Societal Costs of Cigarette Fires

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U.S. Consumer Product
Safety Commission
National Public Services
Research Institute

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Fire Safe Cigarette Act of 1990

Under the Cigarette Safety Act of 1984 (P.L. 98-567), the Technical Study Group on Cigarette and Little Cigar Fire Safety (TSG) found that it is technically feasible and may be commercially feasible to develop a cigarette that will have a significantly reduced propensity to ignite furniture and mattresses. Furthermore, they found that the overall impact of such a cigarette on other aspects of the United States society and economy may be minimal.

Recognizing that cigarette-ignited fires continue to be the leading cause of fire deaths in the United States, the Fire Safe Cigarette Act of 1990 (P.L. 101-352) was passed by the 101st Congress and signed into law on August 10, 1990. The Act deemed it appropriate for the U.S. Consumer Product Safety Commission to complete the research recommended by the TSG and provide, by August 10, 1993, an assessment of the practicality of a cigarette fire safety performance standard.

Three particular tasks were assigned to the National Institute of Standards and Technology's Building and Fire Research Laboratory:

- develop a standard test method to determine cigarette ignition propensity,
- compile performance data for cigarettes using the standard test method, and
- conduct laboratory studies on and computer modeling of ignition physics to develop valid, user-friendly predictive capability.

Three tasks were assigned to the Consumer Product Safety Commission:

- design and implement a study to collect baseline and follow-up data about the characteristics of cigarettes, products ignited, and smokers involved in fires,
- develop information on societal costs of cigarette-ignited fires, and
- in consultation with the Secretary of Health and Human Services, develop information on changes in the toxicity of smoke and resultant health effects from cigarette prototypes.

The Act also established a Technical Advisory Group to advise and work with the two agencies.

This report is one of six describing the research performed and the results obtained. Copies of these reports may be obtained from the **U.S. Consumer Product Safety Commission, Washington, DC 20207.**

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Dale R. Ray

William W. Zamula

U.S. Consumer Product Safety Commission

Ted R. Miller

Peter A. Brigham

Mark A. Cohen

John B. Douglass

Maury S. Galbraith

Diane C. Lestina

Valerie S. Nelkin

Nancy M. Pindus

Patricia Smith-Regojo

National Public Services Research Institute

August 1993

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SOCIETAL COSTS OF CIGARETTE-IGNITED FIRES

Introduction

The Fire Safe Cigarette Act of 1990 ("the Act") prescribes a number of tasks for the Consumer Product Safety Commission (CPSC). Section 2(b)(2) of the Act directs the Commission to "develop information on the societal costs of cigarette-ignited fires." This report provides a summary of the estimated costs of deaths, injuries and property damage resulting from structural fires started with smoking materials. These are the costs most likely to be significantly affected by action to reduce the ignition propensity of commercial cigarettes. As noted in the discussion below, there are other costs associated with fires and fire safety, but those costs are less directly related to cigarette-ignited fires.

A substantial amount of information regarding the cost of injuries was developed for this task. Greatly improved estimates of costs associated with fatal and non-fatal burn, anoxia and other injuries were developed by the National Public Services Research Institute (NPSRI) in a new, CPSC-sponsored fire injury study (Miller, et al, "Estimating the Costs to Society of Smoking Fire Injuries," June 1993; copy attached). This study estimated medical costs, transport costs, productivity losses, lost quality of life (including what is commonly referred to as "pain and suffering"), and legal and health insurance administrative costs for fire-related injuries. These estimates, presented in summary below, are reasonably applicable to injuries resulting from cigarette-ignited fires. Estimates for the numbers of fatalities and non-fatal injuries and for property damage are from CPSC's Directorate for Epidemiology, the U.S. Fire Administration, and the National Fire Protection Association.

Estimated Societal Costs

The total direct cost of cigarette-ignited fire deaths, injuries and property damage in 1990 was approximately $4 billion (in 1992 dollars). This comprises over 1,150 fatal injuries and over 6,000 treated civilian and firefighter injuries in accidental, residential and non-residential, cigarette-ignited structural fires (99 percent of total estimated injury costs -- and virtually all fatalities -- involve civilian casualties, including non-smoker victims) as well as about $0.5 billion in property damage. Fatal injuries account for about $2.5 billion of this total; hospitalized, non-fatal injuries -- chiefly thermal burns and anoxia -- account for over $1.0 billion. Estimated total annual costs for all injuries are shown in Table 1.

The NPSRI report presents detailed breakdowns of injury cost components on a per-case average basis. These components are estimated for burns and anoxia (the major injury categories) as shown in Table 2. There is some controversy over the method of estimating the value of lost quality of life and pain and suffering; the estimates are, however, based on the conservative (i.e., low) end of the observed range of estimates for such costs.

Table 1

Societal Costs of Cigarette-Ignited Fire-Related Injuries

(millions of 1992 dollars)

Cost Component	Estimated Cost	Percent
Medical & Transport	73	2.1
Productivity Loss	852	24.3
Pain & Suffering	2,532	72.2
Legal & Admin	51	1.4
TOTAL	3,585	100.0

Source: Miller, et al, National Public Services Research Institute (NPSRI)

Table 2

Estimated Average Per-Case Cost Components for Burn and Anoxia Injuries from Cigarette-Ignited Fires (thousands of 1992 dollars)

Cost Component	Burns: Fatal	Burns: Non-Fatal (Hosp.)	Burns: ER Only	Anoxia: Fatal	Anoxia: Non-Fatal (Hosp.)	Anoxia: ER Only
Medical & Transport	12	51	1	11	5	1
Productivity	680	43	3	680	16	3
Pain & Suff.	1,380	785	11	1,380	110	10
Legal & Ins./Admin	23	19	≤1	23	3	≤1
TOTAL	2,095	898	15	2,094	134	13

Source: NPSRI. Estimates are based on breakdowns for civilian injuries

The aggregate cost estimates in Table 1 cover all fatal and non-fatal injuries associated with cigarette-ignited fires. It should be noted, however, that more than 20 percent of the fatalities are from fires in which the material reportedly ignited was something other than upholstered furniture or mattresses/bedding (e.g., paper, trash, etc.). Thus, the estimated cost of those fires involving soft furnishings -- the products generally regarded as being directly relevant to the scope of the test method development effort undertaken pursuant to the Act -- is somewhat lower than the $4 billion figure noted above. On the other hand, lower ignition propensity cigarettes may be less likely to ignite materials other than soft furnishings. On balance, the Table 1 loss estimates for all cigarette-ignited fires probably yields a reasonable approximation of the relevant hazard baseline.

It should be noted, however, that cigarette-ignited fire losses are declining over time. Between 1980 and 1990, fatalities decreased by roughly 40 percent (non-fatal injuries may also have decreased, although by much less). Hazard data for 1990 are the latest available containing the appropriate injury breakdowns; these are used in the Table 1 estimates. A preliminary review of 1991 data indicates a 25 percent decrease from 1990 in the number of cigarette-ignited fire deaths. Thus, the estimated total direct cost of cigarette-ignited fires (exclusive of property damage and projected increases in injury treatment costs) may be expected to decrease accordingly.

Conference on Fire-related Injuries

A CPSC/NPSRI-sponsored national conference of leading burn care experts was held on April 15, 1993 to discuss trends in treatments, costs and outcomes of fire-related injuries. The conferees noted the substantial reduction in the mortality rates for hospitalized burn patients over the past two decades led to an increase in the proportion of resources devoted to extremely severe burn cases, i.e., those in which a majority of body surface area is burned, often accompanied by inhalation injury. This emphasis on badly injured victims may tend to increase total costs, especially since treatments being developed for the most severe burn and anoxia cases are likely to be very expensive. Further, cigarette-ignited fire injuries treated at burn centers tend to have higher morbidity and mortality rates than other burn center admissions. Thus, costs can be expected to continue to be very high for fire-related injuries. On the other hand, functional and cosmetic outcomes for less severe burns improved dramatically in recent years, and increasing outpatient management of burn injuries (in lieu of hospitalization) may tend to curb potential cost increases.

Other Costs

Excluded from the $4 billion overall cost estimate are certain other, widely-spread societal costs fractionally associated with cigarette-ignited fires, such as:

--residential and business interruptions;

--product liability insurance premiums and administration;

--professional and volunteer fire services; and

--fire safety in structures, products and maintenance practices.

Previous estimates for such indirect costs range up to $115 billion per year (e.g., Meade, "A first Pass at Computing the Cost of Fire Safety in a Modern Society," March 1991). A portion of these costs may arguably be allocated to cigarette-ignited fires: for example, among residential structural fires, roughly 7 percent are reportedly cigarette-related. This suggests the actual annual national cost of cigarette fires might be as much as $8 billion more than is accounted for by deaths, injuries and direct property damage, for a total of up to about $12 billion. It also implies this figure could be significantly reduced, were there fewer cigarette-ignited fires.

There is substantial uncertainty, however, as to whether the costs of the major components -- fire services and building code and other fire safety requirements -- are rightly attributable to cigarette-ignited fires, or would lessen significantly with decreases in the number of such fires. Most, if not virtually all, of these other costs would be imposed even in the absence of specific subsets of the U.S. fire problem, even the relatively large subset of accidental, cigarette-ignited structural fires. To the extent the societal cost estimates are viewed as a baseline for estimating potential societal benefits of lower ignition propensity cigarettes, the most reasonable -- albeit potentially conservative -- measure of societal costs is the aggregate cost of deaths, injuries and property damage. Comparisons incorporating some additional components may be valid for certain policy purposes; however, given the necessary speculation involved in estimating potential reductions in such costs, that exercise is not undertaken in this report.

Potential Benefits of Lower Ignition Propensity Cigarettes

The Act does not call for an analysis of the economic benefits -- or costs -- of any specific set of performance or other requirements for cigarette fire safety. The level of societal costs of cigarette-ignited fires, however, provides an upper limit for any estimation of potential benefits.

While the $4 billion societal cost estimate above may be conservative in some respects, not all cigarette-ignited fires would be addressable by widespread use of lower ignition propensity cigarettes. Therefore, the overall estimate of the cost of cigarette-ignited fire losses may overstate the likely level of benefits of mandatory or other action to reduce cigarette ignition propensity.

The range of potential benefits would depend on the nature, technical and commercial feasibility, and projected effectiveness of any possible action. The 1987 Technical Study Group (TSG) final report, "Toward a Less Fire-prone Cigarette," suggested various physical cigarette characteristic modifications may be technically and commercially feasible; however, no specific performance or other requirements were contemplated or analyzed. While some commercial cigarettes may have lower ignition propensities, industry representatives continue to maintain that cigarettes embodying ostensibly fire safety-enhancing combinations of physical characteristics would not be generally acceptable to smokers. Thus, uncertainty about the commercial feasibility of lower ignition propensity cigarettes remains. Similarly, the potential net benefits (i.e., net of economic costs) are totally unknown, and may be especially sensitive to any possible adverse health effects of altering the chemical composition of cigarette smoke.

Notwithstanding this uncertainty, the societal cost estimates presented in this report support the belief that substantial fire safety benefits could accompany even modest reductions in cigarette ignition propensity. Any future analysis of the economic efficiency of lower ignition propensity cigarettes would involve estimating the likely benefits (and costs) to the public of a reasoned set of alternatives aimed at improved cigarette fire safety.

Attachment

Appendix A

Estimating the Costs to Society of Cigarette Fire Injuries
Final Report

Ted R. Miller, PhD
Peter A. Brigham, MSW
Mark A. Cohen, PhD
John B. Douglass, MA
Maury S. Galbraith, MA
Diane C. Lestina, BSE
Valerie S. Nelkin, MA
Nancy M. Pindus, MBA
Patricia Smith-Regojo, RN

National Public Services Research Institute
8201 Corporate Drive, Suite 220
Landover, MD 20785
301-731-9891
FAX 301-731-6649

in association with
The Urban Institute
The Burn Foundation

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William W. Zamula, Project Officer

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1. INTRODUCTION

The National Public Services Research Institute, the Urban Institute, the Burn Foundation, and consultants Mark Cohen and Valerie Nelkin are pleased to submit the final report on their study of the costs to society of cigarette fire injury. This study started on March 1, 1993. For each task, this report summarizes the methodology and findings. For convenience, this report refers to the study team collectively as NPSRI.

This report's purpose is to provide unit costs to use for cigarette fire injuries in costing the potential benefits of the fire-safe cigarette. In some cases, burn cost data that were analytic byproducts which appear useful for analysts of other burn issues also are reported. The Consumer Product Safety Commission (CPSC) prescribed six project tasks.

Task 1 estimates medical costs. This task was undertaken in stages. First, costs for broader categories of burns were estimated. Then the broad estimates were used to estimate costs specific to cigarette fire burns. Further analysis prescribed by CPSC broke the costs down by age, sex, and diagnostic details. The cigarette fire burn incidence data available for this study did not differentiate cases admitted to hospital from ones treated in the emergency room and released. Therefore, although the detailed costs enhance understanding of burn injury treatment variations, more aggregated costs are more appropriate for costing the average cigarette fire burn.

Nonhospitalized medical costs (using payments including co-pay as a surrogate) were built from 1987 National Medical Expenditure Survey (NMES) and third party payer data.

Hospitalized costs were built from Workers' Compensation payments data that the Urban Institute previously supplied to CPSC and from NMES data. Then 1984-1990 National Hospital Discharge Survey (NHDS) data on length of stay were used to break the costs down by body part burned and degree of burn.

To assess how burn and anoxia costs vary between cigarette fires and other burn incidents, this study uses two types of data: 1990 hospital discharge data from California, where causes now are coded for more than 90 percent of injuries; and data from burn centers where more detailed causes are recorded. The burn center data come from the Burn Foundation in Philadelphia. They represent serious cases, ones triaged to burn centers. The data cover all burn centers serving Delaware, New Jersey, and the eastern half of Pennsylvania. They include about

40 percent of area burn hospitalizations. Variations by age, sex, and diagnostic details also were analyzed using regressions on California and NHDS burn data.

Fatal injury medical costs for medically treated cases were computed from the burn center data and NHDS data.

Task 2 assesses recent trends in burn injury treatment and hospitalization, as well as their effects on costs and outcomes. This task has three components:

- A review of the medical literature by the Burn Foundation.
- Interviews with burn experts. This work was done by Burn Foundation staff who those experts view as colleagues.
- A conference that assembled experts to discuss these issues.

Task 3 provides in-depth investigational case studies of individual burn and anoxia injuries, with emphasis on injuries in cigarette fires. The case studies are appended. They include focused assessments of physical functioning, psychological impacts and lost quality of life, as well as assessments of out-of-pocket costs; lost work, housework, and schooling for the injured and family and friends; and long-term treatment, costs, and consequences.

Task 4 analyzes jury verdicts to value pain and suffering resulting from burn and anoxia injuries. To accomplish this task, NPSRI purchased data on 397 nonfatal burn verdicts and 209 settlements from Jury Verdict Research, Inc. These data were analyzed using regression analysis by Dr. Mark Cohen, who has used this approach extensively, including on past projects undertaken jointly with NPSRI's team. The estimates were compared with the estimates in CPSC's Injury Cost Model (ICM), which come from a sample that included about 40 burn injuries.

Task 5 models litigation costs. This task combines published data on costs per case by stage, data from Task 4 on litigation frequency, and estimated economic costs of burn injury from Task 1 and the ICM.

Task 6 estimates emergency transport costs. This task drew primarily on burn center data to estimate probabilities of helicopter transport, ambulance transport, and double transport (for transfers). The costs of ambulance transport by hospitalization status came from NMES. The cost for helicopter transport came from an industry survey.

2. BURN AND ANOXIA INJURY MEDICAL COSTS

This task uses several data files, including the National Medical Expenditure Survey (NMES), Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), National Hospital Discharge Survey (NHDS), National Health Interview Survey (NHIS), California hospital discharge survey (HDS), National Council on Compensation Insurance Detailed Claims Information (DCI), Burn Foundation patient record, and National Nursing Home Survey files. Methodologically, the NHDS analysis closely parallels the California HDS analysis.

This section first describes the data bases analyzed. It discusses costs, in turn, for nonhospitalized injuries, hospitalized injuries, and fatalities. Each subsection compares costs and utilization statistics between data sets and recommends average costs per case.

Injury Definitions and Data Base Summaries

Injury data are not collected uniformly. Almost every national data collection agency codes injury descriptions differently. This section discusses sample size, coding, and data quality issues.

NMES, the National and California Hospital Discharge Surveys, CHAMPUS, and NHIS code injuries using the Ninth Edition of the **International Classification of Diseases** (ICD-9). The ICD is designed for the classification of morbidity and mortality information for statistical purposes, for the indexing of hospital records by disease and operations, and for data storage and retrieval. It is not limited to injury-related morbidity or mortality. ICD nature of injury (N) codes have a 3-digit major category. The **Clinical Modification**, ICD-9-CM, provides for greater coding detail (up to six digits). This project used data for ICD N-codes 799.0 (anoxia), 940-949 (burns), 986 (toxic effects of carbon monoxide), and 987 (toxic effects of other fumes and gases). When present in incidents caused by flame/fire, ICDs 428.1, 506, 514.0 (acute pulmonary edema and chemical fume codes), 799.0, 986, 987 (anoxia codes), 947.1 (burn of trachea, larynx, or lungs), or 947.2 (burn of esophagus) are labelled as **inhalation injuries or anoxia.**

The **National Medical Expenditure Survey** (NMES) is a telephone survey of approximately 35,000 individuals in 14,000 households. It provides information on health expenditures, use of health services, insurance coverage, and sources of payment for the civilian population during the period from January 1 to December 31, 1987. NMES uses 5-digit ICD-9-CM codes.

The major NMES expenditure groups currently on public use tapes include prescriptions, ancillary and transportation, outpatient department visits, emergency room visits, and hospital admissions. These groups are on separate files and each visit is a separate event. The files were merged to construct payments for each injury episode. There are 397 hospital admissions for injury and 6,799 non-hospitalized cases. These counts include 10 burn hospitalizations and 167 other medically attended burns.

Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) data cover hospital and medical utilization and charges for roughly 2,000,000 military dependents and retirees. The CHAMPUS annual reports are the only national source known to NPSRI that records payments for outpatient visits, inpatient medical fees, and hospital services by ICD-9 code. CHAMPUS also provides the only national data on outpatient utilization by ICD-9 code. The data include few males aged 18-45 and few people over age 65. CHAMPUS produces annual hard copy summary reports which provide average payment (including co-pay) and utilization data per claimant for inpatient and outpatient care by 3-digit ICD code. One problem with CHAMPUS data is that beneficiaries may continue to receive some of their care from military facilities. Such care is not recorded in the CHAMPUS system. Also, longitudinal tracking of individual claims is not possible with the available CHAMPUS data; the summary reports track patients for only a calendar year.

A limitation of the CHAMPUS outpatient data is that they mix data on those not requiring hospital care with data on care after hospital discharge. Using the data as costs for medically treated injuries not requiring hospital care implicitly assumes that the payments per case are similar for this care and for post-discharge care.

This project used both inpatient and outpatient injury data for calendar years 1986-1991, including 2,167 burn hospital discharges and 25,521 non-hospitalized cases. Each year's data cover claims processed onto the data base over a 16-month period, that is during the year or by the following April 30. The Office of the Civilian Health and Medical Program of the Uniformed Services estimates that 92% of all claims for care during a calendar year are processed by the reporting cutoff date.

National Hospital Discharge Survey (NHDS) data are a nationally representative annual sample of roughly 200,000 hospital discharges. This file excludes discharges from Veteran's Administration hospitals and other government-run facilities. It includes 33 of the 148 U.S.

hospitals in the American Burn Association's 1991 Burn Center Directory (Dennison, 1993). NHDS data are recorded using 5-digit ICD-9-CM codes in six diagnosis fields (i.e., up to six diagnoses are recorded). Code choices are influenced by reimbursement rates in these systems. NHDS records length of stay but not charges. NPSRI extracted NHDS burn cases and suspected anoxia cases for 1984-1991, more than 7,000 cases in all.

The **National Health Interview Survey** (NHIS) is a continuing nationwide household interview survey of a probability sample of the civilian noninstitutionalized population of the United States. It captures about 20,000 injured people annually. Information about the numbers and types of injuries, and the treatment received is self-reported. Because of the small sample size, the number of hospitalized injuries reported in the NHIS is minimal. However, NHIS is valuable as a source of data on minor injuries which are not reported elsewhere, including injuries which received no medical treatment. The injuries are coded in 3-digit ICD-9, but coding is based on the injury descriptions provided by the interview respondents. This study used previously tabulated NHIS data for the period 1984-1986.

The **National Nursing Home Survey** polled a nationally representative sample of 1079 skilled nursing facilities (SNFs) and intermediate care facilities (ICFs) in 1985-1986. It gathered data on 5,243 current residents and 6,023 discharges. The data included up to five 5-digit ICD-9-CM hospital discharge diagnoses, length of stay, prior nursing home usage history, and discharge disposition (died, community hospital, other long-term care, home).

California Hospital Discharge Survey data provide a census of State hospital discharges. This study used data from the second half of 1990, when the state mandate that hospitals record the causes of burns and other traumatic injuries first took effect. More than 93 percent of eligible records were cause-coded. Each record includes 24 diagnosis fields for entry of 5-digit ICD-9-CM codes. The system also records length of stay, hospital charges, age, and sex. NPSRI extracted 614 hospitalized cases caused by fire and flames and 1515 other burn cases (for use in converting NHDS burn data to estimated flame burn data).

For this study, discharge records of people transferred to and from acute care hospitals were linked together to form integrated records wherever possible. In many cases, linked records matched imperfectly. Imperfect matches could occur, for example, because the receiving facility learned more about the patient demographically or diagnostically or due to coding errors. **All flame burn transfers lengths of stay in each facility exceeding one day were matched.** Some other burn transfers proved unmatchable, possibly due to transfers out of state. In computing means, unmatched transfers from another facility (often transfers of non-admitted patients) were included. So were unmatched transfers to another facility with lengths of stay exceeding one day. Excluding unmatched transfers would lower the average length of stay for non-flame burns. Matching these cases would raise the average slightly.

The **Detailed Claims Information** (DCI) data base maintained by the National Council on Compensation Insurance (NCCI) provides longitudinal data on a nationally representative sample of injuries to workers. The sample is restricted to injuries that resulted in Workers' Compensation claims for lost workdays. State laws vary on the number of days of work loss required before an injured worker can claim, with the range from two to seven days. Minor injuries and injuries to nonworkers -- children and the elderly -- are excluded. Advantages of the DCI are detailed payment data from a system with no co-pay or deductibles, a large sample size, and linkage of payments over the injury episode, even if treatment continues for years. The DCI file used contains data on over 13,237 burn injuries for the period 1979-1988, including 3,530 with hospitalization. This study primarily used DCI in-patient data.

The DCI codes the person's most severe injury using the **American National Standards Institute's ANSI Z-16.2** coding system. ANSI defines a two-column coding system akin to National Electronic Injury Surveillance System (NEISS) codes. An injury is coded as a two-digit body part (e.g., elbow) and a two digit nature of specific injury (e.g., burn). These codes are designed for coding from workers' compensation insurance records that lack the diagnostic detail required for coding the ICD-9 categories used by health insurers and hospitals.

In addition to the injury descriptions, DCI data include length of hospital stay if hospitalized, medical costs, hospital costs, nonmedical rehabilitation costs, time lost from work, and disability. Data are reported six months after the injury, and annually thereafter until the case is closed. A case remains open until disability payments are scheduled and all medical charges are paid. If complications arise, the case is reopened and the new medical payments are reported. When medical costs of serious injuries become predictable, the medical loss reserve (an underwriting estimate of remaining payments) is entered into the data base. If actual payments vary significantly from estimates, the insurer is supposed to revise the loss reserve estimate.

DCI data are extracted from claims forms by insurance company clerks who select the injury codes without training or quality control by NCCI. Nevertheless, because the DCI is funded by the insurers, who use it to analyze rate-making and loss control issues, incentives exist to report accurately.

The **Burn Foundation data** cover 1987-1990 discharges from the five Burn Centers that serve Delaware, New Jersey, and Eastern Pennsylvania. The data include type and location of burn, burn size, inhalation involvement, injury causes, charges, length of stay, and patient disposition.

Some flame injuries associated with cigarettes were coded as fire-cause unknown in the Burn Foundation files. These files describe cause information known at the time of admission. Philadelphia fire marshal's records were examined to learn the final cause for all city fires recorded as cause unknown. Checking led to recoding of cause to cigarette fire for 25 cases and to other fire for 85 cases. This rate suggests that another 25 cigarette flame burns in other jurisdictions are coded as flame burns with unknown cause in the file.

Incidence

Estimates of nonfatal burn incidence derive from many sources. NHIS estimates an average of 1.5 million new nonfatal burn injuries annually for 1984-1986 (Miller et al., 1993) and 1.75 million for 1985-1987 (National Safety Council, 1992). Of these, 92 percent led to in-person contact with a doctor. The other 120,000 cases involved telephone contacts with physicians or at least one half day of restricted activity. According to 1984-1986 NHDS data, 66,323 people (4.46 percent of the injured) were hospitalized with primary diagnoses of burn -- ICDs 940-949 (Miller et al., 1993). Overall, from 1984-1990, NHDS indicates that an average of 63,350 people were hospitalized with primary burn diagnoses and 13,150 with secondary burn diagnoses but non-burn primary diagnoses.

For live hospital discharges whose primary ICD code was not a burn but whose injuries resulted from fires, California hospital discharge data show that survivors with secondary burn diagnoses only are 11.7 percent of the primary burn diagnosis count (i.e., for every 100 discharges with primary burn diagnoses, 11.7 discharges have only secondary burn diagnoses), cases with anoxia only are 12.3 percent (excluding ICD 947), and cases with no burn or inhalation injuries are 12.0 percent. Many discharges with only secondary burn diagnoses had primary diagnoses of drugs/alcohol/mental illness, toxic fumes/anomia, pneumonia, or coma. (For all burns, survivors with secondary diagnoses only are 32 percent -- 520/1609 -- of the primary count. Survivors with secondary burn diagnoses only include 48 of 89 burn plus inhalation cases and 1568 of 2040 burn only cases.) Hand checking of California secondary burn diagnosis-only cases with only one burn diagnosis revealed that very few cases appeared to be miscoded as burns.

Hospitalized burn incidence is falling. Figure 1 (at the end of this chapter) shows the trend in NHDS cases with primary discharge diagnoses of burn (meaning burns used the largest amount of hospital resources). Figure 2 (and the Appendix) shows the trend in primary and primary plus secondary burn discharges by year over a shorter time period. The NHDS primary diagnosis totals for 1989-1991 averaged 55,000, with 52,000 cases in 1991. Cases with secondary burn diagnoses only average 20.8 percent of the primary burn count.

Conversely, total burn injuries may be rising. The NHIS count for 1988 was 2.2 million, including treatment for injuries that originated in prior years. This count is not comparable to the new injury count of 1.5 - 1.75 million above, but seems to have grown. Trending NHIS data, however, is treacherous due to the large error in single-year estimates.

NEISS consumer product injury counts for 1991-1992 and workplace injury counts for 1983-1985 suggest an average of 330,000 emergency room (ER) visits per year result from burns. Assuming hospitalized injury causes are representative, this count excludes perhaps 120,000 intentionally inflicted burns and burns associated with transport vehicles (cars, trucks, boats, trains, and airplanes) and natural events (most forest fires and open-air lightning strikes), as well as some unknown number of burns in public places. Table 1 (which appears at the end of this chapter) breaks these cases (and the hospitalized cases) down by cause. Half the injuries result from thermal (flame or hot object) burns. Both the California hospital discharge data and the National Fire Incident Reporting System (NFIRS) count of fire hospitalizations confirm this split. Indeed, the NEISS and California distributions of hospitalized burn injuries by cause are extremely similar. The NEISS hospitalized count of 4,649 workers burned annually, however, is well below the DCI average of 15,872 (adjusted for the percentage of workers covered by Workers' Compensation). The DCI counts burn injuries not treated in emergency rooms.

NMES also can be used to estimate cases by treatment modality. It suggests 763,500 burn cases treated in doctors offices only and 537,000 treated in emergency rooms. NMES reports burns treated in emergency rooms involve an average of 1.22 visits per ER case, while hospitalized burns average 0.1 ER visits after discharge. That suggests 661,000 ER visits annually for burns in 1984-1986. Thus, NMES/NHIS estimates are higher than the NEISS data. The NMES/NHIS estimates have wide uncertainty, however, due to small burn sample sizes.

Nonhospitalized Injury

The 1987 National Medical Expenditure Survey (NMES) provides recent, nationally representative data on medical expenditures. Its sample size is too small to distinguish reliably the amount paid for a burned arm from the amount for a burned face. Nevertheless, it provides the most reliable estimate of average nonhospitalized medical costs (using payments including co-pay as a surrogate) per burn injury. CHAMPUS data are less representative, in part because CHAMPUS is the largest private third party payer. Especially since 1990, CHAMPUS has used its leverage to negotiate favorable prices. CHAMPUS data contain enough cases, however, to show how costs vary among nonhospitalized burn injuries.

DCI data, while covering only temporarily or permanently disabling nonhospitalized injury, can be used to infer costs more than six months after injury (on average, 5.67 percent of total costs for nonhospitalized burns). By assuming the percentage of incidents and payments in DCI parallel all medically treated nonhospitalized injuries, DCI data can be used to estimate payments by body part from more aggregated 3-digit ICD diagnoses.

NMES includes 167 non-hospitalized burn cases. However, because NMES records visits during a calendar year, people hospitalized in 1986 report only their outpatient follow-up visits in 1987. Twelve NMES burn cases were initially seen in the outpatient department of the hospital, which is not normally a primary point of entry for acute treatment. These cases apparently were follow-up treatment for injuries in earlier years, not new burn cases. Table 2 compares payments and treatment intensity per nonhospitalized burn case with and without these cases. The payments were inflated to November 1992 dollars using the Medical Care component of the Consumer Price Index. Excluding the 12 outpatient cases, payments average $61 per physician's office visit, $299 per emergency room visit, and $282 per outpatient department visit. Overall, the average is $166.

Table 3 provides a more comprehensive NMES cost picture. Predictably, burns initially treated in emergency rooms involve much more follow-up and far greater cost than those initially treated in physicians' offices. The average payments per emergency room visit, including follow-up care, are $540. Consistent with prior findings from the 1980 National Medical Care Utilization and Expenditure Survey (Miller et al., 1993), nonhospitalized burn injuries generated no home health services or ancillary payments.

Overall, medically treated nonhospitalized burns average $346 in lifetime medical payments. The average burn treated in the emergency room costs $698. Cases treated in physicians' offices average much less, only $98.

Because more detailed data do not exist, this report assumes flame burn injuries and other burn injuries treated only in emergency rooms generate equal medical payments. In reality, flame burns probably are more costly to treat than scald burns.

Comparison with CHAMPUS Data

CHAMPUS gives average outpatient visits per case and payments per visit. Visits per case are comparable to NMES. They average 2.1 for 1986-1988 CHAMPUS, 1.9 for 1989-1991 CHAMPUS, and 2.0 for NMES when outpatient visits for hospitalized and outpatient department cases are included.

NMES nonhospitalized payments per visit average $166, much higher than the CHAMPUS outpatient visit average of $111 in 1986-1988 or $120 in 1989-1991 (all in November 1992 dollars). With follow-up visits for inpatients included, the contrast would be even larger. NMES is nationally representative, CHAMPUS is not. Therefore, the NMES average payments per visit were used as an overall mean.

Breakdown by Body Region. Table 4 provides estimated visits and payments per nonhospitalized case by three-digit ICD code. To prepare this table, the NMES mean payments per visit were multiplied times CHAMPUS visits per case by ICD code and the ratio of CHAMPUS payments per visit by ICD code to average CHAMPUS payments per visit. The costs include NMES prescription payments per visit. Payments beyond the first six months were computed using DCI payment patterns. The average payments across all cases in Table 4 are slightly higher than in Table 3 because the computation uses CHAMPUS rather than NMES visit rates and patterns.

Among nonhospitalized burn injuries, face and lower limb injuries cost the most per case. For facial burns this is due to high costs per visit, while for lower limb burns, it is due to greater follow-up requirements. The payments estimates for ICD 948, percentage of body burned, are much higher than for other burn diagnoses. Since this ICD records severity in 10 percent increments, it usually is used to code serious burns. The ICD 948 cases probably are predominantly cases involving outpatient follow-up to inpatient care rather than injuries treated only on an outpatient basis. CHAMPUS does not distinguish the two groups.

Anoxia Injury Only. NMES captures almost no anoxia only cases. The best available anoxia medical payments estimate is $617 (in November 1992 dollars). This cost, from Miller et al. (1993), is for nonhospitalized carbon monoxide poisoning. It uses CHAMPUS payments per visit and visits during the acute injury phase, and the DCI percentage of payments within six months of injury.

Other Injury. For other injuries, the recommended payments per case are $515. This amount equals the $444 NMES average costs divided by the DCI percentage of costs in the first six months from Miller et al. (1993). For nonfatal firefighter injury, the $1,093 average injury cost from Miller et al. (1993) is recommended.

Hospitalized Injury

Burn costs for hospitalized cases are estimated by multiplying short-term length of stay times payments per day. The acute care payments then are divided by the percentage of medical payments resulting from follow-up care. Nursing home costs are then added. This section also derives multipliers to convert burn injury payments to payments for cigarette fire burns and analyzes variations in length of stay (and presumably cost per case) by victim demographics and diagnosis.

Length of Stay. As Figure 3 shows, hospital lengths of stay for burns are similar in all the data sets examined. The mean lengths of stay are:

- 10.1 days for NMES weighted data (and 12.7 days unweighted).
- 10.55 days in NHDS for all burn cases and 10.3 days for cases with primary ICDs of burn injury ; average length of stay was stable from 1984-1990.
- 9.7 days in the California HDS for all burn cases and 9.4 days for cases with primary ICDs of burn injury.
- 10.7 days for 1986-1988, 9.6 for 1989, and 8.9 for 1990 and 1991 in CHAMPUS (recall that CHAMPUS moved aggressively to control costs in 1989-90)
- 12.2 days in DCI, including rehospitalization in the first six months after injury.

NMES captures only ten hospitalized burn injuries. The mean length of stay for these injuries is 10.1 days. Two of the injuries have lengths of stay of 1 day, one of 2 days, one of 3 days, three between 10 and 15 days, two between 20 and 25 days, and one of 37 days. In contrast, the mean length of stay for cigarette fire burn injury or flame plus anoxia injury treated at Burn Centers exceeds 34 days, as found in the Burn Foundation data. Clearly, the NMES data are not representative of all hospitalized burn injuries. The survey sample is too small to capture extremely serious injuries representatively.

This study uses 1984-90 average lengths of stay from NHDS. Table 5 shows mean lengths of stay by three-digit ICD code. Stays are especially long for survivors of burns to the trunk or multiple body regions. Flame burns of the hand and wrist involve markedly longer stays than burns from other causes. The regressions probe these variations further, controlling for other factors.

Payments per Day. Table 6 compares NMES, DCI, and CHAMPUS data on reimbursed charges plus short-term post-discharge payments per day of inpatient care (on average, for the first six months). It uses the CPI medical care inflator and an inflator based on the change in hospital cost/day (from the American Hospital Association's (AHA's) annual Hospital Statistics). The latter inflator may be preferable because it incorporates changes in the goods and services used during a hospital stay. Thus, it adds new technologies like magnetic resonance imaging (MRI) and improved burn wound coverage. The Table 6 comparisons use 1989 dollars because more recent AHA data on cost/hospital day were not readily available. Figure 4 inflates the estimates to November 1992 dollars.

The Table 6 estimates also are comparable to the daily cost for burn care inferred from Burn Foundation and California data. The inference involved several adjustments. First, the Burn Foundation burn center costs were multiplied times the ratio of daily charges for burns in the California HDS data to daily charges in the Burn Foundation data. Next, they were multiplied times the ratio of daily hospital costs in California and the U.S., from Bureau of the Census (1992). Finally, the product was multiplied times 1.21, the ratio of hospital plus professional services payments to hospital payments in the CHAMPUS data.

The NMES payments/day are in the same range as the other data. Because NMES has only 10 burn hospitalizations, this study uses DCI payments per day ($1,288 in November 1992 dollars, based on the AHA inflator through 1990 and the CPI inflator thereafter because the AHA inflator was not yet available). Although the CPI inflator seems to give closer agreement on burn costs, the AHA inflator gives better agreement across all injuries and is used here. Multiplying the payments/day times length of stay yields payments/case. The NHDS lengths of stay are used, after adjusting them to six-month lengths of stay. The adjustment procedure to get six-month stays applies an 8-percent burn readmission rate during the first six months and a six-day average readmission stay from Rice et al. (1989). By comparison, Prasad et al. (1991) find 12.4 percent of their burn patients were readmitted over a multi-year time period after injury. Percentage of payments beyond six months (83.7 percent on average) came from the DCI.

Tailoring to Flame Burns. This section refines the cost estimates to reflect just flame injury. It also examines whether cigarette fire injury without accelerants (e.g., gasoline) causatively involved differs from other flame injury. The analysis uses California HDS, NHDS, and Burn Foundation data.

Burn Foundation data were used to differentiate nonfatal burns in cigarette fires without accelerants from other nonfatal flame and nonflame burns. As Table 7 shows, these burns have distinctly longer lengths of stay than other flame burns, especially for cases without anoxia. They also have substantially longer lengths of stay than nonflame burns. The differences between flame and cigarette burn lengths of stay in cases with anoxia may be insignificant. Assuming the unknown survival cases all survived and the unknown if anoxia cases did not involve anoxia, and considering the number of cigarette and other flame burn cases, suggests cigarette burn only cases have 1.22 times the average length of stay for flame burns. They have 1.26 times the average ignoring the unknowns. The comparable ratios for burn plus anoxia are 1.10 and 1.08. Given the relatively small numbers of cases including some with extremely long stays, NPSRI conservatively assumed the difference in length of stay for the cases with anoxia was insignificant. For burn only cases (a larger sample), this study assumes cigarette fire lengths of stay are 1.22 times the average flame burn length of stay.

Table 8 shows costs per day by nature of burn injury for discharges from Burn Foundation burn centers. Costs were computed by multiplying charges times the facility-wide Medicare cost to charge ratio for the year of discharge.

Table 8 also compares length of stay and charge data between Burn Foundation burn centers and all California hospitals (with transfer stays of more than one day included). Predictably, the burn centers treat considerably more severe burns (measured by length of hospital stay). Their charges per day for flame burns are comparable to average California charges per day. For other burns, their charges per day are higher.

Both data sets show flame burns with anoxia have longer lengths of stay or higher charges per day than other flame burn injuries. These differences persist in the regressions, which control for burn nature and severity. NHDS data, shown in Figure 5, also indicate anoxia cases have longer lengths of stay. For flame burns, this study uses the mean NHDS lengths of stay with and without anoxia. For burns without anoxia, the length of stay is multiplied times 1.0625, the ratio of length of stay for flame burn only versus all burn only in the California data. This study also applies the California ratios of burn charges per day to adjust DCI data to reflect flame burns. The computations are described further below.

Nursing Home Costs. National Nursing Home Survey data include 11 burn cases. These cases include 8 current residents, one person who transferred back to a hospital after an 18-day nursing home stay, one person who died after a 1301-day stay, and one person who transferred to an Intermediate Care Facility from a surveyed Skilled Nursing Facility after a 690-day stay. The weighted average length of stay for burn survivors was 606 days for current residents and 463.5 days for the three "discharges." Two of the current residents also had prior stays of unknown duration at other nursing homes. Overall, nursing home stays for burn victims probably average about two years.

Bureau of the Census (1991) reports an annual cost of $68,785 for custodial care in a public mental retardation facility (inflated to November 1992 dollars using the CPI-All Items). Miller et al. (1989) suggest using this cost as a surrogate for ICF cost. It also estimates the average cost of a year in a Skilled Nursing Facility (SNF) is at least double the cost in an Intermediate Care Facility (ICF).

The probability of nursing home admission following hospital discharge was computed from California discharge destinations. Table 9 shows the probabilities by cause of burn (as defined below in the discussion of demographic variation). Flame burns (excluding vehicle-related burns) have a 2.93 percent probability of nursing home admission. All flame burn transfers to nursing homes were to SNFs, as were 92 percent of other burn transfers.

The average nursing home cost per hospitalized flame burn is $7,911. This figure is comparable to the cost for scald burns, but lower than the cost for burns with unknown causes. It is the product of the probability of admission directly after hospital discharge times the cost per year times a two-year stay. Second year costs were converted to present value using a 4-percent discount rate.

Medical Cost per Hospitalized Cigarette Fire Burn Survivor. From above, the length of stay for flame burn only cases equals 10.25 (from NHDS) * 10.2/9.6 (the California ratio of flame burn only to all burn only lengths of stay) = 10.9 days. For cigarette fire burns without accelerants, the average length of stay is 1.22 times as long, or 13.3 days. The payments per day equal 1288 (from DCI) * 3779/2298 (the California ratio of charges per day for flame burn only to all burn cases) = $2118. For burn plus anoxia cases, the length of stay averages 20.15 days (from NHDS). The payments per day equal 1288 (from DCI) * 3523/2298 (the California ratio of charges per day for flame burn plus anoxia to all burn cases) = $1975. The initial hospitalization and associated outpatient treatment accounts for 80.6 percent of the total medical payments for a hospitalized burn according to Miller et al. (1993). Thus, the medical payments per case average $34,899 for flame burn only and $49,317 for flame burn plus anoxia.

Incidence data are required to compute average medical payments for all cigarette flame burns. Weighted National Fire Incident Reporting System (NFIRS) data for 1990 provide them. With unknowns allocated proportionally to knowns, NFIRS suggests 626 hospitalized civilian burn plus anoxia survivors in residential and non-residential structural fires attributable to cigarettes without accelerants. The estimate for hospitalized burn only survivors is 385. Some additional burn victims may have been classified by the fire service into non-burn injury categories. Applying the California ratio of .095 nonprimary nonanoxia burn admissions for every primary fire burn (or burn plus anoxia) admission implies another 96 hospitalized burn only cases (which are included in the average lengths of stay above). Total hospitalized survivors number 1107.

To test the reasonableness of the inferred nonprimary injury count, the death count was multiplied times the ratio of hospitalized fire burn survivors in NEISS to residential flame burn deaths from NFIRS. The ratio is 1.17, based on 4818 nonfatal hospitalizations and 4115 deaths. NFIRS suggests 942 cigarette fire burn deaths. These data suggest 1102 hospitalized survivors.

Weighting the medical payments with these counts yields **average estimated medical payments per hospitalized survivor of burns in a cigarette fire without accelerants** computed as [626 * 2118 * 10.9 *1.22 + 481 * 1975 * 20.15]/[(626 + 481) * .806]. The average is $43,005. Adding nursing home costs yields total medical payments of **$50,963 per case.** By comparison, the average medical payments for all hospitalized burns are $26,700, including $16,851 (10.55 days * $1288/.806) in hospital, physician, and ancillary care payments and $9,849 in nursing home costs.

The California flame data suggest 0.101 (47/465) nonburn injury survivors for every burn survivor. That suggests 112 hospital admissions. The average length of stay for nonburn injuries in California fires is 4.6 days. Applying the average injury payments per day and percentage of payments incurred during acute care from Miller et al. (1993) yields average medical payments of $13,267 for these cases (in November 1992 dollars).

The California flame burn data suggest .110 (51/465) anoxia survivors per burn survivor. That suggests 121 hospital admissions for anoxia only. The average length of stay for the California cases is 3.0 days. (Confirming this figure, for ICDs 947, 986, and 987 in 1984-1986 NHDS data -- a crude approximation of flame anoxia cases -- it is 3.2 days.) The estimated medical payments per day for these injuries equal $1,425, the $1,288 DCI average payment per day for burns times the ratio of anoxia to burn charges per patient day from Table 8. For asphyxiation, 94.9 percent of medical payments occur within six months of injury (Rossman, Miller, and Douglass, 1991). These figures yield medical payments of $4,764 per hospitalized anoxia survivor (1288 * 3/.949).

Variation with Demographics and Diagnosis. This section examines how length of stay varies with survivor and injury characteristics. Table 10 shows the mean length of hospital stay by age and sex among nonfatal California flame burn survivors discharged during the last half of 1990. A non-parametric signs test showed that the lengths of stay did not differ significantly by sex at even the 90 percent confidence level. Lengths of stay appear to be longer for burn survivors over age 60.

Regression analyses on the California and NHDS data further probed variations in length of stay by age, sex, and burn characteristics. NPSRI structured three age variables for the elderly:

- AGEGT59 equal to 0 if over 60 and 1 otherwise
- OLD55STEP, coded as 1 for 55-59, 2 for 60-64, ..., up to 7 for 85 and over
- OLD60STEP, coded as 1 for 60-64, 2 for 65-69, ..., up to 6 for 85 and over.

Similarly, both yes-no age variables and stepped age variables were tested for AGELT15 (under age 15) and ADULT (age 15 to 55 or 60). The age break at 60 and yes-no rather than stepped age variables worked best in the model. This section reports only those results.

Other variables in the regression included:

- SEX, equal to 0 for female, 1 for male
- FACE, equal to 1 if the face was burned, 0 otherwise

- TRUNK, equal to 1 if the trunk was burned, 0 otherwise
- HAND, equal to 1 if a hand was burned, 0 otherwise
- UPLIMB, equal to 1 if an upper limb was burned, 0 otherwise
- LOWLIMB, equal to 1 if a lower limb or foot was burned, 0 otherwise
- MULTREG, equal to 1 if two or more body regions were burned, 0 otherwise
- %BODY, equal to 1 for 0-10% burned, 2 for 11-20% burned, etc.
- DEG1, equal to 1 for erythema (1st degree) and 0 otherwise
- DEG2, equal to 1 for blister/epidermis (2nd degree) and 0 otherwise
- DEG3, equal to 1 for full skin loss (3rd degree), and 0 otherwise
- DEG4, equal to 1 for deep necrosis/amputation and 0 otherwise; this severity occurred so rarely in the California data that DEG3 and DEG4 cases were analyzed together
- INHALE, equal to 1 for burns with inhalation injury, 0 otherwise

Table 11 summarizes the significant coefficients from linear and log-linear regressions. Log-linear regression probably is more appropriate because lengths of stay cannot be negative. Also, the logarithmic transformation reduces the influence of long lengths of stay. Because stays are Weibull-distributed, long stays are more common than is ideal for regression techniques designed for normal distributions. Many cases were missing percentage of body burned, so regressions were run with and without this variable. The log-linear regressions have five fewer cases than the linear regressions because five discharges had 0-day lengths of stay.

The regressions confirm that length of stay for flame burns does not vary by sex. People over age 60 have 42 to 56 percent longer stays for similar injuries (from the log-linear coefficients), averaging 3.9 to 5.2 extra days (from the linear coefficients). Lengths of stay are shorter for children than non-elderly adults. This finding is marginally significant statistically. Children's stays are on average 2.5 to 3 days shorter (29 to 36 percent).

Flame burns of multiple body regions raise length of stay by 51 to 55 percent, or 3.7 to 6.1 days. Survivors with facial burns may be admitted with less severe injuries in order to prevent complications of swelling that could block the airway. Their average length of stay is lower by 38 to 44 percent, 2.5 days. The log-linear regressions suggest that lower limb injuries may have 19 to 26 percent longer lengths of stay. This finding may reflect the greater difficulty in ambulating these patients. Complication by inhalation adds 38 to 47 percent, or 7.8 to 8.4

days, to the average length of a flame burn stay. A one-level increase in burn depth raises length of stay by 57 to 68 percent or 3.9 to 8.6 days. Finally, each 10-percent increase in the percentage of body burned is associated with a 20 percent or 3.7 day increase in length of stay.

Variations in length of stay by demographic and diagnostic factors are similar in the NHDS burn and California flame burn data. As Table 12 shows, the effects of age are consistent in direction but smaller. Males also have slightly shorter lengths of stay than females.

Extending the California flame burn regressions to other causes also made little difference in the estimated influence of the demographic and injury variables with one exception: inhalation injury cases do not have significantly different lengths of stay than other fire cases and cases with unknown causes. Table 13 shows these results. The Appendix defines the cause variables. The definitions parallel the NEISS injury classes. As Table 14 shows, electric and chemical burns involve substantially shorter stays than flame burns, while scald burns cause slightly shorter stays. Flame burn lengths of stay do not differ significantly by nature of fire. Intentionality also affects length of stay minimally.

Fatal Injury

The California HDS data include 31 flame burn fatalities. These deaths have mean charges per day of $8,763 (inflated to November 1992 dollars). By comparison, mean charges per day for 114 flame burn fatalities in the Burn Foundation data were $8,992. The mean daily charges in the data sets are similar. The Burn Foundation data were used because they could be adjusted to costs using Medicare cost to charge ratios. (The ratios by year and facility are appended.) The average cost per hospital day for fatalities is $4,991. Applying the 1989-91 CHAMPUS ratio of $.21 in professional fees per dollar of hospital payments for burn injury, total medical costs per day average $6,039 for flame burn deaths.

The mean length of stay for 31 fatal flame burns is 7.3 days in the California HDS data. For all 78 fatal burns, it is 10.0 days. It is much longer in the other data sets: 19.5 days for all 84 burn deaths in NHDS data; and 27.7 days for 22 deaths from cigarette flame burns without accelerants, 21.9 days for all 190 flame burn deaths, and 23.0 days for all 242 burn deaths in Burn Foundation data. In the Burn Foundation data, the difference between the mean stay for cigarette burn and all flame burn fatalities results may be a sample size effect in data with some extremely long stays. Excluding the case with the longest stay from cigarette burns and from other flame burns yields mean of 19.4 days and 19.0 days respectively. The pooled standard deviation for these two groups exceeds 40. As with nonfatal burns with anoxia, NPSRI conservatively concludes, lengths of stay for burns in cigarette fires without accelerants do not differ significantly from lengths of stay for other flame burns.

The discrepant lengths of fatal stay between the HDS data sets is worrisome. This is a fatality issue; nonfatal lengths of stay in these data sets are comparable. This report uses the NHDS estimate, which is nationally representative. Multiplying lengths of stay times costs per day yields medical costs per burn fatality averaging $117,763. Multiplying times the California length of stay ratio for flame burn deaths to all burn deaths yields an estimated $85,967 in medical payments per flame burn fatality.

For 1982, Burn Foundation analysis of hospital discharge data and state fire death statistics suggests that about a third of Pennsylvania fire deaths and a quarter of New Jersey fire deaths were admitted to hospitals. These rates imply medical costs across all flame burn deaths average about $25,000. NFIRS data indicate only 13 percent of cigarette fire deaths are transported to hospitals. This rate implies medical payments average $11,076 per death.

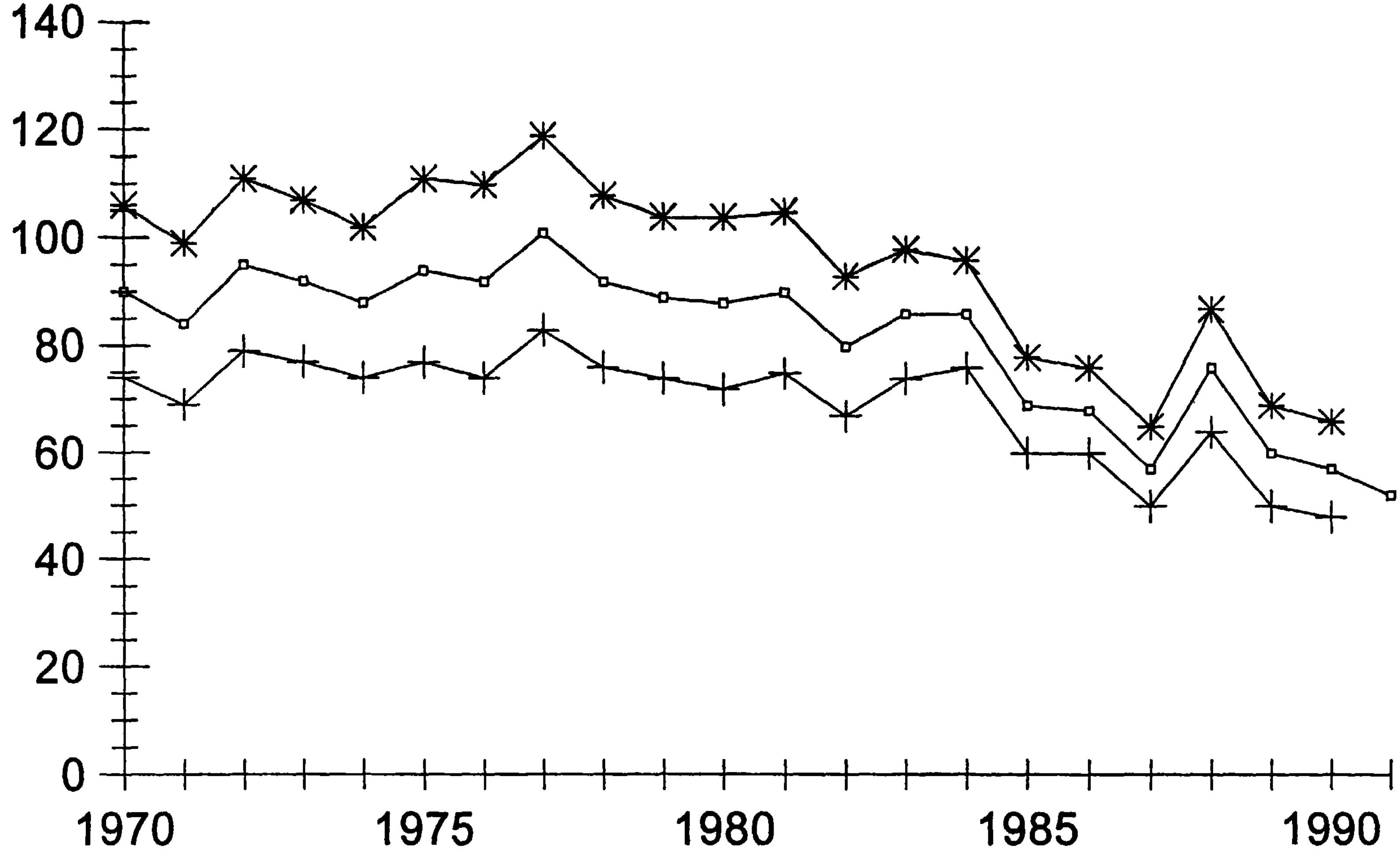
As Tables 7 and 8 show, burn center deaths involving inhalation injury involve shorter than average stays. Deaths from flame burns only typically are preceded by very long stays. Overall, however, flame burn deaths appear to have shorter lengths of stay than other burn deaths.

Deaths in hospital from inhalation injury only are too rare to analyze in depth. The lengths of stay for seven Burn Foundation cases and one California case combined average 14.9 days. NFIRS reports that only 12 percent of the 242 anoxia deaths in cigarette fires are transported to hospitals. Only the California case had charge data. Applying the cost per day for burn deaths to these cases yields a medical cost per anoxia death of $10,860.

For other injuries, the recommended fatality cost is $14,677. This cost is the average medical payments across 3334 deaths covered by Workers' Compensation in 1985 (NCCI, 1989).

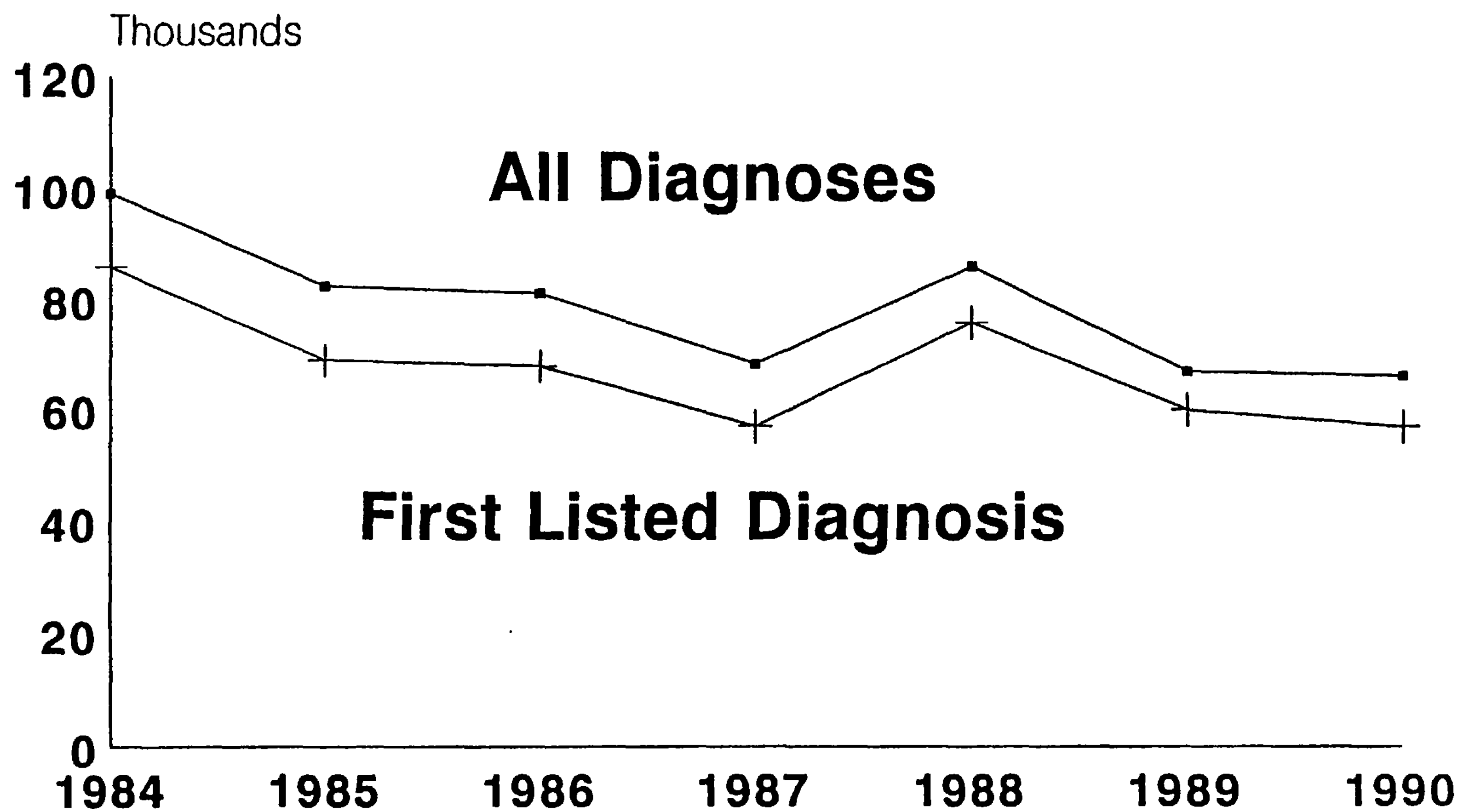
Figure 1. U.S. Burn Hospitalizations, 1970-1990:

Point Estimates and 95% Confidence Intervals (In Thousands).



Source: NHDS Data. Compiled by Peter Brigham, The Burn Foundation.

Figure 2. Trend in Live Burn Discharges For Primary Diagnosis and All Diagnoses in 1984-90 NHDS Data



Source: National Public Services Research Institute, 1993

Table 1. Annual Hospitalized and Emergency Room-Treated Burns by Cause

	Hospitalized Nonwork	Work	Total	%OfBurns	CA%ofBurns
Thermal	11677	2115	13792	51.9%	48.3%
Scald	8460	984	9444	35.5%	38.6%
Electric	582	579	1161	4.4%	4.9%
Chemical	936	680	1616	6.1%	7.2%
Radiation	27	140	167	0.6%	1.0%
Unknown	263	151	414	1.6%	--
TOTAL	21945	4649	26594	100.0%	100.0%

	Emergency Room Only Nonwork	Work	Total	%OfBurns	%Hosp
Thermal	151470	800	152270	50.3%	8.3%
Scald	69440	798	70238	23.2%	11.9%
Electric	5762	3777	9539	3.1%	10.8%
Chemical	40358	623	40981	13.5%	3.8%
Radiation	13471	10771	24242	8.0%	0.7%
Unknown	2623	3098	5721	1.9%	6.7%
TOTAL	283124	19866	302990	100.0%	8.1%

Thermal = Flame or Hot Object

Note: Excludes burn injuries, primarily from flames, involving motorized transport vehicles, most injuries in nature (e.g., in forest fires or lightning strikes) and public places, and most intentional injuries.

Source: National Public Services Research Institute, compiled from 1991-1992 National Electronic Injury Surveillance System (NEISS) data, NEISS workplace injury counts for 1983-1986 from Miller et al. (1993), and California Hospital Discharge Survey data for the last half of 1990.

Table 2. Costs Per Nonhospitalized Burn Injury, With and Without Burns Initially Treated in the Outpatient Department

	Without	With
Cases	155	167
Payments/Visit	$166	$291
Visits/Case	1.85	2.0
Payments/Case	$305	$553
Payments/Hospital Outpatient Visit	$282	$724

Note: The values without cases originating in the outpatient department are best estimates of nonhospitalized case costs. Excludes ancillary and prescription costs. Visits cover utilization in Calendar Year 1987. On average, that period covers six months after injury.

Source: National Public Services Research Institute, tabulated from 1987 NMES data, inflated to 11/92 dollars.

Table 3. Medical and Ancillary Payments and Utilization for Nonhospitalized Cases, By Level of Treatment

	Emergency Room	Physician Office	All Non-Hospitalized
Cases	64	91	155
Visits/Case	2.84	1.18	1.86
ER Visits/Case	1.22	0	.50
% with Outpatient Visits	14%	0.0%	6%
Outpatient Visits/ Case	.83	0	.35
Physician and Ancillary Medical Visits/Case	.79	1.18	1.00
Provider Payments/ Case	$647	$72	$309
% with Prescriptions	36%	43%	40%
Prescription Payments/Case	$12	$21	$17
Total Paid/Case	$659	$93	$326
Total Paid/Visit	$232	$79	$175
Total Paid/ER Visit	$540	--	--
DCI % Paid in 1st 6 Mos	94.3%	94.3%	94.3%
Lifetime Payments/Case	$698	$98	$346

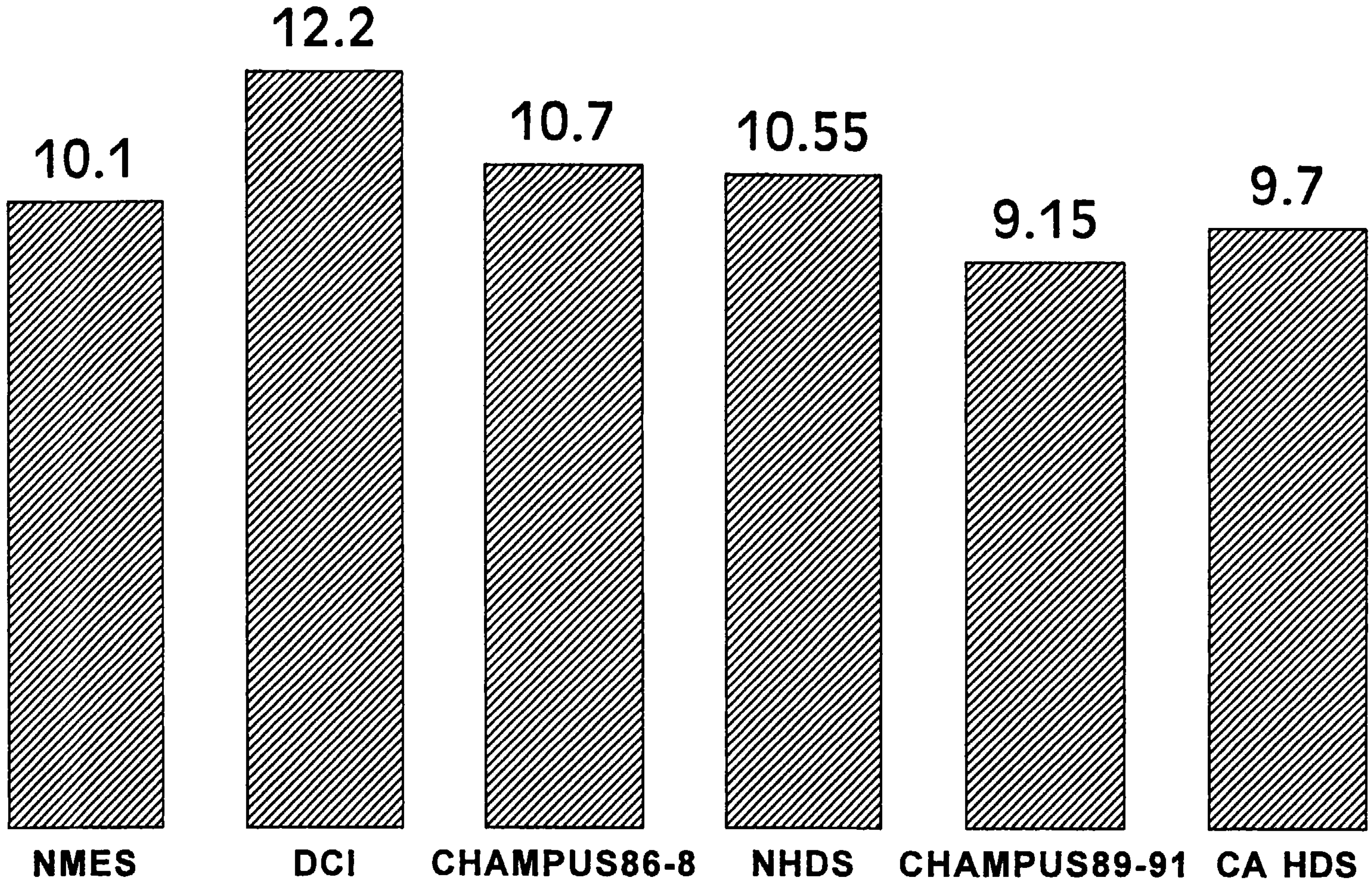
Source: National Public Services Research Institute, tabulated from 1987 NMES data, inflated to 11/92 dollars.

Table 4. Nonhospitalized Medical Payments and Visits by Body Region Injured

ICD		CHAMPUS Cases	Visits/ Case	$/Visit	Lifetime $/Case
940	Eye	348	1.5	106	246
941	Face	402	1.6	160	394
942	Trunk	415	2.1	110	359
943	Upper Limb	597	1.7	121	329
944	Wrist/Hand	1215	1.9	103	311
945	Lower Limb	814	2.4	103	385
946	Multiple	292	1.6	141	341
947	Internal	98	1.5	111	259
948	% of Body	96	1.7	428	1070
949	Unspecified	916	1.8	125	353
All		5193	1.9	120	353

Source: National Public Services Research Institute, based on NMES costs per visit and prescription costs inflated to 11/92 dollars, CHAMPUS visits per case and pattern of payments per visit by ICD, and DCI percentage of payments in the first six months.

Figure 3. Hospitalized Burns: Length of Acute Care Stay by Data Set



Source: National Public Services Research Institute, 1993

Table 5. Case Counts and Length of Stay (LOS) for Burn Injuries by Primary Body Region Burned, from National Hospital Discharge Survey Data and California Flame Burn Data

	NHDS All Causes			
ICD Code	Weighted Cases/Yr	Unwgtd Cases	%	LOS
940 Eye	1132	39	1.6%	2.50
941 Face	5489	305	7.6%	5.30
942 Trunk	6054	308	8.4%	10.15
943 Upper Limb	4925	222	6.8%	7.90
944 Wrist/Hand	7825	418	10.8%	6.15
945 Lower Limb	16828	723	23.3%	10.95
946 Multiple	28216	1104	39.1%	12.85
947 Internal	12310	100	2.4%	8.05
			100.0%	
948.0 LT 10% of Body	1322	726	54.0%	8.55
948.1 10-19% of Body	8458	371	27.6%	13.60
948.2 20-29% of Body	3861	145	10.8%	19.35
948.3 30-39% of Body	1037	50	3.7%	32.20
948.4 40-49% of Body	789	31	2.3%	39.55
948.5 50-59% of Body	155	9	.7%	61.40
948.6 60-69% of Body	65	2	.1%	52.85
948.7 70-79% of Body	175	7	.5%	21.05
948.8 80-89% of Body	42	2	.1%	1.60
948.9 90-99% of Body	31	1	.1%	3.00
			100.0%	

	California All Causes			California Flame Burn		
	Cases	%	LOS	Cases	%	LOS
940 Eye	13	0.6%	4.30	2	.4%	7.50
941 Face	287	14.3%	8.10	87	19.4%	8.75
942 Trunk	288	14.4%	11.30	59	13.2%	13.55
943 Upper Limb	192	9.6%	9.10	42	9.4%	8.90
944 Wrist/Hand	254	12.7%	5.95	56	12.5%	8.05
945 Lower Limb	545	27.2%	9.45	98	21.9%	8.05
946 Multiple	410	20.5%	12.40	103	23.0%	13.20
947 Internal	15	0.7%	4.15	1	0.2%	25.0

Source: National Public Services Research Institute, 1993. Computed from 1984-1990 NHDS data and California HDS data from the second half of 1990.

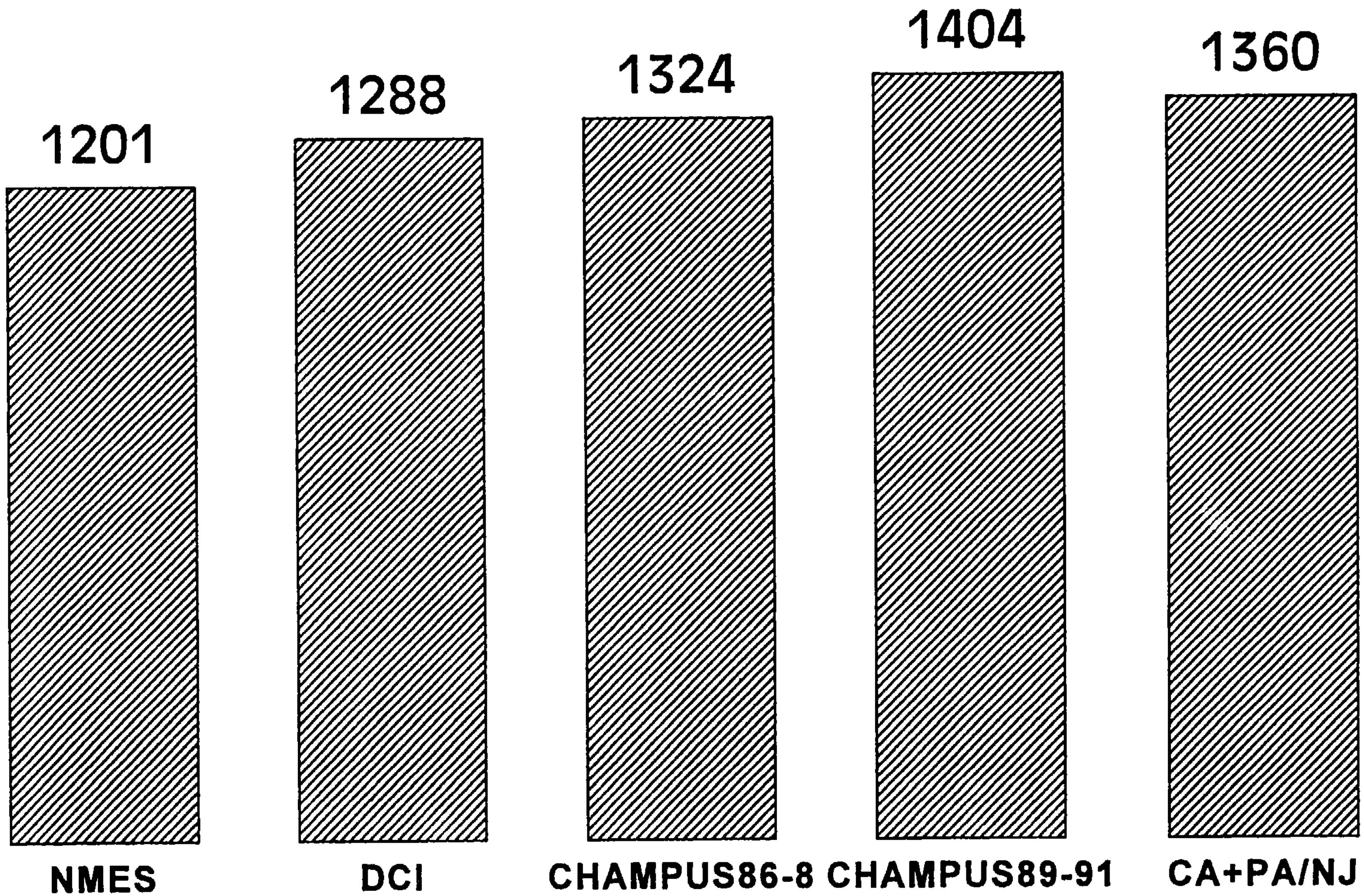
Table 6. Payments per Day of Hospital Stay for Burn Injury, by Data Source and Inflator Series (in 1989 dollars)

	CPI Medical	AHA Cost/Day
NMES 1987	$914	$933
DCI 1979-87	$897	$1001
CHAMPUS 1989-91	$1029	N/A*
CHAMPUS 1986-88	$1065	$1091
CA + Burn Foundation	$925	$935

N/A* = American Hospital Association average cost/hospital day is not yet available for 1991.

Source: National Public Services Research Institute, 1993.

Figure 4. Hospitalized Burns: Payments/Day (in 11/92 $)



Source: National Public Services Research Institute, 1993.

Table 7. Length of Stay (LOS) in Burn Foundation Data for 1987-1990, by Discharge Status, Cause of Burn, and Presence of Inhalation Injury/Anoxia

	Live		Dead		Unknown	
	Cases	LOS	Cases	LOS	Cases	LOS
Cigarette without Accelerant						
Burn Only	30	27.2	4	92.3		
Burn Plus Anoxia	22	52.7	16	14.3		
Burn & Unknown If Anoxia	8	24.4	2	5.5		
Any Flame Burn	60	36.2	22	27.7		
Anoxia Only	2	17.0	6	17.3		
Total	62	35.6	28	25.5		
Other Flame						
Burn Only	786	21.3	40	33.1	120	16.1
Burn Plus Anoxia	311	45.6	99	19.0	33	59.0
Burn & Unknown If Anoxia	101	30.1	29	4.6		
Any Flame Burn	1198	28.4	168	19.9	153	25.4
Anoxia Only	28	27.3	1	1.0	3	16.0
Total	1226	28.4	169	19.7	156	25.2
Other Burn	1729	15.9	41	29.0	N/A	N/A
All Flame Burn	1258	28.8	190	20.8	153	25.4
All Anoxia	30	26.6	7	15.0	3	16.0
All Burn	2987	21.3	231	22.2	153	25.4

N/A = Not applicable. Anoxia is largely confined to flame burn injury.

Source: The Burn Foundation, tabulation of data from the five burn centers serving Delaware, New Jersey, and the eastern half of Pennsylvania, 1993.

Table 8. Utilization, Charges, and Costs in 1987-1990 Burn Foundation and 1990 California Hospital Discharge Data, by Nature of Burn Injury

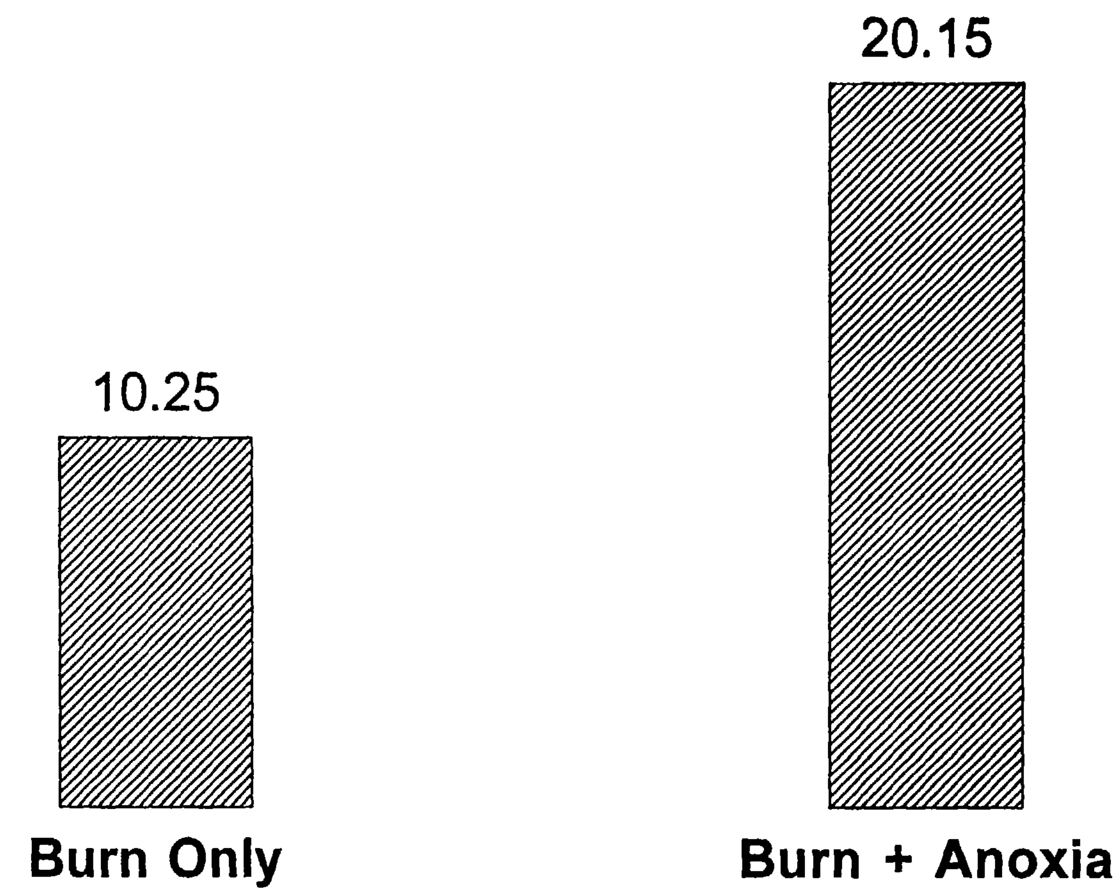
All Flame Burns (Burn Foundation)	Cases	Cost/Day
Live Discharge	1245	$1,831
Survival Unknown	59	1,735
Non-survivor	138	4,991

LIVE DISCHARGES	Flame Burn Only	FlameBurn + Anoxia	Anoxia Only	Burn Only	All Burns
Cases					
California HDS	424	41	51	2040	2129
with charges known	410	40	48	1942	2029
Burn Foundation	816	330	30	2545	2875
with charges known	333	149	10	1707	1856
Length of Stay					
California HDS	10.2	17.4	3.0	9.6	9.7
Burn Foundation	21.6	45.5	26.6	17.7	20.9
Charges/Day					
California HDS avg across patients	2956	5186	2208	2226	2331
avg across days	3779	3523	2543	2573	2298
Burn Foundation avg across patients	2927	3572	2495	2819	2916
Charges/Case					
California HDS	30416	92444	6711	24979	26940
Burn Foundation	61873	132297	22193	43636	55063
Costs/Day					
Burn Foundation	1709	2118	1391	1639	1701
Costs/Case					
Burn Foundation	35614	76440	12483	25119	31734

Note: Charges were converted to costs using Medicare cost-to-charge ratios by facility and year. Data were converted to November 1992 dollars using the Consumer Price Index - Medical Care. California flame burn plus anoxia category excludes 48 vehicle fire and intentional fire injury cases. Including those cases, the average length of stay is 13.0 days and the average charge per case is $70,710. All Burns includes burn plus anoxia cases, but not anoxia only cases. In California, recall some burn plus anoxia cases fall outside the restrictive definition of "flame" burn used with this data set, which exludes incidents like fires in vehicles.

Source: National Public Services Research Institute, Burn Foundation, tabulation of data from California HDS and from four of the five burn centers serving Delaware, New Jersey, and the eastern half of Pennsylvania, 1993.

Figure 5. Length of Stay for Burns in NHDS, by Presence of Inhalation Injury



Source: National Public Services
Research Institute, 1993

Table 9. Number of Hospitalized California Burn Survivors, Probability of Nursing Home Transfer, and Average Nursing Home Cost/Case by Cause of Injury

Cause	Cases	P(Nursing Home Admit)	Nursing Home Cost
Flame	614	2.9%	$ 7911
Electric	83	1.2%	3120
Chemical	128	0.0%	0
Scald	650	2.9%	7570
Radiation	16	6.2%	16186
Moving Motor Vehicle	92	2.2%	5630
Other Vehicle/Machine	57	0.0%	0
Hot Object/Heat	237	4.5%	11712
Not Elsewhere Classified	38	10.5%	27260
Unknown	252	11.8%	25691
TOTAL	2129	3.8%	9849

Source: National Public Services Research Institute, 1993. Case counts from California hospital discharge data for the second half of 1990.

Table 10. Length of Stay (LOS) by Age Group and Sex for Live Hospital Discharges Attributed to Flame Burns in California during July-December 1990

Age	FEMALE		MALE		ALL
Group	Cases	LOS	Cases	LOS	LOS
1-4	11	4.4	28	5.0	4.8
5-14	8	18.8	26	8.8	11.1
15-24	8	7.4	48	8.0	7.9
25-34	16	7.1	69	10.7	10.0
35-44	13	8.0	69	12.7	12.0
45-54	10	9.5	36	8.0	8.3
55-59	4	16.0	13	11.3	12.4
60-69	7	10.0	16	16.1	14.3
70-79	6	15.0	12	19.4	18.0
>=80	4	3.2	10	19.2	14.6
All Ages	87	9.3	307	10.4	10.4

Excludes patients who were transferred between acute care hospitals.

Source: National Public Services Research Institute, 1993, tabulated from California Hospital Discharge Survey public use file.

Table 11. Regressions Explaining Variation in Length of Stay for Live Hospital Discharges Attributed to Flame Burns in California during July-December 1990

Dependent Variable	LOS	LOS	Ln(LOS)	Ln(LOS)
CONSTANT	11.40 (8.21)	10.56 (5.52)	1.71 (15.06)	1.7 (11.53)
AGEGT59	3.89 (2.14)	5.20 (2.18)	0.46 (2.79)	0.56 (3.05)
AGELT15	-2.48 (1.55)	-2.95 (1.44)	-0.36 (2.74)	-0.29 (1.80)
MULTREG	6.12 (4.66)	3.69 (2.06)	0.55 (5.16)	0.51 (3.73)
FACE	-2.49 (1.77)	-2.51 (1.43)	-0.38 (3.26)	-0.44 (3.28)
LOWLIMB	0.66 (0.50)	2.63 (1.58)	0.19 (1.75)	0.26 (2.04)
TRUNK	0.82 (0.57)	-1.09 (0.62)	0.18 (1.57)	0.04 (0.28)
INHALE	8.36 (3.83)	7.84 (2.74)	0.47 (2.64)	0.38 (1.71)
DEG1	-12.24 (3.59)	-15.29 (2.71)	-1.16 (4.16)	-1.31 (3.03)
DEG2	-8.31 (6.62)	-8.55 (5.42)	-0.57 (5.58)	-0.68 (5.56)
%BODY	Excluded	3.70 (6.92)	Excluded	0.20 (4.83)
Degrees of freedom (error)	455	292	455	292
Adjusted r-squared	0.159	0.305	0.182	0.300
F-value	10.72	14.28	12.50	13.92

Ln = natural logarithm

Note: The absolute value of the Student's t statistic is shown in parentheses beside each coefficient.

Source: National Public Services Research Institute, 1993.

Table 12. Regressions Explaining Variation in Length of Stay for Live Hospital Discharges for Burns in 1984-1990 NHDS data.

Dependent Variable	LOS	LOS	Ln(LOS)	Ln(LOS)
CONSTANT	10.30 (15.15)	8.68 (8.63)	1.76 (35.23)	1.78 (24.00)
MALE	-0.96 (1.85)	-1.09 (1.57)	-0.10 (2.76)	-0.13 (2.57)
AGEGT59	3.83 (5.45)	5.67 (5.19)	0.34 (6.47)	0.25 (3.09)
AGELT15	-1.40 (2.57)	-0.62 (0.89)	-0.13 (3.11)	-0.09 (1.81)
MULTREG	3.68 (7.28)	1.90 (2.55)	0.28 (7.61)	0.29 (5.24)
FACE	-3.05 (3.87)	-2.26 (2.54)	-0.48 (8.28)	-0.52 (7.96)
UPLIMB	-1.75 (2.09)	-2.80 (1.85)	-0.06 (0.94)	-0.09 (0.76)
HAND	-3.24 (4.33)	-2.31 (2.71)	-0.29 (5.23)	-0.28 (4.52)
TRUNK	1.07 (1.32)	0.66 (0.47)	0.15 (2.60)	0.20 (1.91)
INHALE	10.20 (7.17)	11.62 (6.67)	0.49 (4.69)	0.47 (3.69)
DEG1	-5.01 (3.89)	-6.98 (4.00)	-0.46 (4.84)	-0.61 94.74)
DEG2	-3.38 (5.32)	-3.50 (4.09)	-0.23 (5.00)	-0.28 (4.44)
DEG3	4.04 (5.98)	3.52 (3.86)	0.39 (7.89)	0.30 (4.51)
DEG4	10.88 (5.70)	14.79 (6.68)	0.57 (4.03)	0.64 (3.91)
%BODY	Excluded	4.98 (16.48)	Excluded	0.24 (10.93)
Degrees of freedom (error)	3452	1808	3452	1808
Adjusted r-squared	0.111	0.288	0.143	0.275
F-value	34.23	53.68	45.38	50.33

Ln = natural logarithm

Note: The absolute value of the Student's t statistic is shown in parentheses beside each coefficient.

Source: National Public Services Research Institute, 1993.

Table 13. Regressions Explaining Variation in Length of Stay for Live Hospital Discharges Attributed to Flame Burns in California during July-December 1990

	Unintentional Injury w/Known Cause		All Burn Injury (expanded causes)	
	ALL REGRESSIONS ARE LOG-LINEAR			
CONSTANT	1.50 (15.89)	1.39 (9.77)	1.57 (19.14)	1.29 (9.93)
AGEGT59	0.36 (4.88)	0.42 (4.30)	0.30 (4.52)	0.44 (4.63)
AGELT15	-0.29 (5.22)	-0.16 (2.35)	-0.23 (4.44)	-0.12 (1.73)
MALE	-0.07 (1.38)	-0.07 (1.02)	-0.07 (1.55)	-0.03 (0.53)
MULTREG	0.41 (7.23)	0.31 (4.33)	0.41 (7.68)	0.37 (5.36)
FRAC	0.51 (2.57)	0.34 (1.51)	0.48 (4.05)	0.46 (2.69)
FACE	-0.20 (3.29)	-0.24 (3.17)	-0.18 (3.09)	-0.20 (2.69)
HAND	-0.17 (2.79)	-0.14 (1.91)	-0.20 (3.54)	-0.17 (2.36)
LOWLIMB	0.18 (3.48)	0.23 (3.52)	0.16 (3.26)	0.22 (3.59)
UPLIMB	-0.02 (0.24)	-0.07 (0.96)	-0.04 (0.75)	-0.07 (0.99)
TRUNK	0.12 (1.98)	-0.02 (0.24)	0.15 (2.68)	0.01 (0.13)
INHALE	0.24 (1.80)	0.10 (0.65)	0.27 (2.14)	0.17 (1.12)
ELEC	-0.38 (3.26)	-0.18 (1.19)	-0.49 (4.14)	-0.20 (1.21)
CHEM	-0.28 (2.64)	-0.12 (0.78)	-0.36 (3.41)	-0.17 (1.08)
SCALD	-0.05 (0.83)	-0.05 (0.64)	-0.07 (1.22)	-0.07 (1.02)
RADIAT	0.01 (0.02)	-1.03 (2.52)	-0.02 (0.09)	-0.94 (2.18)
HOTOBJ	-0.11 (1.31)	-0.20 (1.85)		
DEG1	-0.52 (3.76)	-0.68 (3.10)	-0.43 (3.87)	-0.34 (1.86)
DEG2	-0.13 (1.53)	-0.12 (0.93)	-0.17 (2.46)	-0.05 (0.38)
DEG3	0.43 (4.79)	0.49 (3.67)	0.36 (4.86)	0.53 (4.41)
ARSON			-0.06 (0.17)	-0.28 (0.76)
SUICIDE			0.37 (2.05)	0.28 (1.13)
INTENT			0.16 (1.00)	0.25 (1.33)
MV			-0.05 (0.44)	0.06 (0.39)
OTHMV			-0.05 (0.30)	-0.17 (0.82)
VEHMACH			0.31 (1.45)	0.33 (1.20)
NEC (hot obj, med mal)			-0.06 (0.78)	-0.18 (1.66)
UNK			0.19 (2.33)	0.11 (0.82)
%BODY	Excluded	0.25 (9.79)	Excluded	0.22 (10.08)
Degrees of freedom (error)	1593	964	2102	1168
Adjusted r-squared	0.19	0.28	0.16	0.25
F-value	20.49	19.84	16.84	15.81

Ln = natural logarithm

Note: For definitions of cause variables, see the appendix. The absolute value of the Student's t statistic is shown in parentheses beside each coefficient.

Source: National Public Services Research Institute, 1993.

Table 14. Number of Hospitalized California Burn Survivors and Mean Length of Stay by Cause of Injury

Cause	Cases	% of Cases	LOS
Flame	614	28.8%	11.4
-unintentional	568	26.7%	11.0
Electric	83	3.9%	7.3
-excluding lightning	78	3.7%	7.7
Chemical	128	6.0%	5.2
-unintentional	114	5.4%	4.8
Scald	650	30.5%	8.1
-unintentional	638	30.0%	8.1
Radiation	16	0.8%	8.4
Moving Motor Vehicle	92	4.3%	16.1
Other Motor Vehicle	34	1.6%	13.4
Other Vehicle/Machine	23	1.1%	15.0
Hot Object/Heat	199	9.4%	7.1
Not Elsewhere Classified	38	1.8%	11.5
Unknown	252	11.8%	11.6
TOTAL	2129	100.0%	9.7

Source: National Public Services Research Institute, 1993. Compiled from California hospital discharge data for the second half of 1990.

3. LITERATURE REVIEW OF BURN INCIDENCE AND TREATMENT

Before World War II, those who survived fires and other burn incidents with major injuries received virtually no care before reaching a hospital. If they reached the hospital alive, they would receive largely palliative care. If they escaped the constant threat of death from burn wound sepsis and its complications while their wounds remained open, they generally faced a cosmetically and functionally compromised future, and the unappealing choice of dealing with or hiding from a generally uncomprehending and unsympathetic populace.

Treatment of patients with severe fire and burn injuries has shown remarkable progress in the past 50 years, at a rate that has accelerated in the past 25 years (Alexander, 1985; Dimick et al, 1993). During the same period, death and injuries from fires and burns have declined to current levels of approximately 4500 civilian fire deaths (Karter, 1992) and 52,000 hospitalized primary ICD-code burn injuries per year (National Center for Health Statistics, 1993; Dimick et al, 1993). Counts of additional burn deaths and hospitalized fire injuries, while considerably lower, remain locked in unanalyzed data. Less severe injuries are more frequent. Total burn injuries, defined as contact with medical care and/or reduced activity for at least a day, were estimated at 1.75 million per year, or about .75 per year per 100 population (National Safety Council, 1992, tabulation of National Health Interview Survey, 1985-87).

According to the most recent annual tabulation by the National Fire Protection Association, about 1200 of the nation's 4500 annual fire deaths result from fires started by dropped cigarettes (Miller A, 1993). There is no national system in place which counts all fire and burn injuries by type and ignition source. The National Fire Incident Reporting System (NFIRS), estimates the incidence of fatal and nonfatal fire injuries attended by fire departments. Data from the National Electronic Injury Surveillance System (NEISS) of the U.S. Consumer Product Safety Commission (CPSC) cover many burn injury sources comprehensively. Scattered burn center reviews place dropped cigarette fire injuries at between 3% of admissions (Burn Foundation, unpublished data, 1993) and 6% (Cleon Goodwin, unpublished data, 1993). Projected against the national total of 23,000 specialized burn facility admissions per year (Dimick et al, 1993), these reports suggest that the number of such cigarette fire injuries receiving specialized burn treatment is between 700 and 1400. This does not include additional injuries related to smoking, such as the accidental ignition of an accelerant (gasoline, kerosene, etc.) or the intentional ignition of combustibles by a cigarette, or the misuse of matches or cigarette lighters by children or compromised adults with ready access to smoking paraphernalia.

Overview of Recent Advances

Five landmark articles documenting major advances in burn treatment in recent decades have been cited by Cohen et al (1989). They include:

- a comprehensive approach to fluid and electrolyte needs (Baxter, 1974)
- prevention and control of infection (Heggers and Robson, 1986)
- early debridement and coverage (Janzekovic, 1970; Hunt et al, 1979)
- prevention of contractures with splints and early mobilization (Petros, 1986)
- prevention of hypertrophic scars and keloids with pressure garments (Larsen, 1971)

Additional important areas of recent advances and continuing concern are reflected in the topic headings in the report of the most recent NIH consensus conference on trauma and burn injury (Maddox et al, 1990). These include nutrition and metabolism, pulmonary injury, wound healing, and immunological consequences.

For those who survive a fire or burn injury incident to enter the medical care system, the standard for care is now a mature system extending from prehospital care and transportation through inpatient care and rehabilitation (American Burn Association, 1990; Bayley et al, 1989). Rehabilitation both during and after hospitalization is receiving increased attention (Cromes & Helm, 1992) although the overall societal approach to rehabilitation remains deficient (Salisbury, 1992).

Advances affecting the acute treatment of the most severely injured have particular relevance for the survivors of fire started by dropped cigarettes. Classed by ignition source, injuries caused by cigarettes have the longest hospital course, the most extensive respiratory and other complications, and the highest average hospitalization costs (Jones & Feller, 1988, Burn Foundation, 1990). Cigarette fires typically do not produce substantial quantities of CO and other toxic products while smoldering in a mattress or upholstered furniture before erupting into flame. Many National Institute of Standards and Technology (NIST) studies attest to this. However, those caught in the ensuing conflagrations suffer as a group the most severe mix of respiratory and burn injury of any fire injury scenario.

The literature on the treatment of fire and burn injury is growing by several hundred references each year. There are some 150 new references alone in the two major periodicals dedicated to burn injury, the Journal of Burn Care and Rehabilitation, inaugurated in 1981, and Burns, published in England since 1974. Dozens of articles addressing burn injury appear in other medical publications. Upwards of 250 papers and poster sessions, many remaining unpublished, are also presented each year at the annual meetings of the American Burn Association.

The recent literature documents continuing progress and further promise in advancing the frontier of survival and shortening the hospital stay through improved surgical and nursing technique in the areas of wound coverage and healing (Munster et al, 1992; Carrougher et al, 1991). There is increasing attention to diagnosing and treating inhalation injury, (Clark & Nieman, 1987) which remains the last major challenge to surviving the acute stage of injury (Sobel, 1992). There is also increasing attention to how burn care can most effectively be administered in an era of changing payment mechanisms and reduced burn center occupancy. (Jordan, 1991; Fortune, 1992; Rees, 1992; Silverstein, 1992; Brigham, 1993)

The following review assesses advances in more specific areas of burn care and research, with particular reference to literature published within the past five years, and with special attention to respiratory injury. The review is intended to serve as a guide to recent trends, to aid in determining what effect they have had and are likely to have on outcomes of care and medical costs.

Rescue and Transportation

Fire suppression and rescue techniques have become so refined that the prospect of surviving a conflagration has increased significantly (Chiles, 1992). Investigation of fire fatalities has improved the abilities of architects and builders to prevent fires from occurring and to enhance rescue and escape efforts if a fire breaks out. With advances in air transport and the nationwide spread of emergency medical systems (Dimick et al, 1993), care in the prehospital stage has substantially improved and transportation of the patient directly from the scene to a burn center has become standard practice (Chiles, 1992; Sharar et al, 1988). The widespread use of helicopters has even reached the point of stimulating recommendations for more precise criteria for their use (Baack et al, 1991). Both land and air transport have benefitted from the improvement in monitoring equipment, which is increasingly compact, user friendly and noninvasive, making the monitoring of hemodynamic stability more accurate and precise and enabling corrective action during transit.

Acute Treatment

Burn mortality continues to be associated with advanced age and higher percent of total body surface area burned (Thompson et al, 1986). In addition, mortality remains greater (40%) in any burn combined with an inhalation injury (Herndon, 1986). Those who present to the burn center are frequently more complex due to increased age, advanced disease or complicated medical history. Substance abuse and intoxication also contribute both to the severity of burn injury and to ensuing complications (Kelly & Lynch, 1992; Haponik & Munster, 1990; Clark & Neiman, 1988).

Advanced technology has created an array of new techniques in debridement and skin replacement, such that wound size is reduced more quickly and with fewer complications (Burke, 1990). Better equipment and technique during surgery have improved the control of the patient's wound bed and facilitated healing. Complications associated with prolonged anesthesia have accordingly declined. The contribution of strengthened nutritional status and other supports to the patient's immunological defenses are increasingly well documented (Heimbach, 1990; Garrel, 1991).

Early wound excision and closure have reduced the complications of burn wound sepsis and shortened hospital stays without increasing mortality (Heimbach, 1988). Now that burn care has "come of age", refined skin grafting techniques have enabled surgeons to treat patients quickly and efficiently. Today, burn wounds are frequently excised and autografted on an outpatient basis. Healing time is spent at home, rather than in a high-priced hospital room. This reduces costs and potentially promotes early rehabilitation, if family and professional support is forthcoming.

These improvements have enabled the focus of grafting to expand at an earlier stage from wound coverage to cosmetic and functional restoration. In the most recent Presidential address to the American Burn Association, Warden (1993) communicated the need to establish early cosmesis and return to functional capacity as major goals of contemporary burn treatment.

Respiratory Care

Respiratory injury, and/or the ingestion of toxic gases, is the leading cause of death identified in data sources identifying fire victims (Harwood & Hall, 1989) and patients admitted to burn centers (Thompson, 1986; Tredget et al, 1990). Thompson reported mortality rates of 4% for patients without inhalation injury and 56% where such injury was present. Since inexperienced emergency room personnel may be distracted by the sensational external appearance of a large body surface wound, the emphasis in education is on securing an accurate history and performing a complete examination of the patient. These are crucial first steps in acquiring evidence of inhalation injury and implementing timely treatment (Herndon, 1986). Patients with smoke exposure but no thermal injury are also at risk for ominous complications if the emergency department practitioner does not implement appropriate treatment at the time of the initial examination (Haponik, 1990).

Jones and Feller (1988) reported that patients with a respiratory injury were hospitalized twice as long (46 days) as those without pulmonary involvement (18 days) based on average lengths of stay of patients documented in the National Burn Information Exchange from 1979 through 1986.

The patient who survives a thermal injury accompanied by a pulmonary injury faces a long recovery with multiple complications. Besides the physiologically damaging effects of smoke and heat, particles of smoke can cause toxic consequences that lead to delayed neurological problems (Sharar, 1990; Choi, 1983; Ellenhorn and Barceloux, 1988). Long-term pulmonary complications continue to involve all areas of the pulmonary tree causing restriction, stenosis or obstruction from the larynx and trachea to the bronchioles and parenchyma. Problems such as chronic obstructive pulmonary disease (COPD) can plague the survivor long after their initial hospitalization, complicating their rehabilitation and raising the costs to both patient and society (Colice, 1990).

Bronchoscopy examination is widely used and accepted for quick and effective determination of airway involvement and severity of injury (Herndon, 1986; Clark & Nieman, 1988; Haponik & Munster, 1990) yet it cannot predict the chance of respiratory failure (Shimozu, 1987). The xenon scan is a precise diagnostic tool for identifying a pulmonary injury, but is very expensive and not generally used if bronchoscopy is readily available (Herndon, 1986).