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CHILD AND ADOLESCENT HEALTH AND DEVELOPMENT

CAH

INFORMAL CONSULTATION ON CLINICAL USE OF OXYGEN

Meeting report

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DEPARTMENT OF CHILD AND ADOLESCENT HEALTH AND DEVELOPMENT
DEPARTMENT OF ESSENTIAL HEALTH TECHNOLOGIES

WORLD HEALTH ORGANIZATION

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Contents

The consultation was held to prepare for the writing of a manual "Clinical use of oxygen" which will give practical guidance on oxygen therapy in district hospitals in developing countries. The meeting discussed the factors that limit oxygen use, and how the quality of clinical care can be improved through appropriate clinical use of oxygen.

Objectives of the meeting

- To discuss the contents of a manual "Clinical use of oxygen", which would address all relevant aspect of clinical oxygen therapy in small hospitals in developing countries.
- To develop the outline of the manual and present draft chapters, prepared by participants, for general discussion.
- To discuss research issues associated with the clinical use of oxygen, and to prepare a research agenda.

Background

Acute respiratory infections (ARI) cause more than two million deaths per year in children less than five years old; mostly in developing countries. Many of these deaths are associated with hypoxaemia, and oxygen therapy is life saving for many children with ARI. Previous work of the WHO Programme for the Control of Acute Respiratory Infections and the Division of Devices and Clinical Technology in WHO therefore focused on making oxygen available more easily to patients by promoting and field-testing oxygen concentrators. Concentrators have been estimated to be 25-50% more cost-effective than cylinders in resource poor settings (*1*), and concentrators do not have the limitations of requiring frequent transport for refilling. However, concentrators do need a continuous power supply and maintenance. Although some concentrators will run off a car battery that can be charged by solar panels, there is very limited experience in settings where a continuous mains electricity supply is not available.

To assure the quality and longevity of oxygen concentrators used in developing countries, WHO published specifications for a "WHO test schedule for oxygen concentrators" in 1991 (WHO/ARI/91.2). This resulted in the production of three models of oxygen concentrators by different companies, which conformed to these specifications. Field- testing and evaluation was conducted in trials in Egypt (*2*) and Malawi. However, due to mergers and the development of new models, these concentrators are no longer produced. Probably due to loss of interest in sales in developing countries, no new models were tested according to the WHO test schedule, which is rather demanding. To review the situation, in 2000, the WHO Departments of Blood safety and clinical technology (BCT) and Child and adolescent health and development (CAH) commissioned a review, and a meeting was organised in May 2001 in which currently produced concentrators were reviewed and assessed for their suitability in developing countries, although none of them had undergone testing according to the 1991 schedule. Summary information on the concentrators was made available to countries and to UNICEF on request, but has not been published.

Concerning other aspects of oxygen therapy, the ARI programme and the Department of Child Health and Development supported research studies on the recognition of hypoxaemia and on delivery methods for oxygen. This work was summarised in 1993 in the document "Oxygen therapy for acute respiratory infections in young children in developing countries" (WHO/ARI/93.28) (*3*). Since the publication of this monograph, considerable information has become available on the epidemiology of hypoxaemia in

children, detection of hypoxaemia by clinical means and with the use of pulse oximeters, and the safety and efficacy of oxygen delivery methods. CAH and the International Union against Tuberculosis and Lung Disease (IUATLD) organised a joint symposium at the IUATLD meeting in Madrid in 1999, where these aspects were reviewed, and published in a series of review papers in the Journal of Tuberculosis and Lung Disease.

Despite this activity in the last 15 years, there is some evidence and a general perception that systems for delivering oxygen have not been given a high priority at country programme level. An evaluation of hospital care for children in seven developing countries highlighted inadequate oxygen administration as a major factor in quality of care (*4*). There are several potential reasons why oxygen has been relatively neglected as a therapy in developing countries, while in developed countries it is taken for granted that oxygen is one of the most essential drugs in acute clinical care. These reasons include scepticism that oxygen is life saving, and lack of evidence that it is a cost-effective therapy (in comparison to other simple strategies for prevention and treatment of ARI, for example). Certainly the cost of oxygen is very high when it is provided using cylinders, and there has been little investment in more efficient oxygen concentrator technology. Although there is a wealth of experience in the beneficial effects of oxygen, there have not been any randomized trials.

Other WHO departments recommend use of oxygen for different conditions such as hypoxaemia at child birth, neonatal resuscitation, asthma, management of adult and adolescent lung diseases, trauma and shock due to haemorrhage.

Epidemiology of hypoxaemia

Epidemiology of hypoxaemia in children

A systematic review of the literature on the epidemiology of hypoxaemia was presented (*5*). This included the incidence of hypoxaemia in acute lower respiratory infection in children, and the normal ranges for oxygen saturation at varying altitudes. Evidence was presented that hypoxaemia was often more severe in acute lower respiratory infection in children at higher altitudes than in coastal settings.

In the discussion, gaps in the review were highlighted, including hypoxaemia in HIV positive children especially those with *Pneumocystis carinii* pneumonia (PCP); and hypoxaemia in children with asthma.

Epidemiology of hypoxaemia in neonates

Hypoxaemia is a major complication of neonatal illnesses, because of the frequency of primary respiratory disease (hyaline membrane disease, pneumonia, transient tachypnoea of the newborn) and because apnoea is a common and non-specific response to many common neonatal conditions. The incidence of hypoxaemia in referral hospitals is estimated to be up to 30-40% (*6,7,8*), depending on the level of pre-selection for more severe illness.

In the discussions, and in the presentation on oxygen use in obstetric care, it was emphasized that there is now good evidence that the immediate resuscitation of newborn babies with perinatal asphyxia can be done effectively with positive pressure ventilation via a self-inflating bag and mask, using room air. This does not apply to the resuscitation of older infants, children or adults, or to the acute treatment of other conditions associated with hypoxaemia, where use of oxygen (often in conjunction with positive pressure) is the international standard of care. Where oxygen is used inappropriately, such as in one country where oxygen is given to all normal babies at the time of birth, this vital therapy may be perceived as being an unnecessary expense.

Epidemiology of hypoxaemia in adults (internal medicine)

No data on the epidemiology was presented at the meeting. It was stated that, although there has been the generation of good data on the epidemiology of hypoxaemia in childhood illness over the past 15 years, including the recent findings that hypoxaemia is also seen in non-ALRI conditions, there has been less evidence of the burden of hypoxaemia in adult illness. This may be a factor in the limited advocacy of oxygen as a broad-based therapy.

Epidemiology of hypoxaemia in obstetric care

Data on the epidemiology of hypoxaemia in childbirth was not presented, but the use of oxygen in obstetric care was discussed. According to common practice, oxygen is indicated for severe complications (e.g. eclamptic status, post-haemorrhagic shock, surgery under anaesthesia; general, spinal/epidural). In many countries oxygen is given to the mother during fetal distress, while waiting for delivery of the baby (during both normal or caesarean section deliveries). There may be value in reviewing the utility of this exercise.

Epidemiology of hypoxaemia in surgical care

There were no data presented on the epidemiology of hypoxaemia in surgical patients. It was stated that hypoxaemia occurs in up to 30% of patients in the early post-operative period, so oxygen is vital for perioperative care. Hypoxaemia is likely to be a common complication in surgically ill patients at first referral level hospital; during emergency care, transportation, anaesthesia and post-operative period, and critically ill patients in the intensive care unit. The availability of oxygen is necessary for safe implementation of spinal and even apparently simple anaesthesia using ketamine. This is especially so for patients with underlying co-morbidity, including chronic respiratory disease, shock or obesity.

Availability of oxygen in district hospitals in developing countries

There is evidence of a mismatch between supply and demand of oxygen in hospitals in developing countries. Oxygen was available in the majority of teaching hospitals surveyed in the seven-country study, but less available in district hospitals. Lack of availability of systems for effective oxygen delivery was also found in a survey of 13 district hospitals in Kenya. There is evidence that while oxygen is available in some way in some wards in most hospitals, the equipment for delivering oxygen (flow meters , regulators, etc.) was less commonly available. In a survey in the United Republic of Tanzania, for example, 75% of district hospitals had an oxygen supply for less than 25% of the year (*9*). In Kenya only about half of the district hospitals had a triage process for administration of oxygen. Cylinders of oxygen were often shared between wards, no concentrators or oximeters were available and few hospitals had guidelines for ARI. Where doctors prescribed oxygen in the emergency departments only about 60% of children received it on the hospital wards. There were no guidelines on when to cease giving oxygen.

Experience with introduction of oxygen as part of the Child Lung Health Programme (CLHP) in Malawi

In Malawi, the International Union Against Tuberculosis and Lung Disease, in conjunction with the Ministry of Health and Population, has introduced an Integrated Child Lung Health Programme (CLHP) that was incorporated into the existing ARI/IMCI health services. Baseline data showed that oxygen was often not available, consistent with other surveys in Africa. Up to October 2003, the CLHP has provided 16 DeVilbiss 515KS oxygen concentrators with flow-splitters, appropriate spares and supplies necessary for providing oxygen therapy. Another eight concentrators will be installed by the beginning of 2004, covering all 24 district hospital paediatric wards. The 16 districts have set up either a separate "intensive care" room or an area where the oxygen concentrator is located in the "acute side" of the paediatric ward set aside for severely ill children. Some districts have set up four individual cots for children receiving oxygen, which should decrease cross-infection significantly. Five-day workshops on installation, use, and maintenance of oxygen concentrators have been conducted for biomedical engineers from each of the three central hospitals, anaesthetic clinical officers (ACO) and senior state registered nurses (SRN) working in paediatrics. The workshop consisted of presentations, a video, and practical sessions on how to use and maintain the oxygen concentrator and flow-splitters. A reference manual "*Oxygen therapy for acute respiratory infections in young children in emergent countries with an oxygen concentrator*" was prepared. Practical sessions demonstrated the correct installation of the concentrator on the paediatric ward. The biomedical engineers from each of the three central hospitals carry out regular maintenance visits.

Oxygen sources

Oxygen concentrators

Since the concentrator specifications were first designed in the early 1990s there has been limited commitment from manufacturers to supplying machines appropriate for developing countries. This is partly because of the large market in rich countries for oxygen concentrators for individuals (mostly the elderly, but some ex-preterm newborns) who have chronic lung disease and chronic hypoxaemia. However, there is now a small range of models that are consistent with WHO specifications for district hospitals. These have flow rates of 5-8 litres per minute. Getting companies to routinely manufacture appropriate flow-splitters (necessary for delivery of oxygen to more than one child) has been a challenge, but these