

Paper 184-2011

## Search Phrases with Arrays and Macros: Public Health Death Surveillance

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### ABSTRACT

In recent years, real-time surveillance of data has become an important feature in public health preparedness and response. Surveillance systems for emergency room visits, over-the-counter drugs, and 911 calls have all been developed to detect potential acts of terrorism as well as every day outbreaks. Causes of death from death certificates provide important indicators of the health of a community. A typical death certificate will have the causes of death reported by physicians, entered by public health staff, and then coded to International Classification of Disease standards. The turnaround from the date of death to the date of coding can be weeks to months later. For real-time cause of death surveillance, the phrases written in the causes of death need to be analyzed. This paper provides a method that has been used by Maricopa County Department of Public Health for several years using SAS® macros and arrays to conduct real-time surveillance of death certificates.

### INTRODUCTION

The Maricopa County Department of Public Health (MCDPH) Office of Epidemiology is responsible for conducting surveillance of communicable diseases. Surveillance in public health is the monitoring of the spread of disease to reduce and eliminate morbidity and mortality within a community. To accomplish this task, MCDPH collects and analyzes data from multiple sources. This includes disease reports from medical providers (doctors, nurses, and infection preventionists), laboratory reports from laboratories, hospital discharge data from local hospitals, and death certificates from vital records registration. MCDPH staff that includes epidemiologists, nurses, communicable disease investigators, and administrative assistants, compile and analyze the data to determine both the overall health of the community as well as to identify any events that may be suggestive of a public health emergency, such as a large outbreak or terrorist event. .

In the event of a large public health emergency, one indicator may be a sudden increase of people dying from a common cause. Maricopa County is a large populous county with an estimated population of four million people. About 100 deaths per business day are recorded. MCDPH originally reviewed each death certificate by hand to identify deaths of public health interest and to determine the number of deaths occurring in a week due to a specific cause of death such as pneumonia and influenza. Reviewing every death certificate by hand was a time consuming and tedious task that was subject to error. This paper provides two methods that MCDPH now uses to conduct death surveillance using SAS. The first method involves arrays while the second method involves macros. Both methods have been used by MCDPH for over 6 years.

### THE DEATH CERTIFICATE PROCESS

As stated, about 100 new death certificates are entered into the death database each business day by funeral homes, vital statistic staff, and medical examiners within Maricopa County. Within 72 hours of a death, the medical certifier submits the cause of death (COD) to vital statistic staff for data entry. Under the current death certificate standards defined by the National Center for Health Statistics (NCHS), the cause of death is written in up to 5 fields: COD A, COD B, COD C, COD D ,and Part II. Each COD A-D shows a progression of disease, with COD A being the immediate cause of death and the last COD being the underlying cause of death. The underlying cause of death is typically the cause of death reported in health statistic reports on death within a community. Part II contains information on other significant conditions that contributed to the cause of death. Contributing causes of death are conditions that may have caused the individual to die earlier than an individual who did not have the contributing cause of death. An example of a contributing cause of death may be diabetes. Diabetics have a greater risk of serious illness with many infectious diseases like influenza. An individual with diabetes may die from influenza while that same individual may have lived if they did not have diabetes. Below is an example of physician submitted cause of death (NCHS, 2003).

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CAUSE OF DEATH (See instructions and examples)		Approximate interval: Onset to death
32. PART I. Enter the <u>chain of events</u> —diseases, injuries, or complications—that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.		
IMMEDIATE CAUSE (Final disease or condition resulting in death)	a. <u>Acute renal failure</u> <small>Due to (or as a consequence of):</small>	<u>5 days</u>
Sequentially list conditions, if any, leading to the cause listed on line a. Enter the UNDERLYING CAUSE (disease or injury that initiated the events resulting in death) LAST	b. <u>Hyperosmolar nonketotic coma</u> <small>Due to (or as a consequence of):</small>	<u>8 weeks</u>
	c. <u>Diabetes mellitus, noninsulin dependent</u> <small>Due to (or as a consequence of):</small>	<u>15 years</u>
	d. _____ <small>Due to (or as a consequence of):</small>	_____
PART II. Enter <u>other significant conditions contributing to death</u> but not resulting in the underlying cause given in PART I.		

**Figure 1. Example of the Cause of Death Section of a Death Certificate**

In the above example, the cause of death is entered in the fields for COD A, COD B, and COD C. The fields for COD D and Part II are not used. The medical certifier is required to write a cause of death in COD A, but does not need to write anything in the remaining fields if it is not warranted.

After the receipt of the cause of death, the death certificate is registered within a few days. After registration, the cause of death is submitted for coding using the International Classification of Diseases Revision 10 (ICD-10) (World Health Organization). The ICD-10 codes are commonly used to produce health statistics for the medical and public health communities. However, the time from the date of death to the return of the ICD-10 code may be several weeks. This lag time is too long for meaningful surveillance, i.e., the disease or condition could be well dispersed by the time the data were available. Therefore, MCDPH analyzes the phrases written in the cause of death as a surrogate for the ICD-10 codes to do as near real-time surveillance as possible.

## DEATH SURVEILLANCE

When MCDPH conducts death surveillance, there are two goals. The first goal is to identify any deaths where the COD is due to a disease of public health interest (for example, botulism). When a cause of interest is identified, a case investigation is initiated. This goal supplements traditional surveillance (often referred to as passive surveillance) which relies on the reporting of both disease cases and deaths by medical providers and laboratories. The second goal is to determine the number of deaths due to a particular COD of public health interest over a period of time (for example, the number of pneumonia and influenza cases within a week). The second goal allows the tracking of disease trends in the community over time. Knowing the total number of deaths due to pneumonia and influenza during a defined timeframe helps with the identification of the severity of the influenza season (along with other sources of information such as the total cases, total visits to clinics or emergency rooms, and school absences etc). MCDPH meets the two goals by using two different methods to analyze the COD data: arrays and macros.

Both methods begin with a list of phrases. MCDPH staff selects diseases of public health interest when entered as a cause of death. From the list of diseases, phrases are selected to best identify death certificates where the cause of death was entered taking into account common spelling errors. Another list of phrases are identified to eliminate causes of death that may have been found in the inclusion criteria but did not actually have a cause of death of public health interest. For example, influenza is a cause of death of public health interest. However, some physicians may write Flu instead of Influenza. Therefore, the search phrase to identify influenza deaths may be 'Flu'. There are several other potential causes of death that may have the phrase 'flu' but are not the influenza of interest. For example, exclusion criteria may include the phrase 'para' to exclude death certificates where the cause of death is parainfluenza.

The array method uses an array to identify death certificates with a cause of death of public health interest. The array creates a dataset of death certificates that meet the inclusion criteria (described above) for further review by MCDPH staff. The example discussed will be the goal of identifying deaths of public health significance.

The macro method uses macros to create a new variable in the existing dataset that can be used for tallying the number of deaths due to a particular cause of death. The tallies are then counted and shown in a report that is easily shared with other public health partners. The example discussed will be identifying the total number of death occurring in the community during a time period.

## SURVEILLANCE OF UNREPORTED INFECTIOUS DISEASE DEATHS: ARRAYS

Arrays are temporary processes to perform repetitive calculations to a group of variables within a data step (SAS,

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2007). Arrays are useful when conducting death surveillance because a cause of death may appear in any one of up to five variables and the array allows for searching all five variables without specifying the search phrase five times. The array also allows for multiple statements so that many potential causes of death may be searched without specifying additional arrays.

The array statement used for death surveillance contains the same elements as found in any array statement. In this case, the array name is "cod," the number of array elements being searched is five, and the array elements are the dataset variables that contain cause of death information (COD\_A thru CDC\_II).

```
array cod(5) COD_A COD_B COD_C COD_D CDC_II;
```

After the array statement, a DO Loop is used to process each array element. The DO Loop contains an index variable (j) and the number of times the array must be executed for each dataset observation (5) and concludes with an end statement. Within the DO Loop are find functions that search for words or phrases that may indicate a cause of death of public health interest. As each function is processed within the DO Loop, if a search phrase is found, the location of the found search phrase is stored in memory during SAS processing. Because the location is a numeric value, the SAS function has a value greater than 0. The dataset is then limited to those death certificates that have a value greater than 0. In other words, the dataset contains only those death certificates that have a COD of public health interest.

```
do j=1 to 5;
  if (find(cod(j), 'ANTHRAX')>0) or
    (find(cod(j), 'BOTULISM')>0) or
    (find(cod(j), 'CHOLERA')>0) or
    (find(cod(j), 'DIPHTHERIA')>0) or
    (find(cod(j), 'ENCEPH')>0) or
    (find(cod(j), 'FEVER')>0) or
    (find(cod(j), 'FLU')>0) or
    (find(cod(j), 'INFLUENZA')>0) or
    (find(cod(j), 'LISTER')>0) or
    (find(cod(j), 'MEASLES')>0) or
    (find(cod(j), 'MENIN')>0) or
    (find(cod(j), 'PLAGUE')>0) or
    (find(cod(j), 'RABIES')>0) or
    (find(cod(j), 'SARS')>0) or
    (find(cod(j), 'TYPHO')>0) or
    (find(cod(j), 'VACCINIA')>0) or
    (find(cod(j), 'VRSA')>0) or
    (find(cod(j), 'WEST')>0) or
    (find(cod(j), 'WHOOOP')>0) or
    (find(cod(j), 'PERTUS')>0) or
    (find(cod(j), 'YERSIN')>0)
  then output; end;
```

The SAS array allows for the introduction of new search phrases when needed. For example, during the 2009 Influenza Pandemic, the phrases "H1N1" and "Swine" were added to identify death certificates of decedents who died of novel H1N1 influenza.

MCDPH staff runs the SAS program daily to quickly identify any new deaths.

## RESULTS FOR THE SURVEILLANCE OF UNREPORTED INFECTIOUS DISEASE DEATHS

When using arrays for death surveillance, MCDPH creates a dataset that contains only death certificates with a COD that may be of public health interest. The newly created dataset is then transposed using Proc Transpose and output to a file using macros and Proc Print that reports one death per page. This allows an easy review of each death certificate to identify those that may require further public health investigation.

The Proc Transpose procedure flips the dataset so that the columns become rows and the rows become columns. SAS automatically assigns variable names for the new columns. The first variable name is \_NAME\_ and is the name of the former variable. If the former variable had a label, the next column's variable name is \_LABEL\_. All of the remaining column names are COLx where x refers to the numeric value of the column. Each new column contains the information from each of the old rows. COL1 contains the decedent information for the first row in the dataset created in the array code.

After the dataset is transposed, the results are output using Proc Print. A series of macros are used to create a

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unique page for each observation.

The first macro identifies the number of decedents in the transposed dataset (nvars). In the SAS code below, the macro obsnvars has resolved to the transposed dataset.

```
%macro obsnvars(ds);
  %global dset nvars noobs;
  %let dset=&ds;
  %let dsid = %sysfunc(open(&dset));
  %if &dsid %then
    %do;
      %let nvars=%sysfunc(attrn(&dsid,nvars));
    %end;
  %else
    %put open for data set &dset failed
      - %sysfunc(sysmsg());
  %mend obsnvars;
```

By knowing the number of decedents in the dataset (nvars), the next macro will know how many times it needs to go through a DO LOOP to print the correct number of unique pages.

```
%macro print2;
  ods escapechar='#';
  options nodate nonumber;
  title 'Query for Potentially Interesting Causes of Death';
  %do j=3 %to &nvars+1;
  proc print data=results noobs label;
    var _NAME_ &&col&j;
    label _NAME_='Variables' &&COL&j='Data';
  run;
  %end;
%mend print2;
```

Each page is then reviewed by MCDPH staff to verify that the cause of death is of public health interest. If it is, then the additional information on the printout (such as the decedent's name, date of birth, and place of death) is used to begin a public health investigation of a communicable disease. Figure 2 shows an example of the output. The cause of death circled in red highlights the specific cause of death that resulted in the death certificate being included in the output. In this example, the words 'Enceph' and 'West' in West Nile Virus Encephalitis were identified in the array. The decedent's name, as well as other demographic information, has been deleted for confidentiality.

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Variables	Data
DEATH_COUNTY_NAME	Maricopa
DEATH_CITY_NAME	
DECEDENT_FIRST_NAME	
DECEDENT_MIDDLE_NAME	
DECEDENT_LAST_NAME	
DECEDENT_AGE_UNITS	
DECEDENT_AGE_MEASURE	YEARS
BIRTH_YEAR	
BIRTH_MONTH	
BIRTH_DAY	
RESIDENCE_ADDRESS	
RESIDENCE_CITY_NAME	
RESIDENCE_ZIP	
DEATH_BOOK_YEAR	2010
DEATH_MONTH	
DEATH_DAY	
CERTIFIER_NAME	
CERTIFIER_ADDRESS	
CERTIFIER_CITY	
CERTIFIER_ZIP	
COD_A	PNEUMONIA UNKNOWN ORGANISM
COD_B	VENTILATOR DEPENDENT RESPIRATORY FAILURE
COD_C	WEST NILE VIRUS ENCEPHALITIS
COD_D	
CDC_II	
INDUSTRY_DESCRIPTION	
OCCUPATION_DESCRIPTION	
DEATH_DATE	
FACILITY	
DECEDENT_GENDER	Female
HISPANIC_ORIGIN	
RACE	

Output 1. Array-based Death Surveillance Output

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## SURVEILLANCE OF TOTAL DEATHS: MACROS

SAS Macros are useful functions that allow for the automation and customization of SAS code using minimal text (SAS, 2008). For our purpose, the SAS macro permits the repeated search of multiple variables with different search terms in a large dataset. Each of the search terms are used to include or exclude death certificates that may be of public health interest.

When using macros for death surveillance, MCDPH creates a dataset that allowing easy reporting of counts of deaths due to a particular cause of death. This method is frequently used to report counts to other public health partners. For example, pneumonia and influenza deaths are reported weekly to the Centers for Disease Control and Prevention (CDC), the national public health organization.. The report shows the total number of deaths and the number of pneumonia and influenza-related deaths stratified by age group for the city of Phoenix.

Death surveillance for influenza-related deaths begins with the creation of a new variable called Flu.

```
Flu=0;
```

The next statement defines the macro (INFLU), and assigns parameter names for the macro (var and var1). During the macro call, the parameter names will be used to define the search phrases and to create the unique variable for each search phrase.

```
%macro Influ(var,var1);
```

The next statement contains the SAS statement that needs to be run in the macro. For death surveillance, the Index function is used to identify all death certificates that contain any of the search phrases of public health interest in any of the five COD variables. Each index function has the target (one of the five COD variables) and a value (&var). The value of &var is the search phrase that will be defined in the macro call (e.g., "INFLUENZA").

```
If index(upcase(cod_a),&var.)>0 or index(upcase(cod_b),&var.)>0 or
   index(upcase(cod_c),&var.)>0 or index(upcase(cod_d),&var.)>0 or
   index(upcase(cdc_ii),&var.)>0 Then exc_&var1.=1;
```

The index function is used in an if-then statement to allow the creation of a unique new variable for each search phrase. The new variables are named exc\_&var1, where var1 is defined in the macro call.

The macro call follows the SAS statement, calling the macro Influ. The macro Influ has parameter values that are the search phrase (var; INFLUENZA, HAEMO, HEMO, PARA, H1N1) and the unique variable name ending (var1; aa, bb, cc, dd, ee). The new variable names will be exc\_aa, exc\_bb, exc\_cc, exc\_dd, exc\_ee. Each record will contain these variables with values of 0 or 1.

```
%mend Influ;
%Influ('INFLUENZA',aa);
%Influ('HAEMO',bb);
%Influ('HEMO',cc);
%Influ('PARA',dd);
%Influ('H1N1',ee);
```

The original SAS program used the search phrases 'Influenza' 'Haemo' 'Hemo' 'and 'Para'. In 2009, new search phrases were added to the macro to identify deaths caused by the 2009 H1N1 Influenza. A review of death certificates of known deaths related to the 2009 H1N1 Influenza identified a list of search phrases to test and if necessary, add to the SAS program macro. Although death certificates had causes of death using the phrases 'Swine' and 'Pandemic', it was determined to be unnecessary to add them to the search phrases because other search phrases such as "influenza" and "H1N1" would also identify these causes of death. Therefore, only the search phrase 'H1N1' was added to the list.

Each search phrase is given a value of 1 if found based on the Index function code. The remaining SAS code determines whether or not the death certificate is a true influenza-related death based on whether the search phrase identified was used as an inclusion or exclusion search phrase. Based on the SAS code, a death certificate with a cause of death of 'H1N1 Influenza' is identified as an influenza-related death while a death certificate with a cause of death of 'Parainfluenza' or 'Haemophilus influenza' would not. Although the word influenza occurs in these causes of death, they are not influenza related deaths.

```
If exc_aa=1 Then Flu=1;
If exc_ee=1 Then Flu=1;
```

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```
If exc_bb=1 Then Flu=0;
If exc_cc=1 Then Flu=0;
If exc_dd=1 Then Flu=0;
```

Death surveillance of pneumonia-related deaths uses the same concept as the influenza-related death surveillance. The macro looks for any deaths that mention pneumonia in the cause of death. Exclusion phrase include 'aspir', and 'apnea'. These search phrases exclude deaths caused by non-infectious pneumonia.

```
Pneu=0;
%macro Pneumonia(var,var1);
  If index(upcase(cod_a),&var.)>0 or index(upcase(cod_b),&var.)>0 or
    index(upcase(cod_c),&var.)>0 or index(upcase(cod_d),&var.)>0 or
    index(upcase(cdc_ii),&var.)>0 Then pne_&var1.=1;
%mend Pneumonia;
  %Pneumonia('PNEUMONIA',aa);
  %Pneumonia('APNEA',bb);
  %Pneumonia('ASPIR',cc);
  %Pneumonia('INFLUENZA',dd);
  %Pneumonia('H1N1',ff);
If pne_aa=1 Then Pneu=1;
if pne_bb=1 Then Pneu=0;
if pne_cc=1 Then Pneu=0;
if pne_dd=1 Then Pneu=0;
if pne_ff=1 Then Pneu=0;
```

## RESULTS FOR THE SURVEILLANCE OF TOTAL DEATHS

The results of the macro processes are reported using Proc Tabulate procedure. Proc Tabulate produces summary reports that contain statistics in a tabular structure (SAS, 2008). Proc Tabulate allows the user to customize the table by displaying variables already in the dataset as well as displaying variables created in the Proc Tabulate statements. For this report, Proc Tabulate produces a report that shows the total number of deaths occurring in the community by all causes, pneumonia, influenza, and the total pneumonia and influenza by age group. Below is the SAS code used to produce the summary report.

```
Proc Tabulate Data=PNI Missing;
By Location_occ;
Where (CompleteDate ge '18OCT2009'd and CompleteDate le '24OCT2009'd);
Class AgeGroup/ preloadfmt style={font_size=1.9 background=white};
Classlev AgeGroup/ style={font_size=1.9 background=white};
Var Record Pneu Flu PNI/style={font_size=1.9 font_weight=bold
background=cx66cc33};
Table AgeGroup=' ' all={label='TOTAL'
style={background=white font_size=2.0 font_weight=bold}},
Record='Total Deaths'*n=' '*f=comma8. * {style={font_size=1.7}}
Pneu='Pneumonia Deaths'*sum=' '*f=comma8. *
{style={font_size=1.7}}
Flu='Influenza Deaths'*sum=' '*f=comma8. * {style={font_size=1.7}}
PNI='Total P & I Deaths'*sum=' '*f=comma8. *
{style={font_size=1.7}}
/ printmiss box={label='Age Group' style={font_size=1.7
vjust=bottom background=cx66cc33}}
misstext='0' row=float ;
Options nodate Missing=' '; Run;
```

Proc Tabulate requires a Table statement as well as either a Class statement or Var statement. The first of these statements in the SAS code is the Class statement. The Class statement is the statement that specifies how to group the data. For death surveillance, MCDPH groups the data by age group. The next statement is the Var statement which defines which variables to include in the analysis. The variables shown in this Var statement display the total deaths (Record), the Total Pneumonia deaths (Pneu), the Total Influenza deaths (Flu), and the Total Pneumonia and Influenza deaths (PNI). The final statement is the required Table statement. The Table statement specifies how the table structure will look like when printed. This includes the labels and any statistics needed for the variables.

Sometimes there may not be deaths for a particular age group. When this occurs, the age group will not appear in the summary report. To ensure that all age groups appear, the Printmiss option is used in the Table statement. It forces that age group to appear in the summary report with that age group showing all zeros.

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The report typically shows all new deaths in Phoenix for a week (Sunday-Saturday) when it is sent to the CDC. Output 2 shows an example of the weekly report for deaths occurring in the city of Phoenix and the rest of Maricopa County during the peak of the pandemic. During that week, there were four influenza and 10 pneumonia-related deaths in the city of Phoenix and two influenza and 18 pneumonia-related deaths in the rest of Maricopa County for a total of 34 pneumonia and influenza-related deaths.

Location_occ=City of Phoenix					Location_occ=Maricopa County LESS City of Phoenix				
Age Group	Total Deaths	Pneumonia Deaths	Influenza Deaths	Total P & I Deaths	Age Group	Total Deaths	Pneumonia Deaths	Influenza Deaths	Total P & I Deaths
Under 28 Days	5	0	0	0	Under 28 Days	3	0	0	0
28 days to 1 Yr.	1	0	0	0	28 days to 1 Yr.	1	0	0	0
1 - 14 Years	2	0	1	1	1 - 14 Years	1	0	0	0
15 - 24 Years	3	0	0	0	15 - 24 Years	3	0	1	1
25 - 44 Years	18	0	1	1	25 - 44 Years	12	0	0	0
45 - 64 Years	37	2	0	2	45 - 64 Years	69	5	1	6
65 - 74 Years	29	2	1	3	65 - 74 Years	65	7	0	7
75 - 84 Years	32	5	0	5	75 - 84 Years	101	2	0	2
85+ Years	28	1	1	2	85+ Years	107	4	0	4
Unknown	1	0	0	0	Unknown	2	0	0	0
<b>TOTAL</b>	<b>156</b>	<b>10</b>	<b>4</b>	<b>14</b>	<b>TOTAL</b>	<b>364</b>	<b>18</b>	<b>2</b>	<b>20</b>

#### Output 2. Macro-Based Death Surveillance Output

In addition to the tabulated results, all influenza deaths and all pneumonia deaths to individuals under the age of 65 years are output in a line list. The list includes the name of the individual, the date of birth, date of death, cause of death, location of death, and the certifier. This line list helps MCDPH staff begin an investigation or, if the case is known, it helps in identifying any missing information for that case.

#### LIMITATIONS: DOUBLE COUNTING DEATHS

The last line of SAS code creates an additional variable that sums the total number of deaths related to both influenza and pneumonia. At one point during the 2009 H1N1 influenza pandemic, MCDPH staff noticed that the value in the column 'Total P&I Deaths' was less than the sum of the 'Pneumonia Deaths' and 'Influenza Deaths' columns. This inconsistency suggested that some cases were being counted twice.

It was easy to identify the double counted deaths because the SAS program contained variables identifying both influenza and pneumonia deaths. A review of these double counted deaths revealed that certifiers were writing the cause of death as 'H1N1 Pneumonia'. The pneumonia macro was adjusted to exclude any death certificates that had the search phrase 'H1N1' from the pneumonia count.

#### CONCLUSION

The enhanced death surveillance described here has been conducted for many years at MCDPH and was automated with SAS programs approximately 6 years ago. It has helped in the identification of individuals who died of diseases of public health interest that may have been missed using other methods of surveillance. This automation has allowed MCDPH to easily adapt to new causes of death and new public health emergencies. During the H1N1 2009 Influenza, death surveillance was able to quickly identify several deaths that may have been missed using traditional surveillance methods alone. This was critical in the early stages of the pandemic when public health officials were trying to determine the severity of the disease.

Due to already having a SAS-based death surveillance implemented before the H1N1 influenza, it was easy to adapt the SAS programs quickly to meet the demands of our public health partners. For example, CDC requested daily reporting of the deaths similar to the weekly report that is sent currently. It was simple to comply with the request by making minor adjustments to the existing SAS program.

The major limitation of this specific type of death surveillance is that deaths due to an infectious agent may not always appear on the death certificate. During the pandemic, there were several death certificates that did not

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mention influenza but were known by public health to be influenza-related. One reason for a death certificate not to mention influenza is that the individual died before the test result for influenza was known or the certifier was unaware of a prior illness. Fortunately, MCDPH has an additional method of death surveillance that compares the names on the death certificates to the names in the communicable disease database in order to catch the situation described.

Although this paper focused on death surveillance, the methods described can be modified for other types of surveillance such as hospital discharge or medical billing before the data is coded to ICD codes.

## REFERENCES

NCHS. (2003). *Physicians' Handbook on Medical Certification of Death*. Hyattsville, Maryland: DHHS Publication No. (PHS) 2003-1108.

SAS. (2008). *SAS Macro Language 1: Essentials*. Cary, NC: SAS.

SAS. (2007). *SAS Programming II: Manipulating Data with the Date Step*. Cary, NC: SAS.

SAS. (2008). *SAS Report Writing 1: Using Procedures and ODS*. Cary, NC: SAS.

World Health Organization. (n.d.). *International Classification of Diseases (ICD)*. Retrieved January 2011, from <http://www.who.int/classifications/icd/en/>

## ACKNOWLEDGMENTS

We would like to thank our colleagues, both past and present, at Maricopa County Department of Health who have helped in the development of death surveillance by either writing SAS code or conducting death surveillance. We would especially like to thank Mare Schumacher, Vjollca Berisha, Karen Moffitt, Andrew Edmonds, Philip Zuckerman, Sarah Santana, and Rechelle Moore.

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