# Pneumonia in Children: Implications for Intervention

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## INTRODUCTION

A cute respiratory infections (ARI) are the leading cause of morbidity and mortality in many developing countries (Leowski, 1986). ARI mortality rate was 10.23 per 1000 persons in infants and 3.0 per 1000 persons in children 1 to 4 years of age as of 1983 in the Philippines. These rates are 12 and 50 times higher than the corresponding rates from the United States and Canada which are 0.85 and 0.06 per 1000 persons in infants and children 1 to 4 years of age, respectively (Leowski, 1986). This makes the control of ARI of public health importance of high priority.

## ARI AND POVERTY

A descriptive study on ARI incidence and risk factors for morbidity in a depressed urban community showed a strong social-class gradient, particularly in children (Tupasi, *et al.*, 1988). Within each age category, the rates for ARI were consistently lowest in the high socioeconomic group, followed by the middle; the highest rates were in the low socioeconomic group.

Stepwise logistic regression showed that lower socioeconomic status and age less than 1 year were significant risk factors for ARI morbidity (Table 1). The risk of acquiring ARI, as compared with children from the upper socioeconomic level, was almost 5 times higher among children from the lower level and 3.7 times higher among children from the middle level. These risks were statistically significant. The risk of acquiring ARI among children less than 1 year of age was 1.8 times higher than that among children 1 to 4 years old; this risk was also statistically significant.

**Table 1. Logistic regression coefficients, estimated relative risks, and 95% confidence intervals of the risk factors for ARI morbidity.**

| RISK FACTOR | COEFFICIENT | RR | 95% CI |
|---|---|---|---|
| Socioeconomic status | | | |
| lower | 0.62 | 4.9 | 4.0-5.9 |
| middle | 0.34 | 3.7 | 3.0-4.5 |
| upper* | -0.96 | | |
| Age group (y) | | | |
| <1 | 0.31 | 1.8 | 1.6-2.1 |
| 1-4* | -0.31 | | |

The inverse relation between socioeconomic status and ARI morbidity concurs with findings in other countries (Colley and Reid, 1970; Monto and Ross, 1977). Indeed, low socioeconomic status proved to be the most significant risk factor for ARI morbidity in the population studied. The factors responsible for the association between poverty and high ARI morbidity are quite complex. Certain factors that characterize the poor, such as poor housing facilities, crowding, malnutrition, financial constraints, educational limitations, and resulting ignorance, contribute to this association. Specifically, noncompliance with preventive measures, such as the childhood immunization, was more prevalent in the population studied. Until these factors are addressed through a comprehensive socioeconomic development, the current levels of ARI morbidity in this community will continue.

## MALNUTRITION AND ARI MORBIDITY

To assess the impact of malnutrition on ARI morbidity, a longitudinal study of a cohort of 1,978 children less than 5 years of age was undertaken. These children were from households in the low income group randomly chosen from a depressed urban community.

ARI morbidity risk ratios rates in association with the nutritional status of the children studied utilizing weight for age are shown in Table 2 (Monto and Ross, 1977). Malnourished children with Z scores of <-3 and <-2 SD had a modest increased risk for acquiring ARI at 1.24 (95% CI 1.13, 1.35), and 1.14 (95% CI 1.07, 1.21) times higher than normal children, respectively. These risk ratios were both significant even after controlling for possible confounding risk factors including age, crowding, parental smoking. When a more severe outcome such as ALRI was analyzed, the risk associated with malnutrition was greater at 1.9 (95% CI 1.46, 2.39) for children with Z score of <-3 SD and 1.2 (95% CI 1.03, 1.47) for <-2SD compared with well-nourished children. Again, these risk ratios remained significant after controlling for other risk factors. The summary risk ratio for ARI and ALRI morbidity associated with malnutrition were likewise significant.

**Table 2. Crude relative risk and 95% confidence interval for ARI and ALRI morbidity in children with varying nutritional status adjusted for age, crowding and parental smoking.**

| Z SCORES Wt. for Age | CRUDE RR (95% CI) | ADJUSTED FOR: Age (95% CI) | Crowding (95% CI) | Parental Smoking (95% CI) | SUMMARY RELATIVE RISK (95% CI) |
|---|---|---|---|---|---|
| 1. ARI morbidity | | | | | |
| <-3 SD | 1.24 | 1.37 | 1.22 | 1.09 | 1.24 |
| | (1.14,1.34) | (1.26,1.48) | (1.13,1.32) | (1.01,1.18) | (1.13,1.36) |
| <-2 SD | 1.14 | 1.34 | 1.12 | 1.13 | 1.19 |
| | (1.08,1.19) | (1.28,1.41) | (1.07,1.18) | (1.07,1.18) | (1.11,1.27) |
| =>-2 SD | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2. ALRI morbidity | | | | | |
| <-3 SD | 1.9 | 1.88 | 2.10 | 1.85 | 1.82 |
| | (1.46,2.39) | (1.47,2.41) | (1.64,2.68) | (1.45,2.36) | (1.43,2.33) |
| <-2 SD | 1.2 | 1.30 | 1.38 | 1.21 | 1.30 |
| | (1.03,1.47) | (1.09,1.56) | (1.16,1.65) | (1.01,1.44) | (1.09,1.56) |
| =>-2 SD | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

* Z scores were computed and the basis of international reference population data and children were categorized for each observation period which was 3 months for those younger than 2 years and 6 months for older children.

** In computing incidence rates, the period of observation and at risk were adjusted to take into account missing weeks of observation.

*** Risk ratios were calculated relative to the rates seen among children with anthropometric index in the= > -2 SD category

## MALNUTRITION AND ARI MORTALITY

The clinical outcome of severe ALRI in children with varying nutritional status, expressed in weight for age showed that the risk of dying from ALRI was 3.22, 2.52, and 2.00

times higher in malnourished children with weight for age Z scores of <-4, <-3, and <-2 SD, respectively, compared to normal children with Z scores =>-2 SD. These odds ratios were significant (Table 3).

**Table 3. Outcome of severe ALRI correlated with nutritional status of children studied based on Z-scores in reference to the NCHS/CDC reference population.**

| | TOTAL STUDIED | NO. OF DEATHS | % CFR | OR | (95% CI) |
|---|---|---|---|---|---|
| Wt for age Z-score | | | | | |
| <-4 SD | 63 | 16 | 25.4 | 3.22 | (1.51,6.87) |
| <-3 SD | 138 | 29 | 21.0 | 2.52 | (1.32,4.81) |
| <-2 SD | 149 | 26 | 17.4 | 2.00 | (1.04,3.85) |
| =>-2 SD | 178 | 17 | 9.6 | 1.00 | |

Prospective studies in developing countries have demonstrated increased mortality rates due to pneumonia in malnourished children compared to normal controls (Kielmar and McCord, 1950; Escobal, *et al.*, 1976; and Tunbridge and Wicks, 1967). Our data showing the significant impact of malnutrition on ARI mortality supports the findings of earlier study (Tupasi, *et al.*, 1988). The adverse effect of malnutrition on clinical outcome was independent of clinical findings including dehydration, pneumonic infiltrations, and liver enlargement suggesting possible heart failure.

Immune deficiency in malnourished children (Chandra, 1981; Neumann, *et al.*, 1975), predisposes to infection. In addition, an associated deficiency in Vitamin A, a nutrient which is important not only in ensuring a competent cell mediated immunity but also in maintaining mucosal integrity, further aggravates the predisposition of malnourished children to infection (Beisel, *et al.*, 1981).

An increased frequency of ARI has also been reported in correlation with Vitamin A deficiency associated with malnutrition (Sommer, *et al.*, 1984). Our present study demonstrates that malnutrition, as indicated by a deficient weight for age, is significantly associated with increased ARI as well as ALRI morbidity in these children coming from a homogenous low socioeconomic and environmental background. This impact of malnutrition has been shown to be independent of other sociodemographic risk factors demonstrated to be significant predictors for ARI morbidity.

Our findings underscore the importance of nutritional intervention in the control of ARI morbidity and mortality. Along this line, a Vitamin A supplementation program has been correlated with diminished ARI morbidity (Pinnock, *et al.,* 1986) and mortality, particularly in communities with high prevalence of malnutrition (Sommer, *et al.,* 1986).

## MEASLES AND ARI

In the same study, measles was observed in 258 (48%) of 537 poor children hospitalized for pneumonia (Orren, *et al.,* 1974). Measles in these children tended to be associated with more frequent bacterial infection and was observed to be a significant predictor of ALRI mortality (Table 4). The odds of acquiring bacteremic ALRI was 1.2 times higher in children with measles and the risk of dying from ALRI in these children was 2.4 times higher than in children without measles. The general immunosuppresion associated with measles is well known to predispose to secondary bacterial infection (Shann, 1986). These underscore the importance of the expanded immunization program, particularly against measles, as a part of the comprehensive public health program in the control and prevention of ARI.

**Table 4. Prevalence of bacteremic ALRI and ALRI case fatality rates in children with and without measles.**

| | MEASLES | | |
|---|---|---|---|
| | YES | NO | ODDS RATIO (95% CI) |
| No. of children | 258 | 279 | |
| Bacteremic ALRI | 14.3 | 11.8 | 1.2 (1.1-1.4) |
| Case fatality rate | 23.5 | 12.5 | 2.4 (2.1-4.3) |

## ARI CASE MANAGEMENT

Since majority of life threatening pneumonias in developing countries are bacterial in etiology (WHO, 1982), the World Health Organization (WHO) has proposed antimicrobial therapy in children with cough if there is difficulty in breathing as manifested by tachypnea and/or chest indrawing, failure to feed and/or cyanosis (Lucero, *et al.,* n.d). In a prospective study undertaken to test the validity of tachypnea >50 per minute as an indicator of pneumonia based on chest x-ray infiltrates, tachypnea of >50 per minute as proposed by the WHO ARI algorithm was a good index of pneumonia, in a population of children with a pneumonia prevalence of 69% (Tupasi, *et al.,* n.d.).

However, in another population of 199 children with only 29% prevalence of pneumonia the sensitivity and positive predictive values were much lower with rates of 45% and 37%, respectively for tachypnea >40, and 19% and 31%, respectively, for tachypnea >50 per minute (Table 5).

Utilizing tachypea of >50 per minute as the only basis for initiation of antibiotic therapy would mean that in this population with a pneumonia prevalence of 29%, only 6 of 29 (19%) children with pneumonia will be given antibiotic therapy while the remaining 23 (81%) will not receive treatment. Conversely, 12 out of 70 (17%) children will be given antibiotics without actually having pneumonia.

Tachypnea of >50 per minute can be a valuable tool and can even replace the chest x-ray in the diagnosis of pneumonia in a child with cough in the setting of severely ill children with a high prevalence of pneumonia such as those seen at tertiary care hospitals like RITM but was not found applicable in less severely ill children such as those seen at the MMC. The WHO algorithm, however, was meant to be applied in the community where the cases may even be less severe and where the prevalence of pneumonia may be much lower. However, pneumonic infiltrates are not necessarily bacterial in etiology (Tupasi, *et al.,* n.d.). Utilizing radiologic pneumonia without consideration of etiology as the "gold standard" for validating RR >50 per minute as the basis for deciding on antibiotic treatment may have its limitations. What is crucial to know, however, is what the outcome of the illness is in those children with cough managed according to these guidelines, particularly those with radiologic evidence of pneumonia who would not be given antibiotics because of a respiratory rate of less than 50 per minute. Future studies on the applicability of this clinical

Table 5. Validation of tachypnea > 50 per minute as a predictor of pneumonia in two populations of children with varying prevalence of pneumonia.

| PNEUMONIA PREVALENCE | RESPIRATORY RATE | | PNEUMONIA Yes | PNEUMONIA No | SENSITIVITY | SPECIFICITY | + PRED VALUE | --PRED VALUE | + LIKELYHOOD RATIO | 95% CONFIDENCE INTERVAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. 69% | >50/min | Yes | 74 | 10 | 54 | 84 | 88 | 44 | 5.90 | (2.77,12.56) |
| | | No | 64 | 51 | | | | | | |
| | >40/min | Yes | 101 | 26 | 73 | 57 | 80 | 49 | 3.67 | (1.95, 6.91) |
| | | No | 37 | 35 | | | | | | |
| 2. 29% | > 50/min | Yes | 11 | 24 | 19 | 83 | 31 | 71 | 1.14 | (0.52, 2.51) |
| | | No | 47 | 115 | | | | | | |
| | >40/min | Yes | 26 | 45 | 45 | 68 | 37 | 75 | 1.73 | (0.92, 3.24) |
| | | No | 32 | 98 | | | | | | |
| | >50.min + Sa | Yes | 19 | 29 | 33 | 79 | 40 | 74 | 1.88 | (0.95, 3.73) |
| | | No | 39 | 112 | | | | | | |
| | >40/min + Sa | Yes | 28 | 46 | 48 | 68 | 38 | 76 | 1.93 | (1.03, 3.60) |
| | | No | 30 | 95 | | | | | | |

[a]Symptom complex including chest indrawing and/or cyanosis and/or failure to feed.

predictor of pneumonia in a community setting should include adequate follow-up of children to document the clinical outcome of ARI management. The results of the pilot project in Bohol should provide answers to this question (Tupasi and Tallo, 1985).

## CHILD CARE PRACTICES

The control of acute respiratory infection requires not only the application of known therapeutic remedies such as the administration of antimicrobials, but more importantly requires its timely application. A previous study on the child care practices of mothers indicated that health education to improve their ability to recognize severe disease was found to be of urgent priority as most mothers considered seeking medical help only when the child became cyanotic indicating terminal illness. In this study, the financial hardship experienced by these poor families was noted to be an important constraint to adequate child care and their ability to secure medical services (Tupasi, *et al.,* 1989). This further underscores the urgency for meaningful socioeconomic development which would provide livelihood for the majority of families and empower them to meet their health needs as expected of responsible community members.

## IMPROVED HEALTH SERVICES

Health services should become more accessible as the population becomes more aware of their health needs. The shortage of doctors in remote rural areas should be remedied by harnessing available health personnel both in the public and private sector. Accordingly, traditional healers should be made to participate in the dispensation of health services side by side with the barangay health workers for after all, they are the ones most sought after by the people in need of medical care as shown by a recent study (Tupasi and Tallo, 1985).

## INTERVENTIONS FOR ARI CONTROL

The control of acute respiratory infection requires an intersectoral collaboration. Being a disease of poverty, prevention of respiratory disease requires not only the timely application of antimicrobial treatment. More importantly, the efficient implementation of maternal and child care services including promotion of nutrition, immunization against childhood illnesses, improved maternal health education as well as the empowerment of people through meaningful socioeconomic development which should alleviate poverty are just as essential. These are the essentials of a true primary health care approach to ARI intervention.

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