Am. J. Trop. Med. Hyg., 79(6), 2008, pp. 925–932

Assessment of Children for Acute Respiratory Infections in Hospital Outpatients in Tanzania: What Drives Good Practice?

Clare I. R. Chandler,* Behzad Nadjm, Gloria Boniface, Kaseem Juma, Hugh Reyburn, and Christopher J. M. Whitty
London School of Hygiene and Tropical Medicine, London, United Kingdom; Joint Malaria Programme, Moshi, Tanzania

Abstract. Respiratory infections cause significant mortality in developing countries but are frequently undiagnosed. Reasons for this are unclear. We observed 1,081 outpatient consultations with patients less than five years of age in Tanzania. In 554 patients with cough or difficulty breathing, the absolute percentages examined were 5% for respiratory rate counted, 14% chest exposed, and 25% stethoscope used. Decisions to conduct particular examinations did appear to follow clinical logic, with odds ratios of 4.28 for counting respiratory rate (95% confidence interval [CI] = 1.75–10.47), 2.57 for exposing the chest (95% CI = 1.67–3.95), and 18.91 for using a stethoscope (95% CI = 9.52–37.57) in patients with cough or difficulty breathing. Non-clinical variables, including salary level, were also associated with examinations, and history taking was more common among clinicians originating outside the hospital area. Although respiratory examinations are relatively more common in those with cough or difficulty breathing, the absolute rates are low and related to non-clinical and clinical factors.

INTRODUCTION

Acute respiratory infection (ARI) is one of the leading causes of morbidity and mortality in the world, and especially in low-resource countries. Pneumonia results in approximately two million deaths per year in children less than five years of age, which represents 19% of deaths among children less than five years of age worldwide that are concentrated in Africa and Southeast Asia.[1] Although attempts have been made to raise the profile of pneumonia, it remains relatively under-researched.[2] Case management of ARIs has been highlighted as key to reducing the burden of disease.[3] ARI case management guidelines have improved outcomes and reduced unnecessary antibiotic use in hospital settings,[4] as well as community settings,[5] and have been included in the Integrated Management of Childhood Illness (IMCI) strategy, which as lead to an improvement in correct prescribing and advice about antibiotic administration by health workers trained in IMCI at the health facility level.[6] However, improvements to guideline adherence through such training interventions have been found to be short lived.[7,8]

Poor case management of ARIs persists in routine practice across different settings, with inadequate history taking and examinations reported for patients with ARI symptoms, which contributes to avoidable morbidity and mortality in children.[9–13] Inadequate history taking or examinations may reflect poor knowledge, but at hospital level facilities where patients consult trained clinicians, it is likely that other factors affect practice.[14] ARI has long been recognized as a major disease burden in Tanzania as elsewhere in Africa, and it has become apparent that diagnosis and management remains poor despite IMCI initiatives.[15,16] There is little evidence about why clinicians do not take histories and perform essential examinations when faced with children with symptoms of ARI. Such evidence is needed to guide interventions to improve case management. We observed consultations with clinicians at district hospitals in Tanzania to explore the factors that might lead to inadequate consultations in terms of history taking and examinations for patients with symptoms of ARI, using objective measures of diagnostic practice.

* Address correspondence to Clare I. R. Chandler, London School of Hygiene and Tropical Medicine, 49-51 Bedford Square, London WC1B 3DP, United Kingdom. E-mail: clare.chandler@lshtm.ac.uk

METHODS

Study setting. Consultations were observed at two district hospitals in northeastern Tanzania over a period of six months in 2006 during the dry season. Both hospitals had high annual patient loads, between 25,000 and 30,000 outpatients per year. Hospital I (HI) was in the Kilimanjaro region and run jointly by the Catholic Church and the district council. Hospital II (HII) was in the Tanga region and run by the government via the district council. HI was located at a high altitude, with a low proportion of febrile illnesses caused by malaria, and according to hospital records for 2004, ARI was the most frequent diagnosis (29%) in outpatients less than five years of age. HII was located on the plains of the Masai steppe, an area of high malaria transmission, with 2006 hospital records showing malaria as the leading outpatient diagnosis in persons less than five years of age (38%, ARI = 22%). Febrile children have previously been found to be overdiagnosed as having malaria at both hospitals, with antimalarial drugs prescribed to children without parasitologic evidence of malaria in 20% of outpatients at HI and 51% of outpatients at HII.[17] The prevalence of human immunodeficiency virus in antenatal clinic attendees at each district was similar: 8.1% for HI and 7.9% for HII.

At the time of the study, World Health Organization guidelines for hospital management of childhood diseases[18] had been adopted by the Tanzanian Ministry of Health. These state that ARI should be suspected in all children with cough or difficulty breathing. These guidelines, which were widely taught in Tanzania and provided to all clinicians in this study in the form of a pocket book and local seminar training, emphasize history and examination including specifically counting respiratory rate, exposing the chest to check for indrawing and auscultation with a stethoscope for patients with these symptoms. Because a syndromic diagnosis of pneumonia is not reliable when assessed against radiographic evidence,[19] many clinicians in this setting consider respiratory examinations should also be conducted for patients with fever even in the absence of reported cough or difficulty breathing to identify localizing signs. Therefore, performance against this syndromic definition was also assessed. None of the clinicians observed in this study had attended a formal IMCI course although IMCI, as Ministry of Health policy, was used at all levels of staff training.

Data collection and analysis. This report presents a subset of data from a study using both qualitative and quantitative methods to explore the question of what drives good practice. Findings relating to malaria practice are published elsewhere,[17,20] with a qualitative study on the motivation of clinicians to work well under review (Chandler CIR, and others, unpublished data). In this report, data from observations of consultations in pediatric outpatients at the two study hospitals are explored. Structured data collection forms were used by three of the authors (CIRC, GB, and KJ) to record observations of the content and context of consultations. Five objective diagnostic activities were recorded: any additional history questions asked after initial presentation; lower chest exposed to nipple line; respiration rate counted; stethoscope used; and thermometer used to take temperature. The study examined associations between these diagnostic maneuvers and symptoms. External factors included data about the patient demographics, consultation, clinic session (a particular date and whether seen at the mother and child health clinic [MCH] or the outpatient department [OPD]), and clinician characteristics. These characteristics are summarized in Table 1.

All hospital clinicians involved in pediatric or outpatient care were asked to participate and all gave written consent. Patients were informed of the research and asked to give verbal consent upon entering consultations. Consultations were selected for observation through purposive sampling to represent the proportion of consultations seen by each clinician in the past three months according to hospital records.

Observation data collection forms were double-entered into Microsoft Access (Redmond, WA). Relationships between examinations and symptoms were analyzed using chi-square tests and logistic regression in STATA version #10 (StataCorp, College Station, TX). Associations between different examinations/history taking and other contextual variables were then analyzed with univariate logistic regression. Additional detailed description of the data collection strategy and statistical analysis methods, including formulas, have been reported.[17] Briefly, multi-level models with random intercepts were constructed in MLwiN version 2.10[21] to adjust for clustering at the clinic session and clinician levels. The data were structured in a cross-classified framework (Figure 1) with a cross-over of clinicians working in different clinics over time, and this framework was reflected in a cross-classified analysis.[22] A third level, hospital, was excluded because of small sample size. Multi-level models provided a measure of the variation (termed σ^2) for each outcome (history or examination) attributable to differences between units at each of the two level 2 variables, clinic session ($\sigma^2_{u_1}$) and clinicians ($\sigma^2_{u_2}$). The variance was considered statistically significant at the 95% level if $\sigma^2 > 1.96 \times$ SE and significant at the 90% level if $\sigma^2 > 1.65 \times$ SE. The percentage variance attributable to each level 2 variable, termed the variance partition coefficient,[23,24] was estimated by assuming a continuous unobserved variable underlying the binary response variable and using a threshold model.[24]

Multivariable models were built for each history or examination outcome of interest by adding symptom and contextual variables that were significant at the 90% level in univariate analysis to the basic multi-level model. Variables were added according to *a priori* hypotheses, and those no longer significant at the 95% level when adjusting for multiple explanatory variables were removed. Variance components remained in the final models if they were statistically significant or provided a better fit to the data, as determined by the deviance information criterion.[25] The final models therefore show factors that were significantly associated with each outcome, adjusted for other significant variables and for clustering on the clinic session and clinician levels, and the variation attributable to differences in the outcome between clinic sessions and between individual clinicians.

TABLE 1
Data collected as possible explanatory variables

Level	Factor	Characteristics measured
1	Patient	Age, sex, symptoms, examinations carried out, questions asked by patient or parent/guardian
	Consultation	Time of day, length of consultation, whether admitted, tests requested, explanation given to patient or parent/guardian
2	Clinic session	Number of patients attending clinic that day, number of clinicians working together in that clinic on that day, whether morning or afternoon/ weekend shift
3	Clinician	Age, sex, school education level, most recent qualification, year of graduation, area of origin, number of seminars attended in the past year, number of years worked at the hospital, salary, duration worked at the hospital

RESULTS

Study sample. We observed 1,081 outpatient consultations between 23 clinical officers and children lees than five years of age during 73 clinic sessions, with most (928) at HII where more children attended for consultations each day, a median of 42 at the MCH compared with 14 at the MCH at HI. Two clinicians were scheduled to work at the MCH at each hospital daily, although in reality this varied. At the OPD, more clinicians (5–6) were scheduled to work in the morning OPD at HI compared with 4 at HII. Outpatient clinics typically lasted four hours at both hospitals. Characteristics of the patient, clinic, and clinician samples are described in Table 2.

History and symptom-based examinations. Overall, 554 (51%) children had a cough or difficulty breathing and 617 (57%) had a history of fever. History beyond initial presentation was taken in 84% of the cases. Temperature was taken in 221 (28.12%) patients with fever, cough, or difficulty breathing. Using a strict definition of cough or difficulty breathing to identify patients with symptoms compatible with ARI, only a small minority were examined appropriately. Of 554 patients with cough or difficulty breathing, 26 (5%) had respiratory rate counted, 79 (14%) had the chest exposed to the nipple line, and 137 (25%) had a stethoscope examination. Table 3 shows the examinations conducted for children with different groups of symptoms. Although symptoms that could be ARI did not often trigger appropriate examination

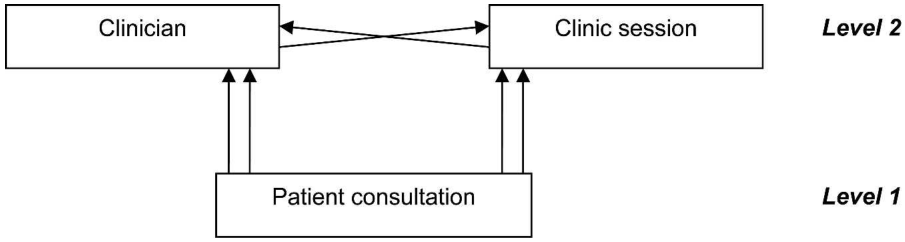

FIGURE 1. Cross-classified framework for analysis.

in absolute numbers, in relative terms they had a significant impact. Extending the analysis of the data shown in Table 3, we present univariate odds ratios (ORs) of the associations between symptoms and examinations observed. For children with a cough or difficulty breathing, the ORs were 2.57 for clinicians exposing the chest (95% confidence interval [CI] = 1.67–3.95), 18.91 for using a stethoscope (95% CI = 9.52–37.57), and 4.28 for counting respiratory rate (95% CI = 1.75–10.47). If the child had a history of fever, the OR was 9.06 for temperature being measured (95% CI = 5.18–14.11) and 4.38 for eyes/palms to be examined (95% CI = 3.02–6.36). By way of comparison, the OR of dehydration being checked was 6.24 (95% CI 3.39–11.48) if the patient had diarrhea.

TABLE 2
Sample of patients, clinics, and clinicians observed

	% Of observed sample*
Variable	Of 1,081 patients
Age of pediatric patient (1–5 years vs. < 12 months)	57.17
Sex of patient female	49.77
Consultations	Of 1,081 consultations
Patient admitted from outpatients	14.62
Referral to other staff during consultation	3.42
Referral to guidelines	1.85
Question asked by the patient/carer	5.55
Explanation given by clinician to patient/carer	44.40
Consultation duration more than 5 minutes	32.77
Consultation started after 10:30 AM	76.69
Clinics	Of 73 clinic sessions
Patient load above median for clinic†	43.39
No. of clinicians in clinic > 2	61.52
Afternoon/weekend shift vs. morning shift	3.98
Electricity present	71.42 (data missing for 11 clinics)
Patient load above median for day	37.41 (data missing for 14 clinics)
Clinicians	Of 23 clinicians
Clinician ≥ 40 years of age	31.17
Graduated with most recent qualification sine 2000	52.91
School education beyond form 4 (General Certificate of Secondary Education equivalent)	35.35 (data missing for 3 clinicians)
Clinician sex female	31.08
Originate from area around hospital	26.64 (data missing for 1 clinicians)
Has attended more than 2 seminars in the past year	70.03
Salary more than 200,000 Tanzanian Shillings per month (~180 US$)	58.33 (data missing for 3 clinicians)
Carries out extra duties at the hospital	46.06 (data missing for 3 clinicians)
Worked at the hospital for more than 2 years	31.82

* Because the sample was not random, percentages represent proportion of sample observed (based on observing clinicians in proportion to the number of patients usually consulting each clinician according to hospital records) and cannot be interpreted as proportion of patients/clinics/clinicians at the hospital overall.
† Because median for patient load varied by clinic type, this variable comprises these different medians.

Context of history and respiratory examination. Univariate analysis of the associations between clinical and non-clinical factors with the decision to take a history, expose the chest, use a stethoscope or take a temperature are shown in Tables 4 and 5. These associations suggest that each decision is associated with factors on the patient, consultation, clinic session, clinician, and hospital levels. Multivariable multi-level models examined which factors in addition to symptoms were associated with each of these decisions with adjustment for statistically significant covariates and for clustering at the clinic session and clinician levels. These models are shown in Table 6. Respiratory rate was counted too infrequently to enable multivariate analysis to be robust. History taking was more common among the first set of patients seen in the morning than later (adjusted OR for consultations after 10:30 AM = 0.61, 95% CI = 0.37–0.96), was more common among clinicians who did not originate in the area around the hospital (adjusted OR for clinicians originating outside the hospital area = 0.40, 95% CI = 0.16–0.91), and was more common in HII (adjusted OR = 3.55, 95% CI = 1.07–9.13). The variation between clinicians in taking a history was not statistically significant at 8% of the overall variation, but the 15% variation attributable to differences between clinic sessions was statistically significant, indicating that factors associated with the environment may have influenced the decision to take a full history.

Clinicians with higher salaries were more likely to expose the chest (OR = 4.47, 95% CI = 1.69–12.34). Stethoscope use was associated with longer consultations (OR for > 5 minutes = 2.86, 95% CI = 1.78–4.62) and with consultations with clinicians earning a higher salary (OR for > $180 = 4.27, 95% CI = 1.25–15.86), and was more frequent at HII (OR = 9.99, 95% CI = 2.17–37.68). The number of years of service and amount of training was not associated with history and respiratory examination, and the influence of salary was independent of these factors. Thermometer use was associated with longer consultations (OR = 4.70, 95% CI = 2.66–8.54) and was more likely at HII (OR = 28.19, 95% CI = 7.19–144.75). Thermometers were available in both hospitals.

Multivariate models for the other examinations shown in Table 3 (checking eyes or palms, dehydration, and abdomen)

TABLE 3
Examinations conducted for different symptoms presented*

Symptom	No.	No. (%) examinations per no. consultations						
		Chest exposed	Respiration rate counted	Stethoscope used	Temperature taken	Eyes or palms checked	Dehydration checked	Abdomen felt
CDB only	145	23 (15.86)	3 (2.07)	30 (20.69)	10 (6.90)	9 (6.21)	1 (0.69)	11 (7.59)
CDB and fever	332	51 (15.36)	18 (5.42)	95 (28.61)	121 (36.45)	100 (30.12)	13 (3.92)	41 (12.35)
CDB and diarrhea	24	2 (8.33)	2 (8.33)	4 (16.67)	7 (29.17)	6 (25.00)	1 (4.17)	2 (8.33)
CDB, diarrhea, and fever	53	3 (5.66)	3 (5.66)	8 (15.09)	20 (37.74)	15 (28.30)	5 (9.43)	4 (7.55)
Any CDB	554	79 (16.26)	26 (4.69)	137 (24.73)	158 (28.52)	130 (23.47)	20 (3.61)	58 (10.47)
Fever	165	12 (7.27)	2 (1.21)	2 (1.21)	32 (19.39)	40 (24.24)	5 (3.03)	21 (12.73)
Diarrhea	54	6 (11.11)	2 (3.70)	1 (1.85)	4 (7.41)	13 (24.07)	11 (20.37)	7 (12.96)
Fever and diarrhea	67	6 (8.96)	2 (2.99)	2 (2.99)	31 (46.27)	22 (32.84)	8 (11.94)	11 (16.42)
Other symptoms	241	8 (3.32)	0 (0.00)	4 (1.66)	3 (1.24)	11 (4.56)	1 (0.41)	17 (7.05)
Total	1,081	111 (10.27)	32 (2.96)	146 (13.51)	228 (21.09)	216 (19.98)	45 (4.16)	114 (10.55)

* CDB = cough/difficulty breathing.

TABLE 4
Univariate associations with history taking

Variable	No.	Odds ratio (95% CI)*
Patient variables		
Age of pediatric patient (1–5 years vs. 12 months)	1,081	0.95 (0.69–1.32)
Sex of patient female	1,064	0.86 (0.62–1.19)
Consultation variables		
Patient admitted during consultation	1,081	**1.88 (1.09–3.23)**
Referral to other staff during consultation	1,081	**0.51 (0.24–1.08)**
Referral to guidelines	1,081	3.78 (0.50–28.41)
Question asked by the patient/carer	1,081	1.81 (0.77–4.28)
Explanation given by clinician to patient/carer	1,081	**1.97 (1.40–2.78)**
Consultation duration more than 5 minutes	1,071	**1.64 (1.13–2.38)**
Clinic variables		
Patient load above median for clinic†	1,081	**1.71 (1.22–2.40)**
No. of clinicians in clinic > 2	1,081	1.25 (0.90–1.73)
Consultation started after 10:30 AM	1,081	**0.60 (0.39–0.92)**
Afternoon/weekend shift vs. morning shift	1,081	1.51 (0.59–3.89)
Electricity present	890	**1.64 (1.03–2.62)**
Clinician variables		
Clinician ≥ 40 years of age	1,081	**0.54 (0.39–0.75)**
Clinician sex female	1,081	1.26 (0.88–1.80)
School education beyond form 4 (General Certificate of Secondary Education equivalent)	1,027	**1.63 (1.10–2.41)**
Graduated with most recent qualification since 2000	1,081	**2.55 (1.82–3.57)**
Originate from area around the hospital	1,078	**0.24 (0.17–0.33)**
Salary more than 200,000 Tanzanian Shillings (~180 US$)	1,027	**1.58 (1.11–2.24)**
Carries out extra duties at the hospital	1,027	1.11 (0.78–1.57)
Worked at the hospital for more than 2 years	1,081	1.01 (0.71–1.43)
Has attended more than 2 seminars in the past year	1,081	**1.53 (1.10–2.15)**
Hospital		
Hospital observed (HII vs. HI)	1,081	**5.79 (3.98–8.44)**

* Variables statistically significant ($P < 0.1$) are in **bold**. CI = confidence interval.
† Because median for patient load varied by clinic type, this variable comprises these different medians.

showed similar results as those for ARI-related examinations. Examinations were associated with relevant symptoms and also conducting other examinations. In addition, contextual variables including the hospital, salary of the clinician, and number of clinicians available during the clinic were associated with examinations.

DISCUSSION

Pneumonia is a leading cause of mortality in children and 90% of this burden is borne in developing countries.[26] Identifying and classifying potential pneumonia cases is essential to effective case management.[5,27] Our study found that most clinical assessments were unsatisfactory and infrequent in absolute numbers, but children were relatively more likely to have their chest exposed and respiratory rate counted (two basic measures that would detect a high proportion of pneumonia diagnoses) if they had a cough or difficulty breathing. This suggested health workers were, to an extent, following clinical logic when deciding to undertake these examinations. However, we also found that personal characteristics of the examining clinician and contextual factors of the consultation were important in predicting whether children were likely to be more fully assessed. Although a number of studies have documented clinical assessments in resource-poor settings, few studies have explored these contextual factors that may provide important indications for how to improve the current situation.

Our findings documenting poor clinical assessment for children with suspected pneumonia are consistent with results of other studies. In primary care settings, a study in Kenya found that children with pneumonia were often not properly assessed with consequent inadequate treatment that impacted mortality.[9] A study of 40 private health providers in India found that respiratory rate was counted in only 14% and chest exposed in only 9% of children with ARI symptoms.[11] Hospital studies have documented that there was no record of respiratory rate in the case notes of 85% and 69% of children admitted with pneumonia to hospitals in Tanzania and Kenya, respectively.[12,13] In 13 pediatric outpatient departments in Tanzania, the chest was exposed in only 28% and respiratory rate counted in only 9% of children whose mother had reported a cough or difficulty breathing.[12]

Financial and non-financial factors were associated with clinical practice, in addition to patient symptoms. This finding

Table 5
Univariate analysis of examinations

Variables	No.	Odds ratio (95% CI)* Chest exposure	Temperature measurement	Stethoscope use
Patient variables				
Age of pediatric patient (1–5 years vs. 12 months)	1,081	**0.71 (0.48–1.05)**	0.99 (0.74–1.53)	**0.63 (0.44–0.89)**
Sex of patient female	1,064	0.83 (0.55–1.23)	0.79 (0.59–1.07)	0.91 (0.61–1.30)
Fever	1,081	**1.44 (0.96–2.17)**	**9.06 (5.81–14.11)**†	**2.29 (1.55–3.37)**
Cough or difficulty breathing	1,081	**2.57 (1.67–3.95)**†	**2.60 (1.91–3.56)**†	**18.91 (9.52–37.57)**†
Diarrhea	1,081	0.79 (0.46–1.35)	**1.97 (1.40–2.78)**†	**0.47 (0.27–0.82)**
Vomiting	1,081	0.82 (0.48–1.41)	**2.28 (1.62–3.21)**†	0.85 (0.53–1.36)
Abdominal pain	1,081	1.76 (0.80–3.85)	**0.15 (0.04–0.63)**	0.56 (0.20–1.57)
Consultation variables				
Temperature taken with thermometer	1,081	**1.95 (1.27–2.98)**	–	**1.56 (1.05–2.32)**†
Chest exposed	1,081	–	**1.95 (1.27–2.98)**	**2.73 (1.72–4.33)**†
Respiration rate counted	1,081	**13.22 (6.37–27.43)**†	**9.00 (4.20–19.31)**†	0.91 (0.32–2.64)
Stethoscope used	1,081	**2.73 (1.72–4.33)**†	**1.56 (1.05–2.32)**	–
Eyes or palms examined	1,081	**1.73 (1.11–5.66)**	**2.15 (1.54–2.99)**†	**1.84 (1.25–2.72)**
Dehydration	1,081	**7.50 (4.00–14.07)**†	**3.18 (1.74–5.85)**†	**1.89 (0.92–3.91)**
Abdomen felt	1,081	**3.07 (1.88–5.01)**†	**1.46 (0.94–2.27)**†	1.42 (0.85–2.38)
Consciousness	1,081	**18.20 (8.86–37.36)**†	**2.59 (1.30–5.18)**	**4.06 (2.00–8.25)**†
Patient admitted during consultation	1,081	**2.71 (1.73–4.26)**†	**8.65 (5.99–12.48)**†	**2.39 (1.58–3.62)**†
Referral to other staff during consultation	1,081	**2.52 (1.12–5.66)**	0.44 (0.16–1.27)	1.00 (0.38–2.61)
Referral to guidelines	1,081	**6.20 (2.48–15.52)**†	1.25 (0.45–3.48)	1.13 (0.33–3.91)
Question asked by the patient/carer	1,081	0.97 (0.41–2.31)	1.14 (0.62–2.13)	1.30 (0.64–2.63)
Explanation given to patient/carer	1,081	**2.78 (1.84–4.21)**†	0.85 (0.63–1.14)	**1.34 (0.94–1.90)**
Consultation duration more than 5 minutes	1,071	**4.93 (3.24–7.49)**†	**3.73 (0.76–5.06)**†	**2.04 (1.43–2.91)**†
Clinic variables				
Patient load above median for clinic	1,081	**1.82 (1.23–2.71)**	**0.54 (0.40–0.74)**†	0.79 (0.55–1.12)
Number of clinicians in clinic > 2	1,081	**1.47 (0.96–2.25)**	0.86 (0.64–1.87)	0.94 (0.66–1.34)
Consultation started after 10:30 AM	1,081	0.89 (0.57–1.40)	1.30 (0.91–1.87)	0.88 (0.59–1.32)
Afternoon/weekend shift vs. morning shift	1,081	**2.07 (0.94–4.59)**	**0.27 (0.08–0.88)**	1.74 (0.82–3.71)
Electricity present	890	0.98 (0.49–1.96)	**33.03 (4.58–238.3)**	**2.14 (1.01–4.52)**
Clinician variables				
Clinician ≥ 40 years of age	1,081	0.88 (0.57–1.36)	**2.12 (1.57–2.88)**†	1.26 (0.87–1.82)
Clinician sex female	1,081	**0.62 (0.39–0.98)**	0.81 (0.59–1.12)	**0.22 (0.13–0.38)**†
School education beyond Form 4 (equivalent to General Certificate of Secondary Education)	1,027	**0.54 (0.34–0.86)**	1.14 (0.84–1.55)	**0.61 (0.41–0.90)**†
Graduated since 2000	1,081	1.24 (0.83–1.84)	**0.39 (0.29–0.53)**†	0.96 (0.68–1.36)
Originate from area around the hospital	1,078	**0.22 (0.11–0.44)**†	**0.07 (0.04–0.15)**†	**0.47 (0.29–0.75)**
Salary more than 200,000 Tanzanian Shillings per month (~180 US$)	1,027	**3.34 (2.04–5.47)**†	**2.33 (1.68–3.22)**†	**4.26 (2.70–6.73)**†
Carries out extra duties at the hospital	1,027	**3.02 (1.96–4.64)**†	**2.23 (1.65–3.01)**†	**2.71 (1.88–3.94)**†
Worked at the hospital for more than 2 years	1,081	1.07 (0.71–1.64)	1.09 (0.80–1.49)	0.81 (0.55–1.20)
Has attended > 2 seminars in the past year	1,081	**1.72 (1.01–2.78)**	**1.37 (0.98–1.19)**	1.11 (0.75–1.64)
Hospital				
Hospital observed (HII vs. HI)	1,081	**2.63 (1.20–5.77)**	**16.00 (5.05–50.67)**†	**13.87 (3.40–56.59)**

* Variables statistically significant ($P < 0.1$) are in **bold**.
† $P < 0.001$.

provides support for the argument that improvement in performance requires both financial and non-financial incentives.[28] The association between salary and better performance is striking, although it may not be causal. In our corresponding qualitative study, we found that higher salary was associated with higher motivation (Chandler CI and others, unpublished data), which may explain better performance among clinicians in the higher salary bracket. Alternatively, higher salary may be a result of better performance if clinicians were paid more in line with performance (so the causality is reversed). However, performance-related pay was not yet instituted at the time of the study when salaries were related to years of service, although additional payments for positions of responsibility were paid to some clinicians, apparently selected on the basis of their relationship with district administration. That clinicians performed better during longer consultations supports the hypothesis that improvement requires an increased availability of time,[29] which also has to be considered in terms of the potential increase in cost.[30] The finding that HII performed better than HI in most outcomes may reflect a higher general standard of care maintained by peer supervision or patient expectations; differences in organizational culture were observed in the qualitative study and are likely to have affect performance.[31]

The variables that affected history taking were different from those predicting examinations. The time of day and clinician origins were important, as well as the hospital. A full history was more likely to be taken if the patient was seen earlier in the day (outpatient clinics began between 7:30 AM and 8:00 AM), which suggests that when clinicians have more energy at the start of the day, patients may receive a more thorough consultation. This finding echoes findings in our qualitative study when lack of opportunity to have breakfast at the traditional time of 10:30 AM (for their non-clinical colleagues and when they are not on clinical duty) was a source of dissatisfaction. Clinicians suggested that the introduction of formal breaks during the working day might increase their

Table 6
Multivariate multilevel models for history and examination decisions

Parameter	Adjusted odds ratio* (95% confidence interval)			
	History	Chest exposure	Stethoscope	Temperature
N	1,078	1,017	1,017	1,071
Fixed part				
Patient				
Fever				14.28 (7.71–28.28)
Cough or difficulty breathing		3.42 (1.92–6.31)	24.22 (12.40–53.30)	3.49 (2.03–6.24)
Diarrhea			0.46 (0.23–0.89)	3.06 (1.69–5.56)
Consultation				
Respiration rate counted		11.02 (3.61–36.93)		5.46 (1.40–22.65)
Dehydration checked		3.22 (1.21–8.60)		
Admitted during consultation				5.10 (2.51–10.56)
Malaria test requested during consultation				1.75 (1.01–1.12)
Consultation started after 10:30 AM	0.61 (0.37–0.96)			
Consultation duration over 5 minutes		2.47 (1.43–4.21)	2.86 (1.78–4.62)	4.70 (2.66–8.54)
Clinician				
Clinician originates in hospital area	0.40 (0.16–0.91)			
Salary more than $180 per month		4.47 (1.69–12.34)	4.27 (1.25–15.86)	
Hospital				
Hospital HII vs. HI	3.55 (1.07–9.13)		9.99 (2.17–37.68)	28.19 (7.19–144.75)
Random part				
Clinic session variance estimate ($\sigma^2_{u_1}$) (SE), partition coefficient, %	0.59 (0.31)† 15.10	2.82 (1.28)† 46.12	0.40 (0.32) 10.84	2.87 (1.27)† 46.59
Clinician variance estimate ($\sigma^2_{u_2}$) (SE), partition coefficient, %	0.28 (0.24) 7.89	0.47 (0.47) 12.50	0.23 (0.93) 27.21	2.81 (1.62) 46.07

* Only variables statistically significant in the model, or that gave a better fit to the data, are presented because validity of the models could be compromised by adding variables that were not significant in univariate analysis because of sample size constraints with a low prevalence of the outcome variables.
† Variance statistically significant at the 95% level.

motivation to work, and this suggestion is supported by the data in this report.

Other studies have also examined the influence of time of day on performance, although their cut-off times were later, which may account for different results. In Malawian health facilities, errors in malaria treatment were more frequent before 1:00 PM, which can be explained by the higher case load compared with that during afternoon consultations.[32] However, in Benin and Kenya, similar analysis found no association with time of consultation.[33,34] We were surprised that clinicians who originated from the hospital district were less likely to take a full history, having hypothesized that their status would rely on provision of good quality of care. However, discussion of this result with clinicians at participating and neighboring hospitals (when we visited to show them our findings) suggested this was not surprising to them, which can be explained by additional distractions of those originally from the hospital area, compared with outside workers who might have more time to spend studying and put more effort into work. If true, this explanation would support programs that rotate clinicians through different placements, including incentive schemes for periods spent in hard-to-reach settings.[35] One of the reasons given for such distractions was financial obligations: time spent on businesses to support family and lifestyle status may be increased under these circumstances. In this case, clinician goals are less likely to be in line with organizational goals of patient-centered care and may lead to poor motivation to perform to a person's maximum ability.[36]

The importance of the context of the consultation was highlighted in our study by the high amount of variation attributable to differences between clinic sessions, which suggested that when clinics are not adequately supported, clinicians may be restricted in their practice. For example, although variance was not significant, there was a much higher percentage variance in examination with a stethoscope attributable to the clinic context, which suggested that having the necessary material at the time of the consultation (in this case a stethoscope) is an important factor. The importance of equipment availability has been reported to restrict to the implementation of IMCI in Uganda.[37] The outcomes analyzed in our study were not associated with clinician age, level of secondary education, year of graduation, or number of seminars attended by clinicians, and there was less variation between clinicians than between clinics attended by the same clinician. However, this does not rule out the potential role of training; all clinicians included in the sample were clinical officers and had received a similar level and style of training, and although there was variation between clinicians in the outcomes, the performance overall was low and this may be improved with training. We did not measure the competence of clinicians, but the variation found within individual clinicians' performance supports the hypothesis of a gap between knowledge and practice. Supervision has been argued as key to maintaining standards, closing the gap between providers' knowledge and practice.[38]

Observation of clinicians may have altered their behavior (Hawthorne effect), but this effect has been shown to reduce rapidly over successive consultations.[39] To maximize this reduction and to get a better understanding of the environmental context, we chose to carry out the research in only two hospitals (a larger total number of consultations were observed in HI but with patients more than five years of age and were not included in this study). This use of only two hospitals limited our ability to detect and quantify differences in context at the hospital level, which we expected, on the basis of other findings,[40] would impact performance. The associations found in this study between specific contextual and practice variables may not be generalizable to other settings, but the finding that practice was associated with measured and unmeasured contextual variables is likely to apply to other settings even if the specific factors differ.

Appropriate examinations of children with symptoms of ARI are infrequent in absolute terms, although respiratory symptoms lead to a significant relative increase in these examinations. Counting the respiratory rate was so rare that a model of its use could not be constructed. Other relevant examinations for ARI symptoms, including chest exposure, stethoscope use, and use of a thermometer, were more likely in longer consultations, when the clinician had a higher salary and in different hospital environments. This report supports the findings of our qualitative study and the argument that improvement in performance may be achievable with financial and non-financial incentives for clinical staff.

Received July 16, 2008. Accepted for publication September 17, 2008.

Acknowledgments: We thank all outpatients, clinical officers, and administrations at both participating hospitals for their participation; and the Joint Malaria Programme of Northeast Tanzania and Kini Chonya, Frank Mtei, Beatrice Siteyian, Frida Temba, and Clara Lweno for their assistance.

Financial support: This study was supported by grants from the Sir Halley Stewart Trust; the Economic and Social Research Council; the Medical Research Council, United Kingdom; and the European Commission (SANTE/2004/078-607).

Authors' addresses: Clare I. R. Chandler, London School of Hygiene and Tropical Medicine, 49-51 Bedford Square, London WC1B 3DP, United Kingdom, E-mail: clare.chandler@lshtm.ac.uk. Behzad Nadjm, and Christopher J. M. Whitty, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, United Kingdom, E-mails: bnadjm@yahoo.com, hugh.reyburn@lshtm.ac.uk, and christopher.whitty@lshtm.ac.uk. Gloria Boniface and Kaseem Juma, Joint Malaria Programme, Kilimanjaro Christian Medical Centre, PO Box 2228, Moshi, Tanzania, E-mails: glosa2003@yahoo.co.uk and kaseem_juma@yahoo.co.uk. Hugh Reyburn, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, United Kingdom, and Joint Malaria Programme, Kilimanjaro Christian Medical Centre, PO Box 2228, Moshi, Tanzania, E-mail: hugh.reyburn@lshtm.ac.uk.

REFERENCES

1. Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell H, 2008. Epidemiology and etiology of childhood pneumonia. *Bull World Health Organ 86:* 408–416.
2. Greenwood B, 2008. A global action plan for the prevention and control of pneumonia. *Bull World Health Organ 86:* 322–2A.
3. Graham SM, English M, Hazir T, Enarson P, Duke T, 2008. Challenges to improving case management of childhood pneumonia at health facilities in resource-limited settings. *Bull World Health Organ 86:* 349–355.
4. Qazi SA, Rehman GN, Khan MA, 1996. Standard management of acute respiratory infections in a children's hospital in Pakistan: impact on antibiotic use and case fatality. *Bull World Health Organ 74:* 501–507.
5. Sazawal S, Black RE, 2003. Effect of pneumonia case management on mortality in neonates, infants, and preschool children: a meta-analysis of community-based trials. *Lancet Infect Dis 3:* 547–556.
6. Bryce J, Gouws E, Adam T, Black RE, Schellenberg JA, Manzi F, Victora CG, Habicht JP, 2005. Improving quality and efficiency of facility-based child health care through integrated management of childhood illness in Tanzania. *Health Policy Plan 20(Suppl 1):* i69–i76.
7. Rowe SY, Olewe MA, Kleinbaum DG, McGowan JE Jr, McFarland DA, Rochat R, Deming MS, 2007. Longitudinal analysis of community health workers' adherence to treatment guidelines, Siaya, Kenya, 1997–2002. *Trop Med Int Health 12:* 651–663.
8. Ofori-Adjei D, Arhinful DK, 1996. Effect of training on the clinical management of malaria by medical assistants in Ghana. *Soc Sci Med 42:* 1169–1176.
9. Lindblade KA, Hamel MJ, Feikin DR, Odhiambo F, Adazu K, Williamson J, Vulule JM, Slutsker L, 2007. Mortality of sick children after outpatient treatment at first-level health facilities in rural western Kenya. *Trop Med Int Health 12:* 1258–1268.
10. Krause G, Schleiermacher D, Borchert M, Benzler J, Heinmuller R, Ouattara K, Coulibaly S, Diasso I, Ilboudo A, Diesfeld HJ, 1998. Diagnostic quality in rural health centres in Burkina Faso. *Trop Med Int Health 3:* 100–107.
11. Chakraborty S, Frick K, 2002. Factors influencing private health providers' technical quality of care for acute respiratory infections among under-five children in rural West Bengal, India. *Soc Sci Med 55:* 1579–1587.
12. Reyburn H, Mwakasungula E, Chonya S, Mtei F, Bygbjerg I, Poulsen A, Olomi R, 2008. Clinical assessment and treatment in paediatric wards in the north-east of the United Republic of Tanzania. *Bull World Health Organ 86:* 132–139.
13. English M, Esamai F, Wasunna A, Were F, Ogutu B, Wamae A, Snow RW, Peshu N, 2004. Assessment of inpatient paediatric care in first referral level hospitals in 13 districts in Kenya. *Lancet 363:* 1948–1953.
14. Leonard KL, Masatu MC, 2003. *Knowledge and Practice in Health Care: Why Do Doctors who Know What To Do Not Do It*? New York: Colombia University.
15. Mtango FD, Neuvians D, Korte R, 1989. Magnitude, presentation, management and outcome of acute respiratory infections in children under the age of five in hospitals and rural health centres in Tanzania. *Trop Med Parasitol 40:* 97–102.
16. Tanzania National Bureau of Statistics, 2005. *Tanzania Demographic and Health Survey 2004–5*. Dar es Salaam: United Republic of Tanzania. Available at: http://www.nbs.go.tz/DHS/index.htm. Accessed July 24, 2008.
17. Chandler CI, Chonya S, Boniface G, Juma K, Reyburn H, Whitty CJ, 2008. The importance of context in malaria diagnosis and treatment decisions—a quantitative analysis of observed clinical encounters in Tanzania. *Trop Med Int Health 13:* 1131–1142.
18. World Health Organization, 2005. *Hospital Care for Children. Guidelines for the Management of Common Illnesses with Limited Resources*. Geneva: World Health Organization.
19. McIntosh K, 2002. Community-acquired pneumonia in children. *N Engl J Med 346:* 429–437.
20. Chandler CI, Jones C, Boniface G, Juma K, Reyburn H, Whitty CJ, 2008. Guidelines and mindlines: why do clinical staff over-diagnose malaria in Tanzania? A qualitative study. *Malar J 7:* 53.
21. Rasbash J, Steele F, Browne W, Prosser B, 2005. *A User's Guide to MLwiN*. Bristol, United Kingdom: Centre for Multilevel Modelling, University of Bristol.
22. Fielding A, Goldstein H, 2006. *Cross-Classified and Multiple Membership Structures in Multilevel Models: An Introduction and Review: Research Report Number 791*. Birmingham, United Kingdom: Department for Education and Skills. University of Birmingham.
23. Goldstein H, Browne W, Rasbash J, 2002. Partitioning variation in multilevel models. *Understanding Statistics 1:* 223–232.
24. Snijders TA, Bosker RJ, 1999. *Multilevel Analysis*. Newbury Park: Sage.
25. Spiegelhalter DJ, Best NG, Carlin BP, van der Linde A, 2002. Bayesian measures of model complexity and fit. *J Roy Statist Soc Ser B Statistical Methodology 64:* 583–616.
26. UNICEF, WHO, 2006. *Pneumonia: The Forgotten Killer of Children*. New York: The United Nations Children's Fund and World Health Organization. Available at: http://www.unicef.org/publications/files/Pneumonia_The_Forgotten_Killer_of_Children.pdf. Accessed July 24, 2008.
27. Ayieko P, English M, 2007. Case management of childhood pneumonia in developing countries. *Pediatr Infect Dis J 26:* 432–440.
28. Weller B, 2008. *Guidelines: Incentives for Health Professionals*. Global Health Workforce Alliance, World Health Organiza-

tion, and International Council of Nurses. Available at: http://www.who.int/workforcealliance/documents/Incentives_Guidelines%20EN.pdf. Accessed July 24, 2008.

29. Adam T, Amorim DG, Edwards SJ, Amaral J, Evans DB, 2005. Capacity constraints to the adoption of new interventions: consultation time and the integrated management of childhood illness in Brazil. *Health Policy Plan 20(Suppl 1):* i49–i57.
30. Khan MM, Shmed S, Saha KK, 2000. Implementing IMCI in a developing country: estimating the need for additional health workers in Bangladesh. *Hum Resour Health Dev J 4:* 73–82.
31. Lethbridge J, 2004. Public sector reform and demand for human resources for health (HRH). *Hum Resour Health 2:* 15.
32. Osterholt DM, Rowe AK, Hamel MJ, Flanders WD, Mkandala C, Marum LH, Kaimila N, 2006. Predictors of treatment error for children with uncomplicated malaria seen as outpatients in Blantyre district, Malawi. *Trop Med Int Health 11:* 1147–1156.
33. Rowe AK, Onikpo F, Lama M, Deming MS, 2003. Risk and protective factors for two types of error in the treatment of children with fever at outpatient health facilities in Benin. *Int J Epidemiol 32:* 296–303.
34. Zurovac D, Rowe AK, Ochola SA, Noor AM, Midia B, English M, Snow RW, 2004. Predictors of the quality of health worker treatment practices for uncomplicated malaria at government health facilities in Kenya. *Int J Epidemiol 33:* 1080–1091.
35. Makundi EA, Mboera LE, Malebo HM, Kitua AY, 2007. Priority setting on malaria interventions in Tanzania: strategies and challenges to mitigate against the intolerable burden. *Am J Trop Med Hyg 77:* 106–111.
36. Franco LM, Bennett S, Kanfer R, 2002. Health sector reform and public sector health worker motivation: a conceptual framework. *Soc Sci Med 54:* 1255–1266.
37. Pariyo GW, Gouws E, Bryce J, Burnham G, 2005. Improving facility-based care for sick children in Uganda: training is not enough. *Health Policy Plan 20(Suppl 1):* i58–i68.
38. Das J, Hammer JS, 2004. *Strained Mercy: The Quality of Medical Care in Delhi. World Bank Policy Research Working Paper 3228*. Washington, DC: The World Bank and The Institute of Socio-Economic Research on Development and Democracy. Available at: http://ssrn.com/abstract = 610269. Accessed July 24, 2008.
39. Leonard K, Masatu MC, 2006. Outpatient process quality evaluation and the Hawthorne effect. *Soc Sci Med 63:* 2330–2340.
40. Leonard K, Masatu M, Vialou A, 2005. *Getting Clinicians To Do Their Best: Ability, Altruism and Incentives. Working Paper*. College Park: University of Maryland.