

# Interrupted Time Series Study on the Completeness and Acceptability of the Cause of Death Statement in Death Certificates

Ma. Carmen C. Tolabing,<sup>1</sup> Josephine M. Carnate,<sup>2</sup> Christine S. Tinio<sup>2</sup> and Danaida B. Marcelo<sup>2</sup>

<sup>1</sup>College of Public Health, University of the Philippines Manila

<sup>2</sup>College of Medicine, De La Salle Health Sciences Institute, Dasmariñas, Cavite

## ABSTRACT

**Objective.** To determine the completeness and acceptability of the cause of death (COD) statements in death certificates before and after the conduct of an educational intervention aimed at improving COD certification in Province X.

**Methods.** A random sample of 7939 death certificates from the year 1986-2006 was obtained. Part I of the COD section of the certificates was evaluated for completeness and for acceptability of the COD. Interrupted time series study was employed with semi-annual as the time point used in the analysis. The study covered 42 time points from 1986-2006. The proportions of complete and acceptable COD for each time point were calculated and segmented linear regression was applied to compare the time trend before and after the educational intervention.

**Results.** Of the 7939 death certificates, only 35.3% were completely filled up, of which 16.5% had acceptable overall COD. The average proportions of all the death certificates with acceptable item entries in the immediate, antecedent, and underlying causes are 30.1%, 57.0% and 25.0%, respectively. The time series data on the acceptability of the COD statement revealed a significantly higher trend after the educational intervention.

**Conclusion.** A large proportion of the COD section of death certificates have incomplete and unacceptable entries. However, the acceptability of the COD statement improved after the educational intervention.

**Key Words:** cause of death, death certificates, immediate cause, antecedent cause, underlying cause, educational intervention

## Introduction

There are reports outlining the various aspects of COD certification which are considered to be unsatisfactory.<sup>1-17</sup> These deficiencies can be classified into two, namely: a) diagnostic inaccuracies of the COD when compared with autopsy or medical reports; and b) errors in accomplishing the COD section of the death certificate.

The above-mentioned errors have been traced to a number of factors, one of which, and maybe the most important, is the certifying physician. Errors have been attributed to the physicians' lack of understanding of the principles underlying certification, lack of training on death certification, and failure of physicians to read certification instructions. Moreover, one report indicated that some physicians perceived death certification as an interruption of their real work, describing the completion of a death certificate as an irritation or a necessary evil.<sup>18</sup>

But no matter how its completeness and accuracy has been questioned, the death certificate has remained to be the most economical and quickest source of data for mortality statistics and epidemiological researches. The death certificate diagnosis of the COD is routinely utilized to establish the COD of an individual. Mortality statistics provides crucial information to the detection of trend in disease occurrence and for planning and allocation of health care and research resources.

Accuracy of the COD is, thus, extremely important. It is expected to foster accuracy of mortality statistics and ensure validity of research findings that utilize mortality data. Hence, efforts should be made towards quality improvement in death certification. Giving importance to physician education has been the suggested strategy to improve the quality of death certification.<sup>8,12,19-21</sup> Unfortunately, there has been little research on the role of physician training in improving accuracy of death certification. Moreover, these reports give contradictory findings.<sup>22-24</sup>

This study determined the completeness and the acceptability of the COD and the change in the proportion of death certificates without complete and acceptable cause of death statement before and after an educational intervention conducted in December 1997.

## Methods

### Research Design

An Interrupted time series study (ecologic design) was employed. The study population consisted of a group of death certificates. The time period covered in the time series was 1986-2006 with the semi-annual period as the time point

Corresponding author: Ma. Carmen C. Tolabing, MPH, DrPH  
College of Public Health  
University of the Philippines Manila  
625 Pedro Gil St., Ermita, Manila 1000 Philippines  
Telephone: +632 5247118  
Email: ctolabing@gmail.com

used in the analysis. The intervention took place in December 1997.

#### *Sampling Method and Sample Size*

A minimum of 162 death certificates per semi-annual time point was required to achieve a 95% level of confidence, an estimated proportion of acceptable entries of the COD of 12% and a precision of 5%.

A total of 7939 death certificates were included in the study. Stratified random sampling was employed to select the sample death certificates with the municipality as the stratum. A proportionate sample was selected from each municipality for every calendar year included in the study.

#### *Method of Data Collection*

Death certificates issued between January 1986 to December 2006 that were on file at the office of the Civil Registrar in Province X were reviewed and entries in Part I of the Medical Certificate Portion of the death certificate, consisting of the underlying cause, antecedent cause, and immediate cause were recorded in individual data collection forms and evaluated for completeness and acceptability by physician evaluators.

#### *Definition of study variables*

1. Completeness of COD statement
  - 1.1 *Complete COD* - All three items in Part I of the COD section labeled (a), (b) and (c) that are used to record the underlying, antecedent, immediate CODs are filled up when necessary; or in cases when it is neither necessary nor appropriate to complete all 3 lines in Part I, information is present on the underlying COD
  - 1.2 *Incomplete* - Not all the items in Part I of the COD section have entries or when not all entries are required there is no entry in the underlying COD
  - 1.3 *No entry* - No information at all on the COD or one of the following statements is found in Part I of the COD section: medico-legal case; see attached sheet and similar statements that do not specify the circumstances of the death.
2. Acceptability of the COD item - a COD entry is considered acceptable if it is listed in ICD-10 and follows the following definition for the particular COD item:
  - "Immediate COD" - can directly lead to death
  - "Antecedent COD" - can lead to the stated immediate COD
  - "Underlying COD" - disease or injury that initiated the train of morbid events that led directly to death, or the injury that initiated

the train of morbid events that led directly to death, or the circumstances of an accident or violence that produced the fatal injury.<sup>25</sup>

3. Acceptability of the Overall COD Statement - the COD statement fulfills the definition of ICD 10, that is, "presented in a logical sequence with the underlying cause as the disease or injury that initiated the train of morbid events that led directly to death, or the circumstances of an accident or violence that produced the fatal injury".
  - 3.1 *Acceptable overall COD* - a COD is considered acceptable if it fulfills all of the following criteria: a) all 3 items in Part I of the COD section have entries; b) all entries are acceptable item entries; and all entries follow a logical sequence of events that may lead to death. In cases when it is not necessary to fill in all three items, the COD is considered acceptable if the underlying cause has an entry and that it is an acceptable COD item entry.
  - 3.2 *Unacceptable overall COD* - a COD is considered unacceptable if at least one of the following conditions applies: a) the COD statement is incomplete or no entry at all; b) at least one of the entries is unacceptable item entry; and c) the entries do not follow a logical sequence of events that may lead to death.
4. Educational Intervention

The intervention, conducted in December 1997, consisted of a training-seminar for MHOs and distribution of the manual published by NSO (Instructions Manual: Civil Registry Forms (Accomplishment and Coding) to all the field health facilities (Municipal Health Office, Rural Health Units and City Health Office) in the province. The training-seminar had 4 parts: 1) a presentation of the results of the research project entitled, "Completeness and Acceptability of the Cause of Death Statement in Province X" by the main proponent of the study; 2) a lecture on the importance and the guidelines in certifying COD by a resource person from the UP-College of Public Health; 3) a lecture on the Medico-legal Aspects of Death Certification by a physician-lawyer, and 4) a discussion on the problems encountered at the National Statistics Office (NSO) in the coding of the COD and the NSO guidelines on COD certification by the head of the Vital Registration Section of NSO.

During the seminar, several examples of incorrectly filled up COD sections of the death certificates were presented, discussed, and critiqued. A handout outlining the common

problems actually encountered by NSO in the coding of the COD in death certificates was distributed to the participants and discussed. Emphasis was also made on the various items that are considered unacceptable entries into the COD, such as, cardiac arrest, heart failure, and DOA, among others.

#### *Assessment of the COD statement*

All the COD entries were assessed separately by two physician evaluators and in the few cases of discordant evaluations, a consensus was made.

#### *Data Analysis*

Calculation of proportions and regression analysis were done using SPSS version 15 and STATA version 10, respectively. The proportion of death certificates with complete and with acceptable COD statements was computed for each time point considered in the time series analysis. The time point in the analysis was semi-annual. Thus, for the period 1986-2006, a total of 42 time points were considered in the regression analysis.

There were two time periods considered in the time series analysis, pre and post intervention. The cut-off point for the two periods was December 1997. The pre-intervention and the post intervention periods covered a total of 22 and 20 time points, respectively. Ordinary Least Squares Estimation was used to assess homogeneity of variance and autocorrelation. Specifically, the White method was applied to test if there is violation of the assumption of homogeneity while the Durbin Watson d statistic was computed to determine presence of autocorrelation.

If the computed Durbin Watson d statistic is significant (or inconclusive) indicating autocorrelation, the estimates were adjusted using the algorithm of Prais-Winsten. Otherwise, estimates were computed from simple regression analysis. Change in intercepts from pre to post intervention was considered as an indication of intervention effect. (Estimates computed included the period slopes and intercepts, changes in slopes and intercepts from pre to post intervention.) Level of significance was set at 0.05 (P-values less than 0.05 were considered as statistically significant.)

### **Results and Discussion**

This study reveals two things: first, a large proportion of the death certificates have incomplete and unacceptable COD, ranging from inadequate entry to no entry at all; and second, the proportion of death certificates with complete and acceptable cause of death statement increased after the educational intervention.

On the average, only 35.3% (2798/7939) of the death certificates had complete entries, of which 16.5% (462/2798) were found to have overall acceptable COD statement, that

is, the COD entries are listed in ICD-10 and are either presented in logical sequence or had acceptable underlying COD statement (Table 1). Time series data on % completeness and % acceptability are shown in Figure 1. This implies that majority of death certificates do not have adequate information to allow for ICD classification and eventual tabulation for mortality statistics.

**Table 1.** Distribution of Death Certificates According to the Completeness and Overall Acceptability of the COD Statement, Province X, 1986-2006

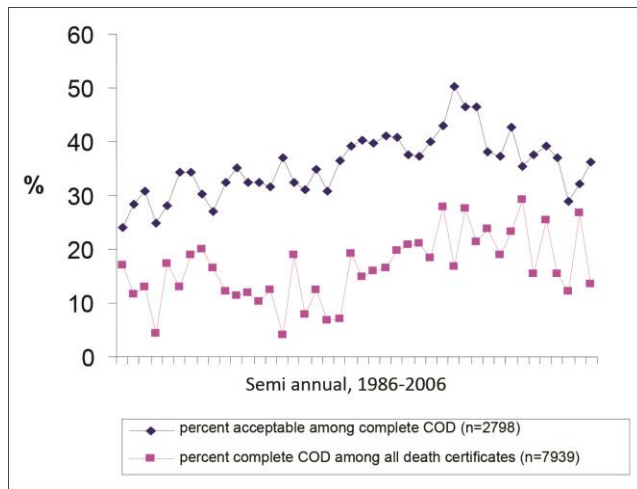
Time point		*Complete COD		**Acceptable Overall COD	
		No.	%	No.	%
1986	Jan-Jun	53	24.1	9	17.0
	Jul-Dec	60	28.3	7	11.7
1987	Jan-Jun	69	30.8	9	13.0
	Jul-Dec	47	24.9	2	4.3
1988	Jan-Jun	58	28.0	10	17.2
	Jul-Dec	70	34.3	9	12.9
1989	Jan-Jun	74	34.4	14	18.9
	Jul-Dec	60	30.2	12	20.0
1990	Jan-Jun	55	27.0	9	16.4
	Jul-Dec	66	32.5	8	12.1
1991	Jan-Jun	71	35.1	8	11.3
	Jul-Dec	67	32.5	8	11.9
1992	Jan-Jun	67	32.5	7	10.4
	Jul-Dec	64	31.7	8	12.5
1993	Jan-Jun	75	37.1	3	4.0
	Jul-Dec	64	32.3	12	18.8
1994	Jan-Jun	63	31.2	5	7.9
	Jul-Dec	65	34.8	8	12.3
1995	Jan-Jun	59	30.7	4	6.8
	Jul-Dec	72	36.5	5	6.9
1996	Jan-Jun	78	39.2	15	19.2
	Jul-Dec	74	40.4	11	14.9
1997	Jan-Jun	81	39.7	13	16.0
	Jul-Dec	79	41.1	13	16.5
1998	Jan-Jun	81	40.7	16	19.8
	Jul-Dec	72	37.7	15	20.8
1999	Jan-Jun	62	37.3	13	21.0
	Jul-Dec	65	40.1	12	18.5
2000	Jan-Jun	72	42.9	20	27.8
	Jul-Dec	78	50.3	13	16.7
2001	Jan-Jun	80	46.5	22	27.5
	Jul-Dec	70	46.4	15	21.4
2002	Jan-Jun	63	38.2	15	23.8
	Jul-Dec	63	37.3	12	19.0
2003	Jan-Jun	69	42.6	16	23.2
	Jul-Dec	58	35.4	17	29.3
2004	Jan-Jun	65	37.6	10	15.4
	Jul-Dec	63	39.1	16	25.4
2005	Jan-Jun	71	37.0	11	15.5
	Jul-Dec	49	28.8	6	12.2
2006	Jan-Jun	60	32.1	16	26.7
	Jul-Dec	66	36.1	9	13.6
Total		2798	35.3	462	16.5

\*denominator used was the total number of death certificates

\*\*denominator used was the number with complete entries

The acceptability level of 16.5% among completely filled up death certificates indicates failure of certifying physicians to present the COD in a logical sequence and/or in filling out the COD items with entries appropriate for the particular item: immediate COD should be one that can directly lead to

death; antecedent COD is the condition that can lead to the stated immediate COD; and underlying COD is the disease or injury that initiated the train of morbid events that led directly to death, or the injury that initiated the train of morbid events that led directly to death or the circumstance of an accident or injury that produced the fatal injury.<sup>25</sup>

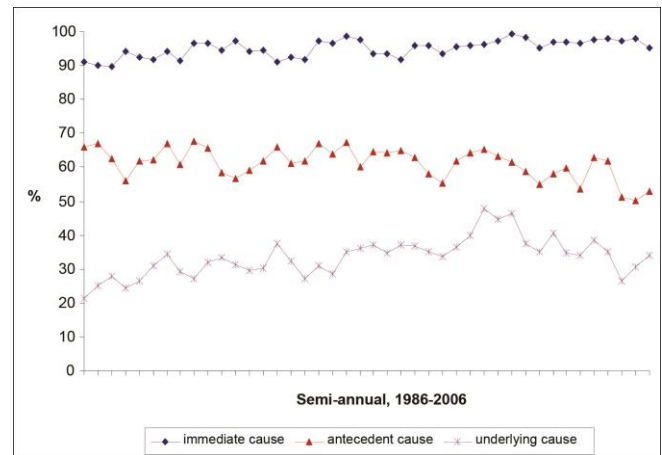


**Figure 1.** Proportion of Death Certificates According to the Completeness and Overall Acceptability of the COD Statement, Province X, 1986-2006

Having complete information on the COD section of the death certificate is one thing and having the correct information is another. The physicians should understand that the importance of not just providing information but providing useful information – acceptable COD items presented in logical sequence. Below are examples of entries that are considered complete but are not logical:

Underlying cause		Antecedent cause
Senility	-	pneumonia
prostatic CA	-	Pneumonia
DM	-	CRA
Preeclampsia	-	U-P Insufficiency
Senility	-	CRA
Malnutrition	-	CRA

Our study further showed that the underlying cause was the least filled up item among the three items, with values ranging from 21.4% (Jan-June 1986) and 47.7% (July-Dec 2000) and an average of 33% of the death certificates with information on the underlying COD. The proportion of death certificates with entries in the immediate cause ranges from 89.7%-99.3% (average for the 42 time points is 94.8%) and for the antecedent cause, the range of values is 50.2%-67.6% (average for the 42 time points is 61.4%) (Figure 2).



**Figure 2.** Proportion of Death Certificates with COD Item Entry, Province X, 1986-2006

In terms of acceptability of the various items found in the cause of death statement, the average proportion of all the death certificates with acceptable item entries in the immediate cause, antecedent cause and underlying cause is 31.7%, 92.8% and 75.3%, respectively (Table 2).

Although the underlying cause entry, when present, was acceptable in 75% of these cases, a large proportion (64.7%) of the death certificates had no information at all on underlying cause. This is a major problem because, among the COD items, the most important item entry is the underlying COD since it is taken as the COD for both statistical tabulation and establishment of the COD of an individual. In the absence of an underlying cause, the provision in the coding manual provides that, "If there is no information on the underlying cause and only the antecedent and/or immediate cause is reported, the item to be coded shall be the antecedent or the immediate cause in that order".<sup>26</sup> This provision only partly addresses the problem because, while a large proportion (94.8%) of the immediate cause has entries, majority (68.3%) of the entries are unacceptable items with cardiac arrest/cardio-respiratory arrest/heart failure accounting for 52% of the unacceptable entries. Following the above-mentioned coding guideline, a death certificate without an underlying COD will have a high probability of ending up with cardiac arrest (cardio-respiratory arrest or heart failure, as the case maybe) as the COD. These entries are not causes of death but are modes of dying and are not acceptable.<sup>25-26</sup> They do not give useful information at all and may even lead to overestimation of diseases of the heart due to coding errors. As coders and tabulators in the NSO, who oftentimes, have no medical orientation, classifying these entries into the category of Disease of the Heart is not a remote possibility. Coders may tabulate cardiac arrest/cardio-respiratory arrest/heart failure under Diseases of the Heart.



**Table 2.** Proportion of Death Certificates According to Acceptability of the Immediate, Antecedent and Underlying Causes, Province X, 1986-2006

Time point		% Acceptable item entry		
		immediate cause	antecedent cause	underlying cause
1986	Jan-Jun	24.5	95.9	74.5
	Jul-Dec	19.4	86.6	66.0
1987	Jan-Jun	24.4	88.6	69.4
	Jul-Dec	21.9	89.6	71.7
1988	Jan-Jun	23.0	88.3	60.0
	Jul-Dec	24.1	91.3	69.8
1989	Jan-Jun	28.7	89.6	74.3
	Jul-Dec	26.9	92.6	75.9
1990	Jan-Jun	23.4	89.9	76.4
	Jul-Dec	27.6	97.7	76.9
1991	Jan-Jun	23.6	100.8	77.6
	Jul-Dec	30.5	94.0	70.3
1992	Jan-Jun	25.8	95.1	83.6
	Jul-Dec	23.6	90.4	73.8
1993	Jan-Jun	24.5	95.5	73.7
	Jul-Dec	29.5	86.8	68.8
1994	Jan-Jun	30.8	92.0	67.3
	Jul-Dec	26.9	93.6	81.0
1995	Jan-Jun	21.1	93.5	69.1
	Jul-Dec	18.6	87.2	66.7
1996	Jan-Jun	28.9	94.2	73.6
	Jul-Dec	31.6	98.3	75.0
1997	Jan-Jun	34.0	91.6	80.3
	Jul-Dec	35.8	96.8	73.2
1998	Jan-Jun	31.4	92.8	79.5
	Jul-Dec	42.1	89.2	77.6
1999	Jan-Jun	38.1	100.0	69.6
	Jul-Dec	38.1	87.0	78.0
2000	Jan-Jun	42.9	94.4	83.6
	Jul-Dec	38.3	86.1	77.0
2001	Jan-Jun	40.1	100.9	68.8
	Jul-Dec	40.7	100.0	78.6
2002	Jan-Jun	42.0	94.8	88.7
	Jul-Dec	39.1	100.0	74.6
2003	Jan-Jun	37.6	101.1	71.2
	Jul-Dec	40.9	90.8	73.7
2004	Jan-Jun	51.5	90.3	86.4
	Jul-Dec	42.7	88.1	87.1
2005	Jan-Jun	37.2	88.2	74.6
	Jul-Dec	35.2	96.6	80.0
2006	Jan-Jun	43.7	98.9	78.9
	Jul-Dec	40.8	86.6	82.3
Total		31.7	92.8	75.3

Even among doctors, there is a problem with agreement in recording cardiac death. It was reported in the literature that certifying physicians disagree on the underlying cause of cardiac deaths in nearly half of cases (46%).<sup>13</sup> In studies that evaluated the COD statements in death certificates, including those studies that utilize mock death certificates based on case vignettes, high frequency of errors had been found in the COD entries. The highest error rate was reported by El-nour et al., where 98.2% death certificates were incompletely filled up and 77.6% had incorrect immediate cause, 56.2% of the incorrect entries were modes of dying.<sup>14</sup> The frequency of death certificates with modes of dying as entries is comparable to our findings where 52% of

the unacceptable immediate cause were statements on mode of dying, such as cardiac arrest and heart failure (Table 3). Studies that looked at certification errors in mock death certificates reported error rates from 77% to 82%.<sup>21-27</sup>

**Table 3.** Distribution of Unacceptable Entries in the Immediate, Antecedent and Underlying Causes of Death, Province X, 1986-2006

A. Unacceptable Immediate Cause	No.	% of all unacceptable entries
Cardiac Arrest*	2765	52.0
Undetermined	103	2.0
DOA	56	1.0
Shock	52	1.0
Others**	2298	44.0
Total	5274	100.0
B. Unacceptable Antecedent Cause	No.	% of all unacceptable entries
Cardiac arrest *	121	17.1
Shock	59	8.3
DOA	3	0.4
Undetermined	42	5.9
Others	225	68.2
Total	707	100.0
C. Unacceptable Underlying Cause	No.	% of all unacceptable entries
Cardiac arrest *	27	4.2
Shock	23	3.4
DOA	1	0.2
undetermined	21	3.2
Others	578	89.0
Total	650	100.0

\* Include other modes of dying

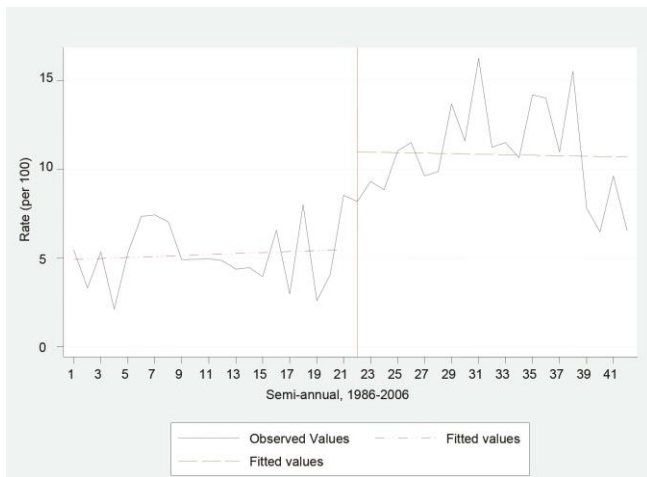
\*\* Include dyspepsia, gunshot wound, jaundice, hypoxia, convulsions, prolonged labor, and degenerative disease, among others

Several reports have attributed deficiencies in the COD statement to the lack of physician education. There are two possible explanations why this is the case. Firstly, many physicians have not received formal training in certifying COD and if they did, this was given early in the course of the medical education and no follow up instruction during the clinical and in the post graduate training years. One report indicated that 40% of the doctors included in the study saw the death certificate for the first time after graduation.<sup>14</sup> Another study found that only 13% among 198 physician medical examiners received death certificate training in medical school.<sup>20</sup> and in one local study 9% of the Rural Health Physicians surveyed remembered having taken up death certification in medical school.<sup>28</sup> Furthermore, Kelly et al reported that death certification is not featured in the curriculum of a number of undergraduate pathology training programs.<sup>29</sup>

Secondly, many clinicians may not have the population perspective and are not aware that the information they provide in the death certificates are essential for public health purposes as well as for research. The task of certifying a death may be regarded by clinicians as a responsibility that they have towards their individual patients only without

any perspective of the other uses of the death certificate. Thus, clinicians perform the task with the notion that the document will be used only for burial or claims purposes. They may not have the realization that the single document can contribute to accurate mortality statistics, which in turn, is utilized for planning and research purposes. Items like cardiac arrest and heart failure have no use for planning and prioritizing disease prevention programs nor for evaluating program effectiveness. What are needed are conditions whose magnitude can be determined and for which prevention measures can be applied. It is, therefore, essential that clinicians see the population perspective of the death certificate and to understand that the death certificate is a valuable document for Public Health purposes and that they can contribute to Public Health of the population by filling out the COD item properly.

As to the usefulness of educational intervention in improving the proportion of death certificates with complete/acceptable COD statement, our study, which employed regression analysis of the time series data, found a statistically significant increase in the acceptability rate of the COD during the time period after the educational intervention (Figure 3 and Table 4).



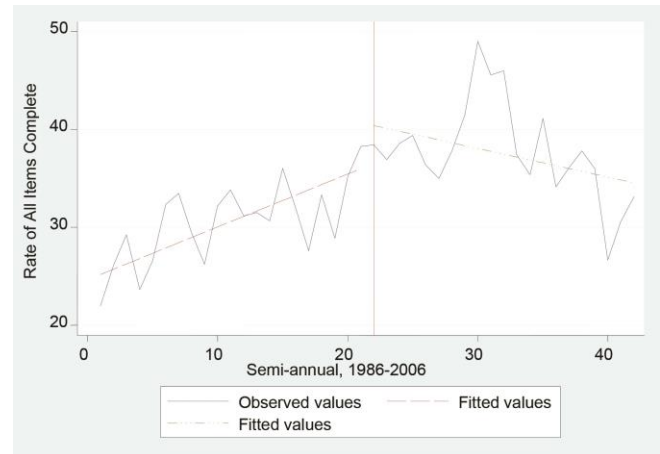
**Figure 3.** Acceptability Rate of all Entries, Province X, 1986-2009

There is, however, much to be desired as far as the magnitude of the increase is concerned. Moreover, the increase that was noted post intervention was temporary with the decline occurring a few years post intervention. This implies the need for follow-up training at regular intervals in order to sustain the positive effect of the intervention.

Figure 4 shows the time trend on the proportion of completely filled up death certificate before and after the intervention.

**Table 4.** Estimates of the Levels of Acceptability of Overall COD Statement among all Death Certificates, Province X, 1986-2009

Period	Predicted mean rate	95% CI	p-value
Pre Intervention (Jan 1986 – Dec 1997)	4.0	2.2, 5.9	<0.001
Post Intervention (Jan 1998 – Dec 2006)	8.4	6.7, 10.2	<0.001
<b>Change</b>	<b>4.4</b>	<b>2.0, 7.0</b>	<b>0.001</b>



**Figure 4.** Completeness of the COD Statement, Province X, 1986-2009

Analysis of the data (Table 5) revealed that the post intervention trend is not significantly different from the pre intervention trend in terms of completeness of the cause of death section of the death certificates ( $p=0.232$ ).

**Table 5.** Estimates of the Levels of Completeness of Overall COD Statement among all Death Certificates, Province X, 1986-2009

Period	Predicted mean rate	95% CI	p-value
Pre Intervention (Jan 1986 – Dec 1997)	36.52866	31.364, 41.693	<0.001
Post Intervention (July 1997 – Dec 2006)	40.40603	35.587, 45.225	<0.001
<b>Change</b>	<b>3.87737</b>	<b>-2.584, 10.339</b>	<b>0.232</b>

### Conclusion

A large proportion of the COD section of death certificates are completed to a poor standard, being illogical or inappropriately completed. Only 35.3% of all the certificates reviewed have complete COD statement, of which, 16.5% have acceptable overall COD. The underlying COD was the least filled up item where only 33.0% had entries.

The educational intervention was found to increase the acceptability rate of the COD statement, both for the overall

statement of COD and the item acceptability of the immediate cause, antecedent cause and underlying cause, after the educational intervention.

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