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Verbal Autopsy:
Using Interviews to Determine Causes of Death in Children

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Verbal Autopsy: Using Interviews to Determine Causes of Death in Children

by Ronald H. Gray[1]

"The death rate is a fact, anything beyond this is an inference."
-- William Farr

INTRODUCTION

Information on causes of death is used to establish public health priorities, study age and sex patterns of disease, monitor trends in mortality from specific diseases, and to evaluate the impact on mortality of preventive or therapeutic measures. The objective of this article is to review methods for data collection and reliability of cause of death information.

It is has long been recognized that registration data on causes of death are flawed and provide only an imperfect record due to errors in physician diagnosis or certification of death, coding errors, and inconsistencies due to revisions of the International Classification of Diseases (1977, Sirken et al, 1987; Goodman et al, 1987; Moriyama, 1989). To evaluate the accuracy of cause of death data, several studies have compared the underlying causes recorded on death certificates with findings at autopsy (Kircher et al, 1985; Battle et al, 1987; McFarlane et al, 1987; Anderson et al, 1989), or with diagnoses made by an independent physician's review of clinical records (Gau and Diehl, 1982; Benavides et al, 1989). All such studies have shown substantial disagreement between the underlying cause on the death certificate and the reference autopsy or panel review diagnosis. The disagreement tends to be greatest for those

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diseases that are most difficult to diagnose clinically and for deaths in the elderly, who often have multiple illnesses. Also, discrepancies are generally greater for deaths which occur in smaller hospitals or at home (Battle et al, 1987; McFarlane et al, 1987). The error rates have changed over time for some diseases such as pulmonary tuberculosis, whereas errors in diagnosis of conditions such as myocardial infarction appear to have remained relatively constant (Stehbens 1987, Anderson et al, 1989). Thus, even in countries with established vital registration systems, there are significant errors in cause of death statistics and some authors argue that we "must come to understand and accept a realistic degree of necessary fallibility" (McFarlane et al, 1989).

Vital registration in many developing countries is incomplete and many deaths go unrecorded. Among registered deaths, information on causes of death is often defective, as indicated by the high proportion ascribed to unknown causes or to nonspecific symptoms such as "fever" or "senility" (WHO, 1977; WHO, 1980). Unsatisfactory death certification is to be expected in situations where many deaths occur outside of hospitals, often without medical attention. Even when a patient has received medical attention, death certification is often of poor quality due to inadequate facilities for accurate diagnoses or pressures on health personnel time. A further difficulty arises with childhood deaths. In developing countries, children often die from multiple infections and undernutrition or from the delayed effects of diseases such as measles. Thus, the convention of ascribing a single underlying cause of death fails to fully capture the synergistic interaction between acute and chronic disease and nutritional insufficiency (Mosley and Chen, 1984).

To overcome these difficulties, investigators have often used information derived from interviews with relatives of the deceased person and attempted to reconstruct events prior to death in order to reach a medically accepted diagnosis. Such interview based diagnoses, or "verbal autopsies," can provide important information, but there has been no critical review of methods and experience with these procedures. This paper draws on the published and unpublished literature, and particularly the results of a workshop held at the Johns Hopkins University,

School of Hygiene and Public Health (Gray et al, 1990a). The focus is on deaths during infancy or childhood. We review the theoretical basis for verbal autopsies and methods for data collection, the diagnosis of specific diseases and experience in field studies. Although this report draws upon information on morbidity, it does not attempt to review the literature on health interview surveys which has been considered elsewhere (Ross and Vaughan, 1986; Kroeger, 1983 and 1985).

VERBAL AUTOPSY METHODS

Certain diseases have characteristic symptoms and signs that in association form a relatively distinct clinical syndrome. Such diagnostic syndromes are frequently used in medicine, particularly when there are no definitive confirmatory investigations available. The objective of a verbal autopsy interview is to identify well defined medical syndromes using information about the terminal illness elicited from close relatives of the deceased person. The approach is most useful when the characteristic symptoms and signs of the disease are sufficiently distinctive to differentiate the disease of interest from other conditions with which it might be confused. The postmortem interview attempts to replicate a conventional medical history used to establish a differential diagnosis (i.e., a list of conditions consistent with a patient's symptoms and signs). However, unlike a physician's diagnosis, the verbal autopsy can not establish a definitive diagnosis because confirmatory information derived from physical examination medical investigations, laboratory tests or autopsy is not usually available. There is, therefore, inevitable uncertainty in the accuracy of verbal autopsy diagnosis.

There are only a limited number of diseases which present sufficiently distinct syndromes that are potentially suitable for verbal autopsy diagnosis. In children, these conditions include acute conditions such as neonatal tetanus, prematurity/low birth weight and birth injury, measles, diarrhea/dysentery, acute lower respiratory infection (ALRI), pertussis, meningitis, and injury, and certain chronic conditions such as tuberculosis (TB), nutritional

deficiency, and AIDS (Gray et al, 1990a). Not all these conditions can be diagnosed with equal accuracy, and the main focus of research has been on diseases which constitute common causes of morbidity and mortality amenable to prevention or treatment. In adults, causes of maternal death have been assessed by verbal autopsy (WHO, 1987; Koenig et at, 1988; Fauveau, 1989), but there is relatively little information on causes of non-maternal adult deaths (Hayes et al, 1989).

Data Collection

Reporting of deaths has been based on longitudinal population surveillance or on retrospective information derived from interviews in population surveys. Surveillance studies have the advantage of more timely and complete reporting of deaths and utilize a cadre of more experienced field workers. They have the disadvantage of higher costs which may limit population size, and thus the number of events, and they require a long duration for data collection. The majority of surveillance studies cover populations in excess of 20,000 persons, with home visits at regular intervals ranging from two weeks up to six months. The duration of data collection has varied from 3-10 years. In contrast, surveys are more economic and expeditious, but have the disadvantage of a longer average interval between death and interview which could introduce recall errors, and may lack personnel experienced in the use of verbal autopsy (Gray et al, 1990a).

Some surveillance studies use medically trained personnel such as physicians or nurses, whereas others use trained lay interviewers who are regularly supervised by professional staff. Surveys generally require the same set of interviewers to administer both the regular survey questions and the verbal autopsy, although some investigators feel that it might be preferable to have a separate staff of specialized verbal autopsy interviewers in order to improve data quality and minimize omission of events (Gray et al, 1990a).

Verbal Autopsy Interviews, Classification and Coding of Causes of Death

The structure of the questionnaires used for verbal autopsy interviews has varied considerably between studies (Zimicki 1986, Garenne and Fontaine 1986, Gray et al, 1990a). Most employ an open ended question regarding the respondent's perception of the circumstances surrounding the death, views on the probable cause of death, and information on use of medical services. It is important to elicit information on "how" the death occurred rather than "why," because the latter question is often interpreted in terms of a metaphysical explanation. Open-ended questions can provide important information on the sequence and timing of events and use of health care. They also help establish rapport with the bereaved respondent, and can be sensitive to local interpretation or terminology for diseases (Zimicki 1986, Garenne and Fontaine 1986, Gray et al, 1990a; Bang et al, 1990). However, unstructured interviews may be difficult to interpret, and if used alone, key information may be omitted. Also, open-ended questions are vulnerable to interviewer bias and to culturally specific interpretation of illness, which may differ from Western medical notions of disease.

Most studies also use structured questionnaires, with either a comprehensive list of specific questions regarding symptoms and signs or a short series of "filter" screening questions that direct the interviewer to disease-specific modules containing more detailed questions (Gray et al, 1990a). An example of a screening questionnaire is given in Table 1. The screening questions should be very sensitive (i.e., detect all cases of the index disease), and the supplementary questions should be highly specific so as to reduce the number of false-positive diagnoses by excluding other conditions that might be confused with the index disease.

To achieve high specificity, it is important to obtain information on the presence of cardinal symptoms and signs, the timing of onset, and the duration and persistence of symptomatology relative to the timing of death. Also, some estimate of severity is needed for certain symptoms; for example,

with diarrhea it is useful to know the number of stools on the worst day of illness. This can entail lengthy interviews and many investigators have used separate instruments for neonates (with a focus on events surrounding birth), as well as questionnaires for older infants and children. However, a single questionnaire for all infant and childhood deaths is usually adequate (Gray et al, 1990a).

TABLE 1. EXAMPLE OF FILTER SCREENING QUESTIONS

1.	Frequent loose or liquid stools	---> diarrhea module
2.	Blood in stools	---> diarrhea module
3.	Cough	---> ALRI module
4.	Difficulty breathing	---> ALRI module
5.	Generalized skin rash	---> measles module
6.	Convulsions/spasms	
	in a neonate	---> tetanus module
	in an older child	---> meningitis module
7.	Stillbirths or deaths	
	<1 week of life	---> perinatal module
8.	Injury	---> injury module

The questions should use lay terminology and, as much as possible, utilize local terms for common well-recognized diseases. However, such local disease terminology may be less specific than the required medical diagnoses. In the Filipino dialect of Cebuano, for example, the word "tipdas" implies all illnesses with a rash, including but not exclusive to measles. Similarly, in Bangla the term "alga", which implies infantile convulsions and cyanosis (turning blue), includes neonatal tetanus as well as other causes of convulsions in the newborn (Zimicki, 1986). Also, the local cultural taxonomy of illness may not conform to recognized biomedical classification. An example is the term "empacho", which issued in Mexico and Central America to describe a disuse related to diarrhea, but which has no biomedical equivalent (Kendall et al, 1984). Thus, local names for a disease may be

insufficient for reliable diagnosis. Some investigators have trained interviewers to demonstrate signs such as rapid breathing in order to avoid miscommunication (Bang et al, 1990).

Supplemental information from a variety of sources can be of value. Medical records, death certificates, child health cards, immunization records, prescriptions or medicine containers can provide important information and should be used when available. In addition, knowledge of local disease patterns can be helpful. For example, if there is an epidemic of disease such as measles, the presence of a rash-related illness prior to death makes the diagnosis of measles more plausible. Similarly, if there is seasonal variation in disease, a death during the season of peak transmission is more likely to be due to the specific disease (e.g., malaria), than a death during the season of low transmission (Gray et al, 1990a).

The optimal interval between death and interview has not been established. Although some investigators have interviewed relatives "as soon as possible" after death, others feel that it is preferable to wait 2-3 months until the phase of acute grief is over (Garenne and Fontaine, 1986). In surveys, interviews are usually conducted 2-9 months after the event (Gray et al, 1990a).

The diagnosis and classification of cause of death often requires medical judgement. Some investigators have used disease-specific algorithms based on the presence and timing of symptoms or signs and the age of the decedent. However, many studies base diagnoses on a review of questionnaires by physicians (Gray et al, 1990a; Fauveau et al, 1990). It is conventional to ascribe immediate, underlying and contributory causes of death on the basis of the temporal ordering of illnesses and knowledge about the relationship between illnesses. For example, in a case of measles with pneumonia, it is likely that the measles is the underlying cause of the pneumonia. Other classification schemes such as primary and secondary diagnoses have also been used (Garenne and Fontaine, 1986; Gray et al, 1990a), but these may be biased by selection of a particular disease of interest as the underlying condition. It is, therefore, preferable to record multiple causes of death to avoid such bias and to facilitate analysis of disease interactions. The medical

definition of syndromes is often based on the presence of specified major criteria which are pathognomonic for the disease, and minor criteria which are symptoms or conditions frequently associated with the disease. Thus, some investigators grade diagnostic accuracy by the degree of relative certainty and classify diagnoses as "definite, possible, or probable" based on the extent to which predefined criteria are met.

The International Classification of Diseases (ICD) (1977) provides a comprehensive coding system using three- or four-digit categories and WHO has produced simplified coding schemes for lay reporting of illness and death (WHO, 1978). However, these coding systems are more complex than usually required and shorter code lists for specific diseases of interest are used in most studies. Considerable training is required for coders, particularly if they are required to distinguish between underlying and immediate or contributory causes of death.

Validation of Verbal Autopsy

Few investigators have attempted to formally validate interview diagnoses of illness or cause of death by comparison with physician diagnoses, confirmatory investigations or laboratory tests (Kalter et al, 1990a and b; Alonso et al, 1987; Greenwood et al, 1987b; Leeuwenburg et al, 1984a and b). The objective of validation is to determine the sensitivity and specificity of the interview or "test" diagnoses relative to a reference or "true" diagnosis based on medical assessment. Sensitivity is measured as the proportion of "true" cases of disease correctly identified by interview, and specificity is the proportion of "true" non-cases correctly identified. Thus, a sensitive test will detect the majority of "true" cases, and a specific test will exclude the majority of non-cases (Barker and Rose, 1979; Swets, 1988).

Frequently there is a trade-off between these two measures, whereby a highly sensitive test may be relatively nonspecific and vice versa. The choice of the best "test" diagnosis will vary depending on the ultimate goal, but in general one strives for a balance of sensitivity and specificity. Another measure of the

utility of a test diagnosis is the positive predictive value, which is the proportion of all positive cases detected by the test that are in fact true positives according to the reference diagnosis However, the positive predictive value varies with the population prevalence of the index disease and is thus much more difficult to generalize (Barker and Rose, 1979).

Accuracy of diagnosis can also be indirectly inferred by comparison of disease patterns derived from interview diagnoses with the known epidemiology of the disease (e.g., variation by age, sex or season). This provides "epidemiologic plausibility." Also, changes in disease patterns following interventions such as immunization can provide indirect evidence for the accuracy of interview diagnoses. Such indirect evaluation of "epidemiologic plausibility" may be flawed because of biased reporting due to transfer diagnoses from the target disease to another condition, or because of the persistence of diagnostic habits that lead to continued reporting of the target disease despite a reduction in its incidence (Zimicki, 1986; Gray et al, 1990a). This diagnostic bias should not, however, affect results from randomized trials.

INTERVIEW DIAGNOSIS OF SPECIFIC DISEASES

The following review will examine verbal autopsy diagnoses
for childhood conditions of public health importance. For each disease we review the main clinical and epidemiologic characteristics, the questions used in verbal autopsy diagnoses, conditions that might be confused with the index disease, and evidence for the accuracy of verbal autopsy diagnoses, as well as experience with field studies. Not all questions have equal weight in achieving a diagnosis, so those questions that are most informative (i.e., major criteria) have been highlighted in bold.

Neonatal Tetanus

Neonatal tetanus is considered to be a major cause of death in developing countries, although reliable data are not generally available. Neonatal tetanus mortality rates estimated from WHO

surveys range from 1 to 67 per 1,000 live births and the proportion of neonatal deaths attributed to tetanus ranges from 7 to 70% in developing countries (Stanfield and Galazka, 1984; Galazka and Stroh, 1986). The disease is due to contamination of the umbilical cord stump by Clostridium tetani spores as a result of poor cord care or local application of substances such as cow dung or ghee (Islam et al, 1982; Foster, 1984; Stanfield and Galazka, 1984; Woodruff et al, 1984; Traverso et al, 1989). Neurotoxin released by the organism causes severe muscle spasms, convulsions and death. The disease can be prevented by improved cord care practices and by maternal immunization with two doses of tetanus toxoid vaccine. The disease symptoms usually commence 2 to 14 days after birth and death occurs between the 3rd and 30th day (although most deaths occur between the 6th and 8th day). While the definitive diagnosis is based on the clinical features of the disease and isolation of the causative organism, the clinical presentation is sufficiently distinctive to permit diagnosis by maternal interview. Usually the presentation is of a child who suckled normally and cried normally for at least two days after birth, then ceased to suckle or cry within 3 to 28 days and developed generalized rigidity and/or convulsions leading up to death. Often there is clenching of the jaw (trismus), and tightness and retraction of the mouth (risus sardonicus). However, in societies where infants are not fed early breast milk (colostrum) during the first few days of life, cessation of swallowing would be a more useful sign than cessation of suckling (Zimicki, 1986; WHO, 1982).

The differential diagnosis of neonatal tetanus requires exclusion of brain damage due to congenital defects or birth trauma and asphyxia, which usually present within the first day of postnatal life as poor feeding, weak crying, flaccidity, coma or seizures. It is more difficult to differentiate tetanus from neonatal meningitis associated with septicemia or metabolic disorders (Galazka and Stroh, 1986).

WHO (1984b) has conducted numerous clinical studies and mortality surveys using an algorithm for tetanus diagnosis based on the questions in Table 2.

TABLE 2. ALGORITHM FOR NEONATAL TETANUS

1. Did the infant **die between the 3rd and 30th day** of life?
2. Was the infant **able to suckle (and/or cry) after birth?**
3. Did the infant **stop suckling (and/or crying)** when it became ill?
4. Did the **illness start between 2-28 days** after birth?
5. Did the infant's **body become rigid?**
6. Did the infant have **convulsions?**
7. Did the mother receive two tetanus toxoid immunizations during this pregnancy or her last pregnancy?
8. What was done to cut the cord and dress the stump?

Affirmative answers to questions 1-6 are diagnostic of neonatal tetanus.

The validity of verbal autopsy diagnoses of neonatal tetanus is difficult to assess directly. In larger clinical series, cessation of suckling is reported in 69-100% of clinical cases, rigidity or spasms in 97-100%, and trismus/risus sardonicus in 71-100% of cases. Fever or umbilical sepsis is reported in 20-50% (Galazka and Stroh, 1986). One study in the Philippines found a sensitivity of 94-100% using a modification of the WHO algorithm, but the specificity could not be adequately assessed (Kalter et al, 1990a). In a Bangladesh study, the WHO algorithm was compared to all possible cases of tetanus identified by open-ended interviews with mothers of deceased children. The WHO algorithm had low sensitivity because many women did not breastfeed for some days after birth, so the question on cessation of feeding had little predictive value in this context (Zimicki, 1986). However, the absence of clinically confirmed diagnoses makes this Bangladesh study difficult to interpret.

There is evidence of epidemiologic plausibility for the verbal autopsy diagnosis in the age distribution of putative

tetanus deaths as compared to other perinatal deaths, and in urban/rural or seasonal differentials of estimated disease incidence. Also, verbal autopsies used in the evaluation of preventive programs of maternal tetanus toxoid vaccination or traditional birth attendant (TBA) training in cord care have shown substantial declines in neonatal tetanus deaths as compared to control populations with no interventions (Stanfield and Galazka, 1984; Foster, 1984). However, in one Bangladesh study where an unstructured interview was used, neonatal deaths classified as tetanus increased after an immunization program; probably because field workers who had been sensitized by the vaccination project overdiagnosed the disease by ascribing to tetanus all deaths reported as "alqa", the local term for convulsive illness (Zimicki, 1986). This clearly indicates the need for careful definition and structured questions. In summary, the WHO algorithm for neonatal tetanus appears to be sensitive, but it is difficult to determine its specificity and it is likely that some nontetanus deaths are misclassified as tetanus.

Perinatal Deaths

The majority of births and perinatal deaths in developing countries occur without medical supervision and are not recorded in vital registration. Surveys may also underestimate perinatal mortality because of failure of maternal recall, or because interviews only ask questions about live births, and thus omit stillbirths. Also, some early neonatal deaths are probably misclassified as stillbirths (WHO, 1984). Nevertheless, a number of investigations suggest that perinatal mortality is a major and relatively poorly-understood public health problem in the developing world.

Hospital-based studies in developing countries suggest that 55-75% of perinatal deaths are associated with prematurity and low birth weight and, as expected, mortality risk varies inversely with birth weight and length of gestation (Kramer, 1987; Gray et al, 1990b; Haas et al, 1987). However, it is difficult to diagnose low birth weight or premature delivery by verbal autopsy methods. To be reliable, birth weight should be measured by an

accurate scale within 24-48 hours of birth, but this information is seldom available, since the majority of deliveries occur at home and TBAs seldom measure birth weight. Recent Egyptian studies of color-coded scales used by TBAs suggest that this simplified technology can be highly sensitive (100%) and specific (94%), but unfortunately such scales are not in widespread use (Ritenbaugh et al, 1989). Studies of proxy measures for low birth weight such as mid-upper arm circumference have found sensitivities between 71-97% and specificity above 80%, but the cut-off criteria have varied from 9.0-10.0 mm for arm circumference (WHO, 1987; Sauer Born et al, 1990). Estimates of gestational age are particularly problematic in cultures where women do not know the dates of their last menstrual period, and specialized neonatal examinations to determine infant maturity cannot be conducted in most field settings (Ferraz and Gray, 1990; Gray et al, 1990b). In summary, objective measures of prematurity/low birth weight are currently not available for the overwhelming majority of births in developing countries.

Birth trauma or asphyxia due to complications of delivery and/or poor obstetrical care are also thought to be major problems in less developed countries, but little information is available outside of hospital deliveries. Also, it may be difficult to differentiate between deaths due to these conditions and deaths due to prematurity/low birth weight (WHO, 1984a).

There are no well established questions that have been used to diagnose perinatal causes of death and the items suggested in Table 3 are derived from a number of reports.

Prospective studies have used structured maternal interviews and open-ended interviews to determine causes of perinatal death in India, Bangladesh and Kenya. The findings are summarized in Table 4. About one-third or more of perinatal deaths were ascribed to low birth weight in the three South Asian studies, compared to one quarter in the Kenyan study. In all four studies, over one-third of deaths were attributed to birth trauma/asphyxia and in approximately one-fifth of cases no specific cause could be identified. The findings were generally consistent between studies and suggest that verbal autopsies can be used to identify major perinatal conditions.

TABLE 3. PERINATAL DEATHS

Identification of Perinatal Death:

1. Did the baby show **any sign of life after birth** (i.e., breathing, crying)?
2. Did the baby **die within one week of birth?**

Low birth weight/prematurity:

3. **How big was the infant at birth?**
   Normal size ____, Small ____, **Very small** ____

4. Was the duration of pregnancy normal ____, or **shorter than normal** (< 8 months) ____?

Birth trauma/asphyxia:

5. Was the **delivery prolonged** (> 12 hours)? **Or complicated**? (specify.....)
6. Were there bruises or marks of injury on the baby's body? (specify .....)
7. Was this a multiple pregnancy?
8. **Did the baby fail to breathe, cry or suckle normally during the first day after birth?**
9. Did the baby have **spasms or convulsions within the first three days of life?**
10. Was the baby **floppy or unconscious during the first 3 days of life?**

Congenital defects:

11. Did the baby have **any abnormalities of the head, body or limbs**? (specify .....).

Questions 1 and 2 establish a perinatal death. Questions 3 and/or 4 suggest low birth weight and/or prematurity. Questions 5-10 suggest birth trauma/asphyxia, and 8-10 differentiate perinatal problems from neonatal tetanus. Question 11 attempts to identify congenital defects.

TABLE 4. PERCENT OF PERINATAL DEATHS ATTRIBUTED TO PREMATURITY/LOW BIRTH WEIGHT AND BIRTH TRAUMA/ASPHYXIA IN COMMUNITY STUDIES

Study Size and Author	Number of Deaths	Low Birth Weight/ Prematurity %	Birth Trauma/ Asphyxia %	Birth Defects %	Infection %	Unknown/ Ill Defined %
INDIA* Kielman et al.[21] (1983)	124	32.2	37.1	6.5	5.6	18.6
INDIA Shah et al.[52] (1984)	172	33.1	34.0	2.3	4.1	26.5
BANGLADESH Faveau et al.[53] (1990)	492	37.8	36.4	2.4	4.1	20.0
KENYA Norbeck et al.[54] (1984)	221	24.9	38.5	8.1	7.2	21.3

* Deaths in the first week of life.

Measles

Measles usually occurs in children over the age of five months and is a major cause of death during childhood in developing countries, with case-fatality rates varying from 1% to 24% (Aaby et al, 1987). The majority of measles deaths are associated with complications such as ALRI or diarrhea. Also, following acute measles, there is an increased risk of subsequent mortality for 9-12 months due to postmeasles pneumonia, diarrhea and nutritional deficiencies (Foster, 1984; Aaby et al, 1987). Although there is debate over the duration of such postmeasles mortality, frequently deaths within one to three months of an acute episode are attributed to measles. The risks of mortality are higher for younger children, and among children who are secondary cases (i.e., children who acquire the disease from other cases within a household). Overcrowding and prior nutritional deficiency may also increase the mortality risk, although the latter issue is debated (Aaby et al, 1983; Aaby et al, 1984 and Aaby et al, 1990; Foster, 1984; Garenne et al, 1990). Vaccination programs can substantially reduce the risk of death from measles.

Measles is often recognized by the mother and frequently there are local terms for the disease that may be useful in diagnosis. However, such local terminology may be applied to other rash-like illnesses and, by itself, is too nonspecific for a diagnosis. The occurrence of a measles epidemic, or of other cases in the household, also helps to establish measles as a probable cause. A history of measles vaccination makes the diagnosis less likely, but does not exclude the disease because vaccine failures are known to occur.

WHO (1984b) program and other investigations have used verbal autopsy methods to diagnose deaths associated with measles. The most common questions are listed in Table 5.

TABLE 5. DIAGNOSTIC ALGORITHM FOR MEASLES

1. Was the child 5 or more months old?
2. Did the child have **fever**?
3. Was there a **blotchy rash lasting 3 or more days**?
4. Was there **peeling or darkening of the skin among children who survived for 5 or more days**?
5. Was there cough, runny nose or red eyes (conjunctivitis)?
6. Were there other cases of measles in the household or a measles epidemic?
7. Did the above conditions occur within 1-3 months prior to death?

Affirmative responses to questions 1-4 are diagnostic for measles. Questions 5-7 are supportive.

Several studies have shown that verbal autopsy diagnosis of measles is highly reliable. A study of 48 measles-associated deaths in the Philippines compared maternal interviews with physician diagnoses. The verbal autopsy diagnosis was found to be 98% sensitive and 90% specific (Kalter et al, 1990). A similar study of children who survived acute measles found a sensitivity and specificity of 94% (Kalter et al, 1990). In a Kenyan study, serological tests for measles antibodies were compared with maternal interview diagnoses for 556 children; the sensitivity was 96% but the specificity was only 54% for all "possible, probable and definite clinical cases." If only "definite" cases are considered (i.e., those meeting all criteria in Table 5), the specificity was 85% (Leeuwenburg et al, 1984a). However, a seroepidemiologic study of 600 unvaccinated children in Mozambique found that a maternal history gave only 50% sensitivity and 83% specificity (Cutts et al, 1990). Several studies using verbal autopsies have shown declines in measles deaths following immunization programs, which adds epidemiologic plausibility to the verbal autopsy diagnosis (John et al, 1980; Kasongo Project Team, 1981; Hull et al, 1983; Clemens

et al, 1988; Aaby et al, 1990; Holt et al, 1990; Koenig et al, 1990).

Diarrhea

Acute or chronic diarrheas and dysentery are known to be associated with a substantial proportion of child deaths in developing countries (Feachem, 1986; Mata, 1983; Black, 1984a). Although caused by numerous pathogens, these diseases have a common pathway of transmission through the ingestion of contaminated food or water due to inadequate sanitation and water supplies, unhygienic food preparation or storage, and poor personal hygiene (i.e., lack of hand washing) (Mata, 1983; Black, 1984a). The age-specific incidence of diarrhea and diarrheal deaths varies, depending on feeding practices in different societies. Breastfeeding is highly protective against diarrhea and the peak period of risk for the disease is during the introduction of supplementary foods or weaning (Mata, 1983; Feachem & Koblinsky, 1984; Black, 1984a; Khin-Maung-U et al, 1985; Clemens, 1990). Poor nutrition is associated with increased diarrheal case-fatality and with longer duration of diarrhea, and conversely, recurrent or prolonged episodes of diarrhea undermine nutritional status (Black et al, 1984b; Mata, 1983). Children who die of diarrhea frequently have other concomitant acute or chronic illnesses (Butler, 1987). Oral rehydration therapy (ORT) can markedly reduce case fatality from dehydrating diarrhea and has become a widespread treatment for this condition. Dysentery, however, requires antibiotic treatment as well as rehydration (Mata, 1983; Black, 1984a; WHO, 1989).

Most studies of diarrheal morbidity or mortality define an episode of diarrhea as a history of more than three to four loose or liquid stools per day, and define dysentery as frequent liquid stools containing blood. Open-ended questions on the presence of "diarrhea" may be unreliable because of the subjective nature of maternal assessment and because of cultural variation in the use of local terms (Black, 1984a; Kendall et al, 1984). Since diarrheal deaths are generally associated with dehydration, interviews usually ask questions about signs of dehydration such

as thirst, sunken eyes, dry mouth, etc. (Black, 1984; WHO, 1989). A suggested list of questions is given in Table 6.

TABLE 6. DIAGNOSTIC ALGORITHM FOR DIARRHEA/DYSENTERY

1. Was there a history of **3-4 or more loose or liquid stools per day**?
2. How many stools were there on the worst day?
3. Was there **blood in liquid stools**?
4. Did the child have any of the following: **dry mouth, thirst, dry wrinkled skin, sunken eyes, lack of urine, depressed fontanelle in infants?**
5. Did the illness persist until time of death?

Question 1 indicates diarrhea and question 2 grades the severity. Question 3 indicates dysentery, and question 4 identifies dehydration.

A Philippines study compared verbal autopsy diagnoses of diarrhea associated deaths with confirmed clinical diagnoses in 43 children who died as a result of diarrhea alone and in 92 children who died of diarrhea plus other associated illnesses (Kalter et al, 1990a). Among the children in whom diarrhea was the sole cause of death, a history of loose or liquid stools ascertained by verbal autopsy had a sensitivity of 84% and a specificity of 79%. The addition of further questions indicating severe diarrhea ($\geq$ 6 stools per day, thirst or sunken eyes) decreased the sensitivity to 68%, but increased the specificity to 92%. In the 92 children who died of diarrhea and another concomitant disease, the history of loose/liquid stools had a sensitivity of 78% and a specificity of 79%; with questions on more severe diarrhea, the sensitivity was reduced to 57% but the specificity increased to 92%. A related study of children who survived a diarrheal episode showed high sensitivity (95%) and specificity (80%) for interview-based diagnoses. The diagnosis of moderate or severe dehydration was unsatisfactory in both fatal and non-fatal cases (Kalter et al,

1990a and b). However, it is difficult to assess the degree of fluid loss without weighing the child before and after rehydration, and even physicians underestimate the severity of moderate dehydration when using clinical judgment (MacKenzie et al, 1989).

A study in Bangladesh compared maternal histories of diarrhea with observation of stool consistency in living children and found an 80% agreement (Black, 1982). However, in a Kenyan study, maternal reports of "diarrhea" (without specifying the number or consistency of stools) were found to over-report 15-40% of episodes when compared to visual inspection of stool specimens by investigators (Leeuwenburg et al, 1984b). This highlights the need for detailed information concerning the characteristics and frequency of stools rather than subjective maternal assessment of "diarrhea". A Gambian investigation of children with marasmus and chronic diarrhea showed that maternal interviews on admission correctly identified 75% of cases; and one month after discharge, maternal interviews agreed with the clinical diagnosis in 91% of cases (Alonso et al, 1987). However, the postdischarge interview may have been affected by communication with the physician during hospitalization.

Field studies using maternal interviews have shown age, sex and seasonal patterns of diarrhea consistent with those observed in clinical studies (Mata, 1983; Leeuwenburg et al, 1984b; Black, 1984a). Also, ORT programs have demonstrated declines in diarrheal mortality based on verbal autopsy, which is consistent with observations from clinical trials (Oberle et al, 1980; Kielman et al, 1985; El-Rafie et al, 1990). This suggests epidemiologic plausibility for interview-based diagnoses.

In summary, verbal autopsy diagnoses of diarrhea appear to be reliable if adequate information is obtained on stool frequency and consistency. However, maternal recognition or recall of the severity of dehydration may be problematic.

Acute Lower Respiratory Infections

Acute lower respiratory infection (ALRI) is a major cause of morbidity and mortality among children in developing

countries. Mortality is higher for infants (10 to 30 per 1000) than for toddlers (1.6 to 4 per 1000) (Chretien et al, 1984; Foster, 1984; Victoria et al, 1989), and mortality is particularly high among premature infants or malnourished children. Case-fatality rates are also increased in populations living at high altitudes or in overcrowded conditions. ALRI is due to infection of the lung or lower respiratory tract by bacteria (mainly *Streptococcus pneumoniae* or *Hemophilus influenzae*) and viruses (mainly respiratory syncytial virus) (Foster, 1984; Berman, 1990). Treatment varies antibiotic therapy can reduce mortality from bacterial, but not viral, ALRI respiratory distress can be treated by oxygen plus bronchodilator drugs (WHO, 1990). Vaccines provide some protection from pneumococcal and H. influenza infections, but are not yet in widespread use (Foster, 1984; Riley, 1986; Berman, 1990).

The diagnosis of ALRI is difficult because the symptoms and signs of respiratory infection vary with age of the child and the severity of illness. Ideally, definitive clinical diagnosis ideally should be based on X-ray findings, culture of the causative organisms, or specialized tests such as pulse oximetry that measure blood oxygen levels. Without such investigations, there is uncertainty in physician diagnoses due to interobserver variation in the detection of respiratory signs during auscultation of the chest (Steinhoff, 1990; Berman, 1990; Redd, 1990).

WHO has developed simplified diagnostic algorithms to facilitate case management of sick children with ALRI (WHO, 1990). Severe pneumonia is defined by cough and chest indrawing, rapid breathing (>50 per minute), and inability to drink. Pneumonia is defined as cough and rapid breathing, but no chest indrawing. However, these guidelines for clinical management are difficult to use as criteria for verbal autopsy and there is still no well-defined algorithm for postmortem diagnosis. The most frequently used verbal autopsy criteria are cough for three or more days, accompanied by dyspnea (defined as difficulty breathing and/or rapid respiration for more than one day before death). It is important to differentiate between respiratory failure at the time of death, which is a common mode of dying, and persistent respiratory distress for some days preceding death,

which is more likely to be due to ALRI. Fever may not be present, particularly in young children (Gray et al, 1990a; Berman, 1990).

The algorithm in Table 7 is in part based on clinical judgment and has not been fully evaluated.

TABLE 7. DIAGNOSTIC ALGORITHM FOR ALRI

1. Did the child have a **cough for more than 3-4 days**?
2. Did the child have **difficulty breathing (dyspnea)** as indicated by the following: chest indrawing, nasal flaring, grunting or wheezing, cyanosis (blue color of lips)?
3. Did the difficult breathing last for **more than one day**?
4. Did the child have **rapid breathing**?

   Affirmative answers to questions 1-4 indicates ALRI. The persistence of cough and difficult breathing differentiates ALRI from terminal respiratory distress.

A validation study of 100 ALRI-associated deaths found that the verbal autopsy diagnosis was problematic (Kalter et al, 1990a). The presence of cough and dyspnea without qualifying the duration of symptoms had high sensitivity (86%) but low specificity (47%), whereas a history of cough lasting four or more days and dyspnoea for one or more days had a sensitivity of 59% and a specificity of 77%. The main difficulty was that many children who died had a cough and signs of terminal respiratory distress which can only be differentiated from ALRI by questions regarding duration of symptoms. We know of no other study to validate the verbal autopsy diagnosis of ALRI. However, field trials of pneumococcal vaccine and studies of antibiotic treatment which used verbal autopsy diagnoses have shown declines in ALRI associated mortality, which suggest that the diagnosis is sufficiently accurate to detect the impact of interventions (Riley, 1986; Black, 1990; Bang et al, 1990).

There have been several investigations of the accuracy of physician diagnoses in children with non-fatal ALRI. Studies which compare physician's findings in sick children with X-ray confirmation of ALRI or pulse oximetry measurements suggest

that the clinical diagnosis may be unreliable. For example, in studies of very young infants, a rapid respiratory rate (>60 per minute) had sensitivities ranging from 40-61% and specificities ranging from 55%-61%. Similarly, chest retractions had a sensitivity range of 66-94% and a specificity range of 28-54% (Berman, 1990). In older children rapid respiration (>50 per minute) had higher sensitivity (66-75%) and specificity (67-98%). However, these investigations were conducted in groups of sick children who were selected as having suspected pneumonia (Redd, 1990). Community studies in the Gambia suggest that for infants, fever, failure to breastfeed and vomiting were predictive of radiologically diagnosed ALRI; whereas for children aged 1-4 years, fever and a respiratory rate >60/minute were most useful signs (Campbell et al, 1989).

Maternal, interview-based diagnoses of non-fatal ALRI have been evaluated in a number of investigations. One British study interviewed mothers whose children had physician-diagnosed ALRI during infancy and found that only 17% of mothers remembered the illness when questioned at the child's first birthday (Watkins et al, 1982). In the Gambia, clinical diagnoses were compared with maternal interviews conducted at the time of hospitalization and were found to agree in 84% of cases (Alonso et al, 1987). In the Philippines, interviews with mothers of children with ALRI who had been discharged from hospital were compared to physician's diagnosis (Kalter et al, 1990b). A combination of cough, fever and dyspnea gave a sensitivity of 68% and a specificity of 84% for the maternal interview diagnoses. Another study in Burkina Faso also found that ALRI diagnoses by field worker interviews underestimated ALRI incidence when compared to physician diagnoses (Lang et al, 1986).

In summary, efforts to validate ALRI diagnoses based on verbal autopsy interview, physician's clinical findings or interviews with mothers of surviving children have shown that there is misclassification of children with ALRI which mandates caution in interpretation of studies of ALRI mortality and morbidity.

Pertussis

Pertussis or whooping cough, caused by *Bordetella pertussis*, is widespread in developing countries and is believed to cause around 4% of deaths in children and adolescents. Case-fatality rates vary from 1 to 7% (Foster, 1984; Muller et al, 1984). The organism causes a chronic paroxysmal cough, often lasting more than a month, reduces nutrient intake, and often leads to severe malnutrition. Most deaths from pertussis occur within three months of infection. Mortality is highest during infancy and among malnourished children. The risks of the disease and death vary with population density. In crowded situations such as urban areas the disease is endemic and infection frequently occurs during infancy, whereas in less dense populations transmission occurs in older children and tends to follow an epidemic outbreak pattern. The disease can be prevented by vaccination (Morley, 1973; Foster, 1984).

The definitive diagnosis is based on culture of the organism or serological tests, but a presumptive clinical diagnosis can be made on a history of paroxysmal coughing which persists for two or more weeks, with choking and/or vomiting after the paroxysms. There may also be a characteristic "whooping" sound during inspiration and children frequently have conjunctival hemorrhages. The algorithm in Table 8 is based on WHO studies and studies in Kenya (WHO, 1984b; Muller et al, 1984).

TABLE 8. ALGORITHM FOR PERTUSSIS

1. Did the child have **severe paroxysms of coughing lasting 14 or more days**?
2. Was there **choking and/or vomiting after the bout of coughing**?
3. Was there a "whooping" sound during inspiration?
4. Was there redness of the eyes (conjunctival hemorrhages) and/or swelling of eyelids (periorbital edema)?
5. Was the child in contact with other cases of whooping cough?

Affirmative responses to questions 1 and 2 identify pertussis. Questions 3-5 are supportive.

There has been no direct validation of the above questions for use in verbal autopsy, but several studies of sick children have validated these criteria for the diagnosis of morbidity. Voorhoeve et al. (1978) compared probable or definite diagnoses of pertussis based on laboratory findings with diagnoses based on maternal history alone. They found confirmatory laboratory evidence for pertussis in over 80% of suspected cases during an epidemic, but only in 40% of sporadic cases seen during non-epidemic periods. A clinical study in the U.S. found that a history of prolonged cough ($\geq$ 14 days) had a sensitivity of 98% and a specificity of 63%; additional criteria for paroxysmal coughing decreased the sensitivity to 52%, but increased the specificity to 83% (Peter et al, 1988). Several vaccine trials using interview based diagnoses have shown declines in pertussis morbidity and mortality (Morley, 1973; Muller, 1984; Foster, 1984). It is therefore likely that the algorithm for pertussis is satisfactory in field settings.

Malaria

Malaria is widespread throughout the moist tropics and endemic malaria is a particularly important public health problem in West Africa, where over 90% of the population is infected by the end of the first year of life (WHO, 1979; Bradley and Keymer, 1984). Because of the complex epidemiology of malaria, it is difficult to estimate its impact on mortality. Studies in the Gambia suggest that acute malaria is responsible for around 4% of infant deaths and 25% of deaths among children aged 1 to 4 years. Mortality rates were estimated at 6.3 per 1,000 for infants and 10.7 per 1,000 for children, and the mean duration of acute illness prior to death was less than three days (Greenwood et al., 1987b). Both acute and chronic malaria can contribute to mortality from other diseases by undermining health (e.g., anemia) and nutrition. Thus studies of mortality following malaria control programs have demonstrated declines in death rates beyond that expected from declines in acute malaria deaths alone (Gray, 1974; Bradley and Keymer, 1984; Greenwood et al, 1988). In addition, maternal malaria infection during pregnancy

results in reduced birth weight which can also contribute to subsequent infant deaths (McGregor, 1983). Stable endemic malaria is predominantly a disease of infancy and childhood because infected survivors develop immunity to the parasite, whereas in relatively nonimmune populations epidemic malaria can cause heavy mortality in all age groups. Malaria can be prevented by mosquito control measures, long-term prophylactic drug use, or drug treatment of acute illness (Bradley and Keymer, 1984).

The clinical diagnosis of malaria can be difficult and a definitive diagnosis depends on demonstration of a high density of parasites in the blood. In Gambian studies, a presumptive diagnosis was made on the basis of a history of high fever in a previously well child, without significant other concomitant respiratory or gastrointestinal illness (Greenwood et al, 1987b). If malaria transmission is seasonal or epidemic, then a febrile illness during periods of peak transmission is more likely to be due to malaria. It is difficult to assess the validity of such presumptive diagnoses, in part because many children in endemic malarious areas have parasitemia without fever, and because children who have already received antimalarial drugs may have no parasitemia. Morbidity surveys in the Gambia found that 65% of children with fever had malaria parasites in their blood, but 30% of afebrile children also had parasitemia (Greenwood et al, 1987b). Similarly, a study of illness in Congolese school children showed that 46% of children with fever had evidence of malaria parasites, but among children suspected of malaria the diagnosis could only be confirmed by blood smear in 20% of the cases (Trape et al, 1987). Physician diagnoses without laboratory confirmation are also problematic; a study of 104,281 patients in Zimbabwe showed that the percent of clinically suspected cases of febrile malaria confirmed by laboratory tests varied from under 5% in the season of low transmission to over 30% in the season of peak transmission (Taylor and Taputaira, 1988). Thus, fever as a criteria for malaria diagnosis is insensitive and nonspecific. One investigation of 16 seriously ill Gambian children with clinically diagnosed malaria found that open ended interviews with mothers gave a presumptive diagnosis of malaria in 75% of

cases on admission to hospital and in 90% of cases one month after discharge (Alonso et al., 1987). Despite these problems with diagnosis, it is noteworthy that a randomized trial of chemoprophylaxis showed substantial declines in malaria mortality using verbal autopsy diagnosis (Greenwood et al, 1988). Since this was a randomized study with blind observation, it is unlikely that diagnostic bias affected the outcome. In summary, more information is needed to assess the accuracy of diagnosis of malaria deaths by verbal autopsy methods. This should be a priority area for research.

Meningitis

Cerebrospinal meningitis occurs throughout the world and is a major public health problem in tropical Africa, where annual epidemics occur during the dry season in a "meningitis belt" of Sahelian countries extending from Sudan to Mali (Greenwood et al, 1984; Tikhomirov, 1987). Meningitis was responsible for approximately 9% of deaths in Gambian children under age 7 years (Greenwood et al, 1987a). The disease is characterized by high fever of sudden onset, severe headaches, and stiff neck, and may progress to delirium, coma and convulsions. Infants often have a bulging fontanel. Diagnosis is confirmed by examination of the cerebrospinal fluid (Robinson, 1985).

Criteria for the verbal autopsy diagnosis of meningitis have not been well established, but studies in Senegal and Nigeria used an algorithm based on fever, headache, neck extension (often with flexed arms and legs), and **swollen fontanelle in infants** (Bradley and Gilles, 1984; Garenne and Fontaine, 1986). Additional signs included convulsions and photophobia. Since most deaths occur during epidemics, the presence of other cases provides supporting evidence. No validation studies for the interview-based diagnosis of meningitis are available.

Chronic Illnesses: Malnutrition, Tuberculosis and AIDS

Many children suffer from chronic ill/health as a consequence of nutritional deficiencies, recurrent acute infections

and chronic infections with diseases such as tuberculosis (Mosley and Chen, 1984). Pediatric AIDS is also a growing a public health problem, particularly in Africa. It is difficult, however, to distinguish these chronic conditions from one another and to determine their contribution to death using verbal autopsy methods.

Anthropometric studies have shown that protein-calorie malnutrition increases the risk of death from a number of infectious diseases (Chen et al, 1980; Briend et al, 1987; Martorell and Ho, 1984). However, only a minority of undernourished children manifest overt clinical syndromes of malnutrition such as marasmus or kwashiorkor which might be diagnosed by verbal autopsy, and in the majority of cases anthropometry is required to detect less severe malnutrition. Unfortunately, anthropometric information derived from growth monitoring charts is seldom available for deceased children and even the recognition of clinical malnutrition may be subject to errors in maternal perception or recall.

Vitamin A deficiency can lead to blindness and has been associated with an increased risk of morbidity and mortality from a variety of infections (Feachem, 1987; Sommer et al, 1983; Sommer et al, 1986). Also, Vitamin A supplementation in deficient populations or in sick children has been associated with reduced mortality (Sommer et al, 1986; Barclay et al, 1987). Vitamin A deficiency is thought to be common in many developing countries as indicated by the prevalence of corneal damage due to xerophthalmia or its precursor of night blindness (Sommer et al, 1981). Thus, a history of these visual problems may provide an indicator of vitamin A deficiency prior to death.

Tuberculosis (TB) is widespread in the developing world and its prevalence is particularly high in Africa and South Asia (Styblo and Rouillon, 1981). Due to the lack of reliable data, it is difficult to estimate the mortality attributable to tuberculosis, although in general incidence and mortality rates are high during infancy and early childhood (Clemens et al, 1983; Curtis et al, 1984). BCG vaccination shortly after birth offers some protection from the disease and TB is responsive to antibiotic therapy. Pulmonary tuberculosis is the most frequent form of

infection, but disseminated infection of the lymph nodes, bones, intestinal tract and brain also occur, particularly in children. Most cases present with chronic cough, low grade fever and weight loss, but may also have hemoptysis (blood in the sputum), joint swelling due to bone infection, abdominal swelling due to intestinal infection, and enlarged lymph nodes in the neck, axillae or groin (Robinson, 1985). These protean manifestations make diagnosis difficult in the absence of X-ray investigations, bacteriologic or serological tests.

Perinatal transmission of human immunodeficiency virus (HIV) from infected mothers to children or from contaminated needles or blood transfusion is an increasing problem in sub-Saharan Africa (Quinn et al, 1986; Mann et al, 1986; Mok et al, 1987; Poulsen et al, 1989). Mortality among infected children is high and in a Zambian study 44% of seropositive children had died by the end of the second year of life (Hira et al, 1989). The immunodeficiency due to HIV infection increases the risk of acquiring other acute infections such as diarrhea or ALRI or chronic infections such as TB, and these conditions in turn undermine nutritional status. Thus, children with AIDS often have multiple infections and the clinical diagnosis of pediatric AIDS is difficult in the absence of confirmatory serological tests (Rubenstein, 1986; Mann et al, 1986; Hira et al, 1989). Also, the interpretation of positive HIV tests in infants is complicated by the passive transmission of maternal antibodies (Mok et al, 1987). A provisional WHO case definition for pediatric AIDS consists of three major signs: weight loss or slow growth, chronic diarrhea and prolonged fever with minor signs including chronic cough, a variety of infections and dermatitis (Quinn et al, 1986). The major features of the disease also vary somewhat with age (Rubenstein, 1986; Hira et al, 1989). Thus, it is difficult to distinguish AIDS and AIDS-related conditions from other chronic or recurrent illnesses, and the WHO diagnostic case definition has limited sensitivity and specificity in sub-Saharan Africa (Mann et al, 1986).

In summary, there is as yet no satisfactory algorithm for the verbal autopsy diagnosis of chronic malnutrition, TB or AIDS. The questions listed in Table 9 may be helpful in

diagnosis, and draw upon several studies, but have not been adequately evaluated. For each question, the possible associated diseases are given in parentheses.

TABLE 9: ALGORITHMS FOR CHRONIC CONDITIONS

1. Has the child had **weight loss or slow growth?** [malnutrition, TB, AIDS]
2. Was there **chronic cough > 1 month?** [TB, AIDS]
3. Was there **prolonged fever > 1 month**? [TB, AIDS]
4. Was there **prolonged diarrhea > 1 month**? [malnutrition, AIDS]
5. Was there **blood in the sputum?** [TB]
6. Was there a generalized skin rash? [AIDS]
7. Was there repeated common infections? [malnutrition, AIDS]
8. Was there generalized enlargement of lymph nodes? [TB, AIDS]
9. Did the child have **scarring of the cornea or blindness**? [vitamin A deficiency]
10. Did the child experience difficulty locating food or toys after dark, compared to other children of the same age (night blindness)? [vitamin A deficiency]

Accidents and Violence

Injuries are potentially important but often overlooked causes of death, particularly during childhood and adolescence (Smith and Barss, 1990). Death rates from injury in the 0-14 age group are similar in developed and developing countries (around 1 per 1,000). In Bangladesh, mortality from injury (primarily due to drowning) was 7.6 per 1,000 in the 0-5 age group (Chen, 1986) and in Sri Lanka there were over 1,000 deaths from pesticide poisoning (Jeyaratam et al, 1982). It is relatively easy to obtain information on deaths due to injury using verbal autopsy methods, by asking descriptive questions on the how the injury occurred (external cause, e.g. car accident) and on the

nature and location of the injury (e.g. fractured skull). However, there may be underreporting of causes such as homicide (particularly infanticide) and suicide, and there may be imprecise descriptions of the nature and location of injury. Confirmation of deaths due to injury may also be obtained from medical or legal records.

WHO (1978) has classified the external causes of injury into nine categories, shown in Table 10.

TABLE 10: EXTERNAL CAUSE OF INJURY

1. Bites or stings of venomous animals
2. Accidental burns
3. Accidental drowning
4. Accidental poisoning (excluding food poisoning)
5. Transport (traffic) accidents, classified by type (e.g., motor vehicle, etc.)
6. Other accidents
7. Suicide, self-inflicted injury
8. Homicide, assault
9. Violence of unknown cause
10. For 5-9, obtain descriptive information on the nature and location of the injury.

The use of verbal autopsy methods and this classification of causes of injury has not been validated for childhood deaths. However, in an Egyptian study of deaths among women aged 15-49 years, 92.8% of injury related deaths reported by interview were confirmed by physician certified death certificates. Also, there was 74.2% agreement on the specific cause of injury (Grubb et al, 1988).

SUMMARY AND CONCLUSIONS

It is unlikely that reliable information on causes of death will be available for major populations in developing countries until there is widespread registration of deaths, adequate medical service coverage and proper completion of death certification. In

the interim, researchers and policy makers will depend upon information derived from secondary sources such as interviews with relatives of the deceased. Such verbal autopsy diagnoses will always be subject to error because few diseases present as unmistakably distinct syndromes with symptoms and signs that can be readily perceived and recalled by the relatives. Moreover, the absence of clinical information will, of necessity, result in less precise presumptive diagnoses rather than definitive clinical diagnoses. Nevertheless, verbal autopsies can provide data of value to public health, particularly data needed for allocation of health priorities and for evaluation of intervention programs. Therefore, it is likely that verbal autopsies will be more widely used in surveillance and survey studies, and that greater standardization of interview methods and wording of specific questions can provide more consistency between investigations.

The objective of this paper has been to review current experience and to suggest approaches to standardization. The review suggests that verbal autopsies may provide relatively reliable diagnoses for diseases such as diarrhea, measles, neonatal tetanus, pertussis and meningitis, and for injuries. However, diagnosis is more problematic for other acute conditions such as ALRI and malaria, or chronic conditions such as TB, AIDS and malnutrition. There clearly needs to be more research to validate verbal autopsy diagnoses against standard clinical diagnoses so as to determine the most sensitive and specific questions for interviews and to determine the effects of cross-cultural variation on the interpretation of questions and on the quality of diagnosis.

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