Research

The etiology of maternal mortality in developing countries: what do verbal autopsies tell us?''

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Objective To reassess the practical value of verbal autopsy data, which, in the absence of more definitive information, have been used to describe the causes of maternal mortality and to identify priorities in programmes intended to save women's lives in developing countries.

Methods We reanalysed verbal autopsy data from a study of 145 maternal deaths that occurred in Guerrero, Querétaro and San Luis Potosí, Mexico, in 1995, taking into account other causes of death and the WHO classification system. The results were also compared with information given on imperfect death certificates.

Findings The reclassification showed wide variations in the attribution of maternal deaths to single specific medical causes.

Conclusion The verbal autopsy methodology has inherent limitations as a means of obtaining histories of medical events. At best it may reconfirm the knowledge that mortality among poor women with little access to medical care is higher than that among wealthier women who have better access to such care.

Keywords Maternal mortality; Cause of death; Death certificates; Autopsy/methods; Interviews; Mexico (*source: MeSH*).

Mots clés Mortalité maternelle; Cause décès; Certificat décès; Autopsie/méthodes; Entretien; Mexique (*source: INSERM*).

Palabras clave Mortalidad materna; Causa de muerte; Certificado de defunción; Autopsia/métodos; Entrevistas; México (*fuente: BIREME*).

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Introduction

Extensive efforts have been made since 1987 to describe the extent and etiology of maternal mortality. The data on this subject have been used to persuade policy-makers and donors to adopt safe motherhood as a priority in public health (*1–5*). On the basis of verbal autopsy data and hospital records it is estimated that approximately 25% of maternal deaths are caused by haemorrhage, 15% by infection, 12% by pregnancy-induced hypertension, and 8% by obstructed labour (*6*). It is thought that 13% are associated with abortion, while 28% are ascribed to other direct and indirect causes, including malaria and anaemia. This information has also been used to identify potentially effective means of reducing maternal mortality. Emergency obstetric care has received special attention because the medical conditions to which most maternal mortality is ascribed generally occur in the period around labour and delivery and cannot be accurately predicted (*6–9*).

Verbal histories and death certificate data have been used to describe the causes of maternal mortality in developing countries. Verbal histories, also termed verbal autopsies, are based on occurrences reported to have been observed by family and community members with little or no medical background. Such histories are used for identifying the medical and social causes of deaths and are often the sole information available on the etiology of maternal deaths where women give birth at home. WHO defines verbal autopsy as a process designed to facilitate the identification of maternal deaths where medical certification is inadequate — to separate maternal deaths from those that are non-maternal —

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through a reconstruction of the events surrounding deaths in the community. The key features of verbal autopsies are the interviewing of family members and neighbours of deceased persons and the reviewing of medical records, where available, in order to (a) reconstruct events preceding death so as to establish the probable medical causes, (b) reconstruct factors associated with care-seeking behaviour and access to and delivery of services, and (c) collect information on background characteristics of the deceased including age, parity, education and other social variables.

We present the results of a reanalysis of data gathered in a verbal autopsy study in Mexico (*10*). The proportion of maternal deaths attributable to specific medical causes exhibits great variability when classified by principal cause of death, sole reported cause of death, or possible cause of death. The classification of the etiology of maternal mortality according to single medical causes may not be a useful way to identify programme priorities for saving women's lives. This is consistent with WHO's view that the recognition of multiple causes of death facilitates the determination of programme priorities (*11*). We question the validity of data obtained by verbal autopsy and their value as a basis for identifying effective means to reduce maternal mortality in developing countries.

Materials and methods

We reanalysed verbal autopsy data from a study conducted by the Population Council in conjunction with the National Safe Motherhood Committee in Mexico (*10*). The original study was conducted in the states of Guerrero, Querétaro and San Luis Potosí, which differ socioeconomically from one another. Guerrero is one of the poorest states in the country, ranking thirtieth of 32 states in economic status (*12, 13*); at the time of the study, its population was approximately 3 739 000; nearly 24% of the adult population was illiterate and 13% did not have Spanish as their first language. In San Luis Potosí, ranking twenty-sixth in economic status and having a population of 2 251 000, 13% of the adult population was illiterate and Spanish was not the first language for 11%; maternal deaths were concentrated in the indigenous population living in the poorest areas of the state. In Querétaro, nineteenth in economic status and with 1 272 200 people, only 2% of the population had a first language other than Spanish and 12% were illiterate. Secondary and tertiary facilities in these states are concentrated in their capital cities and are inaccessible to the poorest areas where the highest maternal mortality ratios occur. All three states have maternal mortality ratios similar to the national average (53 per 100 000 live births). Information obtained from death certificates in 1995 suggested the average maternal mortality ratios to be 44, 58 and 57 per 100 000 live births in Guerrero, Querétaro and San Luis Potosí respectively (*1*),

although the numbers of maternal deaths reported in this study indicated that the actual ratios were 60.5, 63, and 73 per 100 000 live births.

In order to include all maternal deaths we conducted a complete review of all death records of women aged 12 to 49 years in the three states. Records of maternal deaths and of deaths due to complications theoretically associated with pregnancy, including embolism, unspecified infection, and complications of anaesthesia, etc., were included in the sample. The women's relatives were visited and asked whether pregnancy had occurred during the year before death. If it had, death was classified as maternal. The study included all known maternal deaths that occurred during 1995. Because of migration or incorrectly recorded addresses it was impossible to locate the families or neighbours of 19 deceased women with confirmed pregnancies. Complete verbal autopsy information was obtained for 145 of the 164 maternal deaths that were identified.

Verbal autopsy data were collected using a standard technique that consisted of administering a structured and an open-ended questionnaire to close relatives or friends of the deceased women (*11*). The study favoured interviewing women respondents who had been in contact with the deceased woman during the process that led to her death. The respondents were advised about the objectives and procedures of the study. Informed consent was obtained by signature or, in the case of illiterate women, by fingerprint. The interviews were conducted at the homes of the respondents by a trained interviewer. Assistance from well-known translators in the community was obtained in respect of respondents whose mother tongue was not Spanish. The respondents were asked about the dead women's socioeconomic conditions, their reproductive history, the process of identifying health complications and seeking assistance, and the biomedical and social circumstances that were believed to have led to the deaths. Open-ended questions were asked to elicit information about events that occurred between the beginning of pregnancy and death. All available death certificates relating to confirmed maternal deaths were examined, and the stated principal and contributory causes of death were reviewed. However, it should be noted that this information was rarely based on pathological examination or direct observation. Causes of death from the death certificates were coded using the International Classification of Diseases Ninth Revision (ICD-9) codes in each state by state coders and subsequently by expert coders responsible for training state coders at the Ministry of Health. The certificates were reviewed in eight instances where coding discrepancies were encountered and in each case the Ministry of Health coding was supported by the available information and maintained.

On the basis of the verbal autopsy data the frequencies of maternal deaths were analysed by recorded primary cause of death, sole cause of death

(in women with only one recorded cause) and possible cause of death (for women with multiple recorded causes). This procedure yielded estimates of the average, minimum and maximum proportions of maternal deaths that could be attributed to haemorrhage, toxaemia, infection, dysfunctional labour, abortion and other medical causes. We compared these estimates with another, although perhaps equally flawed, indication of the principal causes of death given in death certificates. As far as possible, decision trees were applied to the verbal autopsy data with a view to determining the principal causes of maternal death, as recommended by WHO (11). In order to gather this information, special sections of the interview were administered when respondents indicated that the deceased woman had experienced the obstetric events specified in Box 1. The verbal autopsy modules of the interview were administered in respect of women meeting these criteria in order to further elaborate the causes of death.

WHO flowchart algorithms were applied to women who met the above criteria and for whom verbal autopsy module information was available. However, sufficient information only existed to permit the classification of deaths attributable to abortion and haemorrhage using these algorithms (Box 2).

Results

The mean age of the women who died was 28.6 $\pm$ 8.4 years; 24.3% of the sample were in their first pregnancy; 93.1% were married or in a stable relationship and living with a partner, and 83.2% were living with a husband or partner when death supervened. Only 16.0% had medical insurance. Of the 89 women for whom the respondents knew the type of delivery, 66.3% had vaginal deliveries. About 30% of deaths occurred before delivery, 25.2% during delivery, 24.5% within 24 hours after delivery and 21.0% within 40 days after delivery. The respondents did not know who attended 37 of the 133 deliveries that took place after 20 weeks of gestation. Of the women who had a known birth attendant, 46.3% had non-institutional community-based deliveries and another 7.4% delivered in community health posts. Forty-three per cent of women delivered in private or public clinics or hospitals. Only 19 women were under the continual care of a physician from pregnancy termination until death. All the death certificates indicated the place of death. According to the verbal autopsies, 55.9% of the 145 women in question died in hospital, 39.3% died at home and 4.8% died elsewhere. Hospital records, however, indicated that only 35.9% died in hospital (10).

Table 1 indicates the proportions of maternal deaths attributable to specific medical causes, classified in various ways. The first column presents the principal causes of death indicated on the death certificates of the women in this study. The second

Box 1. **Interview module filters used to identify principal causes of death**

Abortion
Death occurred up to 20 weeks of gestation, reported cause haemorrhage or infection

Haemorrhage
Death occurred at over 20 weeks of gestation, reported cause haemorrhage

Infection
Death occurred at over 20 weeks of gestation, reported cause fever and/or contractions lasting more than 12 hours

Eclampsia
Death occurred at over 20 weeks of gestation, reported cause seizures, severe headache and/or oedema

Pulmonary thromboembolism
Death occurred at over 20 weeks of gestation, reported cause intense chest pain, loss of consciousness, cough, blood clot in pulmonary vein (clinical judgement)

Box 2. **Module filter criteria to further elucidate causes of death**

Septic abortion
Death occurred at up to 20 weeks of gestation +:
- Heavy vaginal bleeding + high fever + foul-smelling vaginal discharge
- Heavy vaginal bleeding + foul-smelling vaginal discharge
- Fever

Antepartum haemorrhage
Death occurred at over 20 weeks of gestation, before delivery +:
- Heavy vaginal bleeding after 20 weeks of gestation, before delivery, + no lower abdominal pain
- Heavy vaginal bleeding after 20 weeks of gestation, before delivery, + steady lower abdominal pain + no history of caesarean delivery + no operation on the cervix or uterus
- Heavy vaginal bleeding after 22 weeks of gestation, before delivery, + steady lower abdominal pain + history of caesarean delivery

Postpartum haemorrhage
Death during or within 40 days of delivery +:
- Heavy vaginal bleeding after 20 weeks of gestation, during or after delivery, + placenta not completely delivered within one hour

gives the percentages of women whose deaths would be classified as caused by haemorrhage or abortion according to the WHO flowchart criteria (Box 2). The third indicates the causes of death defined in accordance with the verbal autopsy module filter (Box 1). The fourth presents the sole cause of death of women for whom there was only one recorded medical cause, providing a minimum estimate of the proportion of maternal deaths due to haemorrhage, toxaemia, infection, dysfunctional labour, abortion, and other medical causes. The final column shows the multiple possible causes of death for women with more than one recorded medical cause, thus indicating the maximum proportions of maternal

Table 1. **Proportion of maternal deaths ascribed to specific causes by various classification systems**

Condition	Principal cause given on death certificate ICD-9 (%)	WHO verbal autopsy flowchart (%)	Primary cause verbal autopsy module filter (%)	Minimum (sole verbal autopsy cause) (%)	Maximum (mentioned in verbal autopsy) (%)
	(n = 127)	(n = 138)	(n = 138)	(n = 144–145)[1]	(n = 129–145)[2]
Haemorrhage	34.6	10.8[4]	17.4	13.8 (47.6)[3]	51.9
Infection	6.3	NA	13.8	1.4 (4.8)	18.5
Long or obstructed labour	NA	NA	NA	1.4 (4.8)	9.7
Toxaemia	NA	NA	NA	4.8 (16.7)	17.8
Pregnancy-induced hypertension	29.1	NA	21.0	9.0 (31.0)	64.6
Abortion	3.9	1.4[5]	5.1	0.7 (2.4)	5.5
Other	26.0	NA	42.8	4.1 (14.3)	42.8

NA = not available.

Long and obstructed labour and toxaemia were not included as verbal autopsy module filters.

[1] Haemorrhage = 145; infection = 144; long labour = 144; toxaemia = 144; pregnancy-induced hypertension = 144; abortion = 144; other = 145. Only 46 of the possible 145 deaths had only one potential medical cause of death reported in the verbal autopsy, accounting for only 32% of the deaths. All cases of toxaemia are included as pregnancy-induced hypertension.

[2] Haemorrhage = 135; infection = 130; toxaemia = 129; pregnancy-induced hypertension = 145; abortion = 137; other = 145.

[3] Figures in brackets indicate samples of women with only one reported cause, n = 42.

[4] Includes any of the following combinations:
Heavy vaginal bleeding after 22 weeks of gestation, before delivery, + no lower abdominal pain; heavy vaginal bleeding after 22 weeks of gestation, before delivery, + steady lower abdominal pain + no history of caesarean delivery + no operation on cervix or uterus; heavy vaginal bleeding after 22 weeks of gestation, before delivery, + steady lower abdominal pain + history of caesarean delivery; heavy vaginal bleeding after 22 weeks of gestation, during or after delivery, + placenta not completely delivered within one hour.

[5] Includes any of the following:
Heavy vaginal bleeding + high fever + foul-smelling vaginal discharge; heavy vaginal bleeding + foul-smelling vaginal discharge; fever.

deaths that could be attributed to the causes covered in the fourth column. The estimates given in columns two to five are based on the verbal autopsy data. Only eleven death certificates listed multiple causes of death suggesting that the cause of death was other than what had already been recorded as the principal one. The study's minimal and maximal estimates based on data from death certificates were almost identical to the death certificate estimates of principal causes of death. They are therefore not presented for the death certificate data.

The information on death certificates on the principal causes of death indicates that nearly 35% of maternal deaths were attributable to haemorrhage, whereas only 17% would be so identified by verbal autopsy. As few as 14% of deaths would be wholly attributable to haemorrhage for women about whom only a single cause of death was reported in the verbal autopsy. Taking into account other causes of death suggested by verbal autopsies, as many as 52% of deaths could have been partially attributable to haemorrhage. In contrast, application of the WHO flowchart algorithm suggests that only 11% of deaths were attributable to this factor. The information on death certificates indicated that infection was the principal cause of death, accounting for 6% of mortality, whereas verbal autopsies suggested that between 1% and 19% of maternal deaths might have

occurred principally because of this factor. Few deaths, ranging from 1% to 5%, were attributed to abortion by all the classifications. The greatest variability was found in deaths attributed to pregnancy-induced hypertension. Verbal autopsy data suggested that as few as 9% and as many as 64% of deaths could have been caused by this condition. The death certificates attributed 26% of deaths to other medical causes, while the verbal autopsies indicated a range of 4–43% of deaths in this category.

Discussion

Table 1 shows wide variations in the proportions of deaths attributed to each cause and suggests that verbal autopsies have little validity in the attribution of maternal deaths to single specific medical causes. This is consistent with the WHO view that multiple causes of death should be considered in the determination of programme priorities (11). In our rural study, many women delivered at home and the information given on death certificates was probably both incomplete and inaccurate, rarely being based on pathological examination or direct observation. According to the death certificates, only 6% of mortality was attributable to infection, whereas the verbal autopsies showed a possible range of 1% to

19% for deaths caused by infection. There were also large variations in the estimates of deaths attributed to haemorrhage: as the principal cause of death, certificates gave 35% of the cases of death as principally attributable to haemorrhage, while the verbal autopsy filter identified only 17% in this category, with a possible range of 14 to 52%.

It is commonly acknowledged that the proportion of maternal deaths attributable to abortion is generally underestimated. In this study, information on such deaths obtained from certificates and verbal autopsy seemed to be highly inaccurate, accounting for only 1% to 5% of mortality. Abortion is legally restricted in Mexico and the clandestine nature of the procedure may contribute to it being underreported. Respondents may lack information on the subject or may be unwilling to share any knowledge they have of the matter with local authorities or interviewers.

In addition to the large variation we observed in this study, there are other reasons to question the validity of causes of death established by the verbal autopsy technique. For instance, the proportion of maternal mortality generally estimated as due to infection, abortion and pregnancy-induced hypertension seems inconsistent with historical knowledge. In 1850, maternal mortality in Western Europe and the USA ranged between 400 and 800 deaths per 100 000 live births. The decline in the last 150 years to approximately 2 per 100 000 live births has generally been attributable to the prevention of deaths associated with infection and haemorrhage (14). The ratio of the proposed proportion of mortality attributable to haemorrhage (25%) and eclampsia (12%) to the theoretical incidence of these conditions (haemorrhage, 7–15%; eclampsia, 1–2%) implies that the probability of death associated with the diagnosis of eclampsia is greater than that of haemorrhage, yet this is questionable and depends on the timeliness and quality of treatment.

Other workers have also found the validity of verbal autopsies to be doubtful in relation to the identification of specific causes of maternal deaths (15) or child deaths (16, 17) in rural areas of developing countries. This has arisen even though there is evidence of close agreement between physicians who have coded principal causes of death (18) and also of agreement between death certificates and verbal autopsy information on the principal causes of death. An 80% concurrence was reported between the principal causes of death recorded on death certificates and the principal causes defined by two experts who also reviewed the information from verbal autopsies in one of the three study districts (10). This is understandable, as many women died in the community and very few were under observation by physicians from delivery until death, indicating that relatives' reports provided the basis for some portion of the determination of causes of death.

Comparatively little is known about the medical etiology of maternal mortality in developing countries, particularly in rural areas. The statement as to cause of death ultimately recorded on death certificates is rarely based on pathological examination or direct observation. Clinicians and laboratory facilities are rarely available to conduct examinations immediately before or after a woman's demise, and formal autopsies are rarely conducted in these settings. Verbal autopsies may provide the only information about the causes of deaths of women who die at home or are travelling to a health facility, but these histories are not dependable. The information on the death certificates of women who survive until they reach such a facility tends to reflect their condition on arrival and the subsequent events. Even data on women who present to a facility in labour and are under medical observation until death are affected by the quality of record-keeping. This varies greatly, depending on the level of training and diagnostic ability of health care providers and on the facility's capacity to conduct diagnostic tests.

The verbal autopsy methodology was evidently not dependable as a means of determining the medical causes of maternal mortality in Mexico. The inconsistency of the data could be attributable to many factors. Ultimately, however, there are inherent limitations in obtaining medical event histories from informants who may not be literate and lack a medical background. At best, data from verbal autopsies may reconfirm knowledge about the non-medical correlates of maternal mortality. In other words, mortality is higher among women who, comparatively, are poor and malnourished and have inadequate access to medical care than among those who are not impoverished and have better access to medical care (1, 19). ∎

Conflicts of interest: none declared.

Résumé

Etiologie des décès maternels dans les pays en développement : quelle est la valeur des autopsies verbales ?

Objectif Réévaluer la valeur pratique des données recueillies par autopsie verbale et qui, en l'absence d'informations plus définitives, sont utilisées pour décrire les causes des décès maternels et identifier les priorités des programmes visant à sauver des vies féminines dans les pays en développement.

Méthodes Nous avons réanalysé les données d'autopsie verbale tirées d'une étude de 145 décès maternels survenus en 1995 à Guerrero, Querétaro et San Luis Potosí (Mexique), en tenant compte des autres causes de décès et en appliquant le système de classification de l'OMS. Les résultats ont aussi été comparés avec les

informations figurant sur des certificats de décès imparfaits.

Résultats La reclassification a montré d'importantes différences dans l'imputation des décès maternels à une cause médicale unique.

Conclusion La méthodologie de l'autopsie verbale a ses propres limites en tant que moyen d'anamnèse. Au mieux, elle peut confirmer ce que l'on sait déjà, c'est-à-dire que la mortalité chez les femmes pauvres et n'ayant qu'un accès limité à des soins médicaux est plus forte que chez les femmes plus aisées, qui ont un meilleur accès à ces soins.

Resumen

Etiología de la mortalidad materna en los países en desarrollo: ¿qué valor tienen las autopsias verbales?

Objetivo Reevaluar el valor práctico de los datos de autopsias verbales que, a falta de información más rigurosa, se han utilizado para describir las causas de mortalidad materna e identificar las prioridades de los programas destinados a reducir la mortalidad femenina en los países en desarrollo.

Métodos Reanalizamos los datos de autopsias verbales de un estudio de 145 defunciones maternas que tuvieron lugar en Guerrero, Querétaro y San Luis Potosí (México) en 1995, teniendo en cuenta otras causas de defunción y el sistema de clasificación de la OMS. Los resultados se compararon además con la

información suministrada sobre certificados de defunción deficientes.

Resultados La reclasificación reveló grandes diferencias en la atribución de defunciones maternas a causas médicas específicas únicas.

Conclusión El método de las autopsias verbales presenta limitaciones inherentes como medio de anamnesis de los eventos médicos. Como mucho permite corroborar una vez más el hecho ya conocido de que la mortalidad entre las mujeres pobres que apenas tienen acceso a atención médica es mayor que entre las mujeres ricas que disfrutan de un mayor acceso a esa atención.

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