METHODS OF ESTIMATING INCIDENCE OF BURN INJURIES

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I. INTRODUCTION

In recent years, the serious problem of burn injuries and deaths has been frequently debated among a wide spectrum of special interest groups. Estimates of the number of injuries and deaths attributable to fire and flame accidents in general, and to flammable fabrics in particular are often quoted, yet rarely related back to a specific population.

The 1953 Flammable Fabrics Act was expanded in 1967 with the Secretary of Commerce being given the authority to act in the public interest if he finds there is unreasonable risk to the public arising from the use of one or more flammable fabrics. Since 1967, several flammability standards have been promulgated including two apparel standards requiring children's sleepwear, sizes 0-14, to be flame-retardant. The children's sleepwear standards have meant increased costs for the consumer due to a higher initial price, reduced wear-life and a reduction in choice. The benefits of such legislation include decreased incidence of burn cases and/or decreased severity of injuries. Cost-benefit analysis could be used in determining whether such programs are in the consumer's interest.

The major thrust of this research was directed toward examining how well incidence could be measured from existing data sources. It should be noted that good estimates of incidence rates represent only one input necessary in a detailed cost-benefit analysis. A number of other studies (3, 11) have addressed the problem. The Pittsburgh Burn Study (11) represents an example of a study undertaken in a specific geographical and time setting.

The Consumer Product Safety Commission and the Department of Commerce are operating an ongoing data collection system for the purpose of gathering information on product related injuries. The establishment of the National Electronic Injury Surveillance System (NEISS), a computerized data-gathering system operative in 119 statistically selected emergency rooms in the United States, should aid in the acquisition of reliable data (10). However, a limitation of the system for determining incidence of burn injuries is that a burn victim entering the hospital by direct admission or through a special burn unit would not be reported by N E I S S. Therefore, the NEISS data yields a lower bound estimate of incidence of burn victims.

Dardis and Schmitt have examined the role of cost-benefit analysis in evaluating flammability standards (3). Their results were designed to illustrate methodology rather than to determine whether the 0 to 6x children's Sleepwear Standard was justified.

Research Setting

Rhode Island is entirely divided into census tracts with census tract recorded in most routinely collected health data. The characteristics of the people closely approximate those of the nation as a whole (2).

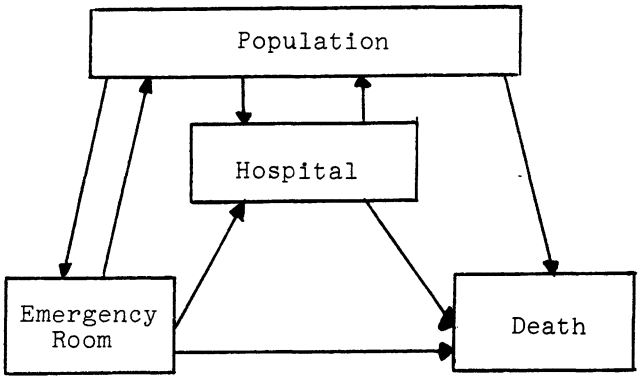
Substantial health data is routinely collected and available through the statewide Center for Health Statistics at Rhode Island Health Services Research, Inc. (SEARCH). In addition, the health care system is a closed system in that most residents receive their medical care within the state. The volume of medical care delivered to residents in nearby states has been documented in other studies.

Flow Diagram for Burn Injuries

In measuring incidence, the flow patterns of burn victims into and through the health care system must be considered. A simplified representation is given in Figure 1.

FIGURE 1

Flow of Burn Injuries in the Health Care System



Burn injuries may first enter the health care system via the emergency room or by direct hospital admission. A burn injury arriving at the emergency room may be cared for and released, admitted to the hospital, or be dead on arrival. A direct hospital admission may be treated for a period of time and released or the victim may die while hospitalized.

Clearly then, to get an accurate estimate of incidence, each of these flows must be carefully tracked. Victims appearing in more than one segment of the system must be separated out. Otherwise some cases will be counted more than once. Also, the estimate of incidence must be related back to the population at risk. For this study, all Rhode Island residents represented the population at risk.

II. EXISTING DATA SOURCES

Census Data

The 1970 census data, tabulated by census tracts were utilized as the basis for the population at risk. However, some Rhode Island hospitals provided medical services to nearby Connecticut and Massachusetts residents. And conversely some RI residents utilized out-of-state hospitals for their medical care. In an effort to rectify these two problems, one of which would affect the number of burn victims and the other which would affect the number in the "population at risk," two methods were employed. First, to correct for RI residents receiving out-of-state medical care - the population in each census tract was adjusted downward to reflect the proportion of each tract's population that sought its medical care outside the state. The adjustment factors for each city and town (5), were applied uniformly to each census tract within the city or town and to each age group within the tract. To correct for out-of-state residents who received care in RI hospitals, these victims were not included in the calculations of the numerators for incidence rates.

In a study, sponsored jointly by the Rhode Island Department of Health and SEARCH, the total Rhode Island population was divided into four socio-economic groups by census tracts. Using factor analysis, Sakoda and Karon (7) developed a socio-economic status factor score for each census tract. The scores were aggregated into four groupings. The population was thus divided as follows: high - 25.6 percent of the population, middle - 38.6 percent, low 28 percent and poverty 7.8 percent, a percentage approximating the number of people on welfare (8). The socio-economic status characteristics of the RI burn population could therefore be studied and analyzed by knowing the patient's census tract.

Vital Statistics

Data on victims who died as a result of their burn injuries for the years 1972 through 1974 were studied.

Hospital PAS Data

Hospital PAS data (4) provided invaluable data on patients hospitalized with a primary diagnosis of burn injury in Rhode Island for the years 1972 through 1974. This was especially helpful as all RI general acute care hospitals are participating PAS hospitals. Most of the desired variables for each hospitalized burn case were available in computer format. However, additional variables were deemed important to the study as it was desirable to examine the role that clothing played in the burn incident. Previous studies (1, 9, 11) had indicated that if clothing ignition occurred, a more severe burn resulted than if the clothing had not ignited. Source of the burn injury and severity of the injury were two other variables worthy of exploration.

In addition, incidence rates for a population based on PAS discharge records alone are subject to two main deficiencies. First, it was difficult to discern the number of "distinct" victims that the PAS abstracts represented; this problem stemmed from victims being readmitted one or more times, with a separate PAS form being completed after each discharge. Second, it was difficult to determine the number of "new" burn cases; the PAS classification system allowed for the coding of a late effect plus an additional code, such as for reconstructive surgery. However the hospitals did not uniformly follow the recommended procedure.

Therefore, one Rhode Island hospital was contacted for a preliminary investigation of their medical records to determine what data were available, in what manner it was available and how difficult it would be to retrieve the additional variables. Through this investigation it was deemed feasible to abstract a sample of individual medical records from the burn population to determine: 1. clothing involvement, 2. source of the burn, 3. type of admission, 4. admission number and 5. severity of burn. Results based on analysis of clothing involvement and source of the burn are given elsewhere (2).

Hospital Medical Records

There were fifteen acute care hospitals in Rhode Island. Hospitals with very few burn injuries or with numerous out-of-state patients were not contacted. Each hospital contact was handled in an individual manner. Because most of the physicians contacted at the hospitals were pediatricians, they advised that the study be limited to the age range 0-19.

Therefore, the sample consisted of victims with a primary diagnosis of burn injury, ages 0 to 19, for the years 1972 through 1974.

Permission was granted by all sever contacted hospitals with the understanding that patient confidentiality would be maintained. These seven hospitals accounted for approximately 79% of the hospitalized Rhode Island burn victims in the 0 to 19 age range.

III. ESTIMATION OF BURN INCIDENCE RATE FOR AGES 0-19

Using the sampled data from medical records, certain estimates of victims within components of the health care delivery system were derived. These estimates were based on the assumption that the results of the sample (approximately 79 percent of the hospitalized Rhode Island burn patients, ages 0-19) were representative of the total number of youths, aged 0-19, who were hospitalized with a burn injury. However, the sample was not a random sample.

A summary of data from the sampled burn population is found in Table 1. The sample data were first segregated into first hospital episodes and subsequent episodes. First hospitalizations were then divided into those admitted through the emergency room and those admitted directly. Percentages were calculated for each group and then applied to the total number of PAS discharges to obtain the estimates given in Table 2. For example, to obtain an estimate of the total number of first admissions, 346 was multiplied by 91.5 percent, the percent of first admissions determined from the sample.

These estimates were combined with data from the other three existing data sources to approximate the number of victims in the various segments of the health care system, as seen in Figure 2. The numbers found in the sample could not be used directly since the sample contained only 79 percent of the RI burn population in the 0 to 19 age group.

Twenty-one Rhode Islanders, age 0 to 19, died from burn injuries. Vital Statistics indicated that ten of these deaths occurred in hospitals, ten deaths occurred at home and one youth was dead on arrival at a hospital. PAS data reported five hospital deaths, providing the number of victims who died as a result of their injuries while being cared for in the hospital. This number did not include victims who died in the emergency room, as PAS was designed for use with inpatient hospitalizations. Therefore, it was assumed that the five remaining hospital deaths, as reported by Vital Statistics, occurred in the emergency room. This assumption was considered reasonable as hospital discharge status and location of death were generally considered to be reliable data items. These results are summarized in Table 3.

TABLE 1

Sample Hospital Data
Ages 0-19

Total Sampled Rhode Island Residents	272
First Admissions Through the Emergency Room	207
First Admissions Admitted Directly	42
Total First Admissions	249
Percentage of First Admissions	91.5%
Percentage of Subsequent Admissions	8.5%
Percentage of First Admissions Through the Emergency Room	83.1%
Percentage of First Admissions Admitted Directly	16.9%

TABLE 2

Total Hospital Data and Applied Percentages, Ages 0-19

Total of PAS Hospitalized Cases	346
Estimate of First Admissions	317
Estimate of First Admissions Through the Emergency Room	264
Estimate of First Admissions Admitted Directly	53

To estimate the total number of burn injuries, the 317 hospitalized cases were added to the sixteen victims who died prior to hospital admittance for a total of 333 victims, or 111 victims per year. Census data, adjusted downward as previously described, yielded an estimate of 324,838 Rhode Island youth, aged 0 to 19. This number represented the population at risk.

TABLE 3

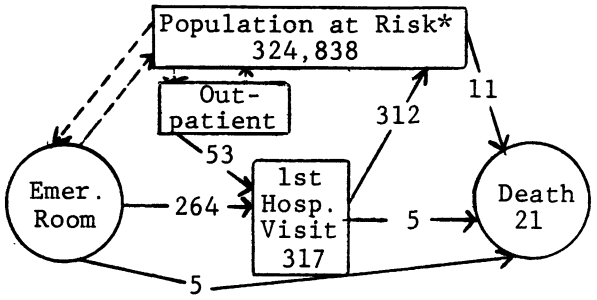
Death Data, Ages 0-19

Total Number of Deaths	21
Number Died at Home	10
Number Dead on Arrival	1
Number Died in the Hospital (V.S.)	10
Number Died in the Hospital (PAS)	5
Estimated Number Died in the Emergency Room	5

The dotted lines in Figure 2 indicate information that was not collected. The current research was not able to estimate the incidence of burn victims cared for in the emergency room, or some other outpatient setting, and released. Nevertheless, information derived through the

FIGURE 2

Flow of Burn Victims
(RI Residents, Ages 0-19)
1972-1974



*All estimates, excluding the population at risk, represent three year totals.

sample yielded 42 hospitalized cases that had been seen in physician's office, clinic, etc. for initial care after the accident. These victims were later admitted to the hospital directly, due to complications. Obviously, many more injuries were treated in outpatient settings that did not later require hospitalization. The present research concentrated only on burn injuries sufficiently serious to warrant hospitalization.

It should be noted that 16 of the 21 victims who died as a result of their injuries, died before being admitted to the hospital. Of the sampled burn population, 16.9 percent were admitted to the hospital directly. If this percentage were representative of the burn population in all age categories in all parts of the country, then the NEISS data collection system would be underestimating the problem of burn injuries by almost 17 percent. However, such a broad generalization can not be made, since the practices of the people seeking medical expertise and the physicians delivering medical care are not uniform throughout the United States.

The incidence rate of Rhode Island youths, ages 0 to 19, who suffered a burn injury resulting in hospitalization or death, was estimated to be 34.2 per 100,000. This estimated rate represents an average for a three year period, 1972 through 1974.

IV SELECTED DEMOGRAPHIC CHARACTERISTICS OF BURN VICTIMS

In the previous section, the incidence rate for burn injuries and deaths in the 0 to 19 year age group were presented. This required the combining of data from four sources including the sample taken from medical records at selected hospitals. If one utilizes only the first three data sources, demographic characteristics of all burn victims can be studied. It should be noted that the rates presented in this section do not represent incidence rates in all cases as hospitalization rates include subsequent re-admissions for some burn victims. However, with this in mind, useful insights can be gained using the readily accessible data alone.

Age and Sex Distribution Of Burn Deaths

Table 4 presents the death rates for Rhode Island residents by age and sex. There were a total of 86 deaths attributable to burn injuries for the three years studied. The death rates calculated, represent three year average rates. The elderly suffered a higher death rate than the other age groups. This finding further substantiated the vulnerability of the aged. The death rates for males exceeded the death rate for females in all age categories but the 5 to 14 year olds. It should be noted however that these rates are based on a small number of events but represent the actual population experience. Due to the small numbers of events, no further breakdown of data on death victims was attempted.

TABLE 4

Age/Sex Specific Death Rates for RI Residents

Sex	Age						Sex Specific
	0-4	5-14	15-19	20-44	45-64	65+	Death Rates
Male	4.4	.4	3.9	3.1	4.9	11.6	3.9
Female	1.9	2.8	.8	1.0	3.1	4.9	2.4

Age and Sex Distribution of Hospital Cases for 1972-1974

Of the 807 patients discharged from Rhode Island hospitals during the years of 1972 through 1974, with a primary diagnosis of burn injury, 738 were Rhode Island residents at the time of their hospitalizations. Using these cases, an estimate of the age/sex specific incidence rates of burn injuries was derived for each year studied (Table 5). It should be recalled that from the sampled hospital data, it was learned that 8.5 percent of the total number of cases sampled were not hospitalizations for the first episode of the burn injury. No determination of subsequent hospitalizations for other age groups was made, as the sample included only patients age 0-19. Therefore, the rates given in Table 5 were calculated using the total number of PAS discharges in each age/sex category. Although it was recognized that incidence

would thus be over-estimated, nevertheless it was decided that to include all hospital discharges for some age groups and only first hospital episodes for other age groups would be biasing the results.

TABLE 5

Age/Sex Specific Rates For Burn Hospitalizations by Year for RI Residents (Per 100,000)

	0-4	5-14	15-19	20-44	45-64	65+	Sex Specific	Total
1972								
Males	93.2	28.0	27.9	28.2	25.4	32.4	33.4	
Females	80.9	14.6	9.9	12.8	8.4	13.1	17.1	25.1
1973								
Males	85.2	22.2	37.2	35.6	26.4	20.0	34.0	
Females	66.9	8.5	9.9	7.9	14.9	16.4	15.4	24.5
1974								
Males	90.5	36.1	41.9	45.7	34.9	37.4	44.2	
Females	75.3	9.7	29.8	11.4	8.4	19.6	18.0	30.9

In both sexes, the incidence rate for children four years of age and younger was at least 2.5 times greater than any other age group. The incidence rate for other age groups was fairly constant for males and females respectively.

Further examination of Table 5 indicates that the age group 0 to 4 was the only age group in which the incidence rates for males and females were similar. In all other age groups, the male incidence rate was at least twice the female incidence rate. Why males experienced burn injuries more frequently than females could not be satisfactorily explained and remains an area for further study.

TABLE 6

Age/Sex Specific Rates for Burn Hospitalizations by Socio-Economic Status Groups (three year average 1972-1974)

	0-4	5-14	15-19	20-44	45-64	65+	Total by Sex*	Total **
High								
Male	71.1	15.8	21.4	21.5	19.3	23.1	24.3	19.3
Female	53.0	6.0	19.2	13.0	5.1	20.3	14.5	
Middle								
Male	42.6	29.4	34.2	28.3	31.0	26.9	30.7	22.6
Female	61.5	9.1	13.2	9.3	13.6	10.5	14.7	
Low								
Male	116.1	29.9	50.2	38.6	27.5	33.2	41.7	30.7
Female	89.2	17.0	13.2	9.8	7.7	24.5	18.9	
Poverty								
Male	260.4	70.2	50.3	131.4	54.1	44.5	98.8	61.9
Female	143.1	17.1	33.4	12.8	22.1	5.1	26.5	

*Sex Specific, age adjusted incidence rates.
**Age/Sex adjusted incidence rates.

Socio-Economic Status Characteristics of the Burn Population

In the available hospital data, there was no direct measure of an individual's socio-economic status; such as income, occupation, education or net worth. Using the patients' census tract which was available as part of the PAS data, the 738 RI hospitalized burn victims, were placed in one of the four SES groups as was described earlier.

Using the 1970 census data adjusted for RI residents going out of state, age/sex specific incidence rates by socio-economic status were calculated per 100,000. Yearly rates were not derived due to the small number of individuals within some cells.

By examining Table 6, a definite trend becomes apparent. The high SES group had an overall rate of 19.3, the middle 22.6, the low 30.7 and the poverty group an alarming 61.9.

The high incidence rates for poverty males should be noted. The age group 0 to 4 and 20 to 44 experienced particularly high hospitalization rates. The causes behind the rates should be further examined.

V CONCLUSIONS

Good estimates of incidence rates require good estimates of the numerator (the number of new burn cases occurring during the specified time period) and the denominator (the number of Rhode Island residents that could have sustained a burn injury during the specified time period). Wherever possible, existing data sources should be utilized.

Hospital PAS data, provided invaluable data on patients hospitalized with a primary diagnosis of burn injury in Rhode Island. This was especially so since all Rhode Island general acute care hospitals are participating PAS hospitals.

A second source of hospital data was needed to compensate for some of the deficiencies of PAS data. This required abstracting data from medical records, a time consuming process which is not feasible on an ongoing basis. In addition, it is necessary to obtain permission from individual hospitals before accessing the records.

Mortality and census data used in this study were readily available in suitable form. Only minor problems were encountered with these sources. The census data was for 1970 and as the RI population is fairly stable, it could be used with reasonable confidence in calculating rates.

As a result of the shortcomings of the existing data sources, it is difficult to obtain an accurate estimate of the inci-

dence rate of burn injuries in the given population. It is necessary to supplement existing data with a special study as was done in this work. However, with this additional data, more detailed information was available.

Periodic studies could be conducted to augment existing data and to determine if the percentages derived from this work are applicable to other age groups and geographical localities. This approach has the potential for offering reasonably good estimates of incidence.

REFERENCES

1. America Burning. The Final Report of the National Commission on Fire Prevention and Control. Quoted in Burn Prevention Fact Sheet. Boston: Shriners Burn Institute, May, 1973, pp. 1-4.

2. Branson, Donna M., "Estimating Population Based Incidence Rates for Burn Cases in Rhode Island," Master's Thesis, University of Rhode Island, 1976.

3. Dardis, R. and Schmitt, J., "Cost Benefit Analysis of Flammability Standards." Proceedings of American Association of Textile Chemists and Colorists Meeting. Chicago, October, 1975.

4. PAS Professional Activity Study, MAP Medical Audit Program. Ann Arbor: Commission on Professional and Hospital Activities, 1971.

5. Patient Origins of General Hospital Admissions...Rhode Island. Rhode Island Department of Health, 1971.

6. Rhode Island - The Picture of Health. Rhode Island Department of Health, Office of Comprehensive Health Planning (January, 1975).

7. Sakoda, James, and Karon, James. Factor Analysis of Rhode Island Census Tracts, 1970. Office of Comprehensive Health Planning of the Rhode Island Department of Health, Rhode Island Health Services Research, Inc. (March, 1974).

8. Scott, Denman and MacKie, Anita, "Decisions to Hospitalize and Operate: A Socio-Economic Perspective in an Urban State." Surgery, Vol. 77, No. 2 (February, 1975), pp. 311-317.

9. Textile Industry Product Safety Committee. Fabric Flammability: What the Consumer Should Know. Washington, D.C. 1973.

10. U.S. Consumer Product Safety Commission Publication, "NEISS: An Overview." NEISS News, Vol. 3, No. 5 (April, 1975).

11. U.S. Department of Health, Education and Welfare. Fourth Annual Report to the President and the Congress on the Studies of Deaths, Injuries, and Economic Losses Resulting from Accidental Burning of Products, Fabrics or Related Materials, 1972.