identify the children needing referral, 79–84% of those referred would have been judged by a paediatrician not to need admission. Because the IMCI algorithm is designed to be used alone, rather than be included as part of a full medical history and physical examination, its correctness in first-level facilities may be less than the results of our study.

Much of the algorithm's over-referral of young infants and children was due to the low specificity of chest indrawing in identifying patients with a provisional diagnosis of pneumonia who, according to the paediatricians, did not need admission to hospital. Intercostal or suprasternal retractions were detected less often but were usually associated with indrawing or other signs of respiratory distress. In effect, they acted as a marker of those patients with indrawing and pneumonia who were most severely ill. Because a third of the study patients had a provisional diagnosis of pneumonia, the addition of the presence of retractions in young infants and children with chest indrawing boosted the algorithm's specificity by 16–27% without reducing its sensitivity. However, the low prevalence of severe pneumonia seen at first-level facilities and the IMCI's moderate baseline specificity would limit the impact of this change on the overall performance in correctly referring sick children. In a health care setting where 10% of the patients seen need hospital admission, using the modified guidelines would decrease the over-referral of young infants from 84% to 77% and children from 79% to 73%.

Few data have been published on the specificity of chest indrawing or intercostal retractions for severe pneumonia or pneumonia requiring hospital admission. Shann et al. in Papua New Guinea studied children with crepitations (50 admitted to hospital and 67 treated as outpatients) and found that chest indrawing (defined as "sternal recession") had 100% sensitivity and 94% specificity (*3*). However, the criteria for hospital admission were not stated and may have included the presence of indrawing. In an analysis combining data from the Philippines and Swaziland (*4*), lower chest wall indrawing had a positive predictive value for paediatrician-defined severe pneumonia of 53%, while only 8% of those with intercostal retractions alone had severe pneumonia. The specificities of the signs were not stated and cannot be determined from the presented data. In a study in India, the specificity of intercostal retractions for identifying children with lower respiratory infection not needing hospitalization was 58% (*5*). Campbell et al. in the Gambia showed that, while intercostal retractions did not identify lower respiratory infection without lobar consolidation (specificity = 39%), the specificity of severe retractions was 94% (*6*).

In our study, the specificity of chest indrawing for a provisional diagnosis of pneumonia requiring admission was only 14% in young infants and 35% in children, yet the positive predictive value was similar to that found by Mulholland et al. (62% (58/94) in young infants and 61% (83/136) in children) (*4*). Our findings for the specificity of retractions for pneumonia requiring admission (83% in young infants and 80% in children), were similar to those of Campbell et al. for severe retractions (*6*). In our highly malnourished study population, it is possible that the paediatricians discounted non-severe retractions as a normal finding. The lower specificity of chest indrawing in younger and better nourished children suggests that this sign is difficult to ascertain in the presence of normal abdominal movement due to breathing or a normal abdominal girth. The specificity of retractions for severe pneumonia was higher and more consistent. Adding retractions to the guidelines, therefore, improved and equalized the IMCI's performance across both age and nutritional strata.

Our findings show that the IMCI guidelines could potentially overburden hospitals and other health centres with unnecessary referrals. It is also likely that some referred patients will not successfully reach a referral centre and could be deprived of lifesaving treatment with oral antibiotics. However, the impact of any case management tool must be judged in the light of current practices. Common problems at first-level health facilities include variable criteria for hospital referral (*18*), as well as poor treatment practices (*19*) and improper drug use (*20*). The IMCI guidelines could potentially reduce many of these difficulties. Use of case management guidelines may improve treatment at first level facilities (*21*), reduce unnecessary referrals (*22*), and decrease mortality levels (*23, 24*).

Our study also identified signs that more closely duplicated a paediatrician's assessment of the need for admission. However, modifying the IMCI algorithm with these signs would probably yield only a small increase in positive predictive value at first-level health facilities. Further study is needed on the usefulness of lower chest wall indrawing, retractions and other signs in identifying severe pneumonia in malnourished and well-nourished populations. The performance of the IMCI algorithm should also be monitored to determine the proportion of young infants and children referred by the guidelines, how many of them successfully reach referral care, how many are admitted to hospital, and the outcomes of patients who are referred and not referred.

A potential limitation of our study was the lack of a perfect standard against which to measure the validity of IMCI referrals. Ideally, the guidelines' performance should be compared to objective measures or indicators of illness severity known to influence the outcome. Past efforts to validate clinical signs of illness severity have used different study designs and reference standards (*3–9*). Some included only hospitalized children and examined risk factors for the most severe outcome, death. Others used the child's admission or non-admission to hospital as the standard. However, admission can occur for non-medical reasons, and some children with a severe illness will not be admitted because a bed is not available or for other reasons.

Our study relied on the judgement of paediatricians to assess the need for hospital admission independent of bed availability and non-medical issues. The physician's judgement of illness severity has been shown to be an accurate predictor of mortality risk in both older patients (*25*) and neonates (*26*). In addition, several measures of illness severity, including the YIOS score (*13*), the presence of multiple diagnoses, and nutritional status, suggest that patients assessed by the study paediatricians as needing admission were more severely ill than those judged not to need admission.

Though physicians can accurately assess disease severity and the need for admission, this may not be an appropriate standard for evaluating the IMCI algorithm's performance in referring all sick children. For example, young infants with fever or convulsions and children with convulsions may require a physician's assessment to determine if they need admission. Hence, these children may always need to be referred by health auxiliaries. In the case of severe malnutrition, the threshold for admission may be raised in a country such as Bangladesh where the prevalence is high and effective community-based nutritional rehabilitation is usually available (*27*). Referral may be more appropriate in countries where these conditions do not exist, and this may call for some degree of local adaptation of the IMCI guidelines.

In conclusion, the IMCI algorithm had good sensitivity, but only low to moderate specificity for a paediatrician's assessment of the need for hospital admission. Modifying the guidelines for referring patients with pneumonia by requiring the presence of retractions in young infants and children with chest indrawing could possibly improve the IMCI's performance. Increasing the specificity will be important for the functioning of the health system to lessen the burden of unnecessary referrals on hospitals and other facilities. At the same time, it may be necessary in many places to adapt the IMCI guidelines to local circumstances and to provide health auxiliaries working at first-level facilities with additional diagnostic and treatment capabilities, so that they can adequately manage these illnesses which previously they would have referred to a higher level of care.

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Résumé

Identification de l'enfant malade nécessitant un transfert à l'hôpital au Bangladesh

L'objet de la présente étude était d'évaluer et d'améliorer les recommandations de la prise en charge intégrée des maladies de l'enfant (IMCI), et notamment l'identification de l'enfant et du jeune nourrisson nécessitant un transfert à l'hôpital, dans un secteur où la prévalence du paludisme est faible. Un échantillon prospectif a été recruté parmi les patients qui se sont présentés à l'hôpital des enfants de Dacca (Bangladesh) et comportait 234 jeunes nourrissons (de 1 semaine à 2 mois) et 668 enfants (de 2 mois à 5 ans). Les pédiatres de l'étude ont procédé à une anamnèse standardisée et ont réalisé un examen physique, y compris sur les paramètres figurant dans les recommandations de l'IMCI mises au point par l'OMS et l'UNICEF. Les pédiatres ont porté un diagnostic provisoire

et estimé si chacun des patient avait besoin d'être hospitalisé. La sensibilité et la spécificité des recommandations actuelles et modifiées de l'IMCI ont été examinées, en utilisant comme référence l'appréciation des pédiatres, pour vérifier si les patients avaient été correctement hospitalisés.

La sensibilité de l'IMCI par rapport à l'évaluation d'un pédiatre concernant l'hospitalisation était de 84% (intervalle de confiance à 95% ($IC_{95\%}$): 75–90) chez le jeune nourrisson et de 86% ($IC_{95\%}$: 81–90) chez l'enfant; la spécificité était respectivement de 54% ($IC_{95\%}$: 45–63) et 64% ($IC_{95\%}$: 59–69). Dans chaque groupe, un quart ou plus des enfants avait un diagnostic de pneumopathie, et la spécificité de l'IMCI était augmentée, sans diminution de la sensibilité, si on modifiait les signes respiratoires utilisés pour prendre la décision d'hospitalisation. Ces résultats montrent que les recommandations de l'IMCI ont une bonne sensibilité pour le transfert de l'enfant et du jeune nourrisson nécessitant une hospitalisation, dans le contexte des pays en développement à faible prévalence paludéenne. La spécificité modérée des recommandations devrait être à l'origine d'un nombre considérable de transferts de patients n'ayant pas besoin d'être hospitalisés, diminuant donc les chances de succès du traitement dans les centres de santé de premier niveau. L'impact des recommandations de l'IMCI sur la santé de l'enfant et sur le système de soins de santé doit être apprécié à la lumière des pratiques thérapeutiques admises, des résultats pour la santé et des modalités de transfert.

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