Rates of Pediatric and Adolescent Injuries by Year of Age

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ABSTRACT. *Objective.* **The purpose of this study was to analyze causes of injury hospitalization/death by individual year of age and by specific causes of injury and to examine how well aggregate age groups represented individual year-of-age rates.**

Methods. **Hospital discharge data and death certificate data for California residents age 0 to 19 years with a principal external cause of injury code (E-code) of E800 to E869, E880 to E929, or E950 to E999, calendar year 1997, were analyzed. Annual rates of injury hospitalization/death by year of age were calculated using combined hospital discharges and deaths as the numerator for major causes and important subcategories. For comparison, rates of injury hospitalization/death were calculated for conventional vital statistics age groups: <1 year, 1 to 4 years; 5 to 9 years, 10 to 14 years, and 15 to 19 years.**

Results. **In 1997 in California, 35 277 children and adolescents 0 to 19 years were hospitalized and 1934 died as a result of injury, a ratio of 17 hospitalizations to 1 death. The distribution was bimodal with rates highest among 18-year-olds (732/100 000) and 1-year-olds (495/100 000). Except for children who were 5 to 9 years of age, the group rates for all injuries were not reflective of the individual year-of-age rates. In specific categories of injuries, variation in rates by year of age were masked by age group rates for unintentional poisoning among 1- to 4-year-olds, self-inflicted poisoning for 10- to 19-year-olds, falls from playground equipment among 5- to 9-year-olds, falls from furniture among 1- to 4-year-olds, and motor vehicle occupant injury rates among 10- to 19-year-olds. The peak rate of falls from playground equipment among 6-year-olds (34/100 000) was more than twice the rate for 9-year-olds (15/1000,000). Motor vehicle occupant injury rates doubled between 10 and 14 years of age and quadrupled between 14 and 18 years of age.**

Conclusions. **Analyses using conventional age groups did not identify the age of highest risk for many causes of childhood injury. Changes in the rates often transected the traditional age groups and were not apparent with conventional age group analysis. These data can inform on the age at which to begin a specific injury intervention and on how to allocate resources. These data allow pediatricians and other health professionals to be anticipatory in providing injury prevention counseling. The greatest impact can be achieved by making the counseling topic most age appropriate in anticipation of the high-risk period.** *Pediatrics* **2001;108(3). URL: http://www.pediatrics.org/cgi/content/full/108/3/e45; *injury hospitalization/death, injury, children, causes of injury.***

ABBREVIATIONS. E-code, external cause of injury code; OSHPD, Office of Statewide Health Planning and Development.

Injury is the leading cause of death and disability for children and adolescents. Substantial progress has been made in defining the extent and impact of injuries in the US population. Using the National Health Interview Survey data, Danseco et al[1] determined an injury rate of 25/100 children through 21 years of age, or 20.6 million injuries per year. The estimated cost of unintentional injuries (medical, future work lost, and quality of life) was $347 billion annually. Guyer et al[2] presented an annual summary of vital statistics data and included an analysis of the 5 leading causes of childhood death. Beyond the first year of life, injuries are the leading cause of death for each age group.

Epidemiologic studies predominantly use the vital statistics age groupings for children: <1 year, 1 to 4 years, 5 to 9 years, 10 to 14 years, and 15 to 19 years of age. In 1989, on the basis of a National Institute of Health and Human Development conference, standard definitions for childhood injury research were developed on the basis of factors such as development and life events. It was determined that broad age aggregations for children mask wide variation within categories as a result of rapid changes in development and risk.[3] These developmental changes result in changes in exposure and the way children interact with hazards. Some investigators developed age categories that take into consideration developmental factors and risk factors, such as legal driving age.[4]

Many investigators have researched age-related differences in causes of injury deaths. Baker et al[5] analyzed specific causes of injury death by age, race, gender, geographic area, urban/rural residence, and per capita income using various age ranges and identifying risk factors. Other studies have examined specific causes of injury and risk factors by year of age using National Center for Health Statistics data.[6] Overpeck et al[7] used National Center for Health Statistics data to identify risk factors for homicide among infants who are younger than 1 year by month of age. Using the Fatal Analysis Reporting System for traffic-related injuries, Agran et al[8] found that through 14 years, the single year of age with the

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highest number and proportion of motor vehicle occupant fatalities was <1 year.

Less research has been done using data on nonfatal childhood injuries by specific cause and by year of age. A study that used a community-based injury registry in Sweden showed that injury incidence was highest for 1- and 2-year-olds and provided data in narrower age ranges than many other studies.[9] In the United States, the primary sources of morbidity data that include narrow age ranges for injury include the hospital discharge data, trauma registries, emergency medical services reports, and traffic records. Hospital discharge data are limited when the particular state does not use external cause of injury codes (E-codes) and does not capture out-of-hospital deaths. Trauma and emergency medical services systems capture a limited portion of the population. Traffic records cover limited causes of injuries and do not have medical documentation. Therefore, many of these databases are limited for comprehensive analyses of injury morbidity by year of age.

Several studies included narrow age categories in examining a specific cause of injury. The median age of trampoline injuries was 10 years in a study that used the National Electronic Injury Surveillance System data collected by the US Consumer Product Safety Commission.[10] The incidence of near drowning and drowning has been found to be highest among 1- and 2-year olds.[11,12] The incidence of burns is highest among children who are younger than 5 years. Tap water scald injuries typically occur between 6 months and 3 years of age.[6] In a study of pedestrian injuries among young children, 1- and 2-year-olds were most commonly injured in driveways by a vehicle that was backing up. In contrast, the 3- to 4-year-olds most frequently were injured in midblock street locations, similar to older children.[13] In an analysis of death rates among drivers, 16- and 17-year-old drivers had markedly higher risk for fatal crashes than older drivers, and the risk increased with the number of passengers in the vehicle.[14]

The use of very narrow age categories can result in small numbers of injuries and unstable rates, but in large data sets, rates for narrow age ranges may be calculated with reasonable precision. In 1991, California, with more than one tenth of the nation's population, was one of the first states to require E-coding to code hospital discharge data. California data afford evaluation of a large database of childhood injury hospitalizations along with the mortality data. The purpose of this study was to analyze causes of injury hospitalization/death by individual year of age, overall, and by specific causes of injury and to examine how well aggregate age groups represented individual year-of-age rates.

METHODS

Hospital discharge data for 1997 were obtained from the Office of Statewide Health Planning and Development (OSHPD), California Health and Human Services Agency. Each civilian hospital in California supplies data to OSHPD on each hospital discharge, including E-codes,[15] for each initial hospitalization for injury. The data supplied by the hospitals are collected and edited by OSHPD. From these data, hospital discharges of California residents age 0 to 19 years with a principal E-code of E800 to E869, E880 to E929, or E950 to E999 were selected. Hospital discharges of infants who were born during the hospitalization were excluded because they should not have an E-code.

Death certificate data for 1997 were obtained from the Office of Health Information and Research, Department of Health Services, California Health and Human Services Agency. Deaths of children and youth age 0 to 19 years with an underlying cause of death of E800 to E869, E880 to E929, or E950 to E999 were selected.

Annual rates of injury hospitalization/death by year of age were calculated using combined hospital discharges and deaths as the numerator. To avoid double counting, we excluded hospital discharges that involved a death. The denominators for the rates were estimates of the 1997 California population by year of age obtained from US Bureau of the Census.[16] Thus, these are population-based rates rather than exposure-specific rates. However, for most of the injuries, exposure to the corresponding hazard is near universal.

Injuries were grouped into external cause categories based on the principal E-code (see Appendix). With some exceptions, the groupings recommended by the National Center for Injury Prevention and Control[17,18] were used. Categories were added for child battery and neglect (E904.0, E967.0–E967.9, E968.4) and for foreign body, except respiratory and eye (E915), because these categories are important causes of injury hospitalization for children. The category for bites and stings was used, but neither the remainder of the natural/environmental category nor the machinery category was used, as these categories would have been too small for this analysis. All transportation injuries were grouped together.

Rates of injury hospitalization/death by year of age were calculated for important subcategories. Unlike the recommended groupings of National Center for Injury Prevention and Control, we combined traffic and nontraffic events in each of the transportation subcategories. On the basis of our previous experience with hospital records, we are not confident that hospitals correctly distinguish between traffic and nontraffic events. For comparison, rates of injury hospitalization/death were calculated for conventional vital statistics age intervals.

Rates were calculated only for 10 cases or more. Thus, using a

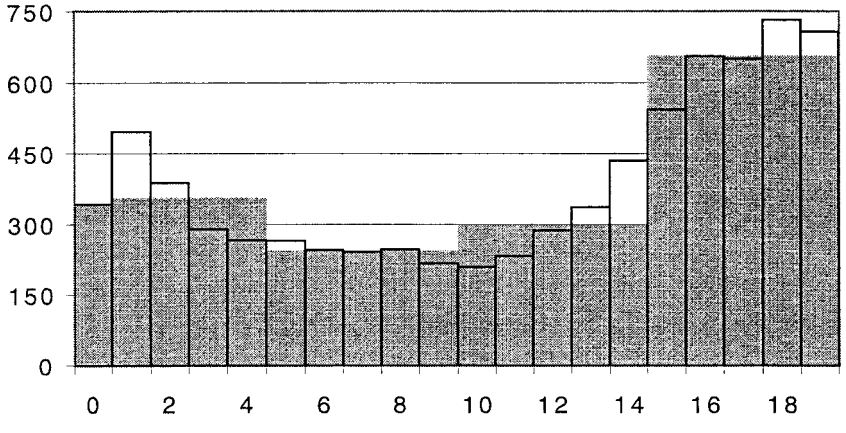

Fig 1. Annual rate of injury hospitalization/death by year of age.

normal approximation to the Poisson distribution, all of the rates shown have 95% confidence limits of <62% above and below the observed rate. The population for each year of age ranged from 430 000 to 576 000 (mean: 490 000). Rates by year of age of 23 or more per 100 000 have 95% confidence limits of <20% above and below the observed rate, and rates of 90 or more per 100 000 have 95% confidence limits of <10% above and below the observed rate.

To measure the variability of rates within an age interval, we calculated a coefficient of variation for the 4 or 5 year-of-age rates within each age interval. This measures the variability of the rates within an interval and is not related to the standard error of the year-of-age rates.

RESULTS

In 1997 in California, 35 277 children and adolescents 0 to 19 years of age were hospitalized and 1934 died as a result of injury, a ratio of 17 hospitalizations for each death. The overall annual rate of injury hospitalization and death was 380/100 000.

Overall Injury Rates

The annual rate of injury hospitalization/death by year of age is presented in Fig 1. The shaded areas are the injury rates for the conventional age groups. The distribution was bimodal with rates highest among the youngest and the oldest. The 15- to 19-year-olds had the highest overall rates of injury and the most rapid rise in rate: 543/100 000 for 15-year-olds to 732/100 000 for 18-year-olds. Among younger children, the 1-year-olds had the highest overall rate of injury (495/100 000) followed by the 2-year-olds (387/100 000).

The mean rate of 657/100 000 for the 15- to 19-year-old age group was not reflective of the high rate among the 18-year-olds, which was 732/100 000. The progressive increase in rates by year among the 10- to 14-year-old age group from 209/100 000 to 435/100 000 was not reflected in the conventional age group overall rate of 298/100 000. The mean rate of injury for the 1- to 4-year-old age group masked the peak rates noted for the 1- and 2-year-olds. For children 5 to 9 years, the group rate was reasonably reflective of the individual year-of-age rates. The rates of overall injury for 3- and 4-year-olds are more similar to the 5- to 8-year-olds than to the 1- to 2-year-olds with whom they usually are grouped.

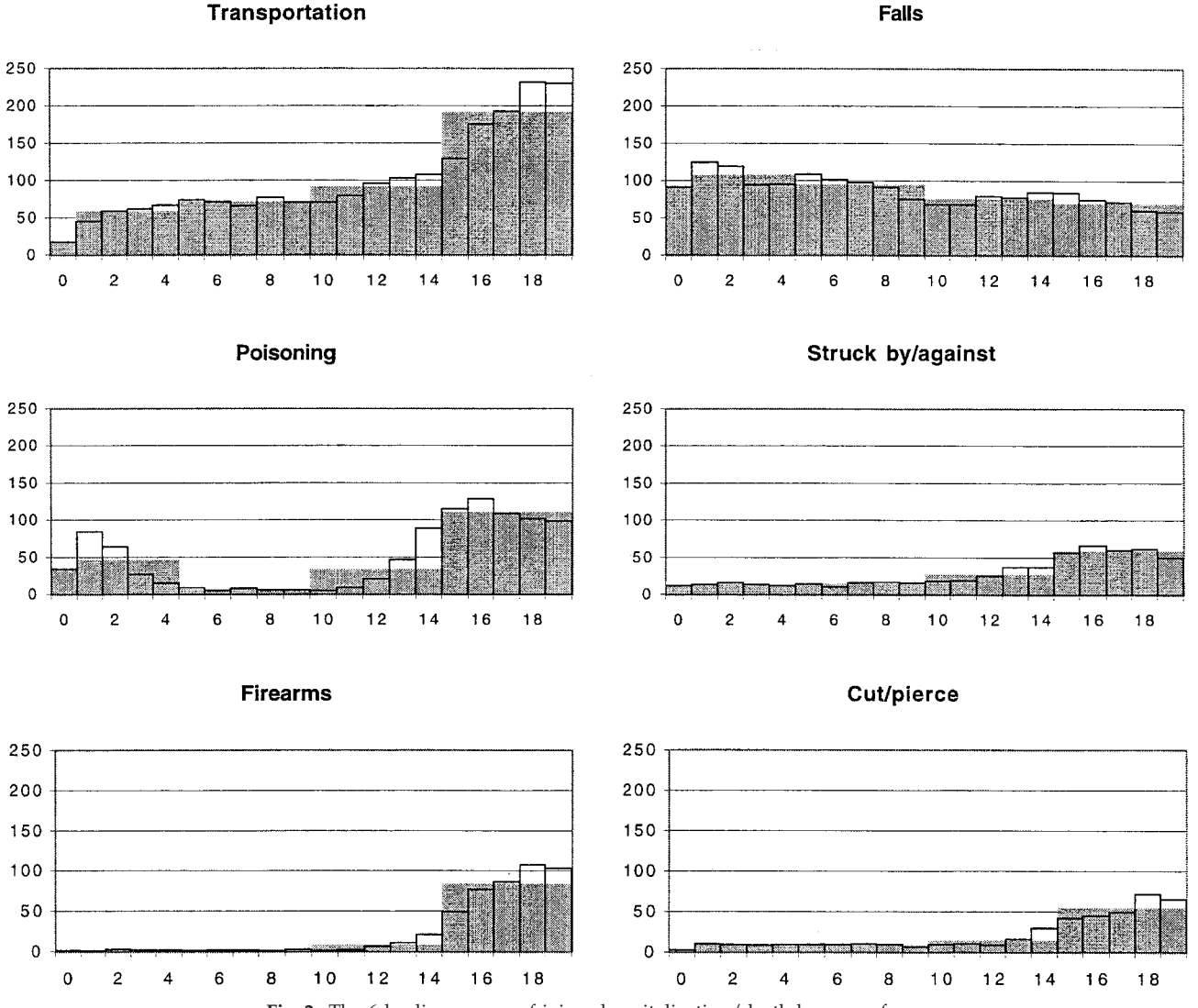

Fig 2. The 6 leading causes of injury hospitalization/death by year of age.

Leading Causes of Injury by Age

The 6 leading causes of injury hospitalization/death by year of age are presented in Fig 2. In decreasing order, they were transportation, falls, poisoning, struck by/against, firearms, and cut/pierce. The shaded areas were the rates by conventional age groupings. For transportation injuries, the group rates were reasonably reflective of the individual year-of-age data and demonstrated the steep rise in rates with increased age. However, the peak rates among the 18- and 19-year-olds were masked in the 15- to 19-year-old age group rate. The conventional age group rates were fairly reflective of the year-of-age data for falls, demonstrating a steady decrease with increased age beyond 1 year. However, the highest rate among the 1-year-olds (125/100 000) and then the 2-year-olds (119/100 000) was not revealed in the overall 1- to 4-year-old rate (108/100 000).

The overall age group rates for poisoning were not reflective of the year-of-age rates. The peak rate among 1-year-olds (83/100 000) was masked by the mean rate among 1- to 4-year-olds (47/100 000). The rapid yearly increase among the 10- to 14-year-olds (4/100 000–89/100 000) was not apparent in the group rate (33/100 000). The peak among 16-year-olds (129/100 000) was not revealed by the overall rate (111/100 000) among the 15- to 19-year-old age group. Firearms injury rates by conventional age groups did not reflect the rapid rise between 12 (6/100 000) and 18 years of age (107/100 000) and the peak at 18 years.

Injury Subcategories

Subcategories of injuries are presented in Fig 3. Motor vehicle occupant injury rates doubled between 10 years (19/100 000) and 14 years of age

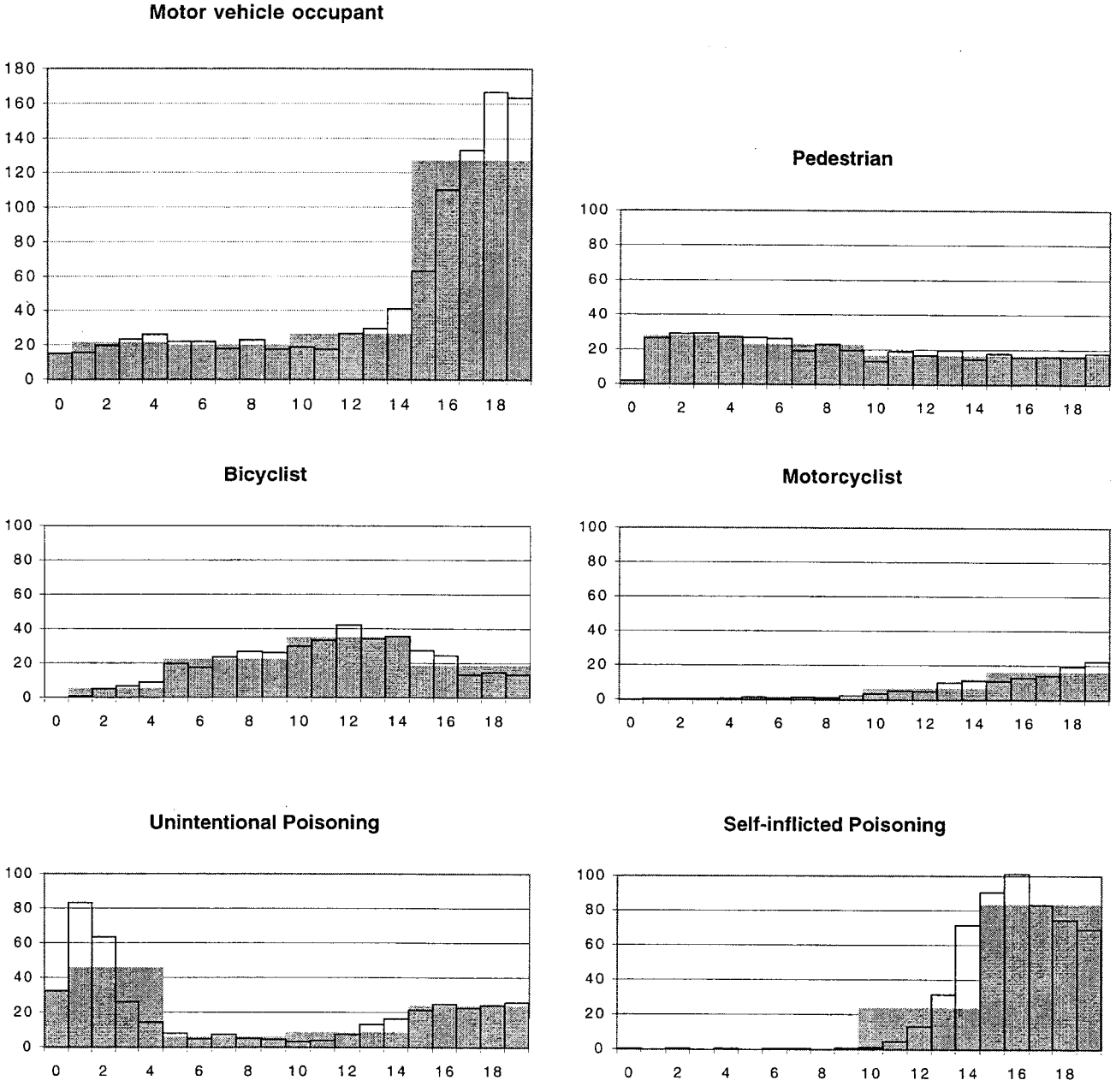

Fig 3. Subcategories of transportation and poisoning injuries.

(41/100 000). The rates quadrupled between 14 and 18 years of age and peaked at 18 years (167/100 000). The conventional age group mean for 15- to 19-year-olds (127/100 000) masked these differences.

Pedestrian injury rates by age group were fairly reflective of the individual year-of-age rates. Similarly, bicyclist injury rates were reasonably reflective, except for the peak in rate at 12 years of age.

Unintentional poisoning rates by age groups failed to demonstrate that the rate among 1-year-olds (83/100 000) was nearly 6 times that of 4-year-olds (14/100 000). The group rate blunted the 1-and 2-year-old peak rates. The self-inflicted poisoning rate for the 10- to 14-year-olds and the 15- to 19-year-olds totally obscured the steep rise between 11 years (4/100 000) and 16 years (101/100 000). Conventional age grouping also missed the marked rise in rates between 14 years of age and the peak at 16 years of age.

Injury rates for falls are subcategorized in Fig 4. When falls were not subtyped, group rates showed little variation across the age spectrum (Fig 2). In contrast, subtyping of rates of falls revealed marked year-of-age differences. The 1-year-old peak rate of falls from furniture (44/100 000) was 3 times that of 4-year-olds (15/100 000) and obscured by group rates. The peak rate of falls from playground equipment among 6-year-olds (34/100 000) was more than 2 times the rate for 9-year-olds (15/100 000) and masked by conventional age group rates.

Table 1 shows the annual rate of hospitalization/death for overall injuries and specific categories and subcategories by aggregate age groups and by individual year of age. The variation in rates for specific causes of injury by year of age is marked for many categories.

The high and low year-of-age rates for selected categories and subcategories of injury are shown by age interval in Table 2. Within each age interval, the injury categories and subcategories are arranged by variability of the year-of-age rates. The age group of 1 to 4 years had the greatest number of injury causes with a variability of 30% or more, and the age groups of 10 to 14 years and 15 to 19 years also had several injury causes with this level of variation.

DISCUSSION

Our analysis of the annual rate of pediatric injury hospitalizations/deaths in a large state with E-cod-

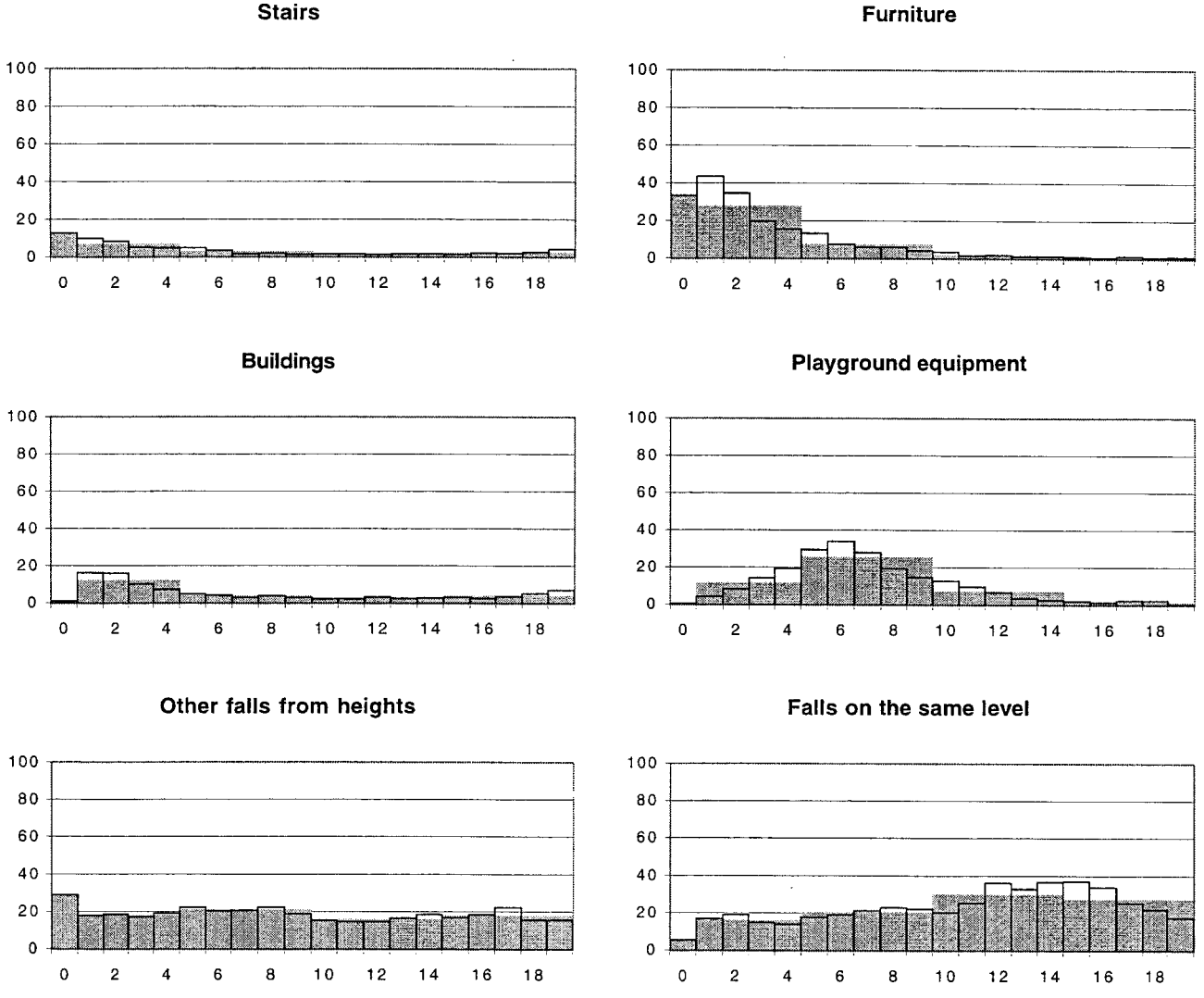

Fig 4. Subcategories of fall injuries.

Table 1. Annual Rate of Injury Hospitalization/Death per 100,000 Population, by Years of Age and by Age Intervals, 0 to 19 Years. California, 1997 (n = 37211).

Category	Age (Years) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Age group (Years) 1-4	5-9	10-14	15-19
All	**343**	**495**	**387**	**289**	**266**	**265**	**245**	**241**	**246**	**216**	**209**	**232**	**286**	**336**	**435**	**543**	**656**	**650**	**732**	**707**	**357**	**243**	**298**	**657**
By intent:																								
Unintentional	282	475	373	279	260	261	241	235	241	209	202	218	258	273	308	341	401	404	440	431	344	238	251	403
Self-Inflicted	-	-	-	-	-	-	-	-	-	-	-	6	15	40	86	112	127	101	110	93	-	-	29	109
Assault	53	16	12	9	5	4	4	5	4	6	4	6	11	20	37	81	119	135	171	173	11	4	15	136
Other & undeter.	8	4	2	-	-	-	-	-	-	-	-	-	2	3	4	8	9	10	12	9	2	1	2	10
By external cause of injury:*																								
Transportation	**17**	**45**	**59**	**62**	**67**	**74**	**72**	**66**	**77**	**71**	**70**	**79**	**96**	**103**	**108**	**129**	**175**	**193**	**232**	**230**	**58**	**72**	**91**	**191**
Motor vehicle occupant	15	15	20	23	26	22	22	18	23	17	19	17	27	30	41	63	110	133	167	163	21	20	27	127
Motorcyclist	-	-	-	-	-	-	-	-	-	2	4	5	5	10	11	11	13	14	19	22	-	1	7	16
Bicyclist	-	-	5	7	9	20	17	24	27	26	30	33	42	34	35	27	25	13	15	13	5	22	35	19
Pedestrian	-	27	29	29	27	27	26	19	23	20	13	19	17	19	14	18	15	16	16	18	28	23	17	16
Other & unspec.	-	2	5	3	5	4	6	4	3	5	5	5	6	10	6	10	12	17	15	13	3	4	6	13
Falls	**91**	**125**	**119**	**95**	**96**	**108**	**102**	**98**	**91**	**76**	**69**	**68**	**79**	**78**	**85**	**84**	**75**	**72**	**61**	**59**	**108**	**96**	**76**	**70**
Stairs	13	10	8	5	5	5	4	-	-	-	-	-	-	-	-	-	2	-	3	4	7	3	1	2
Buildings	-	16	16	10	7	5	4	3	4	3	2	2	3	2	3	3	3	3	5	7	12	4	3	4
Playground equipment	-	4	8	14	19	30	34	28	19	15	13	9	7	3	3	-	-	2	2	-	12	26	7	2
Furniture	33	44	35	20	15	13	8	6	6	4	3	-	-	-	-	-	-	-	-	-	28	8	2	1
Other falls from heights	29	18	19	17	19	22	20	21	22	19	15	14	15	17	18	17	18	22	16	16	18	21	16	18
Falls on the same level	5	17	19	15	14	18	19	21	23	22	20	25	36	33	37	37	34	25	22	17	16	20	30	27
Other & unspec.	10	16	15	14	15	16	13	17	15	12	14	13	16	19	22	23	16	16	13	14	15	15	17	16
Poisoning	**34**	**84**	**64**	**27**	**15**	**9**	**5**	**8**	**5**	**5**	**4**	**9**	**21**	**47**	**89**	**115**	**129**	**109**	**102**	**99**	**47**	**6**	**33**	**111**
Unintentional	32	83	63	26	14	8	5	7	5	4	3	4	7	13	16	21	25	23	24	26	46	6	9	24
Self-inflected	-	-	-	-	-	-	-	-	-	-	-	4	13	31	71	90	101	83	74	69	-	-	24	84
Assault, undeter., other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	3	3	4	1	-	1	3
Struck by/against	**12**	**13**	**16**	**14**	**12**	**14**	**10**	**15**	**16**	**16**	**18**	**19**	**25**	**37**	**37**	**57**	**66**	**60**	**61**	**49**	**14**	**14**	**27**	**59**
Unintentional, in sports	-	-	-	-	-	3	2	3	5	6	6	9	11	20	20	29	33	22	15	9	1	4	13	22
Unintentional, other	10	13	15	12	10	11	8	11	10	10	11	9	11	10	8	9	7	9	11	10	12	10	10	9
Assault	-	-	-	-	-	-	-	-	-	-	-	-	2	7	8	19	24	28	34	29	-	1	4	27
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

ing of hospital discharge data provides an overview of the age-specific causes of injuries among children. The bimodal distribution of overall rates and the steep increase in rates beginning at 14 years of age are portrayed clearly. This study addresses another issue: aggregating data by conventional age groups compared with disaggregation by year-of-age analyses. We demonstrated that analyses that used conventional age groups did not identify the age of highest risk for many causes of childhood injury.

The conventional age groups did not reveal the substantial year-of-age differences in the following major injury categories: transportation, poisoning, and firearms. Also, several injury subcategories with marked differences by year of age were missed by conventional age grouping. The rapid increase in

Firearms	**2**	**1**	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**3**	**2**	**2**	**6**	**11**	**21**	**50**	**77**	**87**	**107**	**103**	**2**	**2**	**8**	**85**
Unintentional	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	7	6	10	9	8	0	-	2	8
Self-inflected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5	5	9	7	-	-	-	6
Assault	-	-	2	-	-	-	-	2	-	2	-	-	3	7	15	38	64	70	84	87	1	2	5	69
Other & undeter.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	5	-	-	-	-	1
Cut/pierce	**3**	**10**	**9**	**8**	**9**	**9**	**9**	**10**	**9**	**6**	**10**	**10**	**9**	**16**	**30**	**42**	**45**	**50**	**72**	**65**	**9**	**9**	**15**	**55**
Unintentional	2	10	9	8	9	9	9	10	9	6	10	9	6	9	12	13	14	16	20	17	9	9	9	16
Self-inflected	-	-	-	-	-	-	-	-	-	-	-	-	-	5	11	13	12	9	18	12	-	-	3	13
Assault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	14	18	25	33	36	-	-	2	25
Other & undeter.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Burns	**28**	**66**	**19**	**19**	**12**	**7**	**7**	**6**	**5**	**6**	**5**	**5**	**6**	**4**	**4**	**3**	**4**	**7**	**7**	**10**	**28**	**6**	**5**	**6**
Fire/flame	3	6	4	6	5	3	2	-	2	3	3	3	4	4	-	-	3	4	4	5	5	2	3	4
Hot object/ substance	25	60	15	13	7	4	5	4	2	2	2	-	2	-	-	-	-	4	3	5	23	3	2	3
Bites & stings	**7**	**18**	**16**	**14**	**12**	**11**	**11**	**12**	**13**	**9**	**7**	**7**	**7**	**5**	**5**	**5**	**5**	**5**	**4**	**6**	**15**	**11**	**6**	**5**
Dog bites	-	7	9	7	5	5	5	5	6	6	3	-	3	-	-	-	-	-	-	-	7	5	2	1
Other bites & stings	5	11	7	7	7	6	6	7	7	3	3	5	4	3	4	4	5	4	3	4	8	6	4	4
Foreign body, except eye & respiratory	**29**	**40**	**16**	**10**	**10**	**6**	**3**	**5**	**4**	**2**	**-**	**3**	**-**	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**19**	**4**	**2**	**2**
Submersion/ drowning	**11**	**28**	**23**	**13**	**8**	**6**	**4**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**5**	**2**	**4**	**2**	**3**	**4**	**18**	**3**	**3**	**3**
Bathtub	6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	-	-
Pool & spa	3	21	19	11	6	4	2	-	-	2	-	-	-	-	3	-	-	-	-	-	14	2	2	1
Other	2	4	3	1	1	1	1	1	1	1	1	1	1	1	2	0	3	1	1	2	2	1	1	1
Overexertion	-	-	**3**	-	-	-	-	-	**3**	-	**3**	**5**	**7**	**7**	**14**	**12**	**15**	**12**	**13**	**13**	**2**	**1**	**7**	**13**
Suffocation/ choking	**25**	**21**	**7**	**4**	**2**	**2**	**2**	-	-	-	-	**2**	-	-	**2**	**3**	**4**	**3**	**6**	**3**	**8**	**2**	**2**	**4**
Choke--food	10	11	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-
Choke--nonfood	10	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-
Other suffocation & choking	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	3	6	3	1	0	1	3
Child battering & neglect	**40**	**10**	**7**	**4**	**2**	-	-	-	-	-	-	-	**2**	-	-	-	-	-	-	-	**6**	**1**	**1**	**1**
All other	**43**	**32**	**27**	**16**	**17**	**16**	**17**	**13**	**17**	**17**	**16**	**20**	**21**	**22**	**32**	**39**	**52**	**46**	**62**	**63**	**23**	**16**	**22**	**52**

*Categories are shown in bold, subcategories are indented and shown in regular type.

'-' indicates there were fewer than 10 cases and rates were not calculated.

motor vehicle occupant injuries within both the 10- to 14- and the 15- to 19-year-old age groups was not apparent. The high risk of unintentional poisoning among the 1- and 2-year-olds was masked by the overall rate for the 1- to 4-year-old age year group. The rise in self-inflicted poisoning beginning as young as 11 years of age and the rapid rise with each increase in year of age are not apparent in the aggregated data. The highest year-of-age rates for falls from furniture, buildings, and playground equipment were not revealed by conventional age group analysis.

Changes in the rates often transect the traditional age groups and were not apparent with conventional age group analysis. For example, the increase in motor vehicle occupant injury hospitalization/death rates began to rise at 14 years and was not apparent in the mean rate for the 10- to 14-year-old age group. The steep rise of self-inflicted poisonings beginning at 11 years of age, the 15-fold increase by age 14, and the peak for 16-year-olds transect 2 age groups and are not readily apparent in aggregated rates.

Year-of age analysis of injury rates is relevant from an epidemiologic perspective to determine ages at highest risk and suggest appropriate interventions and may be useful for evaluation of age-specific interventions (eg, graduated licensing laws). Conventional age group analysis for injury has limitations

TABLE 2. High and Low Year-of-Age Rates for Injury Hospitalization/Death by Age Interval for Selected Categories and Subcategories of Injury

Age Interval	Injury Category or Subcategory	High and Low Year-of-Age Rates (per 100 000)	Rate for Age Interval (per 100 000)
1–4 y	Hot objects/substances;	7, 60	23
	foreign body, except eye and respiratory;	10, 40	19
	unintentional poisoning;	14, 83	46
	falls from playground equipment;	4, 19	12
	pool and spa submersion/drowning;	6, 21	14
	falls from furniture;	15, 44	28
	falls from buildings	7, 16	12
5–9 y	Falls from playground equipment	15, 34	26
10–14 y	Self-inflicted poisoning;	1, 71	24
	unintentional struck by/against in sports;	6, 20	13
	motor vehicle occupant	19, 41	27
15–19 y	Unintentional struck by/against in sports;	9, 33	22
	assault cut/pierce;	14, 36	25
	bicyclist;	13, 27	19
	motor vehicle occupant;	63, 167	127
	motorcyclist;	11, 22	16
	falls on the same level	17, 37	27

Selected categories and subcategories were those with an annual rate of injury hospitalization/death of 10/100 000 or more and a coefficient of variation for the 4 or 5 year-of-age rates within each age interval of 30% or more.

for relating the risk of injury to age-related developmental differences. This is particularly true for the 1- to 4-year-old age group, as this is a period of rapid developmental changes in motor skills, cognitive abilities, and social interactions that affect risk of injury and change exposure.

Information provided by year-of-age analysis is critical to constructing injury prevention programs tailored to the age of highest risk. This allows pediatricians and other health care professionals to be anticipatory in providing injury prevention counseling. This concept is embodied in The Injury Prevention Program of the American Academy of Pediatrics.[19] As time constraints increase in the era of managed health care, it becomes particularly important to assist health care providers in targeting the most crucial age-related injury risks.

Age-specific data can be used to direct resources for prevention programs to those groups that are at highest risk. Adolescent rates of motor vehicle occupant injuries far exceed any other pediatric age group for both drivers and their adolescent passengers.[14] Graduated licensing laws are targeting the ages at highest risk for motor vehicle occupant injury. Similar attention is indicated with self-inflicted poisoning. The rate of self-inflicted poisoning begins to rise in early adolescence, documenting the need for early identification of those who are at risk. Initiating programs among middle school–aged children before the steep rise for self-inflicted poisonings would seem beneficial. Efforts to improve safety of elementary school playgrounds would be indicated on the basis of the steep rise of playground-related injuries at 6 years of age.

Limitations

E-coding of hospital discharge data has proved useful, although there are limitations. There may be insufficient data on the hospital record to assign an E-code, or the E-codes themselves may not be sufficiently discriminatory. For example, many of the falls fell into the subcategory "other," suggesting the need for more detailed charting on medical records and/or additional codes to capture more detail on types of falls. Although sports are known to be a common cause of injury in older children, it is difficult to determine the extent and types of sports injuries with E-codes.

Assignment of intentionality also may be an issue with nonfatal injury data. Hospital medical records may not include or have all available information on intent, thereby limiting the ability of coders to assign intent. In a study that compared E-code discharge data from hospitals to review of medical record documentation, Winn et al[20] determined that 25% of the injuries that resulted from violence might not be accounted for through use of E-codes. Thus, underreporting of child abuse from hospital discharge data should be considered.

Implications

This analysis of pediatric injuries by year of age describes the causes of trauma, the age of onset, the peak age of occurrence, and the ages at which the rates begin to decline. Risk factors by age can be identified, and appropriate interventions can be designed. These data can inform on the age at which to begin a specific injury intervention. These data also inform on how to allocate resources. Specific interventions and strategies can be evaluated in greater detail. Health professionals and, in particular, pediatricians provide injury prevention counseling. Given the time limitations of clinical interactions, the greatest impact can be achieved by making the counseling topic most age appropriate in anticipation of the high-risk period.

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Appendix. E codes for injury categories and subcategories.

Category	Subcategory	ICD9-CM E codes
Bites & stings	Dog bites	E906.0
	Other bites & stings	E905.0-905.6, 905.9, 906.1-906.5, 906.9
Burns	Fire/flame	E890.0-899, 958.1, 968.0, 988.1
	Hot object/ substance	E924.0-924.9, 958.2, 958.7, 961, 968.3, 988.2, 988.7
Child battering & neglect		E904.0, 967.0-967.9, 968.4
Cut/pierce	Unintentional	E920.0-920.9
	Self-inflicted	E956
	Assault	E966
	Undetermined & other	E974, 986
Falls	Stairs	E880.9
	Buildings	E882
	Playground equipment	E884.0
	Furniture	E884.2, 884.4, 884.5
	Other falls from heights	E880.0, 880.1, 881.0, 881.1, 883.0-883.9, 884.1, 884.3, 884.6, 884.9, 957.0-957.9, 968.1, 987.0-987.9
	Falls on the same level	E885, 886.0, 886.9
	Other & unspecified	E888
Firearms	Unintentional	E922.0-922.9
	Self-inflected	E955.0-955.4
	Assault	E965.0-965.4
	Other & undetermined	E970, 985.0-985.4
Foreign body, except respiratory and eye		E915
Overexertion		E927

Poisoning	Unintentional	E850.0-E869.9
	Self-inflected	E950.0-952.9
	Assault, undetermined, other	E962.0-962.9, 972, 980.0-982.9
Struck by, against	Unintentional, in sports	E917.0
	Unintentional, other	E916, 917.1-917.9
	Assault	E960.0, 968.2
	Other	E973, 975
Submersion/ drowning	Bathtub	E910.4
	Pool & spa	E910.8
	Other	E830.0-830.9, 832.0-832.9, 910.0-910.3, 910.9, 954, 964, 984
Suffocation/ choking	Choking—food	E911
	Choking —nonfood	E912
	Other suffocation & choking	E913.0-913.9, 953.0-953.9, 963, 983.0-983.9
Transportation	Motor vehicle occupant	E810-825 (.0,.1)
	Motorcyclist	E810-825 (.2,.3)
	Bicyclist	E810-825 (.6), 826.1
	Pedestrian	E810-825 (.7)
	Other and unspecified transportation	E800.0-807.9, 810-825 (.4,.5,.8,.9), 826.0, 826.2-826.9, 827.0-829.9, 831.0-831.9, 833.0-845.9, 958.5, 958.6, 968.5, 988.5, 988.6

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