Analysis of Young Infant Deaths Using Verbal Autopsies and Accuracy of Verbal Autopsy Tool in Chennai, India

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Objective*:* To identify medical and non-medical factors associated with young infant deaths using verbal autopsies and to evaluate the validity of state verbal autopsy tool in identifying medical causes. **Design***:* Descriptive study to report factors associated with young infant deaths, and diagnostic accuracy study of the verbal autopsy tool. **Results***:* Prematurity related illnesses were the major contributors to mortality. Deliveries were predominantly in health care facilities (99%); lower maternal education (11.2%), lesser birth spacing (80%), and higher birth order (7.5%) were other factors noted. Verbal autopsy questionnaire had a diagnostic accuracy of ≥95% in identifying major causes of death (kappa value 0.8-1.0). **Conclusion***:* Current state verbal autopsy tool is valid in identifying causes of death.

Keywords: *Infant mortality, Newborn death, Still birth, Janani suraksha yojna.*

India contributes to 22% of the global burden of under-5 deaths and nearly half of it are neonatal deaths [1,2]. Routine registration systems do not provide all information on causes of death and the contributory factors. This affects strategy planning as well as implementation of programs [2,3]. In such situations, detailed child death review using verbal autopsy tool will be of great help. Lack of a standardized verbal autopsy instrument and administration methods are key challenges that remain unresolved [4].

This study was conducted to identify factors associated with young infant deaths using State verbal autopsy questionnaire as a tool, and to evaluate its accuracy in determining major causes of death.

METHODS

All young infant deaths (<2 months) between April, 2013 to March, 2015 within Chennai Corporation zones were included in the study. Investigation of these deaths was done using State verbal autopsy forms. Maternal characteristics recorded comprised of socio-demographic, pregnancy and delivery details. Infant characteristics comprised of gender, birth weight, gestational age, age at death, place of death and cause of death. For neonatal deaths and post neonatal deaths, there were set of questions under each cause of death (as per ICD-10 classification). Depending upon the answers, one of the major causes was selected. The tool was used by field workers. They were provided a structured training for two weeks where each question in the tool and possible responses were discussed.

Clinical summaries of babies were collected from health posts near their residence. Clinical diagnosis was considered as the gold standard. The disease pathology which led to deterioration of the baby and death was taken as main cause of death. For home deaths, diagnosis on arrival to hospital or in death certificate was taken.

Statistical analyses: We used descriptive statistics to describe baseline variables. Diagnostic test was used to estimate sensitivity, specificity, positive predictive value and negative predictive value of verbal autopsy tool taking hospital diagnosis as gold standard. Kappa statistics was used to study agreement between verbal autopsy and clinical diagnosis at different time periods after death [5]. We used statistical software package SPSS version 13.0 for analyses.

RESULTS

Of 164009 live births during the study period, there were 865 young infant deaths, accounting for a mortality rate of 5.2 per 1000 live births. Of these, we could access only 629 records **(Fig. 1),** 319 in 2013-14, and 310 in 2014-15.

Consanguinity was noted in 20% of these babies. Most mothers (95%) had ≥3 antenatal visits. 193 (31%) mothers had some antenatal illness, pregnancy induced hypertension (14.1%) being the most common followed by anemia (6.4%) and diabetes (5.9%).
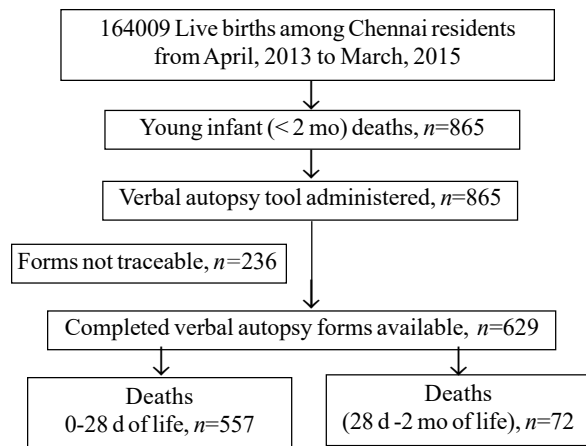
Fig. 1 Flow diagram of the study.

Two third of the babies were low birthweight. More than 99% of the deliveries were institutional. Among the neonatal deaths, care was sought within 24 hours of identifying illness in majority (75%) (**Table I**). Most of the babies who died were preterm (55%) with 11.5% being extremely low birthweight. The single most important cause assigned was asphyxia (27%) followed by respiratory distress syndrome (20%), sepsis (17%), congenital malformations/surgical cases (15%), extreme prematurity (9%), heart disease (6%) and multiple congenital anomalies (3.5%).

According to verbal autopsy tool, asphyxia (32%) was the single major cause of death followed by sepsis and respiratory distress (17% each), congenital anomalies (8%) and heart disease (6%); 10% of deaths were attributed to prematurity alone. Around 30% of neonatal deaths happened within 24 hours of life. There were 50 home deaths (5.7% of total deaths), 66% of which happened between 6 PM and 6 AM (**Table I**).

Diagnostic accuracy of verbal autopsy tool in identifying major causes of death was more than 95%. In the diagnosis of prematurity, positive predictive value was low (77%). Verbal autopsy tool had good agreement in all the major causes with kappa values ranging from 0.82-0.90 (**Table II**).

Only 21.9% of the verbal autopsy tool had been administered within 14 days of death 21.4% were done between 14 and 30 days and 32.9% after 30 days (maximum time of administration, 360 days). Date was not mentioned in 24% of the questionnaires. The sensitivity, specificity, positive, negative predictive values and kappa agreement in our study was equally good across various timeframes. However, the positive predictive value for the diagnosis of prematurity was low and kappa agreement for the same was moderate (**Supp. Table I**).

Table I Delivery Characteristics, Health Seeking Behavior, Access to Health Facilities and Analysis of Home Deaths (N=629)

Characteristics	No (%)
Normal delivery	354 (56.2)
Place of delivery[a]	
Level 1	86 (13.7)
Level 2	46 (7.3)
Level 3	497 (79)
Maturity	
≤28 wk	84 (13.4)
28-37 wk	264 (42)
>37 wk	281 (44.6)
Birthweight	
<1 kg	72 (11.4)
1-1.5 kg	119 (18.9)
1.5-2.5 kg	209 (33.3)
>2.5 kg	229 (36.4)
Illness recognized by parents	58 (9.2)
Duration of illness prior to seeking care	
<24 hr	187 (29.8)
1-3 d	155 (24.6)
>3 d	287 (45.6)
Health seeking behavior	
Yes	609 (96.8)
Transport mode (n=144)	
108 neonatal	102 (70.8)
108 general	10 (6.9)
Private ambulance	22 (15.2)
Travelling time (n = 144) <1 h	89 (61)
Analysis of home deaths (n=50)	
Birthweight	
<1.5 kg	2 (4)
1.5-2.5 kg	14 (28)
>2.5 kg	34 (68)
Postnatal age at death	
<7 d	9 (18)
7-28 d	25 (50)
>28 d	16 (32)
Female	30 (60)
Cause of death	
Sudden infant death syndrome (SIDS)	29 (58)
Aspiration	15 (30)

Data represented as no. (%); [a] home delivery in 1.

DISCUSSION

High institutional deliveries noted in the study can be attributed to government programs providing financial assistance to pregnant women like Janani Suraksha

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- The State verbal autopsy has a good accuracy in ascertaining causes of death and also brings out the improvement in non-medical factors, health care services and health-seeking attitude over the years.

Table II Accuracy of Verbal Autopsy Tool Compared With the Gold Standard (*N*=629)

Diagnosis	Sensitivity	Specificity	AUC	Kappa
Birth asphyxia *n*=171	94.2% (89.5-97.2)	96.9% (94.9-98.3)	0.96 (0.94- 0.97)	0.9 (0.86-0.94)
RDS + MAS *n*=137	82.5% (75.1-88.4)	99.2% (97.9-99.8)	0.91 (0.88-0.94)	0.86 (0.81-0.91)
Neonatal sepsis *n*=108	90.7% (83.6-95.5)	97.5% (95.8-98.7)	0.94 (0.91- 0.97)	0.87 (0.82-0.92)
Prematurity *n*=55	92.7% (82.4-98.0)	97.4% (95.7-98.5)	0.95 (0.92- 0.99)	0.82 (0.75-0.90)

Values in measure (95% CI); Pooled diagnostic accuracy was 92.2%. and Kappa of 0.90 (0.87-092); AUC: Area under the curve, RDS: Respiratory distress syndrome, MAS: Meconium aspiration syndrome.

Yojana (JSY) and Janani Shishu Suraksha Karyakaram (JSSK) [6,7].

Majority of deaths happened in the first three days after birth, similar to other studies [8,9], which is directly related to antenatal, intra partum and immediate neonatal care. Health-seeking behavior of the parents has undergone a marked improvement when compared to previous studies [10]. Access to transport has signi-ficantly increased because of 108 neonatal services, which has helped in timely stabilization and treatment. In the Million Death Study, the major causes of death were prematurity, neonatal infections and birth asphyxia [11]. Prematurity-related illnesses were the major contributors in our study as well.

In many studies, the diagnosis of asphyxia is collated into the prematurity complications, if gestation is less than 34 weeks [12]. Currently, most studies based on verbal autopsy assign a single underlying cause of death [13]. However, some experts have suggested that this may not be the most appropriate strategy and multiple causes of deaths should be considered [14].

As a survey methodology, there is reason to believe that recall bias may affect the validity of verbal autopsy. WHO recommends that, after a period of mourning, the verbal autopsy be conducted as soon as possible, and recalls of more than one year should be interpreted with caution [15]. We found good agreement at different periods of administration and thus every effort should be made to fill the questionnaire even if 14 days have elapsed since death.

Limitations of the study include lack of separate set of questions in this tool for marking cause of death as prematurity or respiratory distress syndrome, and its inability to assign more than one cause of death. Missing verbal autopsy forms could also have influenced the results of the study. The limitations of medical records as a gold standard needs to be recognized as case records may be incomplete and relevant investigations may be missing.

We found State verbal autopsy tool valid in identifying most of the common medical causes of young infant deaths. We recommend incorporating this verbal autopsy tool even in hospital death audits to capture significant non-medical contributing factors.

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