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Using Verbal Autopsy to ascertain perinatal cause of death: Are trained non-physicians adequate?

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Summary

Objectives—To develop a standardized verbal autopsy (VA) training program and evaluate whether its implementation resulted in comparable knowledge required to classify perinatal cause of death (COD) by physicians and non-physicians.

Methods—Training materials, case studies, and written and mock scenarios for this VA program were developed using conventional VA and ICD-10 guidelines. This program was used to instruct physicians and non-physicians in VA methodology using a train-the-trainer model. Written tests of cognitive and applied knowledge required to classify perinatal COD were administered before and after training to evaluate the effect of the VA training program.

Results—53 physicians and non-physicians (nurse-midwives/nurses and Community Health Workers [CHW]) from Pakistan, Zambia, the Democratic Republic of Congo, and Guatemala were trained. Cognitive and applied knowledge mean scores among all trainees improved significantly (12.8 and 28.8% respectively, p<0.001). Cognitive and applied knowledge post-training test scores of nurse-midwives/nurses were comparable to those of physicians. CHW (high-school graduates with 15 months or less formal health/nursing training) had the largest improvements in post-training applied knowledge with scores comparable to those of physicians and nurse-midwives/nurses. However, CHW cognitive knowledge post-training scores were significantly lower than those of physicians and nurses.

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Conclusions—With appropriate training in VA, cognitive and applied knowledge required to determine perinatal COD is similar for physicians and nurses-midwives/nurses. This suggests that midwives and nurses may play a useful role in determining COD at the community level, which may be a practical way to improve the accuracy of COD data in rural, remote, geographic areas.

Keywords

perinatal mortality; education; non-physicians; verbal autopsy

Introduction

Early neonatal deaths (death of a newborn <7 days of age) and stillbirths, together known as perinatal deaths, account for 7 m annual deaths worldwide (Lawn et al. 2005, 2006; Stanton et al. 2006; WHO 2007a). Perinatal deaths contribute four percent of the global burden of disease and are the leading cause of the burden of disease measured in disability adjusted life years (DALYs) in low and middle income countries (LMIC) (Lopez et al. 2006). Perinatal deaths are the leading cause of death (COD) among children 0-14 years of age worldwide, and in this age group, cause twice as many deaths as malaria and HIV/AIDS combined (Lopez & Mathers 2006). 98% of these perinatal deaths occur in LMIC, with more than 70% occurring in community settings, often in the home (Bang et al. 2005; Baqui et al. 2006; Sule & Onayade 2006). Furthermore, a high percentage of births and deaths are not recorded in vital registration systems (Carlough & McCall 2005; Lawn et al. 2005; McClure et al. 2007).

Understanding causes of perinatal death, which vary between and within geographic regions, is essential when developing strategies to reduce perinatal mortality. Decisions about health care spending have competing considerations. Paramount among these must be a thorough and accurate understanding of the leading causes of perinatal death. Unfortunately, a major barrier to improving perinatal mortality outcomes and data collection in LMIC is that vital registration systems that include COD are available for only 3% of all perinatal deaths worldwide. Thus, current data on perinatal COD may be inaccurate, and perinatal mortality rates may be underestimated (Jehan et al. 2007).

Several studies have examined causes of community-based perinatal deaths using verbal autopsy (VA) (Hinderaker et al. 2003; Baqui et al 2006; Setel et al. 2006). VA is a technique used to assign probable COD, based on an interview with a primary caregiver (usually the mother) where health registration systems are weak or unavailable. During the interview, a systematic description of the signs, symptoms, and circumstances preceding the death is recorded. Subsequently, a physician panel removed from the site of death independently assigns COD from the interview data (Marsh et al. 1993; Chandramohan et al. 2005; Baiden et al. 2007). VA provides useful data describing causes of perinatal deaths in developing countries and is an important tool to guide health care programs and policy in low-resource settings (Whiting et al. 2006).

The utility of VA may be limited by the lack of a standard, widely applicable methodology to determine COD, such as validated, training techniques for interviewers and physician panels (Soleman et al. 2006). To address this deficiency, we designed a study to develop and evaluate a VA training program. Our objectives were twofold: 1) to develop a standardized VA tool and training program and 2) to evaluate whether implementation of this tool and training program, using a train-the-trainer model, would result in comparable knowledge regarding uniform classification of perinatal COD by non-physicians compared to physicians.

Methods

Design and development of the VA tool and training program

The VA tool, training manual, and guidelines for conducting the VA interview were adapted from the previously validated *SAmple Vital registration with Verbal AutopsY* (SAVVY 2006) instrument (Mswia et al. 2006). The training program consisted of four modules: 1) Causes of stillbirth and early neonatal deaths worldwide; 2) Principles, guidelines, and rules for assigning COD developed from the International Statistical Classification of Diseases and Related Health Problems, tenth revision (ICD-10) (WHO 2005b); 3) Case definitions of maternal and neonatal causes of death with commonly associated signs, symptoms, and complications, and representative case studies to illustrate common perinatal problems in verbal autopsy; and 4) written tests of cognitive and applied knowledge.

Consistent with ICD-10 classification, the *underlying cause of death* was defined as the single most important disease or condition which initiated the train of morbid events leading directly to fetal or neonatal death or the circumstances of the accident or violence which produced the fatal injury. The *final cause of death* was defined as the one factor/disease that was the final event which resulted in the neonatal/fetal death. *Contributing factors* were all conditions/diseases contributing to neonatal/fetal mortality. Case definitions for the most common underlying, final, or contributing causes of fetal and neonatal death were grouped into maternal and fetal/neonatal causes (Figure 1). These classifications were made to the third character of the ICD-10. To develop these case definitions, all available electronic health and social science reference libraries (including indexed and non-indexed journals) published from 1950-2006 were searched. These included Pub Med/MEDLINE, the Cochrane Reference Library, POPLINE, LILACS, PAHO, African Index Medicus, and EMRO. All papers with an abstract in English were reviewed. Manual reviews of documents and recommendations from the World Health Organization (WHO) and other experts, the Cochrane Reference Library, and monographs on stillbirth and neonatal death from African Ministries of Health and non-governmental organizations such as Saving Newborn Lives and UNICEF were conducted. The training materials were developed and reviewed by an international panel of experts and adapted according to their suggestions. Pilot testing was done using a convenience sample of investigators from the National Institute of Child Health and Human Development Global Network for Women's and Children's Health Research (GN).

Study Setting

This study was conducted within the GN, a multi-country research network committed to improving the health of mothers and infants, building local capacity for performing research, and strengthening scientific and community partnerships. Participating sites included Argentina, Guatemala, Democratic Republic of Congo (DRC), Zambia, Kenya, India, and Pakistan. This VA study involved sites in Guatemala, DRC, Zambia and Pakistan and was conducted between May 2007 and June 2008.

The VA training methods

A train-the-trainer model was used. Initial training was provided by an expert in ICD-10 classification, rules and guidelines for assignment of COD, and VA methodology. Subsequently, nine trainees (eight physicians and one nurse-midwife) from Pakistan, Zambia, the DRC, and Guatemala (designated national coordinators) were trained by this individual over two days. Physician backgrounds included one pediatrician, two internists and five generalists. Upon returning to their respective countries, these trainees trained an additional 53 trainees including 13 physicians and 40 non-physicians. Physician backgrounds included two pediatricians and 11 generalists. The non-physicians consisted of

21 nurse-midwives and 19 Community Health Workers (CHW). CHW included Lady Health Workers (LHW) from Pakistan with 8-12 years of secondary education and 15 months of government health training and community nurses from Guatemala with less than one year of formal nursing education. Study oversight during local training was provided by VA national coordinators. Additionally, a VA core group (CE, WC, LW, EM and BG) conducted telephone conferences with the VA national coordinators to clarify issues that arose during training.

Evaluation

Pre- and post-training tests were administered immediately before and after the completion of a two-day course to evaluate changes in cognitive and applied knowledge. The tests had two modules: 1) Module A (cognitive knowledge module) consisted of 37 true/false questions to evaluate the theoretical knowledge domain and recall of trainees (Figure 2). These questions included assignment of COD based on internationally accepted ICD-10 rules, case definitions used to determine neonatal deaths, and implementation of VA. 2) Module B (applied knowledge module) consisted of case-scenarios which utilized problem-based learning to assess the application of knowledge and decision-making in a given scenario. These case-scenarios included descriptions of circumstances surrounding a stillbirth or early neonatal death from which assignment of COD had to be determined. This module had a maximum of 36 correct answers.

Statistical Analysis

Average pre- and post-training test scores were calculated for all participants and by professional background (physician, nurse midwife/nurse and CHW). Differences between pre- and post-training test scores (overall and for each professional group) were analyzed using a paired t-test. To compare scores of both cognitive and applied knowledge modules across professional groups, regression models were calculated using physicians as the reference standard.

Results

All trainees demonstrated significant improvement in cognitive and applied knowledge following training (13 ± 10% improvement in cognitive knowledge and 29± 23 % improvement in applied knowledge, $p < 0.01$, Table 1). Nurse-midwives/nurses and CHWs scored significantly lower on cognitive knowledge pre-training tests compared to physicians (64%±15% and 50% ±17%, vs. 75% ±11%), while post-training, the scores of nurse-midwives/nurses were comparable to those of physicians (77% ±18% vs. 86% ±9%, respectively). All groups had similar percentage changes in cognitive knowledge from pre-training test scores.

Nurse-midwives/nurses had a 50% greater percentage change from pre-test and attained similar scores to physicians when applied knowledge was assessed. CHWs post-training applied knowledge scores (67±25%) were nearly triple that of their pre-training scores (24±12%). Of the three professional groups, CHWs had the largest percentage change from pre-training test scores, which was approximately double that of nurse midwives and nurses and triple that of physicians. Nevertheless, their post-training test scores remained significantly lower than physicians and nurse midwives/nurses.

By contrast to nurse-midwives/nurses who scored significantly lower on cognitive knowledge pre-training tests compared to physicians, yet post-training had comparable scores to those of physicians (Table 2), CHWs post-training cognitive knowledge test scores remained significantly different compared to those of physicians.

Nurse-midwives/nurses applied knowledge pre and post-training test results were comparable to physicians, in contrast to pre-training test scores of CHW which were significantly different to physicians (Table 3). Post-training applied knowledge test scores of all professional groups were comparable.

Discussion

Using a train-the-trainer model, our standardized educational program resulted in improvement in post-training test scores compared to pre-training test scores among all health workers in all sites. The train-the-trainer model was chosen for several reasons: 1) it utilizes active-mode learning and multimodal techniques involving dialogue between participants and instructors; 2) there is widespread experience with this mode of learning within the Global Network as it has been employed within previous studies; (McClure et al. 2007) and 3) it has demonstrated utility as a method of diffusing knowledge (Trabeau et al. 2008). Train-the-trainer models have many advantages including increasing trainers' knowledge, promotion of ownership, and increasing local capacity. Additionally, the relatively low-cost of this train-the-trainer methodology may make this an attractive consideration for VA scale-up in resource-constrained countries.

One of the major limitations of the widespread use of VA for describing perinatal COD has been the lack of harmonization of perinatal VA tools, field procedures and training, and assignment of COD methods (Soleman et al. 2006). In November 2006 (after the development of our tool used for this study), the WHO tasked an expert panel to harmonize the numerous verbal autopsy tools then in use (Baiden et al. 2006). This effort resulted in the publication of a manual on ascertaining and attributing COD that is currently being used in at least 6 countries (WHO 2007c). How widely this document will be utilized is uncertain; however its development appears to be an important step in standardizing tools and procedures for VA. The development and evaluation of a standardized training methodology has been a missing link in the widespread use of VA, and our study attempted to address this.

Studies of non-physician or mid-level provider-led clinical services both in LMIC and high income countries suggest that with adequate training, mid-level providers are able to conduct specified clinical tasks previously thought to be solely within the domain of physicians (Orfaly et al 2005; Burr et al. 2006; Murphy et al. 2008). The paucity of physicians in LMIC has prompted many countries to actively explore and institute service provision by mid-level providers (Braveman & Roemer 1985; Kyriacos et al. 2005; Malawi MOH 2007). The most common method used to determine COD in VA has been by physician panels which generally consist of two to three physicians. These physicians independently determine COD for each death, together discuss differences in their responses, and complete the process by providing a single underlying COD (Garenne & Faveaus 2006; Fantahun et al. 2006). The overall goal of our study was to determine if non-physician providers could be trained to use VA to accurately assign perinatal COD. Our results demonstrate that nurse-midwives/nurses can achieve a level of both cognitive and applied knowledge comparable to that of physicians, to assign COD using VA. This was most evident for the module that tested applied knowledge using case scenarios. These case scenarios were intended to represent the realities of determining community-based COD and require high-order problem-solving skills. Given the critical lack of perinatal mortality data, particularly in rural areas, our results suggest that with uniform training, nurses and midwives may be a valuable resource in determining COD at the community level and may thus contribute to strengthening data systems in rural, remote, geographic areas.

Despite having significantly lower pre-training test scores on both cognitive and applied knowledge modules, CHWs who have considerably less health training than nurses, midwives, and physicians demonstrated a remarkable increase in cognitive and applied knowledge. This increase was most striking in the applied knowledge module where their post-training test scores were nearly triple that of their pre-training test scores and their percentage change from pre-training test scores double that of nurse-midwives/nurses and triple that of physicians. Perhaps surprisingly, given that they had attained comparable applied knowledge scores to other health professionals, CHWs cognitive knowledge post-training test scores were significantly lower than those of physicians and nurse midwives/ nurses. This may be because the concepts tested in this module, such as ICD -10 nomenclature and rules, are less familiar to CHW compared to concepts of application of known illnesses tested by case scenarios. It is unclear whether the level of CHW cognitive knowledge may be adequate to qualify them to reliably assign an underlying COD given the timeframe of training provided.

In addition to educating participants on detailed clinical aspects of COD ascertainment, a primary goal of this study was to incorporate in the training program a module which addressed the derivations of various indicators of childhood mortality. These included case definitions, methods, formulae and data sources for the numerators and denominators utilized. We believe that adequate comprehension of these aspects is essential for VA reviewers to understand the relevance and significance of their tasks in COD ascertainment and to understand the impact of their decisions in such cases on the mortality measures which form the overall objective of their activity.

It bears emphasizing that the accuracy in COD ascertainment is largely dependent on the quality of VA data collection, which has its own determinants in terms of interviewer training, respondent characteristics, recall periods and language utilized (Soleman et al. 2006). Therefore, good quality data collection would facilitate accuracy in COD ascertainment, particularly by nurse-midwives, who would apply condition-specific diagnostic algorithms with limited clinical experience in cases where there is ambiguity in the information in the completed VA questionnaire.

The major strengths of this study were the extent of data standardization, the study oversight provided by trainers, and the community-based focus and diversity of the clinical settings. Additionally, each trainee served as his/her own control, minimizing confounders in results. There are a number of limitations to this report. The relatively small sample size for the subject groups, particularly physicians, confers reduced statistical power and generalizability of this study. Although this study evaluated the change in specific short-term cognitive level following the development of a VA training program, the ultimate test of this program is whether in the field, non-physicians can determine COD comparably to physicians. A larger adequately powered study comparing responses by non-physicians to physician panels using this VA tool and educational program may demonstrate broad applicability and is currently underway.

Conclusion

We developed a VA educational package, implemented it using a train-the-trainer methodology, and assessed the short-term change of trainees' cognitive and applied knowledge following its introduction. All types of health providers showed improvement in post-training test scores compared to pre-training test scores. Mid-level providers (nurses and midwives) demonstrated comparability to physicians in post-training cognitive and applied knowledge test scores. CHWs demonstrated a large increase in post-training test scores when compared to pre-training test scores, although it is unclear whether CHW are adequately equipped to reliably assign perinatal COD using VA. With appropriate training in VA, nurses and midwives may be able to determine perinatal COD with accuracy comparable to that of physicians, and therefore may play a useful role in determining and improving accuracy of COD data in rural, remote, geographic areas.

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Fetal/neonatal causes

Preterm/complications of prematurity: Infant born before 37 completed weeks of pregnancy (includes maternal

subjective assessment of born early)

Fetal/neonatal infection/sepsis/pneumonia: Congenital or acquired invasion and multiplication of germs (bacteria, fungi or viruses)

Birth asphyxia/intrapartum asphyxia: Failure to initiate and sustain breathing at birth

Congenital malformation: A major structural defect which causes the baby to die

Birth trauma (during labor): Injuries to the infant during the process of birth

Fetal trauma: Injuries affecting the fetus before it is born

Neonatal accident: Any injury or trauma affecting the infant after it is born

Tetanus: Neonates with a normal ability to suck and cry during the first 2 days of life, and who, between day 3 and 28 cannot s

become stiff or have fits/convulsions (i.e. jerking of muscles) or both

Diarrhea: The passage of loose or liquid stools more frequently than is normal for babies

Hypothermia: A neonate who feels cold to touch, or who has a temperature below 36.5 degrees centigrade

Low birth weight: Birthweight less than 2500grams, or smaller in size than expected for the baby's gender, genetic heritage an

(includes mother's opinion of small)

Jaundice: Yellow coloration of the skin or whites of the eyes

Maternal Cause

Antepartum hemorrhage: Heavy bleeding in the last week of pregnancy (excludes “spotting”)

Maternal infection/sepsis: Invasion and multiplication of germs (bacteria, fungi and viruses). This definition includes malaria, and excludes minor infections such as colds

Preterm delivery: Labor and delivery before 37 completed weeks of pregnancy

Maternal accident: Any injury occurring to the mother after 20 weeks of pregnancy that might affect the fetus

Obstructed/prolonged labor: Any condition that results in the labor process being obstructed e.g. because the fetus is too large for the birth canal or the presentation of the fetus prevents the mother from pushing the baby out of the birth canal

Multiple delivery: Birth of two or more babies (even if one of the babies is dead)

Hypertensive disorder/eclampsia: High blood pressure that occurs before or during pregnancy. This may be associated with generalized swelling, headaches or seizures

Cord prolapse/complications: When the baby's umbilical cord falls into the birth canal ahead of the baby's head or other parts

Malpresentation: When the baby is in a difficult position for the birth process

Post-term: any baby born after 42 completed weeks of pregnancy

Figure 1.

Case definitions for maternal and neonatal/fetal underlying, final, and contributing causes of death

	TRUE	FALSE
Verbal Autopsy:		
1. Is a technique only used to assign cause of death.		
2. Is where an autopsy on the patient takes place and people talk about it.		
3. Can be answered by anyone who was present at the birth.		
4. Is widely used to determine cause of death, to conduct rapid assessments in emergency situations, to determine priority diseases and areas of programmatic intervention and to assess the effects of specific programs.		
During Verbal Autopsy:		
5. Causes of neonatal death are coded to ICD 10 classification.		
6. It is best to fill out the questionnaire as it is being administered.		
7. The person asking the questions is not allowed to skip any questions unless instructed on the form to do so.		
8. The person asking the question must ask probing additional questions that are not written on the forms to understand more what respondents mean, just as doctors do when taking a medical history.		
Stillbirth occurs		
9. When the baby is not breathing or moving, but has a detectable heart rate that later stops.		
10. When a baby is felt to move in the womb, is born crying, but does not move.		
11. When the birth attendant checks for a heart rate before birth and can't hear one, and the baby is born without a HR, no breathing and no movement.		

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12. When there is failure to start and maintain breathing at birth, in the presence of a HR		
Jaundice occurs		
13. When the baby has yellow coloring of the teeth, urine and stools.		
14. When the baby has taken too much breast milk (colostrum) on the first day.		
15. When the baby is noted to have yellow eyes, skin, or palms.		
16. When the baby is cold.		
Birth asphyxia occurs in a baby		
17. When there is failure to start and continue breathing, but where there is a detectable heart rate.		
18. When there is a knot in the cord, the baby requires resuscitation, and has early seizures and poor feeding.		
19. When the baby initially does not move, but has a cry and heart rate.		
20. When there is much bleeding by the mother before the delivery, and the infant is born active and crying.		
21. Tetanus occurs		
22. In a baby who has been feeding well for a day, stops feeding, gets cold and dies.		
23. When a baby has a seizure on the same day of birth, becomes blue and dies.		
24. When the baby was feeding well for at least two days, starts feeding poorly, has a seizure and goes stiff.		
25. When a baby has fed poorly since birth, feeds better, has a seizure and		

goes stiff.		
Congenital infections		
26. Only occurs when infections pass from the mother to the baby at the time of birth.		
27. Include a cleft lip or palate.		
28. Can cause stillbirths.		
29. Can cause a baby to feed poorly.		
The Underlying (Precipitating) Cause of Death		
30. Is the final event that occurred causing the baby to die		
31. Is the disease or injury which started the train of events leading to the death		
32. Is the circumstances of the accident or violence which produced the death		
33. The event that occurs only to mothers and not fetuses or neonates		
Contributing Factors to Death		
34. The final event that occurred causing the baby to die		
35. The disease or injury which started the train of events leading to the death		
36. Is the circumstances of the accident or violence which produced the death		
37.The event that occurs only to mothers and not fetuses or neonates		

Figure 2.
Module A (Cognitive knowledge) : Questions used to assess cognitive knowledge

Table 1

Scores on pre- and post-tests by professional group

	n	Pre-training test score Mean (SD)	Post-training test score Mean (SD)	Percentage change from pre-training test score	P-value (change from pre-training test)[b]
COGNITIVE KNOWLEDGE					
All	53	62 (18)	75 (18)	13 (10)	<0.001
Physician	13	75 (11)	86 (9)	11 (6)	<0.001
Nurse midwife / Nurse	21	64 (15)	77 (18)	13 (12)	<0.001
Community health worker[a]	19	50 (17)	64 (19)	14 (10)	<0.001
APPLIED KNOWLEDGE					
All	52	44 (23)	72 (20)	29 (23)	<0.001
Physician	12	62 (15)	77 (10)	15 (16)	0.009
Nurse midwife / Nurse	21	53 (20)	75 (19)	22 (18)	<0.001
Community health worker[a]	19	24 (12)	67 (25)	44 (22)	<0.001

[a]Community health workers include community nurses from Guatemala who received less than one year of formal nursing education and Lady Health Workers (LHW) from Pakistan. LHWs are Pakistani government employees with 8-12 years of education and 15 months basic government health training.

[b]Differences between pre- and post-training test mean scores were tested using a paired t-test.

Table 2

Regression models comparing cognitive knowledge scores across professional groups

Score	B	SE	p
Pre-training test			
Community health worker	−25.6	5.3	<0.001
Nurse/Midwife	−10.9	5.2	0.041
Physician	REF		
Post- training test			
Community health worker	−22.3	6.0	<0.001
Nurse/Midwife	−9.5	5.8	0.110
Physician	REF		
Difference (Post - Pre)			
Community health worker	3.2	3.6	0.374
Nurse/Midwife	1.38	3.5	0.696
Doctor	REF		

Note: B = unstandardized regression coefficient; REF = reference category. Comparisons between CHW and nurse/midwves on the following: pre-training test (B(SE) = −14.67 (4.65); p=0.003); post- training test (B(SE) = −12.83 (5.24); p = 0.018); difference score (B(SE) = 1.84(3.16); p=0.563).

Table 3

Regression models comparing applied knowledge scores across professional groups

Score	B	SE	p
Pre- training test			
Community health worker	−38.2	6.0	< .001
Nurse/Midwife	−9.0	5.9	.132
Physician	REF		
Post-test			
Community health worker	−9.4	7.4	.212
Nurse/Midwife	−2.4	7.3	.746
Physician	REF		
Difference (Post - Pre)			
Community health worker	28.8	7.2	< .001
Nurse/Midwife	6.6	7.0	.350
Doctor	REF		

Note: B = unstandardized regression coefficient; REF = reference category. Comparisons between CHWs and nurse/midwves on the followng: pre-training test (B(SE) = −29.14 (5.15); p < .001); post-training test (B(SE) = −7.01 (6.38); p=.277); difference scores (B(SE) = 22.14 (6.16); p < .001).