INNOVATIONS IN EDUCATION

Improving Death Certificate Completion: A Trial of Two Training Interventions

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The death certificate is an important medical document that impacts mortality statistics and health care policy. Resident physician accuracy in completing death certificates is poor. We assessed the impact of two educational interventions on the quality of death certificate completion by resident physicians. Two-hundred and nineteen internal medicine residents were asked to complete a cause of death statement using a sample case of in-hospital death. Participants were randomized into one of two educational interventions: either an interactive workshop (group I) or provided with printed instruction material (group II). A total of 200 residents completed the study, with 100 in each group. At baseline, competency in death certificate completion was poor. Only 19% of residents achieved an optimal test score. Sixty percent erroneously identified a cardiac cause of death. The death certificate score improved significantly in both group I (14 ± 6 vs 24 ± 5 , $p < 0.001$) and group II (14 ± 5 vs 19 ± 5 , $p < 0.001$) postintervention from baseline. Group I had a higher degree of improvement than group II (24 ± 5 vs 19 ± 5 , $p < 0.001$). Resident physicians' skills in death certificate completion can be improved with an educational intervention. An interactive workshop is a more effective intervention than a printed handout.

KEY WORDS: death certificate; health care policy; intervention; cardiac; workshop.

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INTRODUCTION

Data from death certificates constitute an essential component of national mortality and morbidity statistics. The Department

of Health and Human Services, the National Center for Health Statistics, and the National Death Index rely on the accuracy of these forms. Earlier studies suggest that the accuracy and reliability of certification of underlying cause of death is very poor, and error rates range from 16 to 40%.^{1–5}

Studies have also suggested that medical students, house staff, and junior physicians frequently commit mistakes in death certificate completion.^{6–9} In the majority of teaching hospitals, resident physicians are responsible for death certificate completion, but only a small percentage receives formal training.⁹ There are several documented causes for inaccuracies in death certificate completion at various stages of the process of death certificate completion, impacting mortality statistics.^{6,9–14} Because most academic medical centers do not provide specific training in death certificate completion, an educational intervention may be needed.^{6–9}

Studies have shown that simple educational interventions can improve the accuracy of death certificate completion.^{2,15} In our study, we sought to assess the impact of two common types of educational interventions—an interactive workshop versus printed instruction material as a handout—on the accuracy of identifying the underlying cause of death.

MATERIALS AND METHODS

Subjects

A sample of 219 internal medicine residents from five teaching hospitals (University of Missouri School of Medicine, Kansas City, MO, USA; Creighton University School of Medicine, Omaha, NE, USA; Sinai Grace Hospital, Detroit, MI, USA; Harper Hospital, Wayne State University School of Medicine, Detroit, MI, USA; Harbor Hospital, Baltimore, MD, USA) were requested to complete a baseline and postintervention survey along with a model death certificate using sample cases of in-hospital death. The standard death certificate (World Health Organization [WHO]'s International Classification of Diseases [ICD—10th revision]) was used in the survey material.¹⁰ The participants were volunteers, and no financial compensation was provided.

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Baseline Questionnaire

We designed a questionnaire, which assessed participants' level of training, gender, previous experience, prior formal training, comfort level, awareness of guidelines, and desire for further training in death certificate completion.

Death Certificate Completion Test

After the baseline test (Test case 1), the participants were randomized to one of the two educational interventions—group I (interactive workshop or “workshop group”, $n = 105$) and group II (printed handout or “print group”, $n = 114$) at each of the five participating institutions separately using an internet-based randomization program¹⁶ (Fig. 1). Participants were eliminated from the study if they failed to complete the baseline and postintervention death certificates and/or complete the workshop. Ultimately, data from 100 participants in each group pooled together from all the five participating institutions were available for analysis. The workshop group attended a 45-minute interactive workshop led by one of the authors (DRL, KRB, AKK, and SKR), and the print group received printed instruction materials that outlined the guidelines for optimal completion of death certificates. The authors who were in charge of the workshop were well versed with the guidelines and ICD coding, and the material used for both the interventions was prepared by the authors together. The contents of both types of interventions were the same in all the institutions. After 1 week, both groups were asked to complete a second death certificate (Test case 2) using a different sample case, and these certificates were quantitatively scored. In both model cases, the primary cause of death was noncardiac with patients experiencing unstable cardiac rhythms during resuscitation.

Underlying cause of death is defined as the initiating event, which starts the sequence of clinical events resulting in death. We used a standard death certificate approved by the WHO,

which is in use across the world. Section (a) outlines the chain of events from immediate events to the underlying cause in a descending order. Section (b) outlines the associated comorbidities that add to the disease process. Responses in sections (a) and (b) of the death certificate were tabulated and analyzed based on the MAHI Death Certificate Scoring System.¹⁷ This 15-item scoring instrument uses the guidelines established by the College of American Pathologists, the National Association of Medical Examiners, and the National Center for Health Statistics. Each of the 15 items was scored using a 3-point system (0, 1, or 2) based on agreement with the standard (0 = poor, 1 = borderline, 2 = good). We used a scoring system used in previous studies for quantifying level of performance.¹⁷ With a 0–2 grading system, “1” is representative of those responses which are not ideal but indicate some degree of knowledge and understanding. Each participant's score was summed and labeled as acceptable (≥ 19) or unacceptable (≤ 18). Three evaluators (DRL, KRB, and AKK) blinded to the participant's intervention reviewed all death certificates, and the mean was considered as the final score for each participant. The kappa score for each of the MAHIDCC score variable among the three evaluators was 0.88. The death certificate scores of 14 participants in group I and 12 participants in group II had discrepancy of more than 5 points among the three evaluators and were resolved through reevaluation by all the three evaluators together.

Statistical Methods. Comparison of intervention groups was done using the chi-square statistic when the outcome variable was categorical. The McNemar test was used to compare two proportions estimated in a single population based on a set of random paired observations. The Fisher's exact test was used for comparisons involving the categories of death certificate score. Stepwise logistic regression was used to identify the significant independent predictors of change in the death certificate score. Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 reports the baseline characteristics of the participants. Table 2 demonstrates that both groups showed a significant improvement in all areas of death certificate scored.

The workshop group showed greater improvement compared to the print group in various parameters of death certificate completion as shown in Tables 2 and 3. Of note, the workshop group showed a dramatic reduction of incorrect identification of cardiac causes of death from 56 to 6% ($p < 0.001$).

The stepwise logistic regression analysis showed that desire for further training before intervention ($p < 0.001$), comfort with own ability after intervention ($p < 0.001$), intervention through didactic workshop ($p < 0.001$), preintervention awareness of guidelines ($p = 0.003$), and level of training ($p = 0.037$) were independent predictors of change of death certificate scores from unacceptable to acceptable range.

DISCUSSION

Before an educational intervention, 60% of resident physicians in our study incorrectly identified a cardiac cause of death remarkably similar to a study by Behrendt et al.¹⁸, showing 61% of physicians who noted a nonspecific cardiovascular

Figure 1. Randomization table of the study.

Table 1. Baseline (Preintervention) Characteristics

Variable	Total n = 200	Group I n = 100	Group II n = 100	p-Value
Level of Training				
PGY-1	84 (42%)	39 (39%)	45 (45%)	0.69
PGY-2	52 (26%)	28 (28%)	24 (24%)	
PGY-3	64 (32%)	31 (31%)	33 (33%)	
Sex (M:F)	107:93	56:44	51:49	0.48
Age	33 ± 8	34 ± 7	32 ± 9	0.08
Previous experience				
<10 death certificates	136 (68%)	68 (68%)	78 (78%)	0.27
10–20 death certificates	44 (22%)	22 (22%)	16 (16%)	
>20 death certificates	20 (10%)	10 (10.0%)	6 (6%)	
Prior formal training	28 (14%)	16 (16%)	12 (12%)	0.42
Awareness of guidelines	16 (8%)	12 (12%)	4 (4%)	0.04
Comfort with own ability	98 (49%)	50 (50%)	48 (48%)	0.78
Desire further training	98 (49%)	44 (44%)	54 (54%)	0.16
Correctly identified cause of death	16 (16%)	15 (15%)	16 (16%)	0.85
Erroneously indicated cardiac cause	120 (60%)	56 (56%)	64 (64%)	0.22
Baseline score of ≥ 19	38 (19%)	20 (20%)	18 (18%)	0.72

event as the cause of death. At least 20% of death certificates are assigned with a different cause of death, most commonly after autopsy.^{19,20} Clinicians may poorly perform compared with pathologists due to less training in and familiarity with the death certificate process.²¹ In the face of decreasing autopsies, the degree of accuracy in death certificate completion may decline even further due to lack of training in what is expected on a death certificate.^{1–3,5,6,8,12,15,19,21–25}

Table 2. Differences in Death Certificate Performance Before and After Intervention

Performance variable	Preintervention	Postintervention	p-Value
Correctly identified cause of death			
Group I (n = 100)	15 (15%)	91 (91%)	<0.001
Group II (n = 100)	16 (16%)	55 (55%)	<0.001
Total (n = 200)	31 (15.5%)	146 (84.5%)	<0.001
Erroneously identified cardiac death			
Group I (n = 100)	56 (56%)	6 (6%)	<0.001
Group II (n = 100)	64 (64%)	43 (43%)	0.02
Total (n = 200)	120 (60%)	49 (24.5%)	<0.001
Death certificate score ≥ 19			
Group I (n = 100)	20 (20%)	82 (82%)	<0.001
Group II (n = 100)	18 (18%)	58 (58%)	<0.001
Total (n = 200)	38 (14%)	140 (70%)	<0.001
Mean death certificate score			
Group I (n = 100)	13.7 ± 5.9	24.1 ± 4.8	<0.001
Group II (n = 100)	14.1 ± 4.6	19.1 ± 5.4	<0.001
Total (n = 200)	13.9 ± 5.3	21.6 ± 5.7	<0.001

Group I statistically significant improvement than group II in correct identification of cause of death (91 vs 55%, $p < 0.001$), improvement in death certificate score (10.48 ± 3.97 vs 5.04 ± 4.94 , $p < 0.001$), and postintervention score ≥ 19 (82 vs 58%, $p < 0.001$). Group I also indicated a cardiac cause as the cause of death less frequently than group II (6 vs 43%, $p < 0.001$) after the intervention.

Table 3. Various Erroneous Cardiac Causes Identified by Participants in the Two Groups Before and After Educational Intervention

Type of Cardiac Cause	Total		p-Value		Group I (PI)		Group II		p-Value	
	n = 200		n = 200		n = 100		n = 100		n = 100	
All cardiac causes	60%	25%	<0.001	56%	6%	64%	<0.001	44%	0.007	
Cardiac arrest	22%	6%	<0.001	20%	2%	24%	<0.001	8%	0.014	
Cardiopulmonary arrest	16%	5%	<0.001	12%	1%	20%	0.004	11%	0.12	
Ventricular tachycardia/Ventricular fibrillation	15%	10%	0.17	14%	3%	16%	0.011	15%	0.86	
Asystole	5%	3%	0.44	4%	0%	6%	0.13	8%	0.77	
Arrhythmia otherwise unspecified	2%	1%	0.68	1%	1%	3%	0.48	2%	0.61	

PI Postintervention.

To our knowledge, there are only two previous studies that had evaluated the impact of an educational intervention on the death certification errors.^{15,26} An Australian study on house officers assessed the death certificate error rates 1 month before and after an educational intervention using printed educational material. There was a drop in error rate (22 to 15%) without statistical significance.²⁶ Subsequently, Myers and Farquhar¹⁵ attempted to enhance the likelihood of achieving a significant change through an interactive learning method. A 75-minute didactic session, which details the common pitfalls in death certificate completion, was repeated three times over a period of 6 months. There was a reduction in major error rates (33 to 16%, $p=0.01$) and erroneous identification of cause of death (16 to 6%, $p=0.03$).

In our study, we used case simulations that are prepared based on real-life cases, and our evaluation was done through a validated scoring system instead of counting error rates. Additionally, we tested both types of educational intervention—printed instruction material and interactive workshop—to assess their effects on the learning process. Our results indicate that the accuracy of death certificate completion can be significantly improved by both interventions. However, the interactive workshop is a better mode of teaching than printed handouts. Interactive sessions provide an opportunity for greater one-on-one learning and enhanced understanding.

STUDY LIMITATIONS

This was a small study limited to internal medicine residents. There was a statistically significant difference in the awareness for guidelines in between the two groups. This fraction of participants was small, and the power of intervention is still valid in improving performance. The postintervention assessment of participants' abilities was done after only 1 week. The case scenarios used were simulations created based on real cases that the authors had seen in their clinical practice. This study design limits our capability of testing the participants' performance over time and the need for reeducation.

CONCLUSIONS

Resident physicians have poor skills in death certificate completion and often identify inappropriate cardiovascular causes as the underlying cause of death. Their performance can be significantly improved with an educational intervention. An interactive workshop is a more effective intervention than a printed instruction.

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Potential Financial Conflicts of Interest: None disclosed.

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APPENDIX

TEST CASE 1

The patient was a 29-year-old Caucasian male with known multiple sclerosis for 3 years complicated by paraplegia and chronic decubitus ulcers. His other medical conditions include atopic dermatitis and asthma. He was admitted to the intensive care unit with high-grade fevers, chills, and rigors, and leukocytosis ($19 \times 10^3/\mu\text{L}$) with bandemia of 58%. Vital signs included the following: temperature, 102.5°F; pulse, 128 bpm; blood pressure, 85/55 mmHg; and oxygen saturation, 96% on room air. He also had a chronic indwelling urinary catheter, which had been changed. Urine analysis revealed gross pyuria and bacteriuria. Urine and blood cultures were obtained. He was started on levofloxacin (500 mg once daily intravenously) and was given 1.5 L of fluid bolus, after which his blood pressure improved to 115/60 mmHg. He was continued on normal saline at 100 cm³/h. He was stable for the next 12 hours when his blood pressure dropped to 60/40 mmHg. At that time, he was started on neosynephrine to titrate to systolic blood pressure >80 mmHg. During the next 36 hours, systolic blood pressure stabilized at 80 to 90 mmHg, and serum potassium levels increased from 3.6 to 7.3 mEq/L, whereas serum creatinine levels rose from 1.4 to 4.6 mg/dL. Oxygen saturation dropped to 79% on room air, and he was subsequently put on a 100% nonrebreather mask. Blood pressure started to decrease, and telemetry showed sustained monomorphic ventricular tachycardia. A Code Blue was called. No pulse or spontaneous breaths were detected. Cardiopulmonary resuscitation was initiated, and he was intubated. No pulse or change in rhythm was noted after three DC shocks and three boluses of intravenous epinephrine. Finally, he converted to normal sinus rhythm with shock after lidocaine bolus. He was started on a lidocaine drip. Shock profile was sent, and kayexalate per a nasogastric tube was given to address the high serum potassium level. He remained in normal sinus rhythm with multiple frequent premature ventricular contractions and a blood pressure of 60/30 mmHg. Neosynephrine was increased, and dopamine was started. Another Code Blue was called when the patient was found to be in asystole. Epinephrine and atropine (three boluses each) were administered, and the monitor showed coarse ventricular fibrillation after the fourth dose of atropine. No pulse was noted. He was shocked three times at 360 J, and a lidocaine bolus was given followed by another shock and a procainamide bolus. He was also given a bolus of

MEDICAL CERTIFICATE OF DEATH			
CAUSE OF DEATH	Part I Immediate cause of death	I (a) due to, or as a consequence of	Approx. interval between onset & death
	Antecedent causes, if any, giving rise to the immediate cause (a) above, stating the underlying cause last	(b) due to, or as a consequence of	
		(c)	
	Part II Other significant conditions contributing to the death but not causally related to the immediate cause (a) above	II	

bretylium as a last resort followed by another shock. Fifty minutes after initiating the second Code Blue, upon agreement with everyone involved, resuscitation attempts were discontinued, and the patient was declared dead.

Correct completion of test case 1 would be as follows: Part I, line A = septic shock, line B = urinary tract infection, line C = neurogenic bladder, line D = multiple sclerosis; Part II = atopic dermatitis and asthma.

TEST CASE 2

The patient was a 39-year-old African American woman with known sickle cell disease for the past 22 years. She has been on chronic pain medications for intermittent episodes of sickle cell crises. She was well known to the internal medicine service from her multiple admissions over the last several years for sickle cell crises and her dependence on chronic pain medications. Her other medical problems include hypertension, mild renal insufficiency, and moderate mitral stenosis. She was admitted to the internal medicine service with complaints of painful sickle cell crises involving the lower extremities, fever, nausea, and vomiting. She had mild leukocytosis ($12 \times 10^3/\mu\text{L}$). Vital signs included the following: temperature, 101°F ; pulse, 114 bpm; blood pressure, 180/95 mmHg; and oxygen saturation, 92% on room air. Her hematocrit was 28, and Cr/BUN was 1.3/38. She was being treated with IV fluids, 3 L of inhaled O_2 , and pain medications. Also, she was restarted on her home diltiazem and ACE-I with improvement in her BP. The next day, she started complaining of more leg pain with some tenderness in her right calf. On examination, the right calf looked bigger than the left, and the intern had promptly started the patient on IV heparin, and the patient was wheeled down to the radiology department for bilateral lower extremity Doppler to assess for deep venous thrombosis. As the test was completed, patient complained of sudden onset of pleuritic chest pain with shortness of breath. Her oxygen saturation dropped to 82% on 2 L, and she was subsequently put on a 100% nonrebreather mask. She became hypotensive, and a Code Blue was called. Patient subsequently had agonal breathing without a palpable pulse. Portable monitoring unit showed sinus tachycardia at 140 bpm. Cardiopulmonary resuscitation was initiated, and she was intubated. No pulse or change in rhythm was noted after three boluses of intravenous epinephrine and continued CPR. Monitoring showed ventricular fibrillation, and a 360-J DC shock transiently brought the patient back to sinus tachycardia with feeble pulse. As the intern on the code team started getting central venous access through the right

Correct completion of the test case 2 would be as follows: Part I, line A = massive pulmonary embolism, line B = lower extremity deep venous thrombosis, line C = sickle cell disease, Part II = hypertension, mild renal insufficiency and mitral stenosis.

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MEDICAL CERTIFICATE OF DEATH		
CAUSE OF DEATH	Part I	I
	Immediate cause of death	(a) due to, or as a consequence of
	Antecedent causes, if any, giving rise to the immediate cause (a) above, stating the underlying cause last	(b) due to, or as a consequence of
		(c)
	Part II	II
	Other significant conditions contributing to the death but not causally related to the immediate cause (a) above	

femoral vein, the patient went into asystole, and CPR was reinitiated. After 30 more minutes of ACLS upon agreement with everyone involved, resuscitation attempts were discontinued, and the patient was declared dead.