COMPARISON OF OFFICIAL CODERS VERSUS
PHYSICIAN PANEL IN ASSIGNMENT OF UNDERLYING
CAUSE OF DEATH

Tsung-Hsueh Lu, Hsing-Yi Chang,¹ Chii-Min Hwu,² Hou-Chang Chiu,³ Wei-Hsian Yin,⁴ and Wen-Han Pan⁵

Background and purpose: In outcome analyses of clinical trials and mortality follow-up studies, the underlying cause of death (UCOD) is commonly assigned either by official coders or by a panel of physicians. We evaluated the validity of UCOD assigned by official coders by comparison with the assignments of a panel of physicians who reviewed the available medical records of the deceased.

Methods: The comparisons focused on deaths occurring from October 1995 through June 1998 in a series of residents in a veterans home. Because of limited resources, only the first 104 deaths that occurred during the study period were included. Agreement rate, sensitivity, specificity, and kappa statistics were calculated to assess the consistency of coder versus physician panel assignment of UCOD by selected main causes of death. For 32 of the 104 deaths, the panel concluded that the information obtained from medical records was insufficient to determine the UCOD, and the following analyses were confined to the other 72 deaths.

Results: For the 72 deaths considered by the panel to have sufficient information to determine UCOD, all four physicians agreed on a single UCOD in 50 (69%) cases, while three or four agreed in 66 (92%) cases. A consensus was reached in cases with disagreement. The two procedures completely agreed in 40 (56%) of the deaths. For general category UCOD, the kappa value was high for cancer (0.83) and cardiovascular disease (CVD, 0.73) but only moderate for pulmonary disease (PD, 0.60). When the UCOD assigned by the panel was used as the gold standard, official coders showed relatively low sensitivity for correct determination of UCOD in cases of CVD (0.76) compared with cancer (0.86) and PD (0.80).

Conclusions: Given the high inter-physician consistency and the relatively low sensitivity of official coders in assigning CVD as the UCOD, we conclude that the use of clinical review panels would provide more accurate UCOD assignments for use in outcome analyses in mortality follow-up studies and clinical trials in Taiwan.

Underlying cause of death (UCOD) is often used as an outcome in clinical trials and mortality follow-up studies. The process of outcome assessment is crucial, because it has a direct impact on the ultimate study results. In such studies, the UCOD is commonly coded either by official coders according to the information recorded on the death certificate, or by a panel of physicians reviewing all available clinical information.
The advantages of using officially coded results are the readiness of the data, low cost, and standardization. The disadvantages are the often inadequate and incomplete information provided by the certifiers of death, and the varied reliability and accuracy of official coders [1–8]. The advantages of a panel of physicians determining the UCOD are that greater detail about the circumstances of the death are gathered, and a consensus is reached for ambiguous causes. Nevertheless, panel consensus is more cumbersome and expensive, and may sustain bias in determining the preferred UCOD [9, 10].

Several studies have empirically evaluated the agreement between the two procedures and their impact on outcome analyses [11–13]. Practices of official coder and physician death certification vary from country to country. Previous studies from Taiwan revealed poor quality in death certification and coding [6–8]. This study aimed to evaluate the validity of UCOD selected by official coders with the findings of a panel of physicians who reviewed the available medical records of the deceased. Mortality data from a previous study were used for comparison.

**Materials and Methods**

The study sample included 1003 veterans living in Ban-Chow Veterans Home in Northern Taiwan who had previously participated in a trial involving a low-sodium diet [14]. Residents were assigned to one of 12 squads upon registration. Two squads share one kitchen. Because bed-ridden veterans were assigned to the 12th squad, the squad sharing the same kitchen (squad 11) were also excluded from the study. Squads sharing two of the remaining kitchens were selected as intervention groups and the other three as control groups. The baseline data were collected in July 1995, and included demographic data, current disease status, and biochemical laboratory data. The primary purpose of the trial was to examine the effect of a potassium-enriched, low-sodium diet on reducing blood pressure and cardiovascular disease (CVD) mortality in elderly men.

Although physicians rotated through the veterans home clinic to manage common and easily treated illnesses, most veterans were referred to veterans hospitals if thorough examination and intensive treatments were needed. Veterans General Hospital-Taipei (VGH-T) is the largest veterans hospital in Northern Taiwan, and most veterans are transferred to VGH-T for treatment. Every resident in Ban-Chow Veterans Home has a medical record in VGH-T; nevertheless, the veterans may go to any hospital they choose. Whenever veterans died, a copy of the death certificate is sent back to the veterans home. From October 1995 through June 1998, 174 residents in the 10 participating squads died. Because of limited resources, only the first 104 deaths were selected for this evaluation.

A clinical review panel was formed to carefully determine the UCOD. The panel was composed of four physicians who specialized in cardiology, neurology, endocrinology, and family medicine, respectively. An initial meeting was held to instruct the panel on the UCOD selection rules of the ICD-9 (International Classification of Disease, Ninth Revision) [15].

Because of limited resources, only the medical records from VGH-T and the veterans home were used in this study. Relevant details on the medical records were abstracted by a research assistant and distributed to each panel physician. The physicians reviewed the abstracts independently, determined the major causes of death, and assigned a UCOD without seeing the original death certificate. The physician could ask for the original medical records for more detailed information if needed. The panel met twice to discuss disagreements in assigning a UCOD, and a consensus UCOD was achieved for each death.

In Taiwan, coding of all death certificates is handled by the Office of Statistics of the Department of Health. Four coders assign the UCOD for each death certificate, according to the selection rules of the ICD-9. Each coder is in charge of a similar number of death certificates, according to the county in which the death certificates were issued. To ensure inter-rater reliability in UCOD coding, a sample of death certificates is re-coded by another coder routinely. The coders generally assign the UCOD on the basis of information on the death certificate only. If the information on the death certificate is illogical or too vague for a UCOD to be assigned, the coder can query the certifier to provide more specific information. In this study, we asked the Office of Statistics of the Department of Health to provide the recorded UCOD for each of the 104 deaths. Because we did not invite the official coders to recode the 104 death certificates, the UCOD given for these 104 deaths should reflect the real situation in routine coding practice.

**Analysis**

Agreement rates were calculated to evaluate the consistency of UCOD assignments among the four physicians, according to both the two-digit and three-digit ICD-9 codes [15]. For example, if one physician selected cerebral infarction (ICD-9 code 434) as the UCOD while another selected cerebrovascular accident (ICD-9 code 436), the two physicians were considered in disagreement based on the three-digit code, but in...
agreement based on the two-digit code (ICD-9 code 28). Because of the limited number of deaths in this study, for inter-procedure comparison, we classified the causes of death into four general categories: cancer (ICD-9 code 140–208), CVD (ICD-9 code 390–459), pulmonary diseases (PD; ICD-9 code 460–519), and others.

The data were cross-tabulated and kappa statistics were calculated to assess consistency between the official coders and the panel of physicians, according to the four general categories [16]. We assumed that the UCOD selected by the panel of physicians could be used as the gold standard to evaluate the sensitivity and specificity of disease classification made by official coders.

To assess the possible effects of disagreement on study results, we used data derived from the two coding procedures to calculate the odds ratios (ORs) and 95% confidence intervals (95% CIs) of dying from CVD by different risk factors (i.e., hypercholesterolemia, hypertension, diabetes, and abnormal body mass index [BMI]).

Although every deceased veteran resident had a medical chart in VGH-T, many charts had only outpatient records and many admission records were outdated (e.g., more than 6 months old), or the conditions listed on the discharge diagnoses were not severe enough to cause death. For 32 of the 104 deaths, the panel concluded that the information was insufficient to determine the UCOD. The following analyses were confined to the 72 deaths for which adequate information was available.

**Results**

**Inter-physician agreement**

Before consensus was reached by the panel, all four physicians agreed on a three-digit ICD-9 code for 50 of the 72 deaths, and three physicians agreed for another 16 deaths; thus, three or four of the physicians were in agreement for 66 of 72 deaths. The agreement rate improved if two-digit ICD-9 codes were used: all four physicians agreed on the same UCOD in 61 deaths, and three agreed in another 10; thus, three or four of the physicians were in agreement for 71 deaths.

In six cases, only two physicians agreed on the three-digit ICD-9 code before consensus was reached. In four of these cases, there were two different diagnoses: two physicians favored one diagnosis (e.g., cerebral infarction) while the other two physicians favored another (e.g., cerebrovascular accident). In the remaining two cases, there were three diagnoses: two physicians favored one diagnosis, and the other two each arrived at different diagnoses. In no cases did all four physicians give different UCODs.

**Inter-procedure agreement**

The UCODs selected by the official coders were compared with the consensus UCODs determined by the panel. The two procedures agreed in 40 of the 72 deaths when three-digit ICD-9 codes were used, and in 47 when two-digit ICD-9 codes were used (data not shown). Table 1 shows the cross-tabulation of the UCODs determined with the two procedures, according to general category.

As shown in Table 2, high agreement was found between the two procedures for cancer and CVD deaths and moderate agreement for PD deaths [16, 17]. The official coders showed high specificity for cancer, CVD, and PD deaths, but relatively low sensitivity for CVD deaths compared to cancer and PD deaths. Almost one-fourth (4/17) of the CVD deaths coded by the panel were missed by the official coders.

As shown in Table 3, the two procedures did not yield significant differences in the risk factor analysis, except in the ORs for hypercholesterolemia (OR = 0.81 for official coders versus 1.64 for the physician panel).

**Discussion**

This study found good agreement among physicians in assigning the UCOD, but relatively low agreement between the official coders and the panel of physicians for CVD deaths. The two procedures yielded moderate differences in the risk factor analysis only in cholesterol level, but this difference was not statistically significant.

The inter-physician agreement rate in this study was good compared with those of previous reports [12, 13].

<table>
<thead>
<tr>
<th>Table 1. Cross-tabulation of underlying cause of death* selected by official coders and a panel of physicians</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Official coders</strong></td>
</tr>
<tr>
<td>Cancer (CA)</td>
</tr>
<tr>
<td>Cardiovascular diseases (CVD)</td>
</tr>
<tr>
<td>Pulmonary diseases (PD)</td>
</tr>
<tr>
<td>Others</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

A hospital-based study found that studies in Taiwan showed poor quality in death certification recorded on the death certificate. In this situation, the disagreement between the coders and the physician panel, rather than inconsistency in disease classification between the two procedures. That is, some were 'basically the same' and differed only in the level of causal chains; for example, the death certificate might have listed mitral valve regurgitation while the panel listed mitral valve regurgitation due to rheumatic heart disease. Some discrepancies were due to 'incomplete and poor certification'; for example, some listed only cardiopulmonary failure or septic shock. Five of these were issued by physicians at a university medical center, and the medical records of these five cases revealed that a more specific cause of death could have been provided. This is an important reason why using a panel of physicians to review the medical records would provide more accurate UCODs than using only the information from death certificates.

One limitation of this study was that in almost one-third (32/104) of cases, the panel concluded that the information in the medical records was insufficient to assign a UCOD. Because of limited resources, we did not trace the medical information regarding these veterans. Fourteen of the 32 death certificates with inadequate information were issued by physicians in the Ban-Chow Veterans Home, meaning that these veterans died in the Veterans Home. Although the medical records of these veterans were available to the panel, the progress notes were poorly recorded in the medical charts. Previous studies were all multi-centered, hospital-based investigations that recruited patients in hospitals and had a standardized form for recording medical information on charts [11–13].

As shown in Table 2, the official coders had relatively low sensitivity (0.76) for assigning CVD deaths. Four of the 17 CVD deaths identified by the panel were classified differently by the coders. In one case, the discrepancy arose from a difference in the interpretation of the causal sequence between the official coders and the panel. For the other three deaths, information regarding the CVD was not entered on the death certificates.

As Moriyama suggests, in comparing the agreement between these two procedures we should take into account the different levels of agreement and the reasons for discrepancies [18]. For deaths in which the two procedures differed in their three-digit ICD codes, some were ‘basically the same’ and differed only in the level of causal chains; for example, the death certificate might have listed mitral valve regurgitation while the panel listed mitral valve regurgitation due to rheumatic heart disease. Some discrepancies were due to ‘incomplete and poor certification’; for example, the death certificate may have listed septic shock without stating that it was due to infection of diabetic foot ulcer. Some were ‘real differences’ in assigning the UCOD between the coders and the physician panel.

Most previous studies did not find significant differences between the two procedures in the factor analysis.

### Table 2. Agreement in assigning underlying cause of death between official coders and a panel of physicians for 72 deaths

<table>
<thead>
<tr>
<th>Underlying cause of death*</th>
<th>Kappa</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer</td>
<td>0.83</td>
<td>0.86</td>
<td>0.96</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>0.73</td>
<td>0.76</td>
<td>0.95</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>0.60</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>Other</td>
<td>0.58</td>
<td>0.70</td>
<td>0.90</td>
</tr>
</tbody>
</table>


### Table 3. Estimated odds ratio (OR) and 95% confidence interval (CI) of cardiovascular disease (CVD) death, by risk factor, for underlying cause of death assessed according to official coders and a panel of physicians

<table>
<thead>
<tr>
<th>Risk factor*</th>
<th>Official coders</th>
<th>Panel of physicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum cholesterol</td>
<td>0.81 0.10–6.25</td>
<td>1.64 0.36–7.38</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>0.99 0.89–1.11</td>
<td>1.00 0.92–1.08</td>
</tr>
<tr>
<td>Serum glucose</td>
<td>2.98 0.92–9.66</td>
<td>2.70 0.85–8.64</td>
</tr>
<tr>
<td>Body mass index</td>
<td>0.73 0.24–2.26</td>
<td>0.83 0.27–2.48</td>
</tr>
</tbody>
</table>

*Serum total cholesterol: ≥ 240 vs < 240 mg/dL; systolic blood pressure/diastolic blood pressure: ≥ 140/90 vs < 140/90 mm Hg; serum glucose: ≥ 126 vs < 126 mg/dL; body mass index: ≥ 22 vs < 22.

Nevertheless, the inter-procedure agreement rate, based on three-digit ICD codes, was worse in this study (56%) than in earlier studies, which yielded rates of 71% [11], 60% [12], and 72% [13]. The kappa values for cause of death categories in Davis et al’s study were better than in ours [12]: 0.93 versus 0.83 for neoplasm, 0.71 versus 0.60 for cardiovascular diseases, and 0.68 versus 0.58 for other diseases.

One possible explanation as to why this study showed lower inter-procedure agreement than reported in previous studies is that the certifiers did not adequately translate the information recorded in medical charts to death certificates. In this situation, the disagreements may have been largely due to differences in the quality and extent of information available to the coders and panel, rather than inconsistency in disease classification between the two procedures. That is, while the panel had access to the medical records of the deceased, the coders generally used only the information recorded on the death certificate.

The quality of information provided in death certificates is crucial to the validity of coding. Previous studies in Taiwan showed poor quality in death certification by physicians. A hospital-based study found that only 56.5% of death certificates were completed correctly [6], while a national sample study found that only 61% of death certificates were completed correctly [8]. In the present study, in 22 of 104 death certificates, the cause of death statements were ‘non-specific or ill-defined’; for example, some listed only cardiopulmonary failure or septic shock. Five of these were issued by physicians at a university medical center, and the medical records of these five cases revealed that a more specific cause of death could have been provided. This is an important reason why using a panel of physicians to review the medical records would provide more accurate UCODs than using only the information from death certificates.
Two Procedures for Determining Cause of Death

[12, 13]. In the present study, the two procedures showed moderate differences in ORs of serum cholesterol level for CVD death (OR = 0.81 for official coders versus 1.64 for the physician panel). Because some participating veterans refused to have blood drawn, only a small number of cases had serum risk factor data. As shown in Table 3, a wide 95% CI for serum cholesterol and glucose was found compared with the relatively narrow 95% CI for blood pressure and BMI data.

Given the high inter-physician consistency and the relatively low inter-procedure sensitivity in assigning CVD deaths, and the fact that more specific information was provided to the panel of physicians, we conclude that the use of clinical review panels as opposed to official coding results for UCOD assessment in clinical trials and mortality follow-up studies in Taiwan would greatly improve the accuracy of findings. Greater effort should be expended to ensure that all pertinent medical data for the deceased are collected. Although such efforts would increase cost, the poor quality of the current death certification process in Taiwan warrants efforts to improve the accuracy of UCOD assignment. Educating physicians to correctly write death certificates and coders querying the certifier for more specific information are two important measures to improve the quality of information provided on the death certificate.

References