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Towards an integrated approach to lung health in adolescents in developing countries†

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Summary The World Health Organization strategies, Integrated Management of Childhood Illness and Practical Approach to Lung health provide assessment and management guidelines for health workers in developing countries. We reviewed issues important to lung health in adolescents to highlight whether differences in factors such as adolescent behaviour have consequences for the development of case management guidelines, to form a bridge between guidelines for younger children and for adults and to make suggestions for further study. Pneumonia, asthma and tuberculosis are the leading lung health problems in adolescents. As countries industrialise, the importance of asthma mortality and morbidity increases as that of pneumonia and pulmonary tuberculosis decreases. Guidelines for managing pneumonia and asthma in children and adults in developing and developed countries should be adaptable for use in adolescents in developing countries, although more information is needed on predictors of severity such as respiratory rate cut-offs, level of fever, hypotension, malnutrition and level of consciousness. The effectiveness of low-cost treatment for asthma should be explored further. HIV and the global resurgence of tuberculosis pose significant challenges for improving adolescent lung health, and prevention of smoking initiation during adolescence is a priority goal of any integrated approach to improving lung health.

Introduction

WHO defines adolescents as those aged 10–19 years, youths as those aged 15–24 years and young people as those aged 10–24 years. Although many adolescent health problems are behaviour-related (unplanned pregnancy, abortion, sexually transmitted diseases, substance abuse, violence and injury), lung diseases account for significant morbidity and mortality in this age group. WHO's Integrated Management of Childhood Illness (IMCI) strategy has evolved to tackle major causes of morbidity and mortality in under-5 children in developing countries,[1] and the management of respiratory conditions is an important component of these guidelines. A newer WHO strategy, the Practical Approach to Lung health (PAL) using established tuberculosis control programmes strategies, aims to provide primary care workers with comprehensive tools for managing pneumonia, tuberculosis, asthma and chronic obstructive pulmonary diseases (COPD) in school-age children (>5 years), adolescents and adults.[2] The Department of Child and Adolescent Health and Development in collaboration with other WHO departments initiated a series of literature reviews in order to identify existing recommendations on clinical management

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and assess their appropriateness for adolescents across a wide range of health issues including lung health. It is expected that this process will lead to new recommendations on clinical management where none exist or where existing ones are inappropriate. The focus of these reviews is on developing countries where primary care workers with limited resources and training are required to diagnose, treat or refer any illness in the community presenting to formal health services. It is planned that PAL will interface with the IMCI strategy to train health workers to use clinical care algorithms and manuals. The aim of this paper is to address issues important to respiratory care in adolescents, specifically to highlight whether differences in adolescent behaviour have consequences for the development of case management guidelines, in order to form a bridge between guidelines for younger children and guidelines for adults and to make suggestions for further study. Consideration will need to be given to clinical issues (differences between presentation and treatment in adolescents compared with younger children or adults) and behavioural issues (how adolescent behaviour might impact on guideline implementation).

Adolescent Respiratory Mortality and Morbidity

Pneumonia, asthma and tuberculosis are the leading causes of significant lung disease in adolescents in both high-income and developing countries.

Mortality

World respiratory and HIV deaths and the corresponding data for disability-adjusted life years (DALYs) for children and adolescents aged 5–24 years are shown in Table 1.[3] With increasing age, deaths and DALYs from lower respiratory infections decrease and those from HIV increase. Excluding HIV, 14.4% of deaths and 9.9% of world DALYs for the age range 5–24 years were owing to respiratory causes. These data highlight the male predominance of deaths from asthma and the female predominance of deaths from HIV.

An analysis of WHO adolescent mortality data for 29 high- and middle-income countries shows that respiratory causes of mortality ranked fifth, pneumonia, asthma and tuberculosis being the leading causes (Table 2). These 29 countries were grouped by under-5 mortality rate as a measure of health status, which suggests that the proportion of deaths from respiratory causes falls as health improves while deaths from external causes rise. There also appeared to be a trend for deaths from pneumonia and pulmonary tuberculosis to fall and those from asthma to rise with improving health status.

Limited country-specific data on mortality patterns were identified. In South Africa, respiratory causes accounted for 7.4% of deaths in adolescents aged 10–14 years and 4.9% of deaths in those aged 15–19 years. Corresponding deaths from external causes were 46.2% and 62%.[5] Other data from sub-Saharan Africa include records from 17 rural hospitals in Zambia, Tanzania, Kenya and Ghana (1975–1990).[6] Of the more than 1.2 million admissions, 45% were children under 15 years and 34% aged under 5 years. Pneumonia, malaria and gastro-enteritis were the leading causes of mortality, the case fatality rate for pneumonia ranging from 1.9 to 7.4% in children under 15 years and from 5.5 to 11.7% in adults. Unfortunately, the age cut-offs used in this study and the use of facility-based rather than population-based data limit the interpretation of these case fatality rates in the adolescent age group.

Data from high-income countries such as the USA highlight the importance of external causes in overall adolescent mortality. Mortality trends for 15–24-year-olds in the USA between 1950 and 1993 showed little variation and the leading causes of death were accidents, homicide and suicide.[7] During the period 1989–1991, HIV infection

TABLE 1. *World respiratory deaths and DALYs for children and adolescents aged 5–24 years.*[3]

	5–9 y (%)	10–14 y (%)	15–19 y (%)	20–24 y (%)	5–24 y (%)	M:F (%)
WORLD TOTAL DEATHS						
Lower respiratory infections	16.9	10.4	4.5	3.8	8.7	47:53
Upper respiratory infections	0.2	0.2	0	0	0.1	44:56
Asthma	0.3	0.3	0.3	0.3	0.3	62:38
Whooping cough	0.7	0.5	0.1	0	0.3	50:50
Chronic obstructive pulmonary disease	0.3	0.2	0.2	0.2	0.2	53:47
Tuberculosis	4.1	3.4	5.3	5.8	4.8	46.5:53.5
HIV	2.3	2.3	10.3	18.3	9.2	33:67
Non-respiratory deaths	75.2	82.8	79.2	71.5	76.3	55:45
Total no. (%) of deaths	1123008 (28)	704973 (17)	974442 (24)	1278980 (31)		52:48
WORLD TOTAL DALYs						
Lower respiratory infections	10.7	5.7	2.0	1.9	4.7	47:53
Upper respiratory infections	0.2	0.2	0.1	0	0.1	47:53
Asthma	2.2	2.8	1.3	1.2	1.7	56:44
Whooping cough	0.7	0.5	0.1	0	0.3	52:48
Chronic obstructive pulmonary disease	0.2	0.1	0.5	0.6	0.4	50:50
Tuberculosis	2.9	2.0	2.7	3.2	2.8	47:53
HIV	1.4	1.2	5.6	11.2	5.6	34:66
Non-respiratory DALYs	81.8	87.5	87.9	81.9	84.5	52:48
Total no. (%) of DALYs	68894046 (23)	51609394 (18)	82386226 (28)	91398225 (31)		51:49

TABLE 2. *Main causes of death in adolescents aged 10–19 years for 29 upper- and middle-income countries (1975–95), ranked according to under-5 mortality rates/1000 live births. Source: WHO Mortality Database using dataset created in July 1997.*

	A*	B*	C*	D*	Total	Male:female
Total no. (%) of deaths	784164 (91)	25648 (3)	53294 (6)	1773 (<1)	864879	606655:258224 (70:30)
External causes (B47–56)	66	57	49	33	65	70:52
Neoplasm (B08–17)	11	12	12	11	11	9:15
Cardiovascular (B25–30)	5	6	5	8	5	4:6
Nervous system (B22–24)	5	6	7	7	5	4:5
Respiratory (B31–32)	3	5	9	8	3	3:5
Congenital abn. (B44)	3	4	4	0	3	2:4
Ill defined (B46)	2	1	4	22	2	2:3
Endocrine (B18–19)	2	1	1	1	2	1:2
Infectious (B01, B03–07)	1	1	3	2	1	1:2
Digestive system (B33–34)	1	2	3	2	1	1:2
Blood (B20)	1	1	1	3	1	1:1
Mental (B21)	1	1	0	0	1	1:1
Genito-urinary (B35–37)	0	1	2	3	1	0:1
Musculoskeletal (B43)	0	0	0	0	0	0:1
Obstetric (B38–41)	0	0	1	0	0	0:1
Tuberculosis (B02)	0	0	0	0	0	0:0
Skin (B42), perinatal (B45)	0	0	0	0	0	0:0
Total no. (%) of respiratory deaths	24015 (79)	1389 (5)	4705 (16)	136 (<1)	30245	17498:12747 (58:42)
Pneumonia (B321)	38	75	86	80	48	47:48
Asthma, emphysema (B323)	34	8	3	2	28	29:27
Respiratory NOS (B313–319, B324–329)	20	7	6	6	17	17:17
Influenza (B322)	3	5	0	9	2	2:3
Upper respiratory infections (B310–312)	2	1	0	3	2	2:2
Acute bronchitis, bronchiolitis (B320)	2	3	0	0	2	2:2
Pulmonary TB (B020–021)	1	2	4	0	1	1:1

* Countries included in analysis (population in millions from 1999 World Health Report):
A: Australia (18.5), Austria (8.1), Belgium (10.1), Czech Republic (formerly Czechoslovakia) (10.3), Finland (5.2), France (58.7), Germany (82.1), Greece (10.6), Ireland (3.7), Israel (6), Italy (57.4), Japan (126.3), Netherlands (15.7), New Zealand (3.8), Norway (4.4), Portugal (9.9), Spain (39.6), Sweden (8.9), United Kingdom (58.6), United States of America (274); B: Bulgaria (8.3), Croatia (4.5), Hungary (10.1); C: Romania (22.5), Slovenia (2), former Yugoslavia (10.6); D: Albania (3.1).

NOTE WHO provided these data but all analyses, interpretations and conclusions are the authors' responsibility.

ranked sixth, followed by pneumonia and influenza (eighth) and chronic obstructive lung diseases (tenth).

Morbidity

In primary care and community settings, respiratory conditions account for significant morbidity. In Thailand, 21.6% of outpatients aged 5–14 years had respiratory symptoms. Although only 1.5% of symptoms were chronic, 17.7% with acute respiratory symptoms had a lower respiratory tract infection requiring antibiotic treatment.[2] Twenty-four per cent of children attending an outpatient 'day' hospital in South Africa were aged 6–13 years and upper respiratory tract infection was the commonest condition treated (31%).[8] In New Zealand, the three most important adolescent health problems were assessed to be accidental injury, asthma and mental health disorders, asthma being the commonest chronic health problem.[9]

Pneumonia

Pneumonia is the leading cause of respiratory-related mortality in adolescents in both high-income and developing countries (Fig. 1). Guidelines for the management of pneumonia have been developed for under-5 children in developing countries (IMCI)[1] and for adults in high-income countries.[10–13] In the IMCI guidelines, respiratory rate is the key parameter for assessing children presenting with cough and difficult breathing and for determining whether antibiotics should or should not be used.

Guidelines have been developed in North America[10–12] and Europe[13] to help physicians select drugs for the initial management of community-acquired pneumonia (CAP) in adults (Table 3). Three factors have been identified to predict severity of CAP: diastolic blood pressure $\leqslant 60$, urea >7 mmol/l, respiratory rate $\geqslant 30$. Patients with two or more factors had a 20% risk of mortality.[14] In a subsequent study, mental confusion was added as a fourth factor and patients with any two of the four factors had a 36-fold increased risk of mortality.[15] The study also showed that severity of illness was underestimated in 21% of cases and that the significance of a raised respiratory rate as an indication of life-threatening pneumonia was not well recognised. None of these guidelines specifically addresses clinical diagnosis of pneumonia in adolescents.

Clinical predictors of severity of pneumonia in adolescents could include respiratory rate, level of fever, hypotension, malnutrition and level of consciousness. Review of the literature suggests that normal ranges for respiratory rate are not well established for adolescents. The IMCI guidelines' respiratory rate cut-off of 50 for infants aged 2–12 months and 40 for children aged 1–4 years ensures that about 80% of children with pneumonia will receive antibiotic treatment, although 20–30% of children receiving antibiotics will not have clinical or radiological evidence of pneumonia.[1] Studies will be needed to determine what respiratory rate cut-offs are appropriate for adolescents to achieve acceptable sensitivity and specificity, i.e. to ensure that adolescents with pneumonia receive antibiotics. High fever is associated with increased mortality in children,[16] and is included in a prediction rule to assess severity of CAP in adults.[17] In younger children, a 1°C rise in fever increases respiratory rate by 3.7 breaths/min[18] and, using the IMCI guidelines, reduction of fever resulted in 23% of children changing classification from "pneumonia" to "no pneumonia". Hypotension on admission is associated with increased paediatric and adolescent mortality and is used to assess severity of CAP in adults.[14,15] Whether a certain level of fever and blood pressure should be included in guidelines to assess severity of pneumonia in adolescents needs to be determined. However, it might be difficult to quantify fever and blood pressure in resource-poor developing countries where functioning thermometers and sphygmomanometers are perhaps not always available. Malnutrition

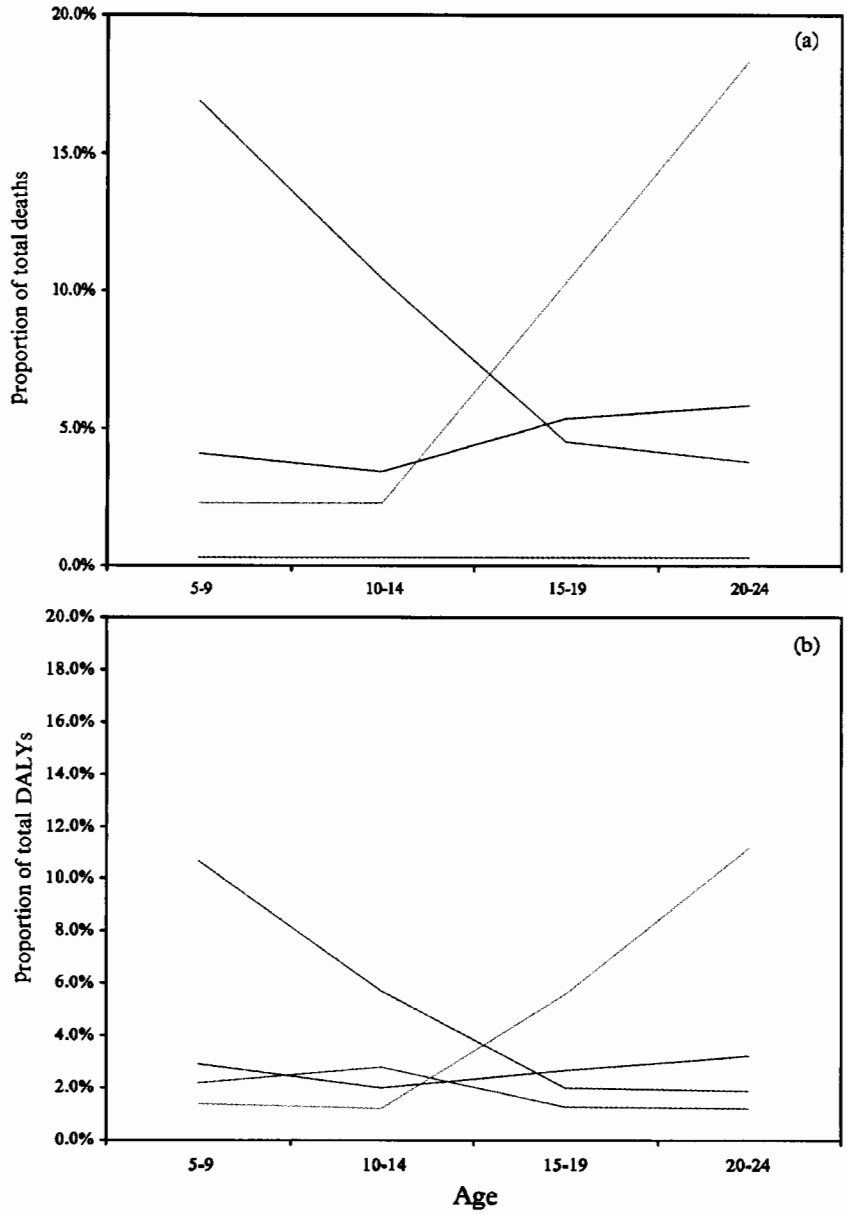

FIG. 1. Deaths during 1999 for groups of children aged 5–24 years showing (a) percentage of overall mortality in relevant age-groups[3] and (b) DALYs due to selected health problems for groups of children aged 5–24 years with relative weight of DALY due to cause compared with all DALYs in the relevant age group.[3]
—lower respiratory infections; —tuberculosis; —HIV; —asthma.

in under-5 children has been associated with increased mortality from pneumonia, even after adjustment for HIV status.[19] Severe malnutrition is an indication for urgent referral under IMCI guidelines.[1] Whether nutritional status should be incorporated in a prediction rule to assess severity of CAP in adolescents needs to be determined. Mental confusion predicts severity of CAP in adults (mean age 58 years),[15] and IMCI guidelines to assess pneumonia severity include lethargy or unconsciousness as danger signs

TABLE 3. *Summary of antibiotic recommendations for empirical treatment of community-acquired pneumonia.*[2,9,12]

	Not severely ill – Outpatient	Severely ill – Hospitalised
WHO Adult Lung Health Initiative/ Practical Approach to Lung health		
<60 y	P or Am or E	Ag (gentamicin) & BP or AM
⩾60 y	Am or BI or CTX	
American Thoracic Society		
<60 y	M (or T)	
<60 + co-morbid illness or >60 y	2C or BI or CXT ± M	
Ward		2/3C or BI ± M
ICU		Iv M + 1 or 2 PS
Infectious Diseases Society of America (1998)		
Not severely ill (17–40 y)	D	
Ward		Q or 2/3C or 2/3C + M
ICU		Iv M + (2/3C or BI)
Infectious Diseases Society of America (2000)		
Not severely ill	M, D or Q	
Ward		(3C + M) or Q
ICU		(3C or BI) + (Q or M)
ICU + structural lung disease		PS + Q
British Thoracic Society (excludes outpatients)	Am or M	2/3C ± E or Ap + F + E
France	Am or M	BI + (M or Q) or 3C + (M or Q)
Italy	BI ± M	2/3C ± M
Spain	PP or E	3C ± E

Am, amoxicillin; Ap, ampicillin; Ag, aminoglycoside; BI, betalactam/beta-lactamase inhibitor combination; BP, benzyl penicillin; 2/3C, 2/3 generation cephalosporin; CTX, cotrimoxazole; D, doxycycline; E, erythromycin; F, flucloxacillin; M, macrolide; P, oral penicillin; PP, procaine penicillin; PS, anti-pseudomonal agents such as ceftazidime, imipenem or ciprofloxacin; Q, fluoroquinolone; T, tetracycline.

requiring urgent assessment and immediate pre-referral treatment. These predictors of pneumonia severity are summarised in Table 4.

To develop specific treatment guidelines for CAP in adolescents, information on common causative organisms and predictors of pneumonia and severity is needed.

TABLE 4. *Predictors of severity of pneumonia used in IMCI and adult guidelines which might be suitable for use in guidelines for adolescents.*

	IMCI†	Adult‡	Adolescent†
Respiratory rate[1]	50 (2–12 mths), 40 (1–4 y)	30	Studies needed
Fever[15]	Might influence respiratory rate	Associated with increased mortality	Associated with increased mortality
Hypotension[13,14,16]	–	Diastolic ⩽60	Associated with increased mortality
Nutritional status[1]	Yes	–	Studies needed
Level of consciousness[1]	Yes	Yes	Studies needed
Blood urea[13,14]	–	>7 mmol/L	–

† For developing countries; ‡ for high-income countries.

Streptococcus pneumoniae, Mycoplasma pneumoniae, Chlamydia pneumoniae and *Haemophilus influenzae* are the commonest pathogens for severe CAP in adults under the age of 65.[11] *Streptococcus pneumoniae, Mycoplasma pneumoniae,* Chlamydia species and viruses were the most common pathogens causing pneumonia in Finnish school-aged children under 15 years with CAP[20] and in Texan children under 16 years.[21] In view of the similarities between causative organisms, antibiotic regimens for pneumonia and severe pneumonia in adolescents should be similar to those recommended for adults in high-income countries taking into consideration cost and availability. Macrolides are included as an option or first choice in the adult guidelines in high-income countries (Table 3) but are not included as a choice in IMCI guidelines for under-5 children in developing countries because they are not effective against *H. influenzae,* a common cause of pneumonia in children under 5 years.

The PAL guidelines suggest that, as 48.6% of CAP is due to *S. pneumoniae,* antibiotic treatment should be effective at least against this organism. Severe cases, or those with co-morbidities, should receive pre-referral treatment with gentamicin and benzylpenicillin or amoxycillin. For non-severe pneumonia under 60 years of age, the recommended antibiotics were oral penicillin, amoxycillin or erythromycin with clinical reassessment after 3–5 days (Table 3).[2] Pharyngitis is of importance in adolescents. Group A β-haemolytic streptococci, the most frequent bacterial cause, require antibiotic treatment to prevent both suppurative and non-suppurative complications.[22] Oral penicillin V, administered two-to-three times daily for 10 days, remains the treatment of choice, and a single intramuscular dose of benzathine penicillin is also highly effective.[23] Newer generation macrolide antibiotics (clarithromycin and azithromycin) offer convenient treatment alternatives to oral penicillin V, but at greater cost.[24] Guidelines for treating pneumonia and respiratory infection in developing countries should help minimise the wastage of antibiotics. Approximately 75% of all antibiotics used are prescribed for acute respiratory infections and many of these prescriptions are deemed unnecessary. Worldwide, an estimated US$8 billion per annum is wasted on drugs to treat symptoms of acute respiratory infection.[25]

Asthma

Asthma is the commonest chronic health problem in adolescents in high-income countries[9,26] and a leading cause of mortality in selected high-income and developing countries (Table 2). It is a growing problem in newly industrialising countries and urban populations of developing countries. The International Study of Asthma and Allergies in Childhood, in which 463,801 adolescents aged 13–14 from 56 countries participated, has documented worldwide prevalences of asthma and allergic disorders using a standardised methodology.[27] There was a 20-fold difference in the 12-month asthma prevalences between the highest- and lowest-prevalence countries and an 8-fold difference in prevalence rates between the 10th and 90th centiles. More than 25% of adolescents had evidence of asthma in the high-prevalence countries whereas in low-prevalence countries the figure was less than 5%.

There is evidence that asthma prevalence has increased in high-income countries over recent decades. A qualitative study examining the profile of ten potentially fatal cases of asthma suggested that non-compliance is an important factor.[28] During the past 20 years, total asthma deaths in the US increased from around 2000 to 5000 per annum,[29] although the peak age of death was 65–74 years. Between 1980 and 1993 in the US, the asthma death rate doubled in the 5–14 and 15–24 years age groups.[26] The world death rates and DALYs related to asthma shown in Fig. 1 suggest that asthma mortality rates are similar between the ages of 5 and 24 years.

A number of countries have developed asthma treatment guidelines for children, adolescents and adults.[30–32] Where these guidelines have been used, asthma mortality has been reduced in all age groups, including adolescents. Themes central to these guidelines are that asthma is primarily an inflammatory condition and that a stepwise approach to treatment should be adopted. Asthma can be under- as well as over-treated.[33]

Asthma is primarily a clinical diagnosis based on a history of persistent or recurrent cough and/or wheeze that responds to bronchodilators. It can be assessed more objectively with the use of peak expiratory flow rates (PEFR). Features supporting a diagnosis include history of atopy, night or exercise-induced cough and seasonal variation. Assessment and management of asthma should be considered in two separate parts: (i) the acute episode and (ii) chronic symptoms. In high-income countries, assessment and treatment of acute and chronic asthma have been well documented.[30] However, some modification of published guidelines might be required for developing countries.

Acute asthma attacks are relieved symptomatically by β-2-agonists, whereas the disease is controlled by corticosteroids. Although nebulised β-2-agonists are the initial treatment of choice for the management of acute asthma attacks in high-income countries, nebulisers might not be routinely available in developing countries. However, β-2-agonists administered by metered dose inhalers (MDI) with a spacer device is as effective, if not more so, than that given by nebuliser.[34,35] Spacer devices can be made inexpensively from plastic drinks bottles. Mild chronic asthma is ideally treated symptomatically as required during acute exacerbations with a short-acting β-2-agonist bronchodilator. When not available, theophylline can be used for maintenance treatment, although there are safety (narrow therapeutic margin) and other concerns. Low-dose theophylline as an anti-inflammatory agent is a possible option but further study is needed.[31]

Sodium cromoglycate has been recommended previously as first-line maintenance therapy for moderate asthma but there are concerns about adherence to treatment and cost. Regularly inhaled corticosteroids are needed for moderate and severe asthma and are being recommended increasingly for use at an earlier stage of the disease process.[36,37] Optimal use of medication is required to minimise side-effects and cost. Adolescents should be able to use MDIs, although spacer devices might be required during acute exacerbation.

Cost is a major barrier to optimal asthma treatment in developing countries. A survey of mission hospitals in 28 developing countries of Africa and Asia showed that oral salbutamol and theophylline were the common first-choice treatments and that less than half the doctors usually prescribed inhaled β-2-agonists. Inhaled steroids, anticholinergics and cromoglycate were not usually available and many hospitals did not have oxygen or nebulisers.[38] Costs of medication in local terms were estimated as a percentage of a trained nurse's average monthly income in the 24 countries that responded: oral salbutamol for 30 days (2.2%), oral aminophylline for 30 days (2.1%), one salbutamol MDI (6.7%), one beclomethasone dipropionate MDI (7.5%) and cromoglycate (17%). Use of international asthma guidelines, recommending increasing doses of inhaled beclomethasone for children with moderate and severe asthma, in a low-income population in Brazil showed improved clinical outcome but at a very significant cost as a percentage of family income.[39]

Asthma in adolescents raises a number of behavioural management issues.[40] Concerns focus on poor adherence to medication and follow-up appointments and on other adolescent behaviour such as smoking. As many as 75% of adolescent asthmatics do not take their medication correctly.[40] The belief that children grow out of asthma is misleading — asthma is almost as common in adolescents

as in young children and more common than in adults. In the UK, three times as many adolescents aged 10–14 years and six times as many youths aged 15–20 years died of asthma compared with those aged 5–10 years. Adolescents desire to achieve independence from family ties but do not wish to be different from their peers. This might contribute to poor adherence to treatment and asthma management is more likely to succeed if combined with peer support.[40] It is important to discover adolescents' anxieties about asthma and its treatment. Negotiation of a treatment plan might give a sense of control[40,41] and thereby improve adherence to treatment. The mode of treatment (oral *vs* inhaled) might also influence adherence to treatment.[42] Whether these issues are equally important in developing countries is not clear.

Tuberculosis

Death from tuberculosis in adolescents in high-income countries is relatively rare (Table 2 and Fig. 1). In developing countries, however, up to 9% of the total tuberculosis caseload is children and adolescents aged 5–14 years.[43] Global resurgence of tuberculosis has been associated with the HIV epidemic and with high rates of dual infection.[44] However, the effect of the HIV epidemic on adolescent tuberculosis is less clear.

A clear distinction needs to be made between evidence of tuberculous infection (positive tuberculin skin test but otherwise well) and tuberculous disease (clinical illness). An intriguing feature of tuberculosis is the variation in age incidence and the variation in the nature of the disease with age. Tuberculous infection steadily increases from birth to the fourth decade.[45] In contrast, tuberculous disease is relatively common in infancy and early childhood, becomes less common between the ages of 5 and 10 years (despite the fact that tuberculous infection is still increasing at this age), and then after 10 years of age increases, the nature of the disease changing from primary to post-primary adult-type. During adolescence, respiratory tuberculosis involves mainly the apices of the lungs and cavitation becomes an integral part of the disease process, leading to further spread within the community. Reports from South Africa indicate that tuberculous infection is commoner in adolescent males and tuberculous disease commoner in females.[46] Tuberculous pleural effusion might be more common in adolescent males.[47]

The World Health Organization's 'Stop TB' programme has developed guidelines for managing tuberculosis but they don't focus on adolescents.[48,49] The highest priority in controlling tuberculosis is identifying and curing infectious cases, i.e. those with smear-positive sputum. Tuberculosis in adolescents is the transition from primary childhood tuberculosis to post-primary adult tuberculosis, and a wide variety of tuberculous lesions are seen, ranging from a primary complex with hilar lymphadenopathy to cavitating, adult-type pulmonary tuberculosis.[47]

Important symptoms in the diagnosis of pulmonary tuberculosis in adults are cough for longer than 3 weeks, sputum production and weight loss.[49] Over 90% of patients with sputum smear-positive tuberculosis develop cough soon after the onset of disease. Other respiratory symptoms suggestive of tuberculosis are haemoptysis, chest pain and breathlessness and constitutional symptoms including fever, night sweats, tiredness and loss of appetite. Whether the frequency of these respiratory and constitutional symptoms varies significantly between the different age groups, particularly in adolescents, is not clear. The primary health care worker will need to be alert to both respiratory and constitutional symptoms if the diagnosis of tuberculosis is not to be missed. The WHO guidelines for investigation of suspected tuberculosis[49] are perhaps less relevant to younger adolescents in whom primary tuberculosis and pleural effusion are relatively more common.

In 1994, The American Academy of Pediatrics recommended that high-risk infants, children and adolescents should be routinely given a Mantoux skin test every year, and that low-risk children living in high-prevalence areas should be screened periodically at the ages of 1, 4–6 and 11–16, depending on the local epidemiology of tuberculosis. In developing countries, 25% or more of adolescents will be infected with tuberculosis and screening for chemoprophylaxis will not be possible, although certain subgroups (e.g. pregnant adolescents) could be targeted.[45]

Treatment of tuberculosis is resource-intensive and patients are required to take a number of drugs, some with significant side-effects, for long periods of time. Poor compliance and erratic supplies increase the likelihood of multi-drug-resistant tuberculosis. To tackle these issues and encourage adherence to treatment, WHO has promoted the 'DOTS' strategy for tuberculosis control. It is possible that adolescents are less likely than adults to take the medication and more likely to miss follow-up appointments. This might be true under some circumstances,[40] but whether it is true for adolescent tuberculosis in developing countries is not established. Measuring adherence to treatment is obviously extremely important when determining the success of any national tuberculosis programme.

Adolescent Immunisation

In the US, recommendations for immunisation of adolescents have been made by The Advisory Committee on Immunization Practices, The American Academy of Pediatrics, The American Academy of Family Physicians and The American Medical Association.[50] A new strategy emphasises vaccination of adolescents aged 11–12 years by establishing a routine visit to the health care provider. Those who had not previously been vaccinated with varicella, hepatitis B or a second dose of MMR would then be vaccinated. At this visit they would also be given a booster of tetanus and diphtheria toxoid and any other vaccine recommended for particular groups, e.g. influenza, pneumococcal polysaccharide and hepatitis A. It is unlikely, however, that this strategy would be applicable in developing countries at this stage.

Adolescent Behaviour and Lung Health

The Youth Risk Behavior Surveillance System (YRBSS) monitors six health-risk behaviours in the US: (i) behaviour contributing to unintentional and intentional injuries; (ii) tobacco use; (iii) alcohol and other drug use; (iv) sexual behaviour that contributes to unintended pregnancy and sexually transmitted diseases; (v) unhealthy dietary behaviour; and (vi) physical inactivity.[51] Tobacco use and sexual behaviour resulting in HIV infection are the two that relate most directly to lung health in adolescents. HIV infection in adolescents is anticipated to result in increases in adolescent pneumonia (both opportunistic and community-acquired) and tuberculosis, although the magnitude of this effect is not known.

Most smokers begin in adolescence and early adult life. Regular, heavy smokers are more likely to have started smoking at a younger age and to experience higher mortality and morbidity from smoking-related diseases.[52,53] The 1997 YRBSS study of high school students in the US noted that 36% had smoked during the past 30 days. Global rates of smoking in adolescent males and females vary considerably (10–70%) and in 24 of 63 countries adolescent girls smoke more than boys.[54] The ongoing Global Youth Tobacco Survey (GYTS) was developed by WHO and the US Centers for Disease Control and Prevention (CDC) to track tobacco use among young people worldwide.[55] Preliminary results from 12 developing countries show that "current" tobacco use amongst school children aged 13–15

ranged from 10% to 33% despite the fact that 53.5% reported being taught in school about the dangers of smoking. The "ever" smoked rate ranged from 15% (Shandong, China) to 70% (Kiev, Moscow and Poland). An estimated 30% of the world's smokers live in China, which leads world tobacco production.[53] A survey in Beijing of 16,996 elementary school pupils aged 10–12 showed that 28% of boys and 3% of girls had smoked: 0.4% reported daily smoking, 0.8% weekly smoking and 15.4% occasional smoking. A survey of nine Caribbean countries found that 5.9% of adolescents under 12 years had experimented with cigarettes.[56] The GYTS showed that one-fifth of young people begin smoking before the age of 10 years.[55] Risk factors for smoking initiation during youth include peer pressure, performing poorly in school, having behaviour problems, not believing that smoking is harmful to health, having parents who smoke or use illicit drugs, having parents from low socio-economic backgrounds, ethnic group and puberty developmental stage.[52]

Summary and Areas for Further Study

Globally, respiratory conditions account for a significant proportion of deaths and DALYs in adolescents (Table 1). Despite the undoubted importance to adolescent health of external causes (violence, suicide, injury), especially in upper-income countries (Table 2), targeting adolescent respiratory illness as a whole is important in view of the burden of disease and demand for care. Implementing improved respiratory care for adolescents through existing health services is likely to produce an earlier impact than the more complex, multisectoral interventions that would be required to reduce mortality and morbidity from external causes.

In both high-income and developing countries, pneumonia is a leading cause of adolescent mortality. Mortality and morbidity from asthma increase as countries become more developed. In high-income countries, pulmonary tuberculosis appears to be relatively less important as a cause of adolescent mortality than in developing countries. Indexed references detailing patterns of morbidity and mortality in adolescents appeared limited, which suggests that such data are collected by national health departments and published locally or not at all.

Pneumonia management guidelines developed for adults in high-income countries and children under 5 in developing countries are probably adaptable for use in adolescents in developing countries. Further data on normal respiratory rate cut-off values in adolescents are needed. Whether clinical parameters such as level of fever, hypotension, malnutrition and level of consciousness should be used to assess severity of pneumonia in adolescents requires further evaluation. Functioning thermometers and sphygmomanometers are considered to be part of the basic equipment and are required as cheap, simple tools for clinical diagnosis. Their availability should be ensured before guidelines recommending their use are implemented. The increasing asthma prevalence and mortality in high-income countries is an important concern. Guidelines for the management of acute and chronic asthma in adults and children are well established in high-income countries. Adaptation of these guidelines for developing countries should not be difficult but cost implications of recommendations are a major concern. Research would be required to assess the feasibility and utility of lower cost modalities. Adolescent asthmatics have some unique needs that need to be addressed in those countries with the necessary resources. Poor adherence to treatment and the associated increase in mortality are often seen as problems of the adolescent asthmatic but might be less relevant to adolescent asthmatics in developing countries.

The resurgence of tuberculosis is a global problem but a very much greater problem in poor developing countries with high HIV seroprevalence rates. During adolescence, the prevalence of tuberculous disease starts

to increase and females are more frequently affected, although the infection rate might be higher in males.[46] This difference might be further accentuated by HIV infection. Adherence to tuberculosis treatment is a major concern for all ages, but adolescents might be particularly at risk. WHO's DOTS strategy for TB control is being widely promoted to improve treatment adherence. Further research is needed in developing countries to determine whether poor treatment adherence is a particular problem in adolescents. HIV and smoking, both behaviour-related issues, are also associated with tuberculosis.

The majority of adolescents with HIV infection acquire it through sexual intercourse. It is likely that HIV-related pneumonia and tuberculosis will start to appear in late adolescence and females will acquire HIV infection at a younger age than males. Research is required to determine the extent to which the HIV epidemic affects lung health in adolescents and whether guidelines for antibiotic treatment for pneumonia would require modification if HIV infection were suspected.

Preventing initiation of smoking during adolescence would have a tremendous impact on lung disease and other causes of morbidity and mortality. In both high-income and developing countries, significant numbers of children as young as 10 years experiment with cigarettes, and a substantial percentage become regular, daily smokers. Identifying risk factors for starting to smoke in different cultural settings would help provide a foundation for intervention strategies.

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