A VALIDATION STUDY OF VERBAL AUTOPSY AS A MEANS OF DETERMINING THE CAUSE OF ADULT DEATH

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i

A VALIDATION STUDY OF VERBAL AUTOPSY AS A MEANS OF
DETERMINING THE CAUSE OF ADULT DEATH

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I HAVE READ THE DISSERTATION AND APPROVE IT FOR THE

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ABSTRACT

Objectives: To validate a verbal autopsy form by comparing diagnoses derived from verbal autopsy with the hospital diagnoses of patients admitted to the medical wards of Muhimbili Medical Centre.

Design: Prospective study of patients who were accompanied by relatives during their admission to two medical wards of Muhimbili Medical Centre during the period 1st July to 31st December 1993.

Setting: Muhimbili Medical Centre, Dar–es–Salaam.

Patients: 835 patients: 508 males and 327 female.

Results:

Among the 835 patients 510 (61.1%) were correctly diagnosed by verbal autopsy. Of the 508 male patients, 326 (64.2%) were accurately diagnosed by verbal autopsy while of 327 females 184 (56.3%) were correctly diagnosed.

The number and proportion of patients accurately diagnosed by verbal autopsy among diagnoses made in the wards were as follows: Tuberculosis associated with Human immunodeficiency virus disease (TB/HIV disease) 48 (62.5%), tuberculosis 79 (74.5%), HIV disease (AIDS) 27 (37.5%), acute gastroenteritis 38 (80.9%), malaria 49 (62.6%),

meningitis 22 (88.0%), cerebral malaria 22 (66.7%), heart failure 23 (63.9%), diabetes mellitus 20 (62.5%), suicide (intentional self harm) 17 (94.4%), liver diseases 11 (47.8%), cancer 4 (30.8%)., anaemia 11 (45.8%), acute lower respiratory tract infection 11 (37.9%).

Sensitivities, specificities, positive and negative predictive values of common diagnoses derived from verbal autopsy compared with hospital diagnoses were calculated. Meningitis, acute gastroenteritis, external causes, suicide and tetanus had sensitivities $\geq$ 80.0% and specifities $\geq$90.0%. Their positve predictive values were > 65.0%; while negative predictive values were > 95.0%. HIV disease, pulmonary tuberculosis, HIV disease associated with tuberculosis, malaria, cerebral malaria, stroke and diabetes mellitus had sensitivities between 60.0–75.0% and specificities > 94%. Their positive predictive values were between 58.0% – 90.0% and negative predictive values > 90.0%. The adult verbal autopsy performed poorly in patients with cancer, abscesses and cellulitis, acute lower respiratory tract infection (pneumonia), liver diseases, abdominal conditions. Their sensitivities were less than 50.0%.

Of the 835 respondents 715 (85.6%) had cared for the patients during the illness which led to admission. The probability of a correct diagnosis using verbal autopsy was greater when patient had been cared for by the respondent (P=0.0001). The gender of respondents was not associated with delivery of a more accurate history.

Conclusion:

This study has shown that for certain conditions verbal autopsy is a useful diagnostic tool, but for others its sensitivity is low. Awareness of the strength and limitation of verbal autopsy is important for those conducting community based studies to determine cause-specific mortality rates.

TABLE OF CONTENTS

ACKNOWLEDGEMENT

DECLARATION

I declare that the whole of this work has not been submitted for a degree in any other

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Date: ....15/11/95...........

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INTRODUCTION

Information on causes of death is regarded in all countries as being extremely important for policy making, planning, monitoring and evaluation of health programmes. However, in developing countries levels of coverage and reliability of vital registration are generally low.

The low coverage of vital registration in many developing countries results from several factors including a lack of incentives to register death, and the lack of locally sited offices at which death may be registered. A shortage of doctors, especially in rural areas, is often an additional factor in countries where the death certificate has to be completed by a medically qualified person. Where deaths are registered, the usefulness and reliability of the certified cause of death are often questionable, partly because the certification of cause of death is often performed by someone without medical qualifications. A survey of deaths in children, in the village under the age of seven years in the Gambia found that 77% of all death occurred at home and only 12% in a hospital or health centre[1]. Kachirayan,in India, found that deaths occuring in hospitals, clinics and nursing homes accounted for 27% of all registered deaths and these were the only ones investigated for the cause of death.[2] In Dar es Salaam 57%, Morogoro Rural District 81% and in Hai district 51% of all deaths occurred at home.[3]

In developing countries cause specific mortality has been estimated from data obtained by verbal autopsies[4] Verbal autopsies are based on interviews with bereaved relatives by doctors, nurses or lay persons. Questions are asked about the symptoms and

signs during the terminal illness and information collected is reviewed independently by one or more physicians who assign the probable causes of death. It is common practice to have three doctors review the data and to reach consensus between at least two of the reviewers. There is a need to test and validate various verbal autopsy forms to establish their reliability as diagnostic tools in determining the cause of adult mortality. There is little if any published work on the validation of verbal autopsy in adults. Most studies of verbal autopsy validation have been carried out in children. This study was therefore undertaken to validate the use of verbal autopsy as a means of determining the cause of adult deaths.

2. LITERATURE REVIEW

2.1 Adult Mortality in sub–Saharan Africa

In sub–Saharan Africa the death of adults before they reach old age remains a major health problem. At current levels of mortality, the proportion of Africans aged 15 who can expect to die before age 60 ranges from around 20 percent to over 50 percent.[5] Despite its high level in sub–Saharan Africa, adult mortality is a public health issue that has received much less attention than infant and child mortality.

Primary health care has been given high priority in recent years. Research attention and health care expenditure have been directed mainly toward the problems of child health. The first consideration of importance is that a large proportion of all serious ill health and deaths occur among young children. Disease incidence and mortality rates

among children are on an order of magnitude higher than those among young adults. While these facts are of major practical significance, the adoption of a lifetime perspective on the chances of ill health and death suggest a rather different picture. The probability that a person in Africa will die between the ages of 15 and 60 is broadly similar to the probability that he or she will die in childhood.[5] Moreover, the social and economic consequences of the death of young adults are particularly serious. Such deaths represent the loss of experienced and productive members of the labour force, and the great majority produce a widowed spouse. Among the most vulnerable groups, serious illness of the principal bread winner can set off a cycle of increasing privation and ill health that may result in the extinction of the whole family. The current AIDS epidemic has highlighted this problem.

A second reason why attention is concentrated on child health is that the great majority of deaths in childhood occur from a limited number of infectious diseases prominently diarrhoea, acute respiratory infections, malaria, measles and neonatal tetanus. Most deaths from such causes are readily preventable. In contrast, the health problems of adults are more diverse and to some extent more intractable. However, little is known about the causes of adult mortality, but respiratory diseases and diarrhoeal diseases which are important causes of death in children, are also considered to account for 25%–33% of young adult deaths.[5]

A substantial proportion of adult deaths arises from a limited range of diseases that could be treated by a basic and effective health care system. Indeed it can be argued

that the achievement of countries such as China, Costa Rica, and SriLanka, which have attained good health at low cost, have been as impressive in the field of adult mortality as in that of child mortality.[6]

Sources of Data and Mortality levels

In almost all of sub–Saharan Africa the registration of vital events, and in particular of deaths, is far too incomplete for data derived from the registration system to be useful for demographic estimation. The majority of deaths occur outside the framework of the official health care system. Generally national death registration statistics in sub–Saharan Africa are far too incomplete for researchers to consider using such data.

Apart from civil registration systems, the major source of routine statistics on adult mortality and morbidity is the health care system. Such statistics are of limited use because, by definition, they refer only to the limited portion of the population that is in contact with the health services. They are also subject to numerous selection biases when treated as data reflecting health problems of the entire population. In many countries the persons responsible for making statistical returns are overwhelmed by the demands put on them, which leads to delays and inaccuracies in the production of tables. Simpler reporting systems are needed that encompass primary health care as well as hospital based services and that can rapidly and reliably produce a few key indicators to be fed back into the planning and monitoring processes.[7]

Data available on levels and trends of mortality in most sub–Saharan countries especially childhood mortality has been derived mainly from indirect estimates based on census and survey data. Several longitudinal studies of mortality levels have been conducted over the past 30 years in defined populations.[5]

In most of these studies interest was focused on childhood mortality, and it is probably true to say, that they have contributed little to our understanding of levels, trends and causes of adult mortality.

Mortality trends

Rapid reduction in the death rates of adults have been achieved by many West and Central African countries during the postwar period, which suggests that the relatively high levels of mortality characteristic of these regions was at one time even more pronounced. The surveys conducted in francophone Africa between the mid–1950s and mid–1960s produced the bulk of the information on adult mortality available for that period. Although varying in quality, many of their results seem plausible.[8] In some instances the levels of adult mortality were very high. For example, surveys conducted in Guinea in 1954–55 and Chad in 1963–64 yielded life expectancies at age 15 of around 30 years.[5]

In much of West Africa the level of adult mortality continued to improve rapidly in the 1960s and 1970s. In Ivory Coast the 1978–79 multiround survey found that the life expectancy at age 15 had risen to nearly 49 years from an estimated 38 years in 1961–62. In Senegal a series of multiround surveys indicated that it had risen from 41

to 50 years between 1965 and 1978.[9] According to orphanhood-based estimates, life expectancy at age 15 increased about seven years in Benin and Cameroon during the decade centered on 1973 and perhaps by even more in the Congo Republic during the 1960s.[8]

Orphanhood data for two Sahelian countries, Mauritania and the Sudan, also indicate rapid reductions in the level of mortality between the mid 1960s and mid 1970s. Although mortality was already lower in both countries than in most of the west African countries cited, life expectancy at age 15 probably increased more than five years in the decade before 1975.[10]

It seems unlikely that the initial advantage enjoyed by these regions of Africa was followed by declines in their levels of adult mortality. In some cases the evidence is unequivocal; the mortality of adults did not fall to any significant extent in Lesotho between the mid 1950s and 1977.[11] Successive series of orphanhood data for Malawi exhibit inconsistencies similar to those for Kenya and offer little evidence of mortality decline.[11] There is evidence that rapid declines in the level of mortality have been concentrated in the Western part of sub-Saharan Africa and adult mortality remains higher in Southern Africa than elsewhere on the continent.

Causes of deaths

Despite increasing interest in using health interview surveys to collect information about patterns of ill health in Africa, only a few published surveys consider the health problems of adults. Community-based studies of causes of death are particularly

important because they provide information about patterns of life–threatening disease. Some important causes of adult death are respiratory tuberculosis, cardiovascular diseases, neoplasms, influenza, pneumonia and bronchitis, diarrhoea and gastroenteritis, diabetes, liver disease, maternal mortality, accidents and violence and other infectious and parasitic infections.[12] Information about patterns of causes of death would yield insights and produce better strategies for health interventions.

In broad outline, the pattern of causes of adult death in sub–Saharan Africa is similar to that found in other high mortality populations. The infectious diseases – respiratory infections and diarrhoeal diseases that are major causes of death in childhood also account for one–quarter to one third of the deaths of young adults.[13,14]

2:2 ADULT MORTALITY IN TANZANIA

Sources of information

Several sources of information on morbidity and mortality in Tanzania are available to the Ministry of Health for guiding the direction of policy and planning. The following are sources of information:

1. **Hospitals** Government and private hospitals compile annual reports which include information on outpatient problems and causes of admission and deaths. This may provide an indication of community health problems, but for reasons of selection such information is likely to be biased and incomplete.

2. **Special health and disease – directed programmes** There is a wide variety of programmes and projects producing information on morbidity and mortality. The following are examples of such programmes: The Expanded Programme on Immunization (EPI)

The Essential Drugs Programme (EDP)

Maternal and Child Health Care Programme (MCH)

National Tuberculosis and Leprosy Control Programme (NTLP)

National AIDS Control Programme (NACP)

National Mental Health Programme (NMHP)

Health Management Information System.

3. **Government and Non–Governmental Organisations.**

United Nations Children's Fund (UNICEF)

UNICEF, working with the Ministry of Health, issues regular reports, particularly on the nutritional status of children in those ares where UNICEF has instituted special Child Survival and Development Programmes. Changes in the nutritional status of children is one of the key methods used in evaluating the effectiveness of programmes. However, mortality rates do not appear to be widely used.

4. **Vital statistics:– Birth and death certification**

Registration of vital events is the responsibility of the department of the Registrar General in the Ministry of Justice. Registration of births and deaths has been compulsory by law in Tanzania since 1921, but since that time little, if any,

information has been published on causes and rates of mortality in Tanzania. The programme has involved the training of several thousand personnel throughout the country. Efforts continue to ensure widespread coverage, but to date, the information collected has been unavailable to planners and others interested in the socio–economic development of the nation. Financial constraints are among the reasons for the failure of the programmes to provide vital data. Others include lack of motivation by the public to register deaths and a lack of locally sited offices where deaths can be registered.

Village register information system.

This programme is the responsibility of the Prime Minister's Office supported by the Ministry of Community Development and Bureau of Statistics. Its purpose is the establishment of village registries in which vital and other data will be recorded. The data will be used by village governments for planning and monitoring purposes.

5. **Special surveys and census**

Information on health and disease in Tanzania is continually generated through numerous research projects and surveys such as the Demographic and Health Survey.

Causes of Death in Dar es Salaam, Morogoro Rural and Hai Districts.[3]

In Dar es Salaam and Morogoro Rural District the adult morbidity and mortality project found that infectious diseases accounted for approximately 60% of all deaths in

men and women and non–infectious diseases for 20% in adults, 15–59 years. In Hai District infectious diseases caused 44% and 49% of all deaths in men and women respectively, and non–infectious diseases accounted for 30.5% of all deaths in men and 26.6% in women. In Dar es Salaam and Hai District, HIV disease with or without tuberculosis is the leading cause of death in males, 15–59 years. For females 15–59 years, HIV disease is the leading cause of death in Morogoro Rural District, Dar es Salaam and Hai District. Maternal deaths are the second commonest cause in Dar es Salaam, the 3rd in Morogoro Rural and 3rd in Hai District.

The top ten causes of mortality included HIV disease, TB/chronic cough, pneumonia, acute febrile illness (probably mostly malaria), acute gastroenteritis, stroke, cancers, chronic liver disease, road accidents, and other external causes.

2:3 Comparison of clinical diagnosis and autopsy diagnosis

A number of studies have compared clinical diagnosis and autopsy findings. Obviously such findings are not necessarily representative of all deaths. There may be a tendency to perform an autopsy when the diagnosis has not been satisfactorily established; those patients dying in hospital may have very different conditions from those dying at home.

Jackson published a report comparing autopsy records over an 18 months period with clinical histories based on a consecutive series of 100 cases where mention had been made of a pathological lesion of the heart. He concluded that the autopsy findings bore a moderately close relationship to the clinical diagnosis.[15] A more extensivestudy

was reported by Cabot based on 300 autopsies at the Massachusetts General Hospital.[16]

Waldron and Vickerstaff analysed records of 1126 patients having autopsies in the Birmingham region. They found that in 47.5 percent the clinical diagnosis was confirmed, in 26.4 percent there was partial agreement, and in 26.1 percent the clinical diagnosis and pathological diagnosis disagreed. They again emphasized that estimates of the numbers dying from certain condition such as malignant disease, were little changed.[17]

Cameron and McGoogan obtained data for deaths occuring in hospitals in South Lothian, Scotland from 1975 to 1977. There were 5663 deaths, of which 25 percent had an autopsy. A form was completed with the clinical diagnosis for 80 percent of the patients prior to autopsy. Some clinical diagnosis could not be verified from the autopsy (eg diabetes) and these were automatically accepted as correct. When the order of importance of several conditions was a matter of opinion, the clinician's judgement was accepted. Data grouped to show the degree of change for the main diagnoses between different chapters of the ICD indicated that in 703 (61%) the main diagnosis was confirmed. After examination of the main diagnosis and its consequences, an attempt was made to assess the significance of the incorrect diagnosis. They do not discuss the details of this but concluded that the statistics from death certificates are so inaccurate that they are unsuitable for uses in research and planning.[18]

In a study of 1098 deaths of childrens under 15 in a French children's hospital between 1966 and 1975, comparison of clinical records and autopsy was available for

377. The diagnosis agreed in 71 percent; in 15 percent an associated condition was revealed by autopsy and in 7 percent a major condition was revealed. There was no clear diagnosis from the autopsy in 5 percent.[19]

A special effort in 1956 increased the number of autopsy reports available to the New York vital statistics office. However, review of these suggested that the certificate would only be changed in 15.2 percent and Erhardt et al concluded that the expenditure in time, money and effort was not justified in relation to the effect on accuracy of the statistics.[20]

2.4 VERBAL AUTOPSY TECHNIQUE:

Appropriate classification of causes of death for verbal autopsies

The need for some system of coding causes of death was recognised over a hundred years ago by William Farr. The primary purpose of classification was to create a tool which would allow identification of major public health problems. The first International classification of Diseases(ICD) was published in 1899, and since that time classification systems have been reviewed and updated every 10 years. Responsibility for revision was undertaken by the World Health Organisation (WHO) as from 1948.

From the perspective of developing countries and public health physicians, the original purpose of disease classification has become somewhat obscured. Nevertheless, classification remains an essential tool for purpose of standardization and comparisons

between and within countries. It also provides a structure to aid the presentation and interpretation of data.

The ICD is based primary on disease categories and therefore assumes availability of diagnostic facilities. Recognising that diagnostic facilities are often not available in developing countries, WHO in 1973 published a classification system based on symptoms. This, however was not widely applied and accepted and has never been revised.[28]

It is recognised that disease categorisation would be ideal, but apart from certain well-defined causes of death, disease categorization is often not possible.

The following is an example of abbreviated classification system which can be used in verbal autopsy.

▍ Diarrhoea and gastroenteritis of presumed infectious

origin.

▍ Tuberculosis.

▍ HIV disease.

▍ Tuberculosis and HIV disease.

▍ Chronic cough.

▍ Pneumonia and other lower respiratory infections.

▍ Malaria.

▍ Meningitis.

▍ Tetanus.

- Hepatitis.

- Other unspecified infectious diseases (febrile illness).

- Malignant neoplasms.

- Anaemia.

- Diabetes.

- Non−infectious diseases of the respiratory system.

- Heart failure.

- Other diseases of the cardiovascular system.

- Cerebrovascular diseases including stroke.

- Mental and central nervous system disorder.

- Disease of the liver.

- Surgical abdominal conditions.

- Pregnancy, Child birth and puerperium.

- Symptoms, signs abnormal clinical findings not classified elsewhere.

- External causes of mortality.

- Undetermined.

The Verbal autopsy tool/instrument

The verbal autopsy technique carries an underlying assumption that each disease category has a distinct pattern of symptoms and signs. It further assumes that symptoms

and signs can be reported accurately by lay respondents even if they do not interpret them within the standard medical classification.

Two quite different approaches have been used in the development of verbal autopsy tools. One, intended for use by interviewers without medical training (lay interviewers), uses a structured questionnaire format, using local terms for illnesses and symptoms, and always administered in the same order and using the same words. The other form relies on the clinical experience and judgement of the interviewer who is assumed to have medical training.[1] The verbal autopsy form may include a simple check list for symptoms review, and space to record a traditional open-ended medical case-history.

The two methods can be combined. The interviewer, for example, can use a form with an extensive list of questions, arranged with a series of filter questions and subquestions. Following this the interviewer may then record the history of the patients present illness in traditional narrative form. The physician using the form to make a diagnosis will thus have both a written history of the last illness and a comprehensive check list of relevant symptoms.

Most experts in this field prefer the use of lay interviewers because medically trained persons are costly and may potentially bias the data since they may try to interpret the responses. However, medically trained person may be able to use a relatively unstructured questionnaire, pick up clues concerning the death and ask supplementary questions in a way that would be impossible for a lay interviewer.

Respondents should be restricted to those aged 15 years or above as children are unlikely to be able to provide reliable information about the symptoms and circumstances relating to an adult death.[21] The spouse might be the most obvious choice, as spouses generally live together and should therefore be expected to report reliably on symptomatology. There are, however, some disadvantages in questioning only spouses because, in some societies, the definition of spouse is not always clear, especially in urban areas where informal unions are common. The best respondent is obviously the person who knows most about the deceased's illness but identifying this person can be a problem. Possible approaches to solving this problem could be, first to leave it up to the interviewer to decide, secondly, have strict guidelines about choice of a respondent, and thirdly have a supervisor first visit, obtain a household roster and then tell the interviewer whom to interview based on available household members.

In some studies, the coders have been asked to assign a single cause of death, usually interpreted as the underlying cause in practice. This has the attraction of simplicity of analysis and interpretation, but may well lead to overemphasis of the contribution of certain causes of death relative to others. For example, if all children who die within one month of measles are classified as dying from measles, but no account is taken of any more immediate cause of the death, such as diarrhoea or acute lower respiratory infections these latter causes will be under-emphasized, while the impact of measles may be relatively over-emphasized. However it is anticipated that multiple cause of death would be rather less common in adults than in children.

Uses of data obtained from verbal autopsies

Data obtained from verbal autopsies could be used:

(i)   To establish the relative public health importance of different causes of death in populations.[22]

(ii)   To identify priorities and appropriate interventions. Interventions can be directed effectively against the known causes of deaths.

(iii)   To evaluate trends in mortality over time, especially as a method of evaluating the effect of intervention programmes.[1]

(iv)   For use in research studies (e.g. to identify risk factors associated with particular causes of death or field trials of interventions against specific diseases).[23]

Validation of verbal autopsy

While several groups have developed verbal autopsy tools to assess the cause of childhood deaths there is relatively little experience with verbal autopsy tools for adult deaths. It is important to develop adult verbal autopsy tools because there are problems associated with adult mortality which include potentially severe economic and social consequences for the immediate family and national economy.

Although verbal autopsy techniques may be the only means of establishing levels of cause specific mortality in parts of rural Africa, its reliability as a diagnostic tool has not been established.

The validity of verbal autopsy can be assessed by the following methods.

(i)   Relatives of patients who die in hospital are subsequently interviewed by verbal

autopsy at home and the result of verbal autopsy compared to the hospital diagnosis (the presumed "gold standard").

(ii)   Relatives of patients who were hospitalized with severe illness are interviewed after discharge and the diagnosis from this interview compared to the hospital diagnosis.

(iii)   Relatives of hospital admissions are interviewed at the time of admission and the diagnosis made from a structured or open interview. The verbal autopsy diagnosis is then compared with the hospital diagnosis.

(iv)   Comparison of verbal autopsy results in patients with a serologically defined illness compared to controls.[24]

A reference diagnosis is therefore required to compare with the diagnosis derived from the verbal autopsy in order to test the validity of verbal autopsy. A reference diagnosis ideally should be accurate and reliable, and representative of the causes of death pattern in the community. The options for reference diagnoses include diagnoses made by real autopsies but, in practice, this may result in a strong selection bias. They may, for example, be poorly performed and may not be acceptable in certain cultures in developing countries, particularly in sub-Saharan Africa.

Another option is clinical based hospital diagnosis but this also may have selection biases which include selective access and differential characteristics of the catchment population. The quality of hospital diagnosis depends on the training and

experience of physicians, local diagnostic preferences, availability and standard of diagnostic facilities (laboratory and Xrays) and medical record keeping.

Diagnoses of death in the community will have less selection bias. However, since only a small proportion of deaths in the community are likely to be seen by a physician this would require very intensive surveillance and considerable extra resources.

At least three studies to validate verbal autopsy have been done each of which used hospital records as the reference standard.

1. In Kilifi District Hospital Kenya , Snow and Armstrong validated the verbal autopsy technique in children. This technique was assessed by comparison with a prospective survey of 303 childhood deaths in Kilifi District Hospital in Kenya where medically confirmed diagnoses were available. Common causes of death, namely: malnutrition, malaria, measles, acute respiratory infection, gastroenteritis, anaemia, trauma–related death, meningitis, sepsis, and neonatal tetanus were detected by verbal autopsy with specificities greater than 80%. Sensitivity of the verbal autopsy technique was greater than 75% for measles, neonatal tetanus, malnutrition and trauma related deaths. In this study, however, malaria, anaemia, acute respiratory tract infection, gastroenteritis and meningitis were detected with sensitivities of less than 50%.[25]

2. In the Philippines, Kalter et al investigated the systematic validation of verbal autopsy for four major causes of death by comparing diagnoses based on postmortem interviews with the hospital medical diagnoses of the same patients.

They found that the method was valid (sensitivities and specificities >78%) for deaths of children from measles, tetanus neonatorum, diarrhoea and pneumonia.[26]

3. The mothers of 87 Gambian children with a potentially fatal illness were interviewed at the time their children were admitted to hospital and attempts were made to establish a diagnosis using the mother's history alone. In 66 cases (76%) the initial diagnosis corresponded to the diagnosis established finally by clinical and laboratory investigations. Diagnoses established at second interviews held with 51 mothers 1 month after their children had left hospital were accurate in 88% of cases. So it was concluded that Gambian mothers can describe accurately a seriousillness in their children and can, therefore, be relied upon to give accurate information about an illness from which a child has died.[27]

Currently in Tanzania, the Adult Morbidity and Mortality Project is conducting a study on adult mortality using the verbal autopsy technique. In January 1993 most of the participants of a workshop on verbal autopsy tools for adult deaths at the London School of Hygiene and Tropical Medicine agreed that verbal autopsies were an attractive option to assess causes of adult deaths in countries with weak registration systems.[28]

There are some limitations of verbal diagnosis, for example, the case definition and diagnosis of malaria is a particular problem. This is due to the following reasons:

1. Symptoms and signs are not specific[29]

2.   Examination of blood slides has limitations

    (a)   a single negative slide does not exclude malaria

    (b)   a positive blood slide does not prove that patients are suffering from malaria and parasitaemia may be entirely asymptomatic in indigenous populations of endemic areas.

3. STUDY RATIONALE AND OBJECTIVES

Study rationale

From the introduction, it is important to know the main causes of death in adults so that priorities in health care can be planned in a rational way. However, in many rural parts of tropical Africa determining the cause of adult death is difficult. So there is need to test and validate various verbal autopsy forms to establish their reliability as diagnostic tools in determining the cause of adult mortality. So far, no validation studies of verbal autopsy as a means of determining causes of adult death have been carried out in Tanzania. Thus such a study seemed justified.

Broad objectives

To validate a verbal autopsy form by comparing diagnoses derived from verbal autopsy with hospital diagnoses among patients admitted to the medical wards of Muhimbili Medical Centre.
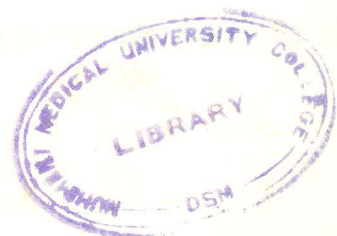
Specific objectives

(i)　　To develop a verbal autopsy form for adults

(ii)　　To derive diagnoses from the adult verbal autopsy form in patients admitted to the medical wards of Muhimbili Medical Centre.

(iii)　　To record hospital diagnoses from patients' files during the study.

(iv)　(a)　　To estimate the proportion of patients accurately diagnosed from verbal autopsy forms with reference to hospital diagnoses.

　　　(b)　　To compare specific diagnoses derived from the verbal autopsy with that of hospital diagnoses.

(v)　　To record characteristics of respondents' (relatives) age, sex, level of education, relationship to patient and whether they cared for patients in the current illness, and to determine if any of these characteristics were related to delivery of a more accurate account of the patients history.

PATIENTS AND METHODS

Source of patients

　　　The United Republic of Tanzania has a population of 23 million people (1988 population census). Dar es Salaam is the country's largest city with a population of about 1.5 million. Muhimbili Medical Centre in Dar es Salaam is the country's only national referral hospital where all serious and difficult cases both from the city as well as from various parts of the country are referred. A few people, especially high income

parastatal or private company employees, attend private hospitals in the city. At the moment there are three district hospitals in the city and several other health centres, dispensaries, and clinics where people are expected to be attended before they are referred to Muhimbili Medical Centre. Patients referred here are those with medical problems such as congestive cardiac failure, rheumatic heart disease, pericardial effusions, anaemia and heart failure, malaria, meningitis, chronic renal failure, diabetes mellitus, dermatoses, pulmonary tuberculosis, HIV disease, patients in status athmaticus, comatose patients and any other illness presenting with obscure findings.

Normally relatives accompany patients when they are referred to Muhimbili Medical Centre except for a few patients from outside Dar es Salaam who are normally escorted by medical staff (nurses). Patients are first seen at the Emergency Medical Department and those needing inpatient care are attended by physicians in the ward where an appropriate history, clinical examination and laboratory investigations are done. All relevant information and results of investigations are documented properly in the patient's file. When patients are discharged, all files are kept in the medical records department office. Patients requiring follow up are given an appointment to attend the general medical outpatient clinic or specialized clinics.

During the study doctors in the respective wards were encouraged to document properly all clinical findings, results of various investigations and hospital diagnoses.

Selection of respondents

Relatives of patients who were available during admission days to medical wards 1 and 4 of Muhimbili Medical Centre during the period 1st July – 31st December 1993

were interviewed. Interviews were not done when interviewers had some other academic committment.

Methods

A verbal autopsy form (Appendix I) was prepared and two interviewers outside the wards interviewed relatives of the patient who knew most about the patient on admission. Without seeing the patient the interviewer filled the verbal autopsy form which included details of each patient: age, sex, education, occupation, marital status and home address. He also filled details on each respondent (relative) which included age, sex, education, whether they cared for the patient in the current illness and their relationship to patient.

For each patient the interviewer recorded the patient's past medical history which included operations or previous admissions, smoking, alcohol intake, chronic illness and history of present illness which included all relevant details to support or explain the diagnosis. The history of present illness was taken using a list of amplified symptoms and signs which covered the major causes of adult deaths. If the answer to any filter question was `yes' then all associated subquestions were asked.

At the end of the interview, the interviewer derived a verbal diagnosis for each patient and filled in the special form. With the help of acceptable objective diagnostic criteria for main categories of causes of adult death, reference hospital diagnoses were subsequently obtained (appendix II). Each diagnostic categories diagnosed by use of specific symptoms, signs and confirmatory laboratory test. Coding of diagnoses derived from verbal autopsies was done by using a specially designed classification of diseases and symptom complexes based on the International Classification of Diseases (ICD 10).

Diseases were broadly classified into infectious, non infectious, external, uncertain/sudden, and, in women, maternal causes. The narrow classification included individual diseases, syndromes or symptom complexes. (Definitions are given in Appendix III).

Data analysis:

Analysis of data was done by using Epinfo programme. Association of respondents' characteristics and correct diagnosis by verbal autopsy (VA) were done by using chi=square test. Sensitivities, specificities, predictive values and their 95% confidence intervals were calculated for the main diagnostic categories. Their calculation was based on the interviewer's diagnosis versus the hospital diagnoses. Verbal autopsy diagnoses were not made by two independent physicians due to pressure of time as it was necessary to present written dissertation before June 1994. It is anticipated that two independent physicians will make their diagnoses from the verbal autopsy and these will also be compared with the hospital diagnoses. This may later lead to some changes in sensitivity and specificity levels.

DEFINITION OF SENSITIVITY, SPECIFICITY, POSITIVE PREDICTIVE VALUE AND NEGATIVE PREDICTIVE VALUE. (For example, pulmonary tuberculosis table 1)

. Sensitivity: is defined as the proportion of people with the disease who have a positive test for the disease.

Sensitivity of pulmonary tuberculosis = $\frac{79}{106} \times 100 = 74.5\%$

. Specificity:

is the proportion of people without the disease who have a negative test.

Specificity of pulmonary tuberculosis = $\frac{696}{729}$ x 100 = 95.5%

. Positive predictive value is the probability of disease in a patient with a positive test result.

Positive predictive value = $\frac{79}{112}$ x 100 = 70.3%

. Negative predictive value is the probability of not having the disease when the test result is negative.

Negative predictive value = $\frac{696}{723}$ x 100 = 96.3%

e.g. validity of verbal autopsy for pulmonary tuberculosis

Table 1: **Shows the calculations for estimating validity of verbal autopsy for a category of causes of illness, Pulmonary tuberculosis.**

| | | Reference diagnosis TB | | |
		Yes	No	Total
Verbal autopsy	Yes	79	33	112
diagnosis	No	27	696	723
Total		106	729	835

RESULTS

Interviews with relatives and friends of the patients were completed for 835 patients admitted to the medical wards during the six months of study.

<u>Age and sex distribution of patients</u>

508 (60.8%) patients were males, 327 (39.2%) were females (Male:Female sex ratio 1.6:1. The mean age of the patients was 32.7 years, median 31.5 years and the range was 8 to 94 years. The 15 – 39 years age group included 529 (63.4%) patients (table 2).

Table 2: Age and sex distribution of patients

Age(years)	Female (%)	Male (%)	Total
4–9	3 (25.0)	9 (75.0)	12 (1.4)
10–14	12 (41.4)	17 (58.6)	29 (3.5)
15–19	34 (49.3)	35 (50.7)	69 (8.3)
20–24	52 (42.3)	71 (57.7)	123 (14.7)
25–29	55 (43.1)	70 (56.9)	123 (14.7)
30–34	47 (38.8)	74 (61.2)	121 (14.5)
35–39	27 (29.0)	66 (71.0)	93 (11.1)
40–44	28 (43.1)	37 (56.9)	65 (7.8)
45–49	15 (30.6)	34 (69.4)	49 (5.9)
50–54	22 (41.5)	31 (58.5)	53 (6.3)
55–59	7 (33.3)	14 (66.7)	21 (3.4)
60–64	18 (41.9)	25 (58.1)	43 (5.2)
65–69	2 (18.2)	9 (81.8)	11 (1.3)
>70	7 (30.4)	16 (69.6)	23 (2.8)
Total	327 (39.2)	508 (60.8)	835 (100)

Marital status

404 (48.7%) were single, 343 (41.33%) were married, and 83 (10%) were divorced or widowed (table 3).

Table 3: Distribution of marital status of patients

Marital status	Frequency	Percent
Single	404	48.67
Married	343	41.33
Divorced	38	4.58
Widow/widower	45	5.42
Total	830	100

Patients' education

507 (61.1%) patients had completed primary education or were still in primary school, 207 (24.6%) had no education. Very few 14 (1.7%) had adult or Arabic education (table 4).

Table 4:   Frequency distribution of patient's level of education

Education	Frequency	Percent
None	207	24.6
Primary	507	60.2
Secondary	91	10.8
University	21	2.4
Adult education	4	0.5
Arabic	10	1.2
Total	830	100

Patients with history of chronic illness

133 (15.8%) patients were reported to have a chronic illness. The commonest chronic illnesses reported were tuberculosis 44 (5.0%), hypertension 29 (3.4%). Only two patients were reported to have Human Immunodeficiency Virus (HIV) disease (table 5).

Table 5: Patients reported to have a chronic illness

Disease	Number of patients	%
Hypertension	29	3.4
Epilepsy	4	0.5
Asthma	6	0.7
Diabetes mellitus	14	1.7
Heart diseases	10	1.2
Cancer	0	0
Sickle cell anaemia	4	0.5
Tuberculosis	44	5.0
Others	24	28.1
Total	133	15.8

Age and sex distribution of respondents.

503 (60.6%) respondents were males, 327 (39.4%) were females. Male:Female mean ratio 1.5:1, mean age 34.7 years, median 32.5 years and range 15–76 years. The 20–44 years age group included 566 (80%) respondents. No respondent was below 15 years. Very few respondents, 30 (3.6%) were more than 55 years and 21 (2.5%) were less than 20 years (table 6).

Table 6:   **Age and sex distribution of respondents.**

Age (years)	Female	Male (%)	Total (%)
15–19	9 (42.9)	12 (57.1)	21 (2.5)
20–24	54 (34.8)	101 (65.2)	155 (18.7)
25–29	36 (29.0)	88 (71.0)	124 14.9)
30–34	70 (41.9)	97 (58.1)	167 (20.1)
35–39	47 (41.2)	67 (58.5)	114 (13.7)
40–44	48 (47.1)	54 (52.9)	102 (12.3)
45–49	31 (43.1)	41 (56.9)	72 (8.6)
50–54	20 (44.4)	25 (55.5)	45 (5.4)
55–59	7 (53.8)	6 (46.2)	13 (1.6)
>60	5 (29.4)	12 (70.6)	17 (2.0)
Total	327 (39.4)	503 (60.6)	830

<u>Education status of respondents</u>

498 (60.0%) had completed primary education or were still in primary school, 165 (18.9%) had attended secondary or University education. 156 (18.8%) had no education. Very few 11(1.3%) had adult or Arabic education (table 7).

Table 7:   Distribution of respondent's level of education

Education	Frequency	Percent
None	156	18.8
Primary	498	60.0
Secondary	135	16.3
University	30	3.6
Adult	1	0.1
Arabic	10	1.2
Total	830	100

Relationship of respondents to patients.

185 (22.3%) of respondents were brothers of patients while 108 (13.0%) were sisters. Sons and daughters were 97 (11.6%). Friends were 92 (11.1%)   (table 8).

Table 8: Relationship of respondents to patients

Relationship	Number	Percent
Brother	185	22.3
Sister	108	13.0
Wife	93	11.2
Husband	59	7.1
Son	66	7.9
Daughter	31	3.7
Father	61	7.3
Mother	61	7.3
Others	80	.9.6
Friends	92	11.1
Total	835	100

<u>Association of characteristic of respondent and correct verbal autopsy diagnoses.</u>

The probability of a current diagnosis made by verbal autopsy was greater when the respondents had been involved in caring for the patient (P=0.0001). The gender of respondents was not however significantly associated with an increased probability of a correct diagnosis (P=o.178) (table 9).

Table 9: **Association of characteristics of respondent and correct verbal autopsy diagnoses.**

		DIAGNOSIS		
		CORRECT	NOT CORRECT	REMARKS
Cared for	Yes	459	254	X^2 =22.11 (P=0.0001)
patient	No	45	63	
Sex of	Female	190	136	x^2= 2.01 (P=0.178)
respondent	Male	321	187	

Hospital diagnoses and deaths.

Table 10 shows the distribution of hospital diagnoses (main diagnostic categories), number of deaths and case fatality rates of patients included in this study. The commonest diagnoses were pulmonary tuberculosis 106 (12.7%), malaria 79 (9.5%), PTB/HIV 77 (9.2%), HIV(AIDS) 72 (8.6%), acute gastroenteritis 47 (5.6%), extrapulmonary tuberculosis 39 (4.7%), acute respiratory infection/pneumonia 29 (3.5%), cerebral malaria 33 (3.9%), diabetes mellitus 32 (3.8%), heart failure 36 (4.3%), meningitis 25 (3.0%), stroke 18 (2.2%), intentional self harm 18 (2.2%), anaemia 24 (2.7%), febrile illness 18 (2.2%), tetanus 9 (1.1%), liver diseases 23 (2.8%), abdominal conditions 4 (1.7%) and in 16 (1.9%) patients the cause of the illness was uncertain.

Other less frequent hospital diagnoses are shown in the table. The number of deaths in each category are indicated in the table.

Table 10: Distribution of hospital diagnoses and deaths

DISEASE	PATIENTS			DEATHS			CASE FATALITY RATE (%)		
	F	M	TOTAL	F	M	TOTAL	F	M	TOTAL
A.Infectious and parasitic	204	334	578	24	60	84	11.8	18.0	14.5
Pulmonary tuberculosis(PTB)	31	75	106	1	10	11	3.2	13.3	10.4
Extra pulmonary tuberculosis	8	31	39	2	4	6	25.0	12.9	13.2
PTB + HIV	38	39	77	10	13	23	26.3	33.3	29.9
HIV/AIDS	36	36	72	7	8	15	19.4	22.2	20.8
Clinical malaria	31	48	79	1	2	3	3.2	4.2	9.7
Cerebral malaria	11	22	33	1	8	9	9.1	36.4	27.3
Meningitis	9	16	25	2	6	8	22.2	37.5	32.0
Acute gastroenteritis	13	34	47	–	1	1	–	2.9	2.1
Chronic gastroenteritis	1	2	3	–	–	–	–	–	–
Viral hepatitis	5	6	11	–	2	2	–	33.3	18.2
Tetanus	1	8	9	–	4	4	–	50.0	44.4
Acute febrile illness	13	5	18	1	–	1	7.7	–	5.6
Abscess/Cellulitis	1	6	7	–	1	1	–	16.7	14.3
Typhoid	–	1	1	–	–	–	–	–	–
Leprosy	1	–	1	–	–	–	–	–	–
Rabies	0	1	1	–	1	1	–	100	100
Herpes zoster	4	1	5	–	–	–	–	–	–
Chronic febrile illness	1	1	2	–	–	–	–	–	–
Amoebic liver abscess	0	2	2	–	–	–	–	–	–
Encephalitis	1	0	1	–	–	–	–	–	–
B.Respiratory disease	11	25	34	–	1	–	–	4.3	2.9
Pneumonia/ARI	9	20	29	–	1	1	–	5.0	3.4
Chronic lower respiratory infection.	0	2	2	–	–	–	–	–	–
Asthma	2	1	3	–	–	–	–	–	–
C.Gastrointestinal disease	7	17	24	–	–	–	–	–	–
Peptic ulcer disease	2	2	4	–	–	–	–	–	–
Acute gastritis	2	1	3	–	–	–	–	–	–
Intestinal Obstruction	1	3	4	0	1	1	–	33.3	25.0
Chronic liver disease	2	9	11	1	2	3	50.0	22.2	27.3
Severe abdominal pain	0	2	2	0	1	1	–	50.0	50.0
D.Endocrine/Metabolic	9	25	34	4	6	10	44.4	24.0	29.4
Diabetes mellitus	8	24	32	4	6	10	50.0	25.0	31.3
Thyrotoxicosis	1	0	1	–	–	–	–	–	–
Malnutrition	0	1	1	–	1	1	–	100	100
E.Haematological diseases	15	14	29	–	1	1	–	7.1	3.4
Anaemia	13	11	24	–	1	1	–	9.1	4.2
Sickle cell disease	1	3	4	–	–	–	–	–	–
Others	1	0	1	–	–	–	–	–	–

Table 10 continued

DISEASE	PATIENTS			DEATHS			CASE FATALITY RATE (%)		
	F	M	TOTAL	F	M	TOTAL	F	M	TOTAL
F.Cardiovascular diseases	31	31	62	3	7	10	9.7	22.6	16.1
Heart failure	21	15	36	1	5	6	4.8	33.3	16.7
Hypertensive diseases	9	13	22	2	2	4	22.2	15.4	8.2
Rheumatic heart disease	1	3	4	–	–	–	–	–	–
G.Genitourinary disease	0	8	8	–	2	2	–	25.0	25.0
Renal failure	0	1	1	–	1	1	–	100	100
Nephrotic syndrome	0	3	3	–	–	–	–	–	–
Benign prostatic hypertrophy	0	2	2	0	1	1	–	50.0	50.0
Urinary tract infection	0	2	2	–	–	–	–	–	–
H.Central nervous system	18	19	27	1	6	7	5.6	31.6	26.0
Epilepsy	0	2	2	–	–	–	–	–	–
Paraplegia/polyneuropathy	3	2	5	–	–	–	–	–	–
Psychoses	5	7	12	–	–	–	–	–	–
Strokes	10	8	18	1	6	6	10.0	75.0	38.9
I.Neoplasms	2	10	12	2	2	4	10.0	20.0	33.3
Hepatoma	0	7	7	0	2	2	–	28.6	28.6
Gastric cancer	0	1	1	–	–	–	–	–	–
Lymphoma	1	1	2	1	–	1	100	–	50.0
Uncertain cancer	1	1	2	1	0	1	100	–	50.0
J.Skin diseases	0	3	3	–	–	–	–	–	–
K.Joint diseases	2	3	5	–	–	–	–	–	–
L.Intentional self harm	10	8	18	1	1	2	10.0	12.5	11.1
M.Acute alcoholic intoxication	3	4	7	0	2	2	–	50.0	28.6
N.Other injuries	4	2	6	–	–	–	–	–	–
O.Uncertain diseases	9	7	16	1	2	3	11.1	28.6	18.8
TOTAL	327	508	835	38	94	132			

Patients accurately diagnosed by verbal autopsy (VA). Among the 835 patients 510
(61.1%) were accurately diagnosed by verbal autopsy while 325 (38.9%) were not. Of
the 508 males, 326 (64.2%) were accurately diagnosed by verbal autopsy while of 327
female patients 184 (56.3%) were correctly diagnosed (Table 11). This observation
however does not take account of the fact that while the verbal autopsy diagnoses may
not have agreed exactly with the ward diagnoses in almost 40% of admissions the verbal
autopsy diagnoses was often closely related to the ward diagnosis, or pointed correctly
to the system predominantly involved. For policy decisions it is probably not of great
significance if a patient has HIV disease with or without tuberculosis (table 12).

Table 11:   Proportion of patients accurately diagnosed by verbal autopsy (VA).

		Number of patients		
		Male (%)	Female(%)	Total
Correct diagnosis by VA	Yes	326(64.2%)	184(56.3%)	510(61.1%)
	No	182(35.8%)	143(43.7%)	325(38.9%)
	Total	508(60.8%)	327(39.2%)	835 (100%)

Diagnoses (correct and incorrect) made for each major diagnostic category.

Tables 12 – 28 show, for each major diagnostic category, the various diagnoses made
by verbal autopsy. While only 510 (61.1%) patients were accurately diagnosed by verbal
autopsy, examination of Table 12 for example, that, in addition to the 27 (37.5%)
patients correctly diagnosed to have AIDS, 17 were said by verbal autopsy to have

tuberculosis and HIV disease and 7 (9.71%) to have tuberculosis. If, therefore AIDS was combined with TB/HIV the diagnostic accuracy of the verbal autopsy would then increase to 61.1%, and if TB was included to 70.8%.

HIV disease/AIDS.

Table 12:   Diagnoses made by verbal autopsy in 72 patients who were diagnosed to have AIDS in the wards.

DISEASE	Number	%
HIV disease	27	37.5
Abscess/cellulitis	1	1.4
Acute febrile illness	5	6.9
Acute gastroenteritis	7	9.7
Acute respiratory infection/		
Pneumonia	3	4.2
Cancer	1	1.4
Meningitis	2	2.8
Stroke	1	1.4
TB(Pulmonary		
tuberculosis)	7	9.7
TB/HIV	17	23.6
Other	1	1.4
Total	72	100

Pulmonary tuberculosis (TB).

106 patient were found to have tuberculosis in the wards. Of these, 79 (74.5%) were correctly diagnosed by verbal autopsy; a further 14 (13.2%) patients were diagnosed to have TB and HIV disease. The criteria for diagnosis of pulmonary TB are described in appendix II (table 13).

Table 13:   Diagnoses made by verbal autopsy in 106 patients with `confirmed' pulmonary tuberculosis.

DISEASE	NUMBER	%
Pulmonary tuberculosis (TB)	79	74.5
Abscess/cellulitis	1	0.9
Acute gastoenteritis	1	1.8
ARI/pneumonia	1	0.9
Cancer	1	0.9
Heart failure	3	2.8
Cerebral malaria	1	0.9
HIV disease	2	1.8
Meningitis	2	1.8
TB/HIV	14	13.2
Other	1	0.9
Total	106	100

Pulmonary tuberculosis/Human Immunodeficiency Virus Disease (TB/HIV).

77 patients were found to have tuberculosis/HIV disease in the wards, of these, 48 (62.5%) were correctly diagnosed by verbal autopsy. A further 17 (22.0%) and 5 (6.5%) patients were diagnosed to have tuberculosis and HIV disease respectively (table 14). The criteria for diagnosis of tuberculosis/HIV disease are described in appendix 2.

Table 14: **Diagnoses made by verbal autopsy in 77 patients who were diagnosed to have pulmonary tuberculosis and HIV disease (AIDS) in the wards.**

DISEASE	NUMBER	%
TB/HIV	48	62.5
HIV	5	6.5
Malaria	1	1.3
TB	17	22.0
Heart failure	1	1.3
Acute febrile illness	1	1.3
Other	4	5.2
Total	77	100

Acute gastroenteritis.

47 patients were found to have acute gastroenteritis in the wards, of these, 38 (80.9%) were correctly diagnosed by verbal autopsy. A further 3 (6.4%) were diagnosed to have malaria. Only one patient was diagnosed to have HIV disease (table 15).

Table 15: **Diagnoses made by verbal autopsy in 47 patients with acute gastroenteritis**

DISEASE	NUMBER	%
Acute gastroenteritis	38	80.9
Acute febrile illness	2	4.2
HIV disease	1	2.1
Malaria	3	6.4
TB	1	2.1
Other	2	4.2
Total	47	100

<u>Malaria</u>.

79 patients were found to have malaria in the wards, of these, 49 (62.0%) were correctly diagnosed by verbal autopsy. A further 8 (10.1%) were diagnosed to have meningitis while 7 (8.9%) were diagnosed to have cerebral malaria (table 16).

Table 16: **Diagnoses made by verbal autopsy in 79 patients with malaria.**

DISEASE	NUMBER	%
Malaria	49	62.0
Acute febrile illness	6	7.6
Acute gastoenteritis	3	3.8
Cerebral malaria	7	8.9
HIV disease	5	6.3
Meningitis	8	10.1
Other	1	1.3
Total	79	100

Meningitis.

25 patients were found to have meningitis in the wards. Of these 22 (88.0%) were correctly diagnosed by verbal autopsy. Only 1 patient was incorrectly diagnosed by verbal autopsy as cerebral malaria (table 17).

Table 17: **Diagnoses made by verbal autopsy in 25 patients with meningitis.**

DISEASE	NUMBER	%
Meningitis	22	88.0
Cerebral malaria	1	4.0
TB	2	8.0
Total	25	100

<u>Cerebral malaria</u>.

33 patient were found to have cerebral malaria in the wards. Of these 22 (66.7%) were correctly diagnosed by verbal autopsy. A further 4 (12.1%) patients were diagnosed to have meningitis (table 18).

Table 18: **Diagnoses made by verbal autopsy in 33 patients with cerebral malaria.**

DISEASE	NUMBER	%
Cerebral malaria	22	66.7
Abscess/cellulitis	1	3.0
Meningitis	4	12.1
Other	3	9.1
Total	33	100

Heart failure.

36 patients were found to have heart failure in the wards. Of these 23 (64.0%) were correctly diagnosed by verbal autopsy. A further 5 (13.9%) patients were diagnosed to have tuberculosis (table 19).

Table 19:   Diagnoses made by verbal autopsy in 36 patients with heart failure.

DISEASE	NUMBER	%
Heart failure	23	63.9
Liver disease	2	5.5
Meningitis	1	2.8
TB	5	13.9
TB/HIV	1	2.8
Other	4	11.1
Total	36	100

Diabetes.

32 patients were found to have diabetes mellitus in the wards. Of these 20 (62.5%) were correctly diagnosed by verbal autopsy. A further 2 (6.2%) were diagnosed to have acute respiratory infection/pneumonia (table 20).

Table 20: **Diagnoses made by verbal autopsy in 32 patients with diabetes.**

DISEASE	NUMBER	%
Diabetes	20	62.5
Acute febrile illness	1	3.1
Acute gastoenteritis	1	3.1
ARI/pneumonia	2	6.2
Cerebral malaria	1	3.1
Liver diseases	1	3.1
Stroke	1	3.1
Other	5	15.6
Total	32	100

Tetanus.

9 patients were found to have tetanus in the wards, of these 8 (88.9%) were correctly

diagnosed by verbal autopsy. Only one was diagnosed to have meningitis (table 21).

Table 21:   **Diagnoses made by verbal autopsy in 9 patients with tetanus.**

DISEASE	NUMBER	%
Tetanus	8	88.9
Meningitis	1	11.1
Total	9	100

Suicide (intentional self harm).

18 patients were diagnosed to have intentional self harm in the wards, of these 17 (94.4%) were correctly identified by verbal autopsy. Only one patient was diagnosed to have another condition (table 22).

Table 22: **Diagnoses made by verbal autopsy in 18 patients who attempted suicide (intentional self harm).**

DISEASE	NUMBER	%
Suicide	17	94.4
Other	1	5.6
Total	18	100

Liver diseases

23 patient were found to have liver diseases, only 11 (47.8%) were correctly diagnosed
to have liver diseases (table 23).

Table 23:   Diagnoses made by verbal autopsy in 23 patient with liver diseases.

DISEASE	NUMBER	%
Liver disease	11	47.8
Acute febrile illness	1	4.3
Acute gastroenteritis	2	8.7
ARI/pneumonia	1	4.3
Heart failure	2	8.7
HIV only	2	4.3
Malaria	1	4.3
Other	4	17.4
Total	23	100

Stroke.

18 patients were found to have stroke in the wards. Of these 14 (77.8%) patients were correctly diagnosed by verbal autopsy. 2 (11.1%) were diagnosed to have joint disease (table 24).

Table 24:   Diagnoses made by verbal autopsy in 18 patients with confirmed stroke.

DISEASE	NUMBER	%
Stroke	14	77.8
Heart failure	1	5.5
Joint disease	2	11.1
Other	1	5.6
Total	18	100

<u>Anaemia.</u>

24 patients were found to have anaemia in the wards. Of these 11 (45.8%) patients were correctly diagnosed by verbal autopsy. 3 (12.5%) were diagnosed to have malaria (table 25).

Table 25: Diagnoses made by verbal autopsy in 24 patients with confirmed anaemia.

DISEASE	NUMBER	%
Anaemia	11	45.8
Acute febrile illness	3	12.5
Malaria	3	12.5
TB	1	4.2
Other	4	16.7
Total	24	100

<u>Acute respiratory infection (ARI)/Pneumonia.</u>

29 patients were found to have acute respiratory tract infection/pneumonia in the wards.

Of these only 11 (37.9%) were correctly diagnosed by verbal autopsy. 4 (13.8%)

patients were diagnosed to have tuberculosis/HIV disease (table 26).

Table 26: **Diagnoses made by verbal autopsy in 29 patients with acute respiratory infection/pneumonia.**

DISEASE	NUMBER	%
ARI/pneumonia	11	37.9
Acute febrile illness	1	3.4
Heart failure	2	6.9
HIV	1	3.4
Joint disease	1	3.4
Liver disease	1	3.4
Malaria	2	6.9
Meningitis	1	3.4
TB	3	10.3
TB/HIV	4	13.8
Other	2	6.9
Total	29	100

Cancer.

13 patients were found to have cancer in the ward. Of these only 4 (30.8%) were correctly diagnosed by verbal autopsy (table 27).

Table 27:   Diagnoses made by verbal autopsy in 13 patients with cancer.

DISEASE	NUMBER	%
Cancer	4	30.8
Acute gastroenteritis	1	7.7
Liver disease	2	15.3
TB	2	15.3
TB/HIV	1	7.7
Other	3	23.1
Total	13	100

<u>Sensitivities, specificities and predictive values of diagnoses derived from verbal autopsy compared with hospital diagnoses.</u>

Table 28 shows the extent to which verbal autopsy correctly identified (sensitivity) and correctly excluded (specificity) the main categories of hospital diagnoses, and the positive/negative predictive values using the adult verbal autopsy technique. Meningitis, acute gastroenteritis, external causes, suicide and tetanus had sensitivities ≥ 80.0% and specificities ≥ 90.0%. Their positive predictive values were > 65.0%; while negative predictive values were > 95.0%. All Human Immunodeficency Virus disease, pulmonary tuberculosis, Human immunodeficency virus disease with tuberculosis, malaria, cerebral malaria, stroke and diabetes mellitus had sensitivities between 60.0–75.0% and specificities > 94%. Their positive predictive values were between 58.0% – 90.0% and negative predictive values > 90.0%. Adult verbal autopsy technique performed poorly for cancer diseases, abscesses/cellulitis, acute respiratory tract infection/pneumonia, liver disease, febrile illnesses, HIV diseases and abdominal conditions. Their sensitivities were below 50.0% (table 28).

Table 28: Sensitivities, specificities and predictive values of diagnoses derived from verbal autopsy compared with hospital diagnoses

	Sensitivities		Specificity		Positive predictive values		Negative predictive values	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
All HIV	66.0	58.3–73.7	94.0	92.2–95.8	69.8	62.2–77.4	92.9	91.0–93.8
HIV	37.5	26.2–48.8	96.6	95.5–97.7	58.8	44.8–72.8	94.5	92.9–96.1
TB	74.5	69.4–79.6	95.5	93.1–97.9	70.3	64.4–76.1	96.2	94.5–97.9
HIV/TB	62.8	52.1–73.5	94.0	92.3–95.7	51.6	41.6–61.6	96.1	95.7–97.5
Meningitis	88.9	78.0–99.8	96.7	95.5–97.9	65.5	51.8–78.2	99.6	99.2–100
Acute gastro-enteritis	80.9	69.7–92.1	97.5	96.4–98.6	65.5	53.3–77.7	98.9	98.2–99.6
Febrile illness	23.5	3.3–43.7	96.1	94.8–97.4	11.1	9.1–13.1	99.6	99.2–100
Malaria	62.0	52.3–71.7	97.3	96.2–98.4	68.6	57.7–79.5	98.8	98.0–99.6
Cerebral malaria	66.7	50.6–83.4	98.0	97.0–99.0	57.9	42.2–73.6	98.8	98.0–99.6
External causes	100	–	99.9	99.7–100	96.9	93.9–99.9	100	–
Anaemia	45.8	25.4–66.2	100	–	100	–	98.6	97.8–99.4
Heart failure	64.0	47.9–80.1	96.8	95.6–98.0	45.8	31.7–59.9	98.5	97.7–99.3
Stroke	77.8	56.6–99.0	99.4	98.9–99.9	70.6	48.9–92.3	99.5	99.0–100
Diabetes mellitus	62.5	45.7–79.3	99.8	99.6–100	90.9	81.9–99.0	98.5	97.7–99.3
Abdominal conditions	27.8	7.7–47.9	99.8	99.6–100	33.3	10.0–56.6	99.5	99.0–100
Suicide	94.4	88.8–100	100	–	100	–	99.9	99.8–100
Liver diseases	47.8	27.4–68.2	98.9	98.2–99.6	55.0	33.2–76.8	98.5	97.7–99.3
Tetanus	88.9	78.5–99.3	100	–	100	–	99.8	99.6–100
Acute respiratory infection/ pneumonia	37.9	20.2–55.6	99.0	98.3–99.7	55.6	32.6–78.6	97.8	96.8–98.8
Abscess, cellulitis	57.1	20.4–93.8	99.6	99.2–100	57.1	20.4–93.8	99.6	99.0–100
Cancer	30.8	5.0–56.66	99.8	99.6–100	66.7	39.0–94.4	98.9	98.1–99.6

CI denotes confidence intervals

DISCUSSION

The verbal autopsy technique carries an underlying assumption that each disease category has a distinct pattern of symptoms and signs and can be reported accurately by lay respondents even if they do not interpret them within the standard medical classification of illness. To my knowledge, no comparable published work on the validation of verbal autopsy exist for adults.

Such a study could only be undertaken in a hospital population in which I was able to determine the true cause of illness. However the performance of verbal autopsy may be different when the technique is used in the community and results should perhaps be used with care for illness occuring outside the hospitals. There are several reasons for such caution. First, the natural history of illness may be different in patients attending health services and in those in the community who do not attend health services. Second, it should be recognised that interviewers (doctors) are likely to be influenced by their experience of disease prevalence in hospital when using the verbal autopsy technique. It is likely that prevalence of diseases in hospital is different from that in the community.

Distribution of hospital diagnoses and death in medical wards.

Some patients had two or more hospital diagnoses. However, it seemed reasonable to concentrate on the underlying condition that appears to have distinct features that are well recognised by the adult verbal autopsy technique.

Infectious and parasitic diseases were the leading causes of admission to the medical wards of Muhimbili Medical Centre. They accounted for 578 (69.2%) admissions. Of these 334 (57.7%) patients were male and 204 (35.3%) were females. This study gives a similar picture compared with other studies done in sub-Saharan

Africa.[3,5] Under infectious and parasitic diseases, tuberculosis, tuberculosis and HIV disease, and HIV disease alone were the leading causes of admission. Others were malaria, cerebral malaria, acute gastroenteritis, meningitis, and tetanus.

Respiratory diseases accounted for 34 (40%) admissions. Most of these were due to acute respiratory infection/pneumonias, for 29 (85.0%), of which effective strategic health interventions can be planned.

Other common causes of admissions were diabetes mellitus, stroke, cardiovascular diseases, accidents and intentional self harm. Most of these are non–communicable disease. These are conditions which formerly were mostly seen in developed countries, but which in recent times are becoming important causes of illness and death in developing countries as well. Information about patterns of causes of illness and death would yield insights and produce better strategies for health interventions.

It was preferable to use hospital diagnoses as reference diagnosis than real autopsy. In practice real autopsy may result in strong selection because it may be poorly performed and unacceptable in certain cultures. Furthermore, real autopsy often show disagreement between clinicians and pathologists[30].

Validity of adult verbal autopsy tool:

Overall, regardless of the cause of illness, verbal autopsy and reference hospital diagnoses agreed exactly in 510 (61.1%) admissions. There were 326 (64.2%) males and 184 (56.2%) females.

High percentage of agreement will be meaningful but low agreement gives no information as to which causes are achieving better or worse agreement. Worse or better agreement will be demonstrated in individual diagnostic categories.

DIAGNOSES MADE (CORRECT AND INCORRECT) FOR EACH MAJOR DIAGNOSTIC CATEGORY BY VERBAL AUTOPSY.

<u>Pulmonary tuberculosis, HIV disease, TB/HIV disease.</u>

Among 106 patients found to have pulmonary tuberculosis (TB) in the wards, 79 (74.5%) were correctly diagnosed by verbal autopsy. In addition to the 79 (74.5%) patients correctly diagnosed by verbal autopsy to have pulmonary tuberculosis, 14 (13.2%) patients were diagnosed as having pulmonary tuberculosis and HIV disease. If TB/HIV disease was combined with TB the diagnostic accuracy of the verbal autopsy would have increased to 87.7%. This occurred because patients with HIV disease can present with respiratory symptoms like chronic cough, difficulty in breathing as well as systemic symptoms like recurrent fever and loss of weight which can be present both in TB and HIV disease. Similar observations were made in 72 patients diagnosed to have HIV disease in the wards. 27 (37.5%) of these patients were correctly diagnosed by verbal autopsy to have HIV disease, 17 (23.6%) were diagnosed as having tuberculosis/HIV disease and 7 (9.71%) as having tuberculosis. If therefore HIV disease was combined with TB/HIV disease, the diagnostic accuracy of verbal autopsy would have increased to 61.1% and if TB was included to 70.8%. The low verbal autopsy accuracy in identified HIV disease could be explained by its multiple presentations; and respondents may focus on one aspect of the features of illness. It is known, for example, that patients with HIV disease can present to hospital with acute fever, acute cough, acute diarrhoea[31] and probably respondents focused on these illnesses and completely ignored other symptoms. Of 72 patients diagnosed to have HIV disease in the wards, 15 (20.8%) patients were diagnosed by verbal autopsy as having acute febrile illness, acute gastroenteritis or acute respiratory infection/pneumonia. One patient diagnosed by verbal

autopsy as having stroke, indeed had stroke as a complication of HIV disease. Of 77 patients diagnosed to have TB/HIV disease in the wards, 48 (62.5%) were correctly diagnosed by verbal autopsy. If therefore patients diagnosed to have TB/HIV disease are combined with patients diagnosed to have TB alone and HIV alone the accuracy of verbal autopsy would have increased to 90.9%. This could indicate that verbal autopsy technique has difficulty in identifying correctly HIV disease when patients present with respiratory symptoms.

Acute gastroenteritis:

47 patients were diagnosed to have acute gastroenteritis in the wards; 38 (80.9%) patients were correctly diagnosed by verbal autopsy. 2 (4.2%) patients and 3 (6.4%) were incorrectly diagnosed by verbal autopsy as having acute febrile illness and malaria respectively. This could be explained by the patients presenting with fever on top of gastrointestinal symptoms. Respondents sometimes ignored certain symptoms and concentrated on particular symptoms which they thought were important.

Malaria:

Of 79 patients diagnosed to have malaria in the wards, 49 (62.0%) were accurately diagnosed by verbal autopsy. Others were inaccurately diagnosed by verbal autopsy. However, this was possibly to be expected because most of these diagnoses were infectious diseases namely acute gastroenteritis, meningitis, cerebral malaria. These are acute infectious diseases, usually presenting with an acute onset of fever and leading to difficulties in making a correct diagnosis by verbal autopsy.

Meningitis:

The verbal autopsy tool diagnosed correctly 23 (92.0%) patients out of 25 patients diagnosed to have meningitis in the wards. Only one patient was incorrectly

diagnosed as having cerebral malaria. Neck stiffness is common to meningitis especially in patients presenting with acute onset of high grade fever and who are late in being referred.

Cerebral malaria:

33 patients were found to have cerebral malaria in the wards, 22 (66.7%) were correctly diagnosed by verbal autopsy. Verbal autopsy misclassified 4 (12.1%) patients as meningitis. Again this is an infectious diseases, commonly present with acute onset of fever and disturbances of behaviour and consciousness. Verbal autopsy may sometimes fail to differentiate them.

Heart failure:

38 patients were found to have heart failure in the wards; 64.0% were correctly diagnosed by verbal autopsy. Heart failure symptoms can be confused with respiratory symptoms. 5 (13.9%) patients, for example, diagnosed to have heart failure in the wards were diagnosed as having pulmonary tuberculosis.

Diabetes mellitus:

Of 32 patients with confirmed diabetes mellitus in the wards, 20 (62.5%) were correctly diagnosed by verbal autopsy. Verbal autopsy diagnosed one as having an acute febrile illness, one as having acute gastroenteritis, two to have acute respiratory infections/pneumonia. Relatives may focus on one aspect of the patient's illness. It is known that patients with diabetes mellitus are prone to infections, and an infectious disease may precipitate diabetic ketoacidosis.

Tetanus:

In adults, tetanus presents with recurrent spasms, neck retraction and lock jaw. These are unique features. Verbal autopsy correctly diagnosed tetanus in 8 (88.9%) of

9 patients with clinically confirmed tetanus in the wards. Only one patient was incorrectly diagnosed by verbal autopsy as having meningitis.

Intentional self harm (suicide attempt):

These are common events in the community and relatives identified and reported them accurately. Verbal autopsy correctly identified 17 (94.4%) of 18 patients who had attempted to commit suicide.

Acute respiratory infection/pneumonia:

29 patients were found to have an acute respiratory tract infection/pneumonia in the wards. Only 11 (37.9%) patients were correctly diagnosed by verbal autopsy. 7 (24.1%) patients were diagnosed by verbal autopsy as having tuberculosis or TB/HIV disease. This could be due to respondents who exaggerated the duration of illness.

Sensitivities, specificities, predictive values:

Meningitis, acute gastroenteritis, external causes, intentional self-harm and tetanus had sensitivities >80.0%, specificities >90.0% and positive predictive values >65.0% (table 28). In adults, these were diagnostic categories which were well defined; symptoms and signs were distinct and readily recognised and reported by relatives (respondents). Verbal autopsy techniques may therefore be a useful tool to diagnose these conditions during community based surveys. However, at Kilifi District Hospital in Kenya, child verbal autopsy had sensitivities <50% for gastroenteritis, malaria and meningitis.[18] The conflicting results of child adult verbal autopsy may possibly be explained by differences in presentation of these in adult and children diseases.

The adult verbal autopsy technique appeared to differentiate meningitis and cerebral malaria, probably because meningitis commonly presents with neck stiffness which is unusual in cerebral malaria. Of 25 patients with hospital diagnosed meningitis

only one was incorrectly diagnosed by verbal autopsy as having cerebral malaria. Of 33 patients with hospital diagnosed cerebral malaria 4 (12.1%) were misclassified as meningitis by verbal autopsy. Both of these conditions may present with acute onset of fever but neck stiffness is more marked in meningitis. Relatives therefore noted and reported the difference effectively. Tetanus typically presents with clinical lockjaw, and spasms, and these were accurately (sensitivity 88.9%) specificity 100%) reported by relatives. Only one patient among of hospital diagnosed patients with tetanus was misclassified as having meningitis. The child verbal autopsy technique found neonatal tetanus had a sensitivity and specificity >75.0%.[18,19] Suicide (intentional self harm) and external causes of illness e.g. assault are common events in the community and were accurately recognised and reported (sensitivity >94.0%, specificity >99%, positive predictive value >96%, negative predictive values >99.9%).

All HIV disease, HIV/TB, pulmonary tuberculosis, cerebral malaria, malaria, stroke and diabetes were fairly accurately identified by adult verbal autopsy (sensitivities >60%, specificities >94%, positive predictive values >58.0%, negative predictive values >90%).

Adult verbal autopsy technique performed poorly when applied to cancer, acute respiratory infection/pneumonia, liver diseases, and abdominal conditions. Liver diseases and abdominal conditions often share symptoms.

HIV disease (AIDS) had a low sensitivity (37.1%) but higher specificity (96.6%). HIV disease may present with non-specific symptoms and signs i.e. it can present with respiratory, gastrointestinal or general systemic symptoms. Among 72 patients diagnosed to have HIV disease (AIDS), 17 (23.6%) were incorrectly identified as PTB/HIV, while 7 (9.7%) were diagnosed as PTB and 7 (9.7%) as acute

gastroenteritis. When all HIV disease combined then sensitivity increased to 61.0%.

Characteristic of respondents: Respondents who cared for patient during illness had a greater probability of giving a proper history, thus enabling a correct diagnosis to be made more often (P=0.0001). This is perhaps to be expected compared to respondents who did not care for the patient and probably knew less about patient's illness. The sex of the respondent was not associated with presentation of more accurate history. Most child verbal autopies were done by interviewing mothers who obviously cared for children.[18,19,20]

CONCLUSION:

My primary interest in this study was to develop and test the validity of the adult verbal autopsy tool. I tried to develop a verbal autopsy form for adults, use it to interview relatives of patients admitted to the medical wards of Muhimbili Medical Centre, and then derive a diagnosis. Comparison between verbal autopsy results and hospital based diagnoses (the gold standard) was then performed. The results showed that there are some diagnostic categories which are major causes of illness and death which can be correctly identified or excluded by the adult verbal autopsy technique. However, there are some other major causes of death that performed poorly with verbal autopsy; these need other approaches. Verbal autopsy, despite its limitations can be a useful tool in identifying the causes of adult death in developing countries.

Recommendations

1.   Researchers in developing countries should apply the adult verbal autopsy in identifying the causes of adult death.

3.   Researchers in developing countries should apply adult verbal autopsy to assess the impact of disease intervention.

3.   To conduct further studies to compare result of verbal autopsy conducted by medical training interviewer and lay interviewer.

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