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SPINAL CORD INJURY

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Inside This Issue

Spinal Cord Injury (SCI) is one of the most debilitating types of trauma. Disability, loss of productivity, extreme use of medical resources, and untold human suffering routinely accompany these injuries. In order to assess the need for services for people with SCI, estimate the impact on the medical system, and focus prevention efforts a Kentucky-specific understanding of the epidemiology of SCI is needed. Beginning in 1999 the Kentucky Acquired Brain Injury Trust Fund Advisory Board contracted with the University of Kentucky, Kentucky Injury Prevention and Research Center, to conduct statewide surveillance of acquired brain injury, traumatic brain injury, and spinal cord injury. The SCI data presented in this report are part of the larger surveillance effort.

OBJECTIVES, DEFINITIONS, AND METHODOLOGY

This report focuses on providing data for six specific questions about SCI in Kentucky during 1998:

1. How many Kentuckians sustained fatal or serious (hospitalization required) SCI in 1998, and what was the statewide rate?
2. What were the demographic and geographic distributions of these cases?
3. What were the causes of SCI?
4. What was the extent of hospitalization?
5. What was the hospital discharge status?
6. How many cases were work-related and who were the primary payers?

A SCI was included in the surveillance if it met the standard criteria established by the Centers for Disease Control and Prevention (CDC). CDC defines SCI by the following International Classification of Diseases, Ninth Revision (ICD-9)[1] diagnostic codes:

806.0-806.9	fracture of vertebral column with spinal cord injury and
952.0-952.9	spinal cord injury without evidence of spinal bone injury.

Cases of SCI that occurred during 1998 were ascertained from three electronic data sets. These three data sets were computer linked, using a probabilistic data linking algorithm to identify as many cases as possible. The three data sets are:

- National Center for Health Statistics (NCHS), Kentucky Supplemental Death File,
- Kentucky Hospital Discharge Data, or HDD (Uniform Billing-1992 [UB-92], inpatient only), and
- Level-I trauma data from the University of Kentucky Hospital, and University of Louisville Hospital, including the Tennessee Trauma Registry for Kentucky residents seeking care at Tennessee trauma centers.

Data linkage assures there are no duplicate cases and an optimal amount of data is available for each case. In other words, by combining hospital, death, and trauma records, the same case is not counted multiple times, and information missing from one data set can often be found in the others.

To match records from different data sets, date of birth, date of death, date of discharge, gender, age, race, county of residence, zip code of residence, and county of injury were all considered as linkage variables. Personal identifiers such as social security number, street address, and phone number are never used for linkage, nor acquired by the project, ensuring confidentiality.

In addition to computer data linking, a medical records abstractor visited the 25 hospitals to review SCI records. Hospital discharge records were chosen for abstraction if they did not link to either of the other data sets. The medical records abstractor collected external cause of injury codes (E-codes) and other data elements suggested by CDC *Guidelines for the Surveillance of Central Nervous System Injuries*[2].

RESULTS

The surveillance system identified 162 new cases of SCI in 1998, for an incidence rate of 4.1 per 100,000 Kentuckians. This incidence rate is very similar to what has been found in other studies[3,4]. Approximately 10,000 new spinal cord injuries (SCI) occur every year in the United States, about 4 cases per 100,000. Kentucky is very similar to the United

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States in the incidence rate of SCI.

Table 1 shows the distribution of SCI by age and gender. Males outnumber females by about 2 to 1, and most injuries occur within the 25-44 age range.

Table 1. Kentucky SCI by Age & Gender, 1998

	MALE			FEMALE			TOTAL	
AGE	**Non-Fatal**	**Fatal**	**Total**	**Non-Fatal**	**Fatal**	**Total**	**No.**	**%**
0-4	-	1	1	1	-	1	2	1.2%
5-14	3	2	5	2	1	3	8	4.9%
15-24	8	5	13	5	3	8	21	13%
25-44	39	6	45	10	7	17	62	38%
45-64	18	7	25	5	2	7	32	20%
65+	17	3	20	12	5	17	37	23%
Total	85	24	109	35	18	53	162	100%

<u>Geographic Distribution of SCI</u>

Jefferson and Fayette counties had the greatest number of SCI cases—23 and 10, respectively. These two counties accounted for over 20% of all cases. Perry County had 6 cases, and all other counties had 5 or fewer cases in 1998.

<u>Causes of SCI</u>

Causes of SCI were compiled using ICD-9 external cause of injury E-codes from all data sets and abstraction. Nearly 1 in 5 E-codes was unknown. Almost one-quarter of all cases were fatal. Table 2 shows the major causes of both fatal and non-fatal SCI. Motor vehicle traffic crashes account for less than one-third of all SCI, but over half of *fatal* SCI.

Table 2. Causes of Fatal & Non-Fatal SCI, 1998

E-CODED CAUSE	**NON-FATAL**	**FATAL**	**TOTAL**
Motor Vehicle Traffic Crashes (E810-E819)	26(22%)	22(52%)	48(30%)
Falls (E880-E888)	32(27%)	7(17%)	39(24%)
Motor Vehicle Non-Traffic Crashes (E820-E825)	13(11%)	2(4.8%)	15(9.3%)
Other Injuries (E916-E928)	8(6.7%)	1(2.4%)	9(5.6%)
Homicide & Assault (E960-E969)	2(1.7%)	3(7.1%)	5(3.1%)
Other	11(9.2%)	4(9.5%)	15(9.3%)
Unknown	28(23%	3(7.1%)	31(19%)
TOTAL	120(100%)	42(100%)	162(100%)

<u>Length of Stay for SCI</u>

Length of stay was calculated for every hospital discharge and trauma record that had both an admit date and discharge date (n=127). Table 3 shows the mean, median, and mode stays for 1998.

Table 3 Hospital stays for SCI, 1998

# Cases	**Mean**	**Median**	**Mode**	**Maxi-mum**	**Total**
127	11.9 days	6 days	0 and 1 days (bimodal)	126 days	1485 days

<u>Discharge Status for SCI</u>

Table 4 summarizes the discharge status for all SCI hospital discharge records (n = 99). The great majority of SCI cases were discharged once admitted to the hospital, and only very few left against medical advice or expired. Discharge status was unknown in four percent of records.

Table 4. Discharge status for SCI, 1998

Type of Discharge	**Number of Cases**	**%**
Discharged to home or self care	40	40%
Discharged/transfer to another type of institution for inpatient care or referred for outpatient services to another institution	24	24%
Discharged/transferred to skilled nursing facility (SNF)	9	9.1%
Discharged/transferred to home under care of organized home health services organization	9	9.1%
Discharged/transferred to another short term general hospital for inpatient care	9	9.1%
Expired	3	3.0%
Left against medical advice or discontinued care	1	1.0%
Other/Unknown	4	4.0%
Total	99	100%

<u>Primary Payers for SCI</u>

Primary payers are summarized for hospital discharge records only in Table 5. Four percent of records contained no information on the primary payer. Insurance companies were the leading primary payer (32% of cases), and Medicare and Medicaid together accounted for 39% of primary payers.

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Table 5. Primary payers for SCI hospital stays, 1998

Primary Payer	Non-Fatal	%	Fatal	%	Total	%
Insurance Company	30	33%	2	29%	32	32%
Medicare	21	2%	2	29%	23	23%
Medicaid	15	16%	1	14%	16	16%
Self Pay	7	8%	1	14%	8	8%
Blue Cross	7	8%	-	-	7	7%
Workers' Compensation	6	7%	-	-	6	6%
Other	2	2%	-	-	2	2%
CHAMPUS	1	1%	-	-	1	1%
Unknown	3	3%	1	14%	4	4%
Total	92	100%	7	100%	99	100%

Work-Related SCI

After linkage and abstraction were completed, 6 records, or 4% of all cases, were identified as work-related. All records listed the primary payer as workers' compensation, and there were no fatalities. All cases were males, and the average age was 42 years, with a range of 25 to 52 years.

DISCUSSION

Although the data presented here are very useful, there is much room for improvement. The cause of almost 1 in 5 SCI is still unknown, and the project is still missing valuable data for 1998 that may show an even greater incidence of SCI*. Also, in other studies violence has been estimated to be the cause of SCI in about 25% of cases[1]. This surveillance system found violence ("Homicide & Assault" in Table 2) caused only 3.1% of SCI. The nature of this discrepancy is unknown, but certainly warrants closer investigation. Data linkage improves the robustness of the data, as does abstraction. But proper data collection and medical records coding are essential to a successful surveillance system of any kind. The development of a SCI registry, where cases are identified and followed over time, would significantly contribute to our understanding of these issues and others

Finally, the results of this surveillance suggest prevention efforts would be best directed towards motor vehicle crashes. This cause accounted for injury in 39% of all SCI cases, and almost 57% of fatal SCI in 1998. Most motor vehicle injuries are traffic-related, but a significant portion of these are non-traffic, meaning the injuries probably involved motor vehicles, such as all terrain vehicles (ATV) and "dirt bikes", being used off-road in a recreational capacity.

FOR MORE INFORMATION

This report was based on the SCI section of the TBI/SCI Surveillance Project Final Report, prepared by W. Jay Christian, Project Manager, and funded by the TBI Trust Fund. Information on TBI and acquired brain injury (ABI) is also now available for 1998. For copies of this report, data requests, questions, or other correspondence, Mr. Christian can be reached at the addresses or phone numbers below.

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*Although it has already improved for 1999, hospital discharge data reporting in 1998 was poor, which could lead to an underestimation of incidence.

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1. Karaffa MC, ed. International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-M). Los Angeles: Practice Management Information Corporation, 1993.
2. Thurman DJ, Sniezek JE, Johnson D, Greenspan A, Smith SM. Guidelines for Surveillance of Central Nervous System Injury. Atlanta: Centers for Disease Control and Prevention, 1995.
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IMPLEMENTATION OF THE YEAR 2000 AGE-ADJUSTMENT STANDARD

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Introduction

Following recommendations made by the National Center for Health Statistics (NCHS), a new population standard based on the projected year 2000 U.S. standard population was implemented in the United States, effective with 1999 death data. Although there were no compelling technical reasons to change from the existing standard based on the 1940 population, it has been increasingly perceived in recent years to be outdated and incompatible with the current "older" age structure of the population. In Kentucky, the year 2000 standard will replace both the 1970 standard used in the *Kentucky Annual Vital Statistics Report* since 1985 and the 1940 standard used in *Kentucky County Health Profiles* since 1996. Implementation of this new, uniform standard by NCHS and all the states will reduce the current confusion caused by the use of multiple standards, but will result in changes affecting the interpretation and use of age-adjusted death rates (AARs). This article discusses the rationale for the change and implications of the most apparent difference, the increase in the magnitude of the rates.

Crude, age-specific, and age-adjusted death rates

The crude death rate (the number of deaths in a population divided by the population, and usually expressed per 100,000 population) is a widely used measure of mortality. As such, the crude rate represents the "true" risk of dying in a population. However, crude death rates are influenced by the age composition of the population, and therefore, comparisons of crude death rates over time or between groups may be misleading if the populations being compared differ in age composition. Age adjustment is one of the key tools used to control for the changing age distribution of the population, and thereby to make meaningful comparisons of rates over time and between groups.

The most informative method of making comparisons of mortality risk between groups is to examine differences in age-specific death rates (ASRs). The age-specific death rate is defined as the number of deaths occurring in a specified age group divided by the population of that age group, usually expressed per 100,000 population. Age-specific comparisons can be cumbersome, however, because they require a relatively large number of comparisons, one for each age group.

The age-adjusted death rate is a summary measure that controls for variation in age distribution between populations by the computation of a single number. The age-adjusted death rate is defined as the death rate that would occur if the observed age-specific death rates were present in a population with an age distribution equal to that of a standard population, and is typically computed by the method of "direct standardization." The AAR computed by the direct method is a weighted average of the age-specific death rates, where the weights represent proportions by age of a standard population. Mathematically, the AAR is the sum of the products of each ASR and its appropriate standard population proportion. It is important to note that the numerical value of an age-adjusted rate is relative and depends on the standard used and, therefore, is not meaningful by itself. It is appropriate only when comparing groups or examining trends across multiple time periods. A thorough explanation of age-adjusted death rates can be found on the NCHS web site at http://www.cdc.gov/nchs/data/sttnt6rv.pdf.

Effects of the change on the magnitude of the overall death rate

Changing to the year 2000 standard will result in age-adjusted rates higher than rates based on the previous standards. This difference in magnitude will be most apparent when comparing the new standard with the oldest standard, the 1940 population. This is because the age structures of the 1940 and 2000 populations differ. From 1940 to 2000, the U.S. population "aged" considerably. In 1940, over 59 percent of the population was under age 35, compared to only 49 percent in 2000.

Figure 1 compares the percents of the 1940 and 2000 standard populations by age group. The percent of the 1940 population exceeds the percent of the 2000 population in every age group from under 1 year up through 25-34 years. In contrast, the percent of the 2000 population exceeds the percent in 1940 in every age group from 35-44 through age 85 and over. In particular, the percent of the population in the oldest group, age 85 and over, in 2000 is over five times the percent in 1940. Because the standard populations serve as the weights for calculating age-adjusted rates, the differences in the age structure of the populations between 1940 and 2000 translate directly into a change in the weights used for age adjustment.

Figure 1. 1940 and 2000 U.S. Standard Populations: Percent of Total Population by Age Group

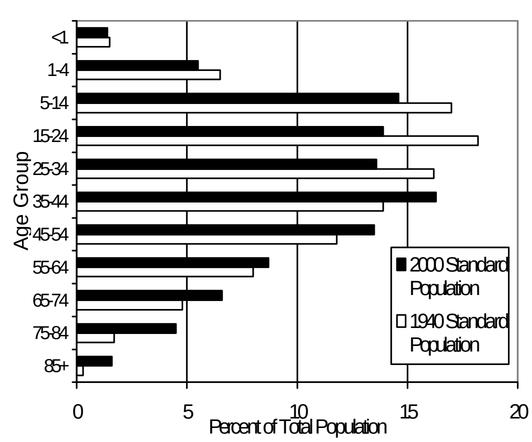


Table 1 compares the crude rate and age-adjusted rates computed by the 2000, 1970, and 1940 standard populations for Kentucky resident deaths due to all causes from 1990 through

IMPLEMENTATION OF THE YEAR 2000 AGE-ADJUSTMENT STANDARD (continued)

1999. These data demonstrate two prominent features of the year 2000 AAR: it is much greater in magnitude than either the 1940 or 1970 standard, and it is much closer in magnitude to the crude rate. The age-adjusted rate based on the year 2000 standard is greater in magnitude than that based on the 1940 standard primarily because the 2000 standard gives much greater weight to the older population groups in which mortality is higher. In addition, the year 2000 standard AAR is much closer to the crude rate because the year 2000 U.S. standard population has an age structure that more closely resembles the actual 1999 Kentucky population.

Table 1. All Causes of Death, Kentucky, 1990-1999 Crude and Age-Adjusted Rates

Year	Crude Rate	AAR/2000	AAR/1970	AAR/1940
1999	983.2	1003.2	741.9	535.5
1998	961.1	984.2	733.0	533.4
1997	966.8	996.5	743.4	541.1
1996	957.7	952.4	719.2	532.2
1995	960.7	967.2	729.5	539.8
1994	964.8	982.4	739.9	545.3
1993	969.7	997.7	752.6	555.2
1992	932.6	969.6	732.7	541.5
1991	948.7	1014.8	763.7	561.1
1990	948.9	1015.4	766.7	564.6

Figure 2 compares the same rates graphically and shows how much closer the year 2000 standard AAR is to the crude rate than the AARs based on the older standards were. This figure also demonstrates another feature of age-adjusted rates: the trend lines are roughly parallel, showing that the overall trend in the age-adjusted rate is similar regardless of the standard used. (Over the 10-year period, the 2000 standard AAR consistently exceeded the 1940 AAR within a range of 79-87 percent.) This indicates that the choice of standard actually makes relatively little difference in terms of the overall relative trend. Nevertheless, the fact remains that due to its similarity in magnitude to the crude rate, the year 2000 AAR will probably be less obscure to the average person than the seemingly unrelated AARs based on the previous standards.

Effects of the change on the rates of specific causes of death

Whereas changing to the year 2000 standard will have moderate effect on the magnitude of the overall death rate and little effect on its trend, its effect on the magnitudes and, in some cases, the trends of specific causes of death may be much greater. Figure 3 compares the five leading causes of death in Kentucky in 1999 in terms of the 1940 and 2000 standard age-adjusted rates. For those causes in which risk increases sharply with age, the change in magnitude will be most dramatic. The 2000 standard AAR for cerebrovascular disease (stroke) is almost two and one-half times the 1940 standard AAR (72.9 to 29.7 per 100,000), and the 2000 standard AAR for diseases of heart (319.8 per 100,000) is over twice the 1940 standard AAR (150.7 per 100,000). The differences in malignant neoplasms (cancer) and chronic lower respiratory diseases, as well as other diseases such as diabetes, nephritis (kidney disease), Alzheimer's disease, septicemia, and influenza and pneumonia will also be sizable, though less dramatic. Age-specific death rates for these causes of death are higher in the older age groups, and as a result, these causes are more affected by the larger weights of the year 2000 standard.

In contrast however, the 2000 standard AAR for unintentional injuries (43.4 per 100,000) will be only 21 percent greater than the 1940 standard AAR (36.0 per 100,000). For this and other causes where risk is more uniform among the age groups, the differences in rates based on the two standards will be much smaller. Mortality due to these causes, which include suicide, homicide, and HIV infection, is more concentrated in the younger and middle-age groups, and consequently is much less affected by the disparity in weights between the two populations. It is also worth noting, that if the five leading causes shown in Figure 3 were to be ranked by the 1940 standard AAR, unintentional injuries would be the third leading cause, rather than the fifth leading cause as it is ranked by both the crude and 2000 standard rates. This difference in ranking results from the fact that the 1940 standard was based on a much "younger" population than the 2000 population, and so the rate was not affected by the greater weights in the older age groups.

Figure 2. Age-adjusted rates based on the 1940, 1970 and 2000 standard populations, and crude rates: Kentucky, 1990-1999

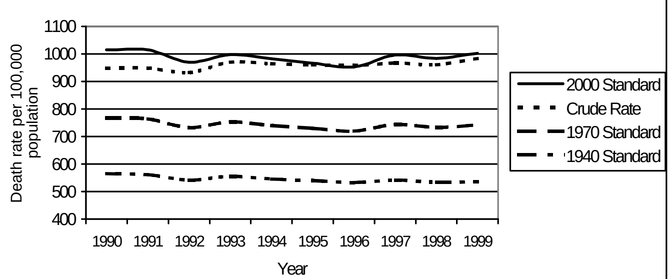
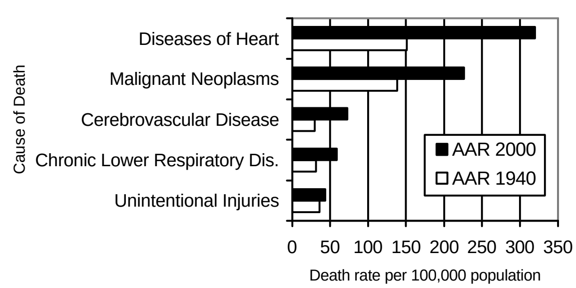


Figure 3. Leading Causes of Death: Kentucky, 1999 Age-Adjusted Rates: 1940 and 2000 Standards



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IMPLEMENTATION OF THE YEAR 2000 AGE-ADJUSTMENT STANDARD (continued)

Conclusions

Age-adjusted rates based on the year 2000 standard will often be substantially larger than rates based on previous standards. In addition, differences between the rates as well as differences in trends will be greatest for those causes of death where mortality is highest among the oldest age groups.

It cannot be over-emphasized that age-adjusted death rates based on different standards are not comparable for purposes of comparing relative risk or tracking trends in mortality. The change to the year 2000 standard will require recomputing age-adjusted rates for past years at both the national and state levels so that valid comparisons can be made. Both the National Center for Health Statistics and the Kentucky State Center for Health Statistics plan to release such figures later this year. Ultimately, the adoption of the 2000 standard should reduce confusion among data users by resulting in a rate more in line with the “true” risk of mortality within the current population, as well as a single standard to be used by all agencies for all causes of death.

Notes:
All Kentucky mortality data cited in this article are from the Kentucky death statistical files, Surveillance & Health Data Branch.

Reference: Anderson RN, Rosenberg HM. Age standardization of death rates: implementation of the year 2000 standard. National vital statistics reports; vol. 47 no. 3. National Center for Health Statistics, 1999. http://www.cdc.gov/nchs/data/nvsr47_3.pdf